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Stability and change in students' motivational profiles in mathematics classrooms: The role of perceived teaching

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HIGHLIGHTS

- We examined the stability and change in motivational profiles in mathematics.
- Latent profile analysis identified medium, low, high and mixed motivation profiles.
- Stability in profile membership from Grade 9 to 10 was typical for all profiles.
- Instructional clarity was related to changes in profile membership.

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ABSTRACT

Person-centered research has shown that individuals can be assigned to different motivational profiles, but only scattered studies have addressed motivational profiles in specific domains. We investigated the stability and change in motivational profiles in mathematics classrooms and examined how perceived teaching predicted changes in profile membership. Data for this study stemmed from the PISA-I Plus study ($N = 6020$). Latent profile analysis identified four motivational patterns: Medium, Low, High and Highly confident, hardly interested. Stability in profiles from grade 9 to 10 was typical. Instructional clarity and teaching for meaning predicted changes in profile membership.

1. Introduction

Recent research has shown that students can be assigned to different motivational profiles (e.g., Lazarides, Viljaranta, Aunola, Pesu, & Nurmi, 2016; Nurmi & Aunola, 2005; Viljaranta, Aunola, & Hirvonen, 2016) and those are malleable over time (e.g., Lazarides, Viljaranta, Aunola & Nurmi, 2018). Only scattered studies have addressed motivational profiles in specific domains and their changes across time (Alexander & Murphy, 1998; Bråten & Olaussen, 2005). Addressing such questions, however, is relevant for educational research and practice because a better understanding of the heterogeneity in student motivation and in motivational development might increase the quality of teaching: When teachers are informed about motivational patterns in class, they can address this heterogeneity by supporting their students based on students' specific needs.

It is further important to understand how student-perceived teaching is related to the changes in students' motivational patterns when aiming to better understand how students' perceptions of their learning environments can contribute to an adaptive motivational development in class. However, studies that focus on the relationship between student-perceived teaching practices and changes in student motivational profiles are largely missing. Such studies would be a first step to enable teachers to provide teaching methods that are perceived by students as supportive and that thus enhance an adaptive motivational development for all students.

This study addressed these research gaps by using a longitudinal person-centered research approach and investigated the stability and change in adolescent motivational profiles in mathematics

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classrooms and how changes in student motivational profiles were related to student-perceived teaching in mathematics.

The findings of this study will enable researchers and educational practioners to better understand (a) which different groups of students exist in relation to their interest, utility value and academic self-concept in mathematics and (b) whether student-perceived characteristics of teaching are important for students' changes across these profiles.

1.1. Motivational profiles

This study focuses on students' success expectancies and subjective task value, as these motivational constructs are generally considered as highly relevant for achievement-related behaviors (Eccles et al., 1983). Success expectancies are defined as an individual's ‘beliefs about how well [he or she] will do on an upcoming task’ (Wigfield & Eccles, 2002, p. 94) and can be conceptualized empirically in different ways. Common operationalizations are academic self-concept and self-efficacy (Wigfield & Eccles, 2002). In this study, we operationalized success expectancies as student academic self-concept. Academic self-concepts are subjective beliefs about one's abilities in specific academic domains (Marsh & Martin, 2011; Wigfield & Eccles, 2000).

Subjective task value, in turn, can be differentiated into four components: (a) the enjoyment the individual gains from doing a task (*intrinsic or interest value*); (b) the personal importance of a task (*attainment value*); (c) the fit of a task with the individual's future plans (*utility value*) and (d) the perceived cost of participating in a task (*cost value*).

Based on the Eccles's et al. model of achievement related choices (Eccles et al., 1983) this study used motivational variables to identify student profiles from the 9th to 10th grade. We examined mathematics-related intrinsic value and utility value, as well as the students' academic self-concept in mathematics as criterion variables of motivational profiles. We focused on intrinsic value and utility value as these constructs play an important role in student educational and occupational choices at the end of secondary school (Eccles, 2005). Moreover, we differentiate intrinsic value and interest as distinct intrinsic values, since intrinsic value refers only to the affective dimensions of learning, while interest also refers to cognitive aspects, such as value and knowledge (Renninger & Hidi, 2016).

Against the theoretical backdrop of the Eccles's expectancy-value model (Eccles et al., 1983), person-centered studies have already examined domain-specific motivational profiles of children (Viljaranta, Kiuru, et al., 2016) and adolescents (e.g., Lazarides, Rubach, & Ittel, 2016; Chow, Eccles, & Salmela-Aro, 2012; Chow & Salmela-Aro, 2014). These studies have shown profiles that differed in terms of the mean level of motivation (high/medium/low), while also showing profiles characterized by the co-existence of adaptive and maladaptive aspects of learning and motivation. In particular, studies suggest evidence for profiles with a high academic self-concept while also exhibiting low interest (Viljaranta, Aunola, et al., 2016; Viljaranta et al., 2017). Lazarides, Rubach et al. (2016) found another profile with students who focused only on the utility of mathematics (low intrinsic value, low academic self-concept, moderate utility value).

Studies that also focused on motivational constructs as criterion variables of the student profiles (Bråten & Olaussen, 2005; Linnenbrink-Garcia et al., 2018; Tuominen-Soini, 2012) or on both cognitive and motivational-affective characteristics to form student profiles (Alexander & Murphy, 1998; Jurik, Gröschner, & Seidel, 2014; Pintrich, Anderman, & Klobucar, 1994; Seidel, 2006), identified profiles characterized by differences in the levels of motivational and cognitive variables, as well as profiles with inconsistent levels of motivational and cognitive variables. Seidel (2006), for example, identified a profile of ‘uninterested’ students with low interest but with a high academic self-concept in physics. These students also showed a high general cognitive ability. Linnenbrink-Garcia et al. (2018) identified a profile of students with high interest and competence beliefs, but low performance goal orientation.

The special value of our study is to refer to the Eccles's et al. model of achievement-motivation (Eccles et al., 1983) using a person-centered research approach. Many previous studies within the Eccles' et al. theoretical framework have applied variable-centered research approaches (i.e., Eccles, Wigfield, Harold, & Blumenfeld, 1993; Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Wigfield & Eccles, 1994). However, variable-centered studies do not allow considering different configurations of relations between variables – for example, academic self-concept and interest are closely related in variable-centered studies (Bong, 2004; Lauermann, Tsai, & Eccles, 2017). The few existing person-centered studies based on Eccles's et al. model of achievement-motivation (Eccles et al., 1983) suggest that this is not the case for all students. Viljaranta et al. (2017), for example, identified a subtype of elementary students with ‘low skills, negative self-concept but high interest’ and a subtype of students with ‘high skills but low interest’. Patrick, Mantzicopoulos, Samarapungavan, and French (2008) identified a ‘low competence but high liking’ profile among kindergarteners in science. Our study addressed such intraindividual heterogeneity in the relations among task values and academic self-concept in an adolescent sample and examined the role of student-perceived teaching in the stability and changes of motivational profiles.

1.2. Stability and change of motivational profiles

Domain specific longitudinal person-centered studies focusing on motivation have mainly examined college students (Alexander & Murphy, 1998; Bråten & Olaussen, 2005). Studies that analyse the stability and change of motivational profiles of adolescents have not focused on one specific domain (Hayenga & Corpus, 2010; Tuominen-Soini, Salmela-Aro, & Niemivirta, 2012), illustrating the need to investigate which domain-specific motivational profiles exist in adolescence and how they evolve. This would allow for greater effectiveness in supporting students based on their individual patterns of motivation.

Existing findings indicate that learners' motivational profiles remain relatively stable in adolescence and early adulthood (e.g., Alexander & Murphy, 1998; Lazarides, Viljaranta et al., 2016). Low motivation profiles seem to be particularly stable (Hayenga & Corpus, 2010), while high motivation profiles were described as less stable (Alexander & Murphy, 1998; Hayenga & Corpus, 2010). Students in high motivation profiles, however, were unlikely to change to low motivation profiles (Alexander & Murphy, 1998; Bråten & Olaussen, 2005), but were likely to change to moderate motivation profiles (Bråten & Olaussen, 2005) or to motivational profiles characterized by both adaptive and maladaptive aspects (Alexander & Murphy, 1998). The changes in student motivational profile membership thus might be related to their initial strengths and weaknesses.

1.3. Perceived teaching and student motivation in mathematics

According to Eccles's socialization model (Eccles & Jacobs, 1986), adolescents' perceptions of socializers' beliefs and behaviors influenced their success expectancies and values. We apply this theoretical model to the classroom context and examine how student-perceived teaching predicts the change in student motivational profiles. Regarding perceived teaching, we focus on four components of effective teaching (Brophy, 2000; Walberg & Paik, 2000). These components are teacher enthusiasm, teaching for meaning, instructional clarity and teacher support. components are indicators of instructional quality (Praetorius et al., 2017; Stipek, Givvin, Salmon, & MacGyvers, 2001) and are related to mathematics motivation (e.g., Ahmed, Minnaert, van der Werf, & Kuyper, 2010; Kunter et al., 2013; Wang, 2012).

Teacher enthusiasm, defined as the "degree of intrinsic value, excitement and pleasure that teachers typically experience in their professional activities" (Kunter 2008, p. 470), relates positively to student intrinsic value (Becker, Goetz, Morger, & Ranellucci, 2014; Frenzel, Pekrun, & Goetz, 2007; Kunter et al., 2013), and interest in mathematics (Keller, Goetz, Becker, Morger, & Hensley, 2014).

Teaching for meaning is the introduction of new concepts in reference to students' everyday-experiences (Brophy, 2000). As a component of cognitive activation in class, it enables students to build connections between new learning content and previous knowledge (Hugener et al., 2009). Student-perceived teaching for meaning has been shown to predict student mathematics self-concept and task values (Wang, 2012).

Instructional clarity refers to the teacher's ability to explain content clearly to the students (Stronge, Ward, & Grant, 2011). As a central component of structuredness in classrooms (Lipowsky, 2015), it enhances persistence in learning (Pascarella, Seifert, & Whitt, 2008), self-efficacy and interest (Maulana, Opdenakker, & Bosker, 2016; Schiefele, 2017).

Finally, *teacher support* refers to constructive teacher feedback, supportive teaching behaviors or teachers' constructive error management (Fauth, Decristan, Rieser, Klieme, & Büttner, 2014). Student-perceived teacher support relates positively to the development of intrinsic motivation, effort and interest (Dietrich, Dicke, Kracke, Noack, 2015; Wentzel, Battle, Russell, & Looney, 2010).

1.4. Validating profiles of mathematics motivation

A pivotal aspect of studies aiming to classify students into profiles is the validation of such profiles with external criteria. In this study, we select gender, mathematics achievement, effort in mathematics, and mathematics anxiety as validation criteria.

Gender is one antecedent of motivation, especially in math and science (Eccles et al., 1983). The gender of a child predicts his or her academic self-concept in mathematics through the ability perceptions of the parents (Jacobs, 1991), while interest value and utility value in math show girls reporting lower interest value and utility value than boys (Gaspard et al., 2015). Person-centered research shows that boys are overrepresented in high-math-and-science motivational profiles, while girls dominate low-math-and-science profiles (Chow & Salmela-Aro, 2011).

Task values and academic self-concept are assumed to predict student achievement and achievement-related behaviors, such as effort (Eccles, 2005). Accordingly, students in low motivation profiles report lower mathematics achievement (Lazarides, Rubach et al., 2016) and show lower levels of effort (Kusurkar, Croiset, Galindo-Garré, & Ten Cate, 2013) than students in profiles characterized by high levels of motivation. On a variable-centered level, effort is strongly correlated with student competence beliefs (Dietrich, Viljaranta, Moeller, & Kracke, 2017).

Finally, Pekrun's control-value theory of achievement emotions (Pekrun, 2006), describes subjective control over achievement outcomes and subjective values of achievement activities as proximal determinants of achievement emotions, such as anxiety. In this vein, previous research found that low motivation profiles were associated with high levels of anxiety (Yli-Piipari, Watt, Jaakkola, Liukkonen, & Nurmi, 2009). In line with the theoretical assumptions of the control-value theory of achievement emotions (Pekrun, 2006), student task-related interest and competence beliefs are to be closely related to student anxiety in class (Meece, Wigfield, & Eccles, 1990).

2. The present study

This longitudinal study contributes to previous research in several ways. First, we identify student profiles of motivation in mathematics (based on students' academic self-concept, intrinsic value, interest, and utility value in mathematics) and examine profile stability and change from grade 9 to 10. Second, we investigate how different facets of student-perceived teaching in mathematics classes (teachers' enthusiasm, teaching for meaning, instructional clarity, teacher support) relate to changes in motivational profiles. We tested the following hypotheses:

(1) We expected that the identified motivational profiles would reflect level-differences in student motivation (high, medium, low). We also expected to find profiles of students with adaptive and maladaptive aspects of motivation (e.g., high interest but low confidence, highly confident, hardly interested, or utility-focused).
(2) Concerning the validation of these profiles, we expected that boys would be overrepresented in the high-motivation profile, while girls would be overrepresented in the low-motivation profile. Furthermore, we expected that the high-motivation profile would be highest in achievement and effort, and lowest in anxiety, while the low-motivation profile would be highest in anxiety and lowest in achievement and effort. Profiles with inconsistent levels of motivational variables (e.g., profile of 'uninterested' students with low interest but with a high academic self-concept in mathematics) were expected to be associated with high (low) levels of anxiety in particular for profiles characterized by low (high) academic self-concept in mathematics, and with high (low) levels of effort for high (low) task value in mathematics.
(3) On the developmental dimension, we expected the motivational profiles to be rather stable from grade 9 to 10. Thereby we expected that the low motivation profile would be particularly stable (Hayenga & Corpus, 2010), while the high motivation profile would be less stable (Alexander & Murphy, 1998; Bråten & Olaussen, 2005). We explored the development of profiles with intraindividual differing levels of motivation characterized by both adaptive and maladaptive aspects.
(4) Finally, concerning perceived teaching, we anticipated that higher levels of teachers' enthusiasm, teaching for meaning, instructional clarity, and teacher support in grade 9 would be associated with a higher likelihood for adaptive changes and a lower likelihood of maladaptive changes in motivational profile membership from grade 9 to 10.

3. Method

3.1. Sample

The data for this study stemmed from the German extension of the Programme for International Student Assessment (PISA), namely from the PISA-I Plus study in 2003 (Prenzel, Baumert, et al., 2006; Prenzel et al., 2013). PISA provides evidence regarding the competencies of students in mathematics, reading and science (OECD, 2005). The PISA 2003 focused on mathematics. In 2003, Germany opted for an additional grade-based sampling (random

Table 1
Descriptives of the study variables in Grade 9 (data for Grade 10 in parentheses).

Variable	*M*	*SD*	*Range*	ICC_1	ICC_2	*N*
Self-concept	2.52 (2.52)	0.82 (0.86)	1–4	.02 (.03)	.35 (.38)	4543 (4326)
Interest	2.21 (2.24)	0.77 (0.79)	1–4	.09 (.04)	.68 (.45)	2010 (4329)
Intrinsic value	2.17 (2.13)	0.77 (0.76)	1–4	.07 (.05)	.62 (.52)	4499 (4333)
Utility value	2.78 (2.78)	0.71 (0.70)	1–4	.05 (.06)	.54 (.56)	4547 (4328)
Achievement	538.57 (563.48)	74.44 (73.29)		.52 (.45)	–	4612 (4612)
Effort	3.23 (3.24)	0.61 (0.63)	1–4	.02 (.01)	.25 (.21)	2012 (1927)
Anxiety	2.20 (2.19)	0.81 (0.81)	1–4	.01 (.01)	.19 (.12)	4499 (4332)
Enthusiasm	3.13	0.80	1–4	.17	.81	2475
Meaning	2.40	0.80	1–4	.25	.88	2472
Clarity	2.58	0.88	1–4	.35	.92	2473
Support	2.71	0.56	1–4	.21	.85	4543

Note. Missingness by design is responsible for the varying amounts of N. Meaning = teaching for meaning; Clarity = instructional clarity.

sampling of two entire grade 9 classes per school). These classes were assessed once more one year later in a national study when the students were in grade 10. In the German school system, students are allocated in different school tracks after elementary school based on their school achievement. At the Gymnasium (college-bound track) students mostly enter college after the final examination in grade 12 or 13. At the Realschule (middle track) students mostly enter vocational training after the final examination in grade 10. In this study, data was assessed from those tracks in spring of grades 9 (Time 1) and 10 (Time 2). We used data from those students who participated at both time points (N = 6020 adolescents).[1] Of the 6020 students, we used a subsample of 4612 students (55.6% girls) from 152 schools who participated in both time points *and* who did not experience a change of mathematics teacher. The largest group of students (90.7%) reported that they were born in Germany. The other groups reported that they were born in Russia (or countries of the former Soviet Union) (3.7%), Poland (1.3%), Bosnia and Herzegovina (0.2%), Turkey (0.2%), Greece (0.1%), Italy (0.1%), other country (1.0%) and 2.7% missing. The highest educational degree attained by the parents of almost half of the students (40.9%) was a high-school diploma ("A-levels"; in German: Abitur) or university of applied sciences entrance qualification ('Fachhochschulreife'). The parents of 24.9% of the students reported that their highest degree was a middle school degree (in German: 'Realschule'). The parents of 14.3% of the students reported that a degree from vocational school was their highest educational degree. The parents of 10.3% of the students reported that a degree from compulsory basic secondary schooling (in German: 'Hauptschule') was their highest educational degree. The remaining 9.6% were students whose parents reported to have another school degree (2.5%), to have no school degree (0.6%) or to have a degree from a polytechnic institute/extended secondary school (0.4%), and 6.1% were missing data.

3.2. Measures

We based our latent profile analyses on motivational constructs assessed in grades 9 and 10, and measured validation variables in both grades. Teacher beliefs and behaviors were assessed via student ratings in grade 9. Means and standard deviations of the variables that were included in the analyses are reported in Table 1. The response categories for the motivational constructs and for most scales that assessed perceived teaching ranged from 1 (*strongly disagree*) to 4 (*strongly agree*). The response format of student-perceived teacher support differed with response categories ranging from 1 (*every lesson*) to 4 (*never or hardly ever*).

3.2.1. Motivational constructs

Mathematics self-concept was assessed with a five-item scale. Example items were "I learn Mathematics quickly" and "I get good grades in mathematics" Reliabilities were α = 0.91 (grade 9) and α = 0.93 (grade 10).

Mathematics interest was assessed with a five-item scale. Example items were "I am interested in the things I learn in Mathematics" and "Mathematics is personally important to me". Reliabilities were α = 0.87 (grade 9) and α = 0.89 (grade 10).

Mathematics intrinsic value was assessed with a six-item scale. Example items were "I look forward to my mathematics lessons" and "Mathematics is fun for me". Reliabilities were α = 0.91 (grade 9) and α = 0.91 (grade 10).

Mathematics utility value was assessed with a four-item scale. Example items were "I will learn many things in Mathematics that will help me get a job" and "Mathematics is an important school subject for me because I need it for my future studies". Reliabilities were α = .82 (grade 9) and α = 0.83 (grade 10).

3.2.2. Validation variables

Student *achievement in mathematics* was measured using the PISA 2003 mathematics test. The test measured "the capacities of students to analyse, reason, and communicate ideas effectively as they pose, formulate, solve, and interpret mathematical problems in a variety of situations" (OECD, 2003, p. 20). The estimates of achievement are plausible values based on item response models. The mean of the scale across OECD countries was 500 points (SD = 100). In our sample, the mean was M = 538.57 (SD = 74.44).

Mathematics effort was assessed with a four-item scale. Example items were "In mathematics, I try to understand everything as well as possible" and "In mathematics, I try to do everything as well as possible". Reliabilities were α = 0.78 (grade 9) and α = 0.79 (grade 10).

Mathematics anxiety was assessed with a seven-item scale. Example items were "I am very nervous before mathematics tests" and "In mathematics, I am often worried that I understand less than all others". Reliabilities were α = 0.89 (grade 9) and α = 0.90 (grade 10).

3.2.3. Perceived teaching

All scales measuring perceived teaching in mathematics classes were assessed via student ratings.

Teachers' enthusiasm was assessed with a three-item scale. Example items were "Our mathematics teacher seems to enjoy teaching very much" and "Our mathematics teacher is enthusiastic about mathematics as subject". Reliability was α = 0.83 (grade 9).

Teaching for meaning was assessed with a three-item scale.

[1] For a more detailed description of the sample see also Prenzel, Carstensen, Schöps, and Maurischat (2006).

Example items were "To explain mathematics topics, our mathematics teacher often uses an example from everyday life" and "When learning something new in mathematics, we often start with our own experiences and examples from everyday life". Reliability was $\alpha = 0.77$ (grade 9).

Instructional clarity was assessed with a three-item scale. Example items were "Our mathematics teacher always explains things in an understandable manner" and "Our mathematics teacher explains the usefulness of mathematics using examples from everyday life". Reliability was $\alpha = 0.89$ (grade 9).

Teacher support was assessed with a five-item scale. The anchor phrase was "How often does the following situation occur in your mathematics class …". Example items were "The teacher shows an interest in every student's learning" and "Our teacher explains content until we understand". Reliability was $\alpha = 0.78$ (grade 9).

3.2.4. Control variable

Student *socio-economic status* was measured using the index for economic, social and cultural status (ESCS). The ESCS index for PISA 2003 was derived from the highest level of parental education, highest parental occupation and number of home possessions (OECD, 2005). Example categories for home possessions include desk, computer, own room, study place, textbooks or dictionary, see OECD (2005) for more information. Sample mean for ESCS within our sample was $M = 0.49$ ($SD = 0.84$).

3.3. Analysis strategy

First, we tested measurement invariance across time (across grade 9 and 10) for the motivational variables. In line with Byrne (1989), we tested whether the factor structure (configural invariance), the factor loadings (metric invariance), and the intercepts remained the same across the two time points (scalar invariance). Partial metric invariance across time was established, which indicates that the motivational variables reflected the same constructs at each measurement occasion. Further information is provided in Appendix A in the online supplement.

Subsequently, we applied a person-centered analysis approach that allows for the heterogeneity of the student population by classifying students into homogenous groups with similar patterns of variables (Bergman, Magnusson, & El Khouri, 2003). We identified similar patterns of variables in grades 9 and 10 using the I-states-as-objects analysis procedure (ISOA; Bergman & El-Khouri, 1999), which allows for studying developmental stability and change in patterns of variable values (Bergman, Nurmi, & von Eye, 2012). When using ISOA, we applied a correlated latent profile analysis assuming that criterion variables are intercorrelated. This applies especially to interest and academic self-concept (Köller, Trautwein, Lüdtke, & Baumert, 2006) and interest and intrinsic value (Renninger & Hidi, 2016). We evaluated the appropriate number of latent classes based on the Bayesian information criterion (BIC: lowest; Schwarz, 1978), the entropy value (>0.80) (Rost, 2006), and the adjusted Lo-Mendell-Rubin Likelihood Ratio Test. Theoretical interpretation and the number of cases per profile were also used as criteria for model selection (Berlin, Williams, & Parra, 2014). To validate the latent profiles, we computed a multivariate analyses of variance (MANOVA) with students' most likely latent profile membership as independent and mathematics anxiety and effort as dependent variables. Student gender ratio within the latent profiles was assessed using cross-tabulation with χ^2-Test.

To examine stability and change in the profile membership from grades 9 to 10, we conducted a Configural Frequency Analysis (ConFa; Bergman et al., 2012), based on a cross-tabulation of categories over the two measurement points. Going beyond an overall χ^2-Test, ConFA provides a test for each cell indicating whether this cell contains more (called type) or fewer cases than expected by chance (antitype). We performed ConFA with the 'confreq' package in R (Heine & Alexandrowicz, 2015), using the z-Test with Bonferroni correction for the cell-specific significance tests.

Subsequently, dummy variables with stability being coded as '0' and change being coded as '1' were computed that reflected student changes across profiles from grades 9 to 10. We then conducted binary logistic regression analyses to investigate the relations between student-perceived teachers' beliefs and behaviors in grade 9, as well as the change in student motivational profile membership from grades 9 to 10 when controlling for student gender, achievement level and socio-economic status. In latent profile analyses and logistic regression analyses, missing data were addressed using full-information maximum likelihood (FIML) estimation which is a theory-based maximum likelihood (ML) approach for treating missing data (Enders & Bandalos, 2001). Latent profile analyses and logistic regression analyses were conducted in Mplus (Muthén & Muthén, 1998-2015). We used the TYPE = COMPLEX function that allows to correct standard errors and χ^2 values when analyzing data nested in clusters. In our study, students were nested in classrooms (N = 217 classrooms; average classroom size of 21.8 students per classroom). Intraclass correlations (ICCs, see Table 1) showed that only between 2 and 8% of the variance in motivational variables were due to sharing the same classroom, while for perceived teaching the amount was between 18 and 35% (Table 1; ICC_1). The reliability of the class-mean ratings (ICC_2) was low as values ranged between 0.35 and 0.66 for the motivational variables (Lüdtke, Robitzsch, Trautwein, & Kunter, 2009). Given the relatively low ICCs in motivation, we limited our interpretations to the student level and only corrected the standard errors for the nested data structure.

4. Results

4.1. Motivational profiles

After conducting a series of correlated latent profile analyses (extracting one to eight latent classes), we selected the four-class solution as the final solution. We selected this solution based on theoretical criteria as it was not possible to clearly identify a preferable solution by statistical criteria, the reason being a strong inconsistency in model fit indices[2] (see Table 2). We decided to focus on solutions which were characterized by profiles with level differences in the motivational variables, but also by a profile of mixed motivation (solutions with three classes upwards). This 'mixed profile' was characterized by intraindividual different configurations of motivational variables. Such 'mixed' profiles allowed for an examination of intraindividual mixed patterns of motivation, which is a primary goal of this study. The 'mixed' profile was characterized by high mathematics self-concept, low interest and intrinsic value, and medium utility value, and was labeled highly confident, hardly interested profile. This profile corresponded to findings of previous research (Seidel, 2006; Viljaranta, Kiuru, et al., 2016).

We then compared the three and four class solution, because the profile solutions with more than four classes showed only a splitting-off of motivation in a wide range of level differences. Here, the special value of person-centered research allowed us to examine the emergence and antecedents of intraindividual different patterns of motivation. Thus, we decided not to focus on

[2] BIC value consistently declined; adjusted LMR LR Test showed a significantly better fit of the six-class solution in comparison to the seven-class solution; entropy score showed a good fit to the five-class solution.

Table 2
Model fit criteria of the one to eight class solutions in latent profile analysis (N of I-states = 8894).

	1	2	3	4	5	6	7	8
BIC	59316.36	58826.16	58413.31	58197.64	57962.74	57824.01	57730.55	57642.42
Entropy		0.606	0.635	0.714	0.804	0.772	0.762	0.755
LMR		535.66	458.32	261.14	280.37	211.34	108.87	61.82
*p*LMR		0	0.0002	0.0015	0.0016	0.0208	0.6632	0.3425

Note. BIC, Bayesian Information Criterion. LMR: Lo-Mendell-Rubin adjusted likelihood ratio test.

profile solutions that were mostly characterized by level differences (five-profile solution onwards) that could also be investigated by means of variable-centered research.

Compared to the three-class solution, the four-class solution additionally included a medium profile that resembled the profile that was characterized by high academic self-concept in mathematics/low interest in mathematics in its levels of interest, intrinsic value, and utility values. The medium profile was also characterized by lower levels of mathematics self-concept than the highly confident, hardly interested profile.

We selected the four-profile solution as the final solution because the 'medium motivation' profile is important: It reflects the student population in which not all students are either highly or little motivated (Linnenbrink-Garcia et al., 2018; Viljaranta et al., 2017). The latent profiles of the four-class solution are displayed in Fig. 1.

In the four-class solution, most of the students (grade 9: 41.5%; grade 10: 37.5%) displayed a *medium motivation profile* characterized by medium levels of mathematics self-concept, interest, intrinsic value, and utility values. Almost one third of the students (grade 9: 33.2%; grade 10: 32.5%) displayed a *low motivation profile* that was characterized by low levels of mathematics self-concept, interest, intrinsic value, and utility values. Every fifth student (grade 9: 20.1%; grade 10: 20.0%) displayed a *high motivation profile* characterized by high mathematics self-concept, interest, intrinsic value, and utility values. The smallest motivational profile was characterized by high mathematics self-concept and moderate levels of utility value, but low levels of mathematics interest and intrinsic value (*highly confident, hardly interested profile*; grade 9: 4.5%; grade 10: 4.5%).

The profiles differed statistically significantly in the criterion variables, $F\,(12, 16701) = 1905.99$, $p < .001$; Wilk's $\Lambda = 0.10$; partial $\eta^2 = 0.53$ (see Appendix B).

4.2. Validation of profiles

The motivational profiles in grade 9 differed significantly in mathematics anxiety, academic effort in mathematics and mathematics achievement in grade 10 when including gender, anxiety, effort and achievement in grade 9 as covariates, $F\,(9, 4563) = 9.27$, $p < .001$; Wilk's $\Lambda = 0.02$.

Students in the highly confident, hardly interested profile reported significantly lower anxiety than students in the medium and low motivation profile, significantly lower effort than students in the high motivation profile, but significantly higher effort than students in the low motivation profile. They also had significantly higher mathematics achievement than students in the medium and low motivation profiles (see Appendix C).

Examination of the gender distribution [$\chi^2(6, N = 4560) = 228.76$, $p < .001$)] for profile membership in grade 9 showed that boys were statistically significantly more often than expected by chance in the high motivation profile (adjusted residuals = 6.1; observed: $n = 523$, 56.7%; expected: $n = 400$) and in the highly confident, hardly interested profile (adjusted residuals = 4.3, observed: $n = 131$, 63.0%; expected: $n = 214$). Boys were statistically significantly less often than expected by chance in the low motivation profile (adjusted residuals = −8.0, observed: $n = 456$, 29.9%; expected: $n = 661$). Girls were statistically significantly more often than expected by chance in the low motivation profile (adjusted residuals = 7.1; $n = 1055$, observed: 69.2%; expected n = 847). Girls were statistically significantly less often than expected by chance in the high motivation profile (adjusted residuals = −5.4; $n = 390$, observed: 42.3%; expected n = 513) and in the highly confident, hardly interested profile (adjusted residuals = −4.2; $n = 71$, observed: 69.2%; expected n = 116). Similar results applied to the gender distribution in profiles in grade 10.

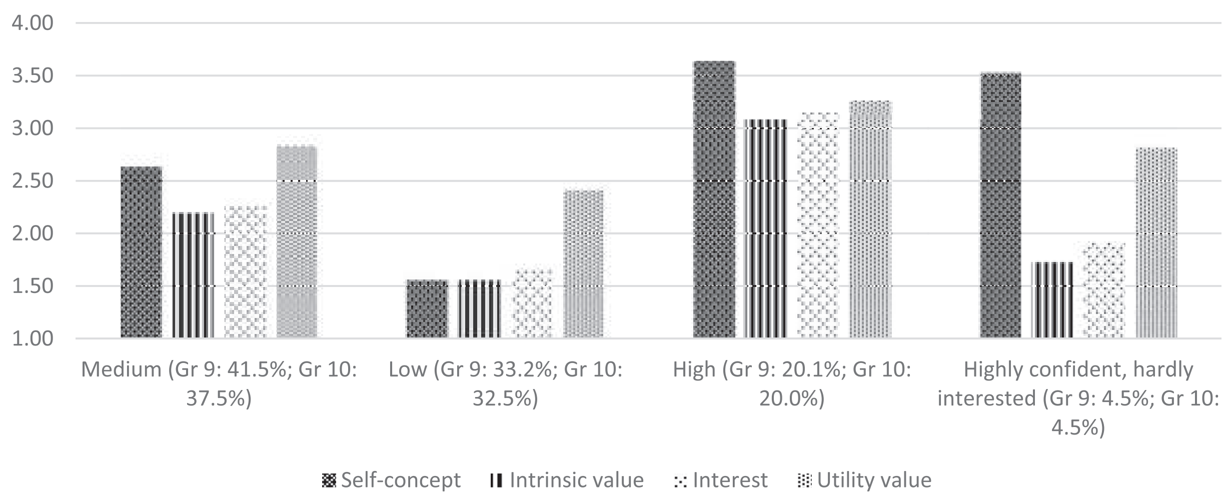

Fig. 1. Mean levels of mathematics self-concept, intrinsic value, interest and utility value in the latent profiles (I-states: N = 8894).

4.3. Stability and change in profile membership

Table 3 showed the results of a ConFA. It was untypical (less likely than expected by chance) for students in the medium motivation profile or those in the low motivation profile to move to the other profiles one year later. Moreover, for students in the high motivation profile in grade 9 it was untypical to move to the low motivation or medium motivation profile, but typical (more likely than expected by chance) to move to the highly confident, hardly interested profile in grade 10. It was also untypical for students in the highly confident, hardly interested profile in grade 9 to move to the low motivation profile. In general, the profile membership from grade 9 to 10 was rather stable.

4.4. Perceived teaching and change in profile membership

We examined the effects of student-perceived mathematics teacher beliefs and behaviors in grade 9 on the stability and change of profile membership when controlling for student gender, mathematics achievement and socio-economic status using logistic regression analyses. First, we calculated the mean values and standard deviations of the teaching variables for each latent profile (see Appendix D). We further analyzed how perceived teaching in grade 9 was related to student profile membership in grade 9 and in grade 10 (see Appendix E). Finally, we conducted the logistic regression analyses as reported in Tables 4 and 5 for those changes that pertained to more than 1% (n = 46) of the sample. Significant findings regarding student-perceived teacher beliefs and behaviors are reported in the text. The non-significant coefficients and the coefficients of individual variables are not reported in the text, but in the tables.

Below we first present the findings reflecting adaptive changes in motivational profiles from lower to higher levels of motivation. Results are reported in Table 4. Following that we report findings reflecting maladaptive profile changes. Results are reported in Table 5. However, not all profile changes can clearly be labeled as adaptive or maladaptive. This regards the changes from the highly confident, hardly interested profile to other profiles and vice versa: Students with a highly confident, hardly interested profile showed high achievement and low anxiety like students with a high motivation profile, but their effort was similar to students with a medium motivation profile (see Appendix C). We therefore report all findings involving the highly confident, hardly interested profile in the end of this section. Results are reported in Table 6.

Table 4
Unstandardized regression coefficients predicting changes to more adaptive profiles from grade 9 to 10.

Variable	Low → Medium *n* = *341*				Medium → High *n* = *250*			
	B	*SE*	*OR*	*p*	*B*	*SE*	*OR*	*p*
Boys	**0.22**	**0.09**	**1.25**	**.009**	**0.16**	**0.08**	**1.70**	**.041**
Achieve	**0.01**	**0.01**	**1.00**	**< .001**	**0.01**	**0.01**	**1.00**	**.005**
ESCS	0.01	0.08	1.01	.910	−0.05	0.10	0.95	.599
Enth	−0.22	0.16	0.80	.058	0.22	0.19	1.25	.241
Meaning	**0.30**	**0.13**	**1.35**	**.025**	0.15	0.14	1.16	.291
Clarity	**0.32**	**0.12**	**1.37**	**.006**	−0.06	0.15	0.94	.664
Support	−0.08	0.13	0.93	.554	**0.32**	**0.15**	**1.37**	**.036**

Note. *N* = 4251. Achieve = Standardized test result; ESCS = economic, social and cultural status, Enth = Teacher enthusiasm; Meaning = teaching for meaning, Clarity = instructional clarity; High = High motivation profile; Low = Low motivation profile; Medium = Medium motivation profile.

Table 5
Unstandardized regression coefficients predicting change to more maladaptive profiles from grade 9 to 10.

Variable	Medium → Low *n* = *390*				High → Medium *n* = *799*			
	B	*SE*	*OR*	*p*	*B*	*SE*	*OR*	*p*
Boys	−0.04	0.09	0.96	.632	0.10	0.09	1.11	.292
Achieve	**−0.01**	**0.01**	**0.99**	**< .001**	**−0.01**	**0.01**	**0.99**	**.005**
ESCS	0.05	0.08	1.05	.500	0.09	0.10	1.05	.371
Enth	0.18	0.14	1.20	.187	0.17	0.22	1.18	.446
Meaning	−0.02	0.13	0.98	.852	0.02	0.16	1.02	.883
Clarity	**−0.37**	**0.13**	**0.69**	**.006**	**−0.35**	**0.17**	**0.70**	**.038**
Support	−0.10	0.15	0.90	.472	−0.01	0.18	0.99	.952

Note. *N* = 4251. Achieve = Standardized test result; ESCS = economic, social and cultural status, Enth = Teacher enthusiasm; Meaning = teaching for meaning, Clarity = instructional clarity; High = High motivation profile; Low = Low motivation profile; Medium = Medium motivation profile.

4.4.1. Changes to more adaptive motivation profiles

Change from low motivation to medium motivation profile (n = 341). Students in the low motivation profile in grade 9 who perceived high levels of teaching for meaning in mathematics ($B = 0.30$, $SE = 0.13$, $p = .03$, $OR = 1.35$) or those who perceived high levels of instructional clarity ($B = 0.32$, $SE = 0.12$, $p = .01$, $OR = 1.37$) were more likely to change to the medium motivation profile in grade 10 than to stay in the low motivation profile. Furthermore, students in the low motivation profile with high mathematics achievement were significantly more likely to change to the medium motivation profile instead of staying in the low motivation profile in grade 10 ($B = 0.01$, $SE = 0.01$, $p < .001$, $OR = 1.00$).

Table 3
Transition probabilities for motivational profiles from Grade 9 to 10 (cross tabulation of most likely latent profile memberships) and configural frequency analysis results.

Profile Grade 9	Profile Grade 10	*N* (observed)	% of Profile Grade 9	*N* (expected)	*z*	*p*	Type/Antitype
Medium	Medium	1093	60.9	711.49	14.30	<.001	T
	Low	390	21.7	617.24	−9.15	<.001	A
	High	250	13.9	379.94	−6.67	<.001	A
	Highly confident, hardly interested	62	3.5	86.33	−2.62	.004	A
Low	Medium	341	23.9	566.42	−9.47	<.001	A
	Low	1056	73.9	491.38	25.47	<.001	T
	High	19	1.3	302.47	−16.30	<.001	A
	Highly confident, hardly interested	13	0.9	68.73	−6.72	<.001	A
High	Medium	205	23.2	349.60	−7.73	<.001	A
	Low	23	2.6	303.29	−16.10	<.001	A
	High	594	67.3	186.69	29.81	<.001	T
	Highly confident, hardly interested	60	6.8	42.42	2.70	.003	T
Highly confident, hardly interested	Medium	67	33.8	78.48	−1.30	.097	
	Low	11	5.6	68.08	−6.92	<.001	A
	High	48	24.2	41.91	0.94	.173	
	Highly confident, hardly interested	72	36.4	9.53	20.25	<.001	T

Note. χ^2 (9, $N = 4304$) = 3063.97, $p < .001$. Bonferroni corrected alpha = .003.

Table 6
Unstandardized regression coefficients predicting changes involving the highly confident, hardly interested profile.

Variable	Medium → Highly confident, hardly interested *n* = *62*				High → Highly confident, hardly interested *n* = *60*			
	B	*SE*	*OR*	*p*	*B*	*SE*	*OR*	*p*
Boys	**0.23**	**0.10**	**1.26**	**.022**	−0.15	0.14	0.86	.294
Achieve	**0.01**	**0.01**	**1.01**	**.002**	0.01	0.01	1.01	.078
ESCS	0.05	0.16	1.05	.746	−0.18	0.17	0.84	.287
Enth	**−0.87**	**0.28**	**0.42**	**.002**	0.19	0.38	1.20	.627
Meaning	0.05	0.26	1.05	.862	−0.07	0.27	0.50	.778
Clarity	0.09	0.30	1.21	.753	**−0.70**	**0.27**	**0.50**	**.011**
Support	0.21	0.32	1.24	.504	−0.52	0.30	0.60	.080

Note. $N = 4251$. Achieve = Standardized test result; ESCS = economic, social and cultural status, Enth = Teacher enthusiasm; Meaning = teaching for meaning, Clarity = instructional clarity; High = High motivation profile; Low = Low motivation profile; Medium = Medium motivation profile.

Compared to girls, boys who were in the low motivation profile in grade 9 were more likely than expected by chance to change to the medium motivation profile instead of staying in the low motivation profile in grade 10 ($B = 0.22$, $SE = 0.09$, $p = .009$, $OR = 1.25$).

Change from medium motivation to high motivation profile (n = 250). Students in the medium motivation profile in grade 9 who perceived high levels of mathematics teacher support were more likely to change to the high motivation profile instead of staying in the medium motivation profile in grade 10 ($B = 0.32$, $SE = 0.15$, $p = .01$, $OR = 1.37$). Students in the medium motivation profile with high mathematics achievement were more likely to change to the high motivation profile instead of staying in the medium motivation profile in grade 10 ($B = 0.01$, $SE = 0.01$, $p < .001$, $OR = 1.00$). Compared to girls, boys who were in the medium motivation profile in grade 9 were more likely than expected by chance to change to the high motivation profile instead of staying in the medium motivation profile in grade 10 ($B = 0.16$, $SE = 0.08$, $p = .041$, $OR = 1.70$).

4.4.2. Changes to more maladaptive motivation profiles

Medium motivation to low motivation profile (n = 390). Students in the medium motivation profile in grade 9 who perceived high levels of instructional clarity in mathematics were less likely to change to the low motivation profile instead of staying in the medium motivation profile in grade 10 ($B = -0.37$, $SE = 0.13$, $p = .01$, $OR = 0.69$). Furthermore, students in the medium motivation profile with high mathematics achievement were less likely to change to the low motivation profile instead of staying in the medium motivation profile in grade 10 ($B = -0.01$, $SE = 0.01$, $p < .001$, $OR = 0.99$).

Change from high motivation to medium motivation profile (n = 205). Students in the high motivation profile in grade 9 who perceived high levels of instructional clarity in mathematics were less likely to change to the medium motivation profile instead of staying in the high motivation profile in grade 10 ($B = -0.35$, $SE = 0.17$, $p < .01$, $OR = 0.70$). Students in the high motivation profile with high mathematics achievement were less likely to change to the medium motivation profile instead of staying in the high motivation profile in grade 10 ($B = -0.01$, $SE = 0.01$, $p < .005$, $OR = 0.99$).

4.4.3. Changes involving the highly confident, hardly interested profile

Change from medium motivation to highly confident, hardly interested profile (n = 62). Students in the medium motivation profile in grade 9 who perceived high levels of mathematics teacher enthusiasm were less likely to change to the highly confident, hardly interested profile instead of staying in the medium motivation profile in grade 10 ($B = -0.87$, $SE = 0.28$, $p = .01$, $OR = 0.42$). Students in the medium motivation profile with high mathematics achievement were more likely to change to the highly confident, hardly interested profile instead of staying in the medium motivation profile in grade 10 ($B = 0.01$, $SE = 0.01$, $p < .001$, $OR = 1.01$). Compared to girls, boys who were in the medium motivation profile in grade 9 were more likely than expected by chance to change to the highly confident, hardly interested profile instead of staying in the medium motivation profile in grade 10 ($B = 0.23$, $SE = 0.10$, $p = .041$, $OR = 1.26$).

Change from high motivation to highly confident, hardly interested profile (n = 60). Students in the high motivation profile in grade 9 who perceived high levels of instructional clarity in mathematics were less likely to change to the highly confident, hardly interested profile instead of staying in the high motivation profile in grade 10 ($B = -0.70$, $SE = 0.27$, $p = .01$, $OR = 0.50$).

5. Discussion

This study identified adolescents' motivational profiles in mathematics and investigated their stability and change from grade 9 to 10. Our person-centered longitudinal study contributes to current research by extending knowledge regarding the stability and change of motivational profiles of adolescents in mathematics. Beyond that, this study enriched research on teaching as it investigated how teaching characteristics related to changes in profiles of student motivation. Previous longitudinal research on the associations between perceived teaching and student motivation in mathematics (Dietrich et al., 2015, Lazarides & Watt, 2015; Kunter et al., 2013; Wang, 2012) had primarily applied variable-centered approaches and had not focused on specific patterns of motivation.

5.1. Motivational profiles — stability and change

Our study built upon previous variable-centered research that showed strong and positive relationships between students' interest in mathematics and their mathematics self-concept (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005) as well as between students' interest and their utility value (Eccles, 2005; Gaspard et al., 2015). It is, however, important to go beyond such variable-centered findings and to gain knowledge about the differences among subgroups of students in classrooms.. Such knowledge will help to understand that motivational stability and change do not occur for all students equally. For example, stable motivational profiles of students would indicate that teachers can plan their instruction based on students' stable motivational needs (e.g., providing instructional clarity to all students, especially to those who need it to remain interested in class). However, understanding not only stability but also the changes across student motivational profiles could help to identify and address students who might be ‘at risk’ for a motivational decline in mathematics.

In line with our expectations (Hypothesis 1), we identified motivational profiles in mathematics that reflected relative level-differences in student motivation (labeled high, medium, and low profile). As hypothesized, we also identified a highly confident, hardly interested profile. This profile resembles a profile reported by previous research that focused on 9th graders in physics classes ('uninterested' group; Seidel, 2006), on elementary school students in the reading domain (Viljaranta et al., 2017), and on kindergarteners in science (Patrick et al., 2008). However, the previous studies included cognitive variables to form the student profiles. Seidel (2006), for example, identified an ‘uninterested’ group with high cognitive ability and pre-knowledge, but low interest and an intermediate probability for high academic self-concept in physics.

Viljaranta et al. (2017) showed a ‘positive self-concept but low interest’ profile as well as a ‘high skills but low interest’ profile. Patrick et al. (2008) found a profile of students with low competence and ease, and medium levels of liking (13.6%) in their study. Moreover, other findings of Linnenbrink-Garcia et al. (2018) identified a ‘intrinsic and confident’ profile among college students in science with high levels of science interest and competence beliefs but low levels of performance goal orientations. Compared to our study, the other cited studies (Patrick et al., 2008; Seidel, 2006; Viljaranta et al., 2017) focus on younger students' motivation in specific school subjects and found other configurations of motivational variables. It might thus be assumed that the combination of motivational variables varies by students' age. However, further research is needed to address this question.

Even though we did not include cognitive variables, our findings point to similar profiles, and this may be an indication of the generalization of different profiles between school subjects. However, further research is needed to investigate this assumption.

Our findings also point to the medium motivation profile as an important subgroup among students. In this study, this profile can be seen as a group of students who are not ‘at risk’ for a maladaptive development in school because their anxiety levels are not particularly high. However, students in this group need to improve certain aspects of their academic behaviors given that their levels of effort are relatively low.

Concerning Hypothesis 2, our findings are in line with Eccles's expectancy value theory (Eccles et al., 1983) that conceptualizes gender as one antecedent of student motivation, especially in math and science. Corresponding with previous person-centered research (Chow & Salmela-Aro, 2011), we showed that boys were overrepresented in high-math-and-science motivational profiles, while girls dominated low-math-and-science profiles. Interestingly, girls were underrepresented in the highly confident, hardly interested profile which reflects their comparably lower mathematics self-concept (Marsh & Yeung, 1998). It is important to acknowledge, however, that the gender differences that we found may be reversed when focusing on language arts since studies have shown that girls report higher interest in reading than boys (McGeown, Goodwin, Henderson, & Wright, 2012). Consequently, our gender-specific findings cannot be generalized to other domains.

Even if the motivational profiles found in this study were anticipated, are plausible and showed plausible relations to validation variables such as achievement, anxiety or effort (in line with Hypothesis 2), we still could not find a clearly best fitting empirical model to portray the different motivational profiles. Furthermore, even if other studies (Seidel, 2006; Viljaranta et al., 2017) have found similar types of mixed-motivation, one may raise the question of whether or not the group of highly confident, hardly interested students with only 4.5% of the sample is substantial. Consequently, further research is needed to investigate the development of such ‘mixed’ motivational profiles.

Regarding the stability and change of the identified profiles (Hypothesis 3), the profiles were relatively stable as 61–74% of the students remained in the medium, low and high motivation profiles from grade 9 to 10. It is important to note that this is only a relative stability as students still changed to other profiles. For example, although 74% of the students remained in the low motivation profile from grade 9 to 10, 26% of the students changed to other profiles. The highly confident, hardly interested profile showed lower stability than the other profiles as 36% of students remained in this profile compared to, for example, 74% who remained in the low motivation group (see Table 3). This relatively low stability contradicted prior findings that indicated a relatively high stability profiles with inconsistent patterns of motivation (Alexander & Murphy, 1998; Hayenga & Corpus, 2010). A possible interpretation for the low stability of the highly confident, hardly interested profile is that students may have an inherent tendency to balance out motivational discrepancies.

Despite the relative stability of profiles, this study identified one instance of systematic change: More students moved from the high motivation profile to the highly confident, hardly interested profile than expected by chance, indicating that a small group of highly motivated students tended to decrease their math task values from grade 9 to 10 while remaining high on mathematics self-concept (and high on achievement/low on anxiety). Taken together, the relative stability in motivational profiles was in line with Hypothesis 3 and earlier studies (Alexander & Murphy, 1998; Lazarides, Viljaranta et al., 2016; Hayenga & Corpus, 2010). Partly corroborating Hypothesis 3, students in a high motivation profile were the only group where systematic changes occurred. This agrees with previous studies reporting a lower stability of high compared to low motivational profiles (Alexander & Murphy, 1998; Bråten & Olaussen, 2005).

5.2. Perceived teaching and student motivation in mathematics

This study not only investigated the stability and change of adolescents' motivational profiles within the domain of mathematics, but also examined how specific student-perceived teacher behaviors were related to specific changes within specific groups of students (Hypothesis 4). Many variable-centered longitudinal studies have analyzed the relations between student-perceived mathematics teaching and their motivation (e.g., Kunter et al., 2013; Rakoczy, 2008; Wang, 2012). However, these studies could not address the heterogeneity in students' motivational development, leaving open the question whether teaching relates to motivation in the same way for all students or just for the students in a certain motivational profile.

In this study, the factor most relevant for changes in motivational profiles was perceived instructional clarity. Students who perceived that their teachers made efforts to present mathematical problems in an understandable manner were less likely to experience a decrease in their mathematics interest, utility value and self-concept (e.g., changes from the high motivation profile to the medium motivation profile, and from the medium to the low motivation profile). Moreover, students with high motivation perceiving high instructional clarity were less likely to lose their mathematics interest (to change from the high motivation profile to the highly confident, hardly interested profile) which points to the importance of clear instruction especially for sustaining high interest and intrinsic value. Student-perceived instructional clarity (and also student-perceived teaching for meaning) moreover related to adaptive motivational changes as students who perceived high instructional clarity were more likely to change from the low to the medium motivation profile. Going beyond previous research, our findings showed that student-perceived instructional clarity was relevant for specific changes and irrelevant for others – for example, student-perceived teacher support but not student-perceived instructional clarity was predictive for changes from the medium motivation profile to the high motivation profile. Consequently, students who have *low* interest, academic self-concept and utility value in mathematics might especially benefit from instruction that they perceive as being understandable and clear while students who already have a certain level of mathematics interest, self-concept and utility value (medium profile) might benefit more from perceived teachers' support when they need help in concrete learning situations.

Furthermore, those students in the medium profile might have been affected by perceived teacher enthusiasm as high enthusiasm related to lower chances of making the change to the highly confident but hardly interested profile. Stated differently, *low* perceived teacher enthusiasm may increase the odds that some students with moderate levels of motivation lower their interest and intrinsic value in mathematics, but at the same time their self-concept might still go up. This finding extends previous variable-centered research on perceived teacher enthusiasm in mathematics (Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009; Kunter et al., 2013) adding a more nuanced view to the relationship between enthusiasm and student motivation.

Interestingly, profile changes in students who were in the highly confident, hardly interested profile in grade 9 to other profiles in grade 10 were not significantly related to perceived teaching. A possible explanation for the nonsignificant effects of perceived teaching on students in the highly confident, hardly interested profile is the small number of students in this group limiting the statistical power to detect effects. Further studies are therefore needed to validate the findings related to this profile.

In general, we assumed that the teaching measured during the 9th grade was related to the motivation during the 10th grade because a student who had the same mathematics teacher for both grades would likely experience relatively similar teacher practices in 9th and 10th grade. Also, we assumed that teaching in the last year of the German middle school was particularly relevant for students' motivation in school subjects. In 10th grade, students have to make career choice relevant decisions, such as course selections or occupational choices (Nagy, Trautwein, Baumert, Köller, & Garrett, 2006). Related calibration processes of personal interests and abilities might lead to an up- or a downgrading of school subjects like mathematics, and students may use school experience as a source of information for this process (Cramer, Herr, & Niles, 2004).

5.3. Limitations

The nature of the study, being based on student ratings of teaching presents one caveat of the present study. Socialization processes operate through individuals' perceptions of others' behaviors (Eccles et al., 1983), and therefore it is highly important to focus on student perceptions of their classroom environment. However, further research is needed that includes multiple perspectives on instructional quality because teachers' perceptions of the classroom environment are also relevant for student academic development (Clausen, 2002). Another issue related to the perceived teaching scales might be that the items assessed perceived teaching referring to different levels of frequency of shown teaching behavior (see example items). We do not know how this difference in the wording might have affected the findings. Consequently, further studies with a greater focus on the methodological aspects of assessing teaching behaviors using student ratings should address this point.

Second, we did not consider bidirectional effects between socializers' behaviors and student motivation (Lazarides, Rubach & Ittel, 2017), because our data set only includes the perceptions of students regarding teaching in classrooms. Future research could investigate reciprocal changes in student motivation and teaching behaviors by using observational data of teaching or obtaining teacher-reports of their behavior.

Third, one further limitation is the high amount of missing data on some teaching variables caused by missing by design. More information about the multiple matrix sampling design that was applied in the PISA studies is provided by Prenzel, Baumert, et al. (2006) and Baumert et al. (2001). Problems that can occur when using this design are position effects that can cause of biased item parameter estimates – accurate answers may be given more frequently if an item is presented in a cluster at the beginning of a booklet rather than at the end of a booklet (Frey, Hartig, & Rupp, 2009).

5.4. Implications for teacher training and teaching practice

The findings of this study have practical implications for teacher training and teaching practice. Teacher training should take into consideration the different types of learners characterized not only by differing levels in motivation, but also by both adaptive (high academic self-concept in mathematics) and maladaptive (low interest and intrinsic value, moderate utility value in mathematics) patterns of motivation. Because students' motivation is much more than the level of their intrinsic values and expectancies (Linnenbrink-Garcia et al., 2018), future research should focus on other important motivational indicators such as goal orientations or attributions.

Regarding teaching practices, we identified high instructional clarity as highly important especially for motivational changes across these patterns. In this study we assessed explanatory clarity, that is, the ways in which instructors expand upon details that give substance to structure (Titsworth & Mazer, 2016). Related teaching practices include for example explanations of content (Stronge et al., 2011) or the provision of definitions, examples, illustrations, and other information to assist students in schema development (Titsworth & Mazer, 2016). Even though teachers should strive for clarity and teach for meaning in all classrooms, we suggest that if teachers have students with particularly low motivation in mathematics, a *special emphasis* on clear and understandable explanations and tasks that are related to students' everyday life might help to increase these students' motivation.

Moreover, because in our study perceived teacher support positively predicted the change from the medium to the high motivation profile, we conclude that when students already show some interest and have some beliefs in their competency in mathematics, strongly supportive teaching when struggling with problems seem to be a good way to increase students' motivation. This may take place for example by showing interest in every student's learning.

It is important to note that many teachers probably already teach in an understandable and clear manner. Our findings do not suggest that these teachers should change their teaching. In the sense of differentiated instruction (Tomlinson et al., 2003), our findings provide deeper knowledge about how specific groups of students will especially benefit from specific aspects of teaching.

Our findings have also implications for school counselling and school psychologists who are informed by the findings of this study about students 'at risk' for a maladaptive motivational development. Students in the low motivation group are, for example, such a risk group as they are highly likely to remain in their profile. The low motivation profile was also characterized by high levels of anxiety and low levels of effort. Given that high levels of mathematics anxiety have been shown to be relevant for achievement (Ma, 1999), educational decisions (Meece et al., 1990) and high school completion (Duchesne, Vitaro, Larose, & Tremblay, 2008), students in the low motivation group are important to address in school psychology and counselling. However, the other groups are also relevant— students in the highly confident, hardly interested profile, for example, reported low effort in mathematics, which may in the long run lead to a decline in their high performance.

Taken together, the implication of our findings for teaching practices show that clear explanations and instructions and teaching for meaning may lead to an adaptive motivational development in highly heterogeneous groups of students. For teacher education and training, our findings emphasize the need to reflect and discuss such educational practices that allow teachers to address the needs of different groups of students effectively in their mathematics classrooms.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tate.2018.12.016.

References

Ahmed, W., Minnaert, A., van der Werf, G., & Kuyper, H. (2010). Perceived social support and early adolescents' achievement: The mediational roles of motivational beliefs and emotions. *Journal of Youth and Adolescence, 39*(1), 36–46. https://doi.org/10.1007/s10964-008-9367-7.

Alexander, P. A., & Murphy, P. K. (1998). Profiling the differences in students' knowledge, interest, and strategic processing. *Journal of Educational Psychology, 90*(3), 435–447. https://doi.org/10.1037/0022-0663.90.3.435.

Baumert, J., Klieme, E., Neubrand, M., Prenzel, M., Schiefele, U., Schneider, W., … Weiß, M. (2001). *PISA 2000: Basiskompetenzen von Schülerinnen und Schülern im internationalen Vergleich. Opladen: Leske and Budrich*.

Becker, E. S., Goetz, T., Morger, V., & Ranellucci, J. (2014). The importance of teachers' emotions and instructional behavior for their students' emotions – an experience sampling analysis. *Teaching and Teacher Education, 43*, 15–26. https://doi.org/10.1016/j.tate.2014.05.002.

Bergman, L. R., & El-Khouri, B. M. (1999). Studying individual patterns of development using I-States as objects analysis (ISOA). *Biometrical Journal, 41*(6), 753–770. https://doi.org/10.1002/(SICI)1521-4036, 199910)41:6<753::AID-BIMJ753>3.0.CO;2-K.

Bergman, L. R., Magnusson, D., & El Khouri, B. M. (2003). *Studying individual development in an interindividual context: A person-oriented approach*. Mahwah, NJ: Lawrence Erlbaum.

Bergman, L. R., Nurmi, J.-E., & von Eye, A. (2012). I-states-as-objects-analysis (ISOA): Extensions of an approach to studying short-term developmental processes by analyzing typical patterns. *International Journal of Behavioral Development, 36*(3), 237–246. https://doi.org/10.1177/0165025412440947.

Berlin, K. S., Williams, N. A., & Parra, G. R. (2014). An introduction to latent variable mixture modeling (part 1): Overview and cross-sectional latent class and latent profile analyses. *Journal of Pediatric Psychology, 39*(2), 174–187. https://doi.org/10.1093/jpepsy/jst084.

Bong, M. (2004). Academic motivation in self-efficacy, task value, achievement goal orientations, and attributional beliefs. *The Journal of Educational Research, 97*(6), 287–298. https://doi.org/10.3200/JOER.97.6.287-298.

Bråten, I., & Olaussen, B. S. (2005). Profiling individual differences in student motivation: A longitudinal cluster-analytic study in different academic contexts. *Contemporary Educational Psychology, 30*(3), 359–396. https://doi.org/10.1016/j.cedpsych.2005.01.003.

Brophy, J. E. (2000). *Teaching. Educational practices. Series 1*. Geneva: International Buero of Education.

Byrne, B. M. (1989). Multigroup comparisons and the assumption of equivalent construct validity across groups: Methodological and substantive issues. *Multivariate Behavioral Research, 24*(4), 503–523. https://doi.org/10.1207/s15327906mbr2404_7.

Chow, A., Eccles, J. S., & Salmela-Aro, K. (2012). Task value profiles across subjects and aspirations to physical and IT-related sciences in the United States and Finland. *Developmental Psychology, 48*(6), 1612–1628. https://doi.org/10.1037/a0030194.

Chow, A., & Salmela-Aro, K. (2011). Task-values across subject domains: A gender comparison using a person-centered approach. *International Journal of Behavioral Development, 35*(3), 202–209.

Chow, A., & Salmela-Aro, K. (2014). Does priority matter? Gendered patterns of subjective task values across school subject domains. In I. Schoon, & J. S. Eccles (Eds.), *Gender differences in aspirations and attainment: A life course perspective* (pp. 247–265). Cambridge: Cambridge University Press.

Cramer, S. H., Herr, E. L., & Niles, S. (2004). *Career guidance and counseling through the lifespan*. Boston, MA: Pearson Education Inc.

Dietrich, J., Dicke, A. L., Kracke, B., & Noack, P. (2015). Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. *Learning and Instruction, 39*, 45–54.

Duchesne, S., Vitaro, F., Larose, S., & Tremblay, R. E. (2008). Trajectories of anxiety during elementary-school years and the prediction of high school noncompletion. *Journal of Youth and Adolescence, 37*(9), 1134–1146.

Eccles, J. S. (2005). Subjective task value and the Eccles et al. model of achievement-related choices. In A. J. Elliot, & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–131). New York, London: Guilford.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., et al. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75–146). San Francisco, CA: Freeman.

Eccles, J. S., & Jacobs, J. E. (1986). Social forces shape math attitudes and performance. *Signs, 11*(2), 367–380.

Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self-and task perceptions during elementary school. *Child Development, 64*(3), 830–847. https://doi.org/10.1111/j.1467-8624.1993.tb02946.x.

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling, 8*(3), 430–457.

Fauth, B., Decristan, J., Rieser, S., Klieme, E., & Büttner, G. (2014). Student ratings of teaching quality in primary school: Dimensions and prediction of student outcomes. *Learning and Instruction, 29*, 1–9. https://doi.org/10.1016/j.learninstruc.2013.07.001.

Fredricks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology, 38*(4), 519–533. https://doi.org/10.1037/0012-1649.38.4.519.

Frenzel, A. C., Goetz, T., Lüdtke, O., Pekrun, R., & Sutton, R. E. (2009). Emotional transmission in the classroom: Exploring the relationship between teacher and student enjoyment. *Journal of Educational Psychology, 101*(3), 705–716. https://doi.org/10.1037/a0014695.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Perceived learning environment and students' emotional experiences: A multilevel analysis of mathematics classrooms. *Learning and Instruction, 17*(5), 478–493. https://doi.org/10.1016/j.learninstruc.2007.09.001.

Frey, A., Hartig, J., & Rupp, A. A. (2009). An NCME instructional module on booklet designs in large-scale assessments of student achievement: Theory and practice. *Educational Measurement: Issues and Practice, 28*(3), 39–53.

Gaspard, H., Dicke, A.-L., Flunger, B., Schreier, B., Häfner, I., Trautwein, U., et al. (2015). More value through greater differentiation: Gender differences in value beliefs about math. *Journal of Educational Psychology, 107*(3), 663–677. https://doi.org/10.1037/edu0000003.

Hayenga, A. O., & Corpus, J. H. (2010). Profiles of intrinsic and extrinsic motivations: A person-centered approach to motivation and achievement in middle school. *Motivation and Emotion, 34*(4), 371–383. https://doi.org/10.1007/s11031-010-9181-x.

Heine, J. H., & Alexandrowicz, R. W. (2015). Confreq: Configural frequencies analysis using log-linear modeling. R package version 1.4. https://cran.r-project.org.

Hugener, I., Pauli, C., Reusser, K., Lipowsky, F., Rakoczy, K., & Klieme, E. (2009). Teaching patterns and learning quality in Swiss and German mathematics lessons. *Learning and Instruction, 19*(1), 66–78. https://doi.org/10.1016/j.learninstruc.2008.02.001.

Jacobs, J. E. (1991). Influence of gender stereotypes on parent and child mathematics attitudes. *Journal of Educational Psychology, 83*(4), 518–527.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*(2), 509–527. https://doi.org/10.1111/1467-8624.00421.

Jurik, V., Gröschner, A., & Seidel, T. (2014). Predicting students' cognitive learning activity and intrinsic learning motivation: How powerful are teacher statements, student profiles, and gender? *Learning and Individual Differences, 32*, 132–139. https://doi.org/10.1016/j.lindif.2014.01.005.

Keller, M., Goetz, T., Becker, E. S., Morger, V., & Hensley, L. (2014). Feeling and showing: A new conceptualization of dispositional teacher enthusiasm and its relation to students' interest. *Learning and Instruction, 33*, 29–38. https://doi.org/10.1016/j.learninstruc.2014.03.001.

Köller, O., Trautwein, U., Lüdtke, O., & Baumert, J. (2006). Zum Zusammenspiel von schulischer Leistung, Selbstkonzept und Interesse in der gymnasialen Oberstufe [The interplay of achievement, self-concept, and interest in upper secondary school]. *Zeitschrift für Pädagogische Psychologie [Journal of Educational Psychology Germany], 20*(1), 27–39.

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology, 105*(3), 805–820. https://doi.org/10.1037/a0032583.

Kunter, M., Tsai, Y.-M., Klusmann, U., Brunner, M., Krauss, S., & Baumert, J. (2008). Students' and mathematics teachers' perceptions of teacher enthusiasm and instruction. *Learning and Instruction, 18*(5), 468–482. https://doi.org/10.1016/j.learninstruc.2008.06.008.

Kusurkar, R. A., Croiset, G., Galindo-Garré, F., & Ten Cate, O. (2013). Motivational profiles of medical students: Association with study effort, academic performance and exhaustion. *BMC Medical Education, 13*(1), 2–8. https://doi.org/10.1186/1472-6920-13-87.

Lauermann, F., Tsai, Y.-M., & Eccles, J. (2017). Math-related career aspirations and choices within Eccles et al.'s expectancy–value theory of achievement-related behaviors. *Developmental Psychology*. https://doi.org/10.1037/dev0000367.

Lazarides, R., & Watt, H. M. (2015). Girls' and boys' perceived mathematics teacher beliefs, classroom learning environments and mathematical career intentions. *Contemporary Educational Psychology, 41*, 51–61.

Lazarides, R., Rubach, C., & Ittel, A. (2016a). Motivational profiles in mathematics:

What role do gender, age and parents' valuing of mathematics play? *International Journal of Gender, Science and Technology, 8*(1), 124–143.
Lazarides, R., Viljaranta, J., Aunola, K., Pesu, L., & Nurmi, J. E. (2016b). The role of parental expectations and students' motivational profiles for educational aspirations. *Learning and Individual Differences, 51*, 29–36.
Lazarides, R., Rubach, C., & Ittel, A. (2017). Adolescents' perceptions of socializers' beliefs, career-related conversations, and motivation in mathematics. *Developmental Psychology, 53*(3), 525.
Lazarides, R., Viljaranta, J., Aunola, K., & Nurmi, J. E. (2018). Teacher ability evaluation and changes in elementary student profiles of motivation and performance in mathematics. *Learning and Individual Differences, 67*, 245–258.
Linnenbrink-Garcia, L., Wormington, S. V., Snyder, K. E., Riggsbee, J., Perez, T., Ben-Eliyahu, A., et al. (2018). Multiple pathways to success: An examination of integrative motivational profiles among upper elementary and college students. *Journal of Educational Psychology*. https://doi.org/10.1037/edu0000245.
Lipowsky, F. (2015). Unterricht [classroom teaching]. In E. Wild, & J. Möller (Eds.), *Pädagogische psychologie* (pp. 73–101). Heidelberg: Springer.
Lüdtke, O., Robitzsch, A., Trautwein, U., & Kunter, M. (2009). Assessing the impact of learning environments: How to use student ratings of classroom or school characteristics in multilevel modeling. *Contemporary Educational Psychology, 34*(2), 120–131. https://doi.org/10.1016/j.cedpsych.2008.12.001.
Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education, 30*(5), 520–540. https://doi.org/10.2307/749772.
Marsh, H. W., & Martin, A. J. (2011). Academic self-concept and academic achievement: Relations and causal ordering. *British Journal of Educational Psychology, 81*(1), 59–77. https://doi.org/10.1348/000709910X503501.
Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*(2), 397–416. https://doi.org/10.1111/j.1467-8624.2005.00853.x.
Marsh, H. W., & Yeung, A. S. (1998). Longitudinal structural equation models of academic self-concept and achievement: Gender differences in the development of math and English constructs. *American Educational Research Journal, 35*(4), 705–738. https://doi.org/10.3102/00028312035004705.
Maulana, R., Opdenakker, M.-C., & Bosker, R. (2016). Teachers' instructional behaviors as important predictors of academic motivation: Changes and links across the school year. *Learning and Individual Differences, 50*, 147–156. https://doi.org/10.1016/j.lindif.2016.07.019.
McGeown, S., Goodwin, H., Henderson, N., & Wright, P. (2012). Gender differences in reading motivation: Does sex or gender identity provide a better account? *Journal of Research in Reading, 35*(3), 328–336.
Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82*(1), 60–70. https://doi.org/10.1037/0022-0663.82.1.60.
Muthén, L., & Muthén, B. (1998-2015). *Mplus user's guide*. Los Angeles, CA: Muthen & Muthen.
Nagy, G., Trautwein, U., Baumert, J., Köller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. *Educational Research and Evaluation, 12*(4), 323–345. https://doi.org/10.1080/13803610600765687.
Nurmi, J.-E., & Aunola, K. (2005). Task-motivation during the first school years: A person-oriented approach to longitudinal data. *Learning and Instruction, 15*(2), 103–122. https://doi.org/10.1016/j.learninstruc.2005.04.009.
OECD. (2003). The PISA 2003 assesment framework. https://www.oecd.org/.
OECD. (2005). PISA 2003 technical report. https://www.oecd.org/.
Pascarella, E. T., Seifert, T. A., & Whitt, E. J. (2008). Effective instruction and college student persistence: Some new evidence. *New Directions for Teaching and Learning, 2008*(115), 55–70. https://doi.org/10.1002/tl.325.
Patrick, H., Mantzicopoulos, P., Samarapungavan, A., & French, B. F. (2008). Patterns of young children's motivation for science and teacher-child relationships. *The Journal of Experimental Education, 76*(2), 121–144. https://doi.org/10.3200/JEXE.76.2.121-144.
Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review, 18*(4), 315–341. https://doi.org/10.1007/s10648-006-9029-9.
Pintrich, P. R., Anderman, E. M., & Klobucar, C. (1994). Intraindividual differences in motivation and cognition in students with and without learning disabilities. *Journal of Learning Disabilities, 27*(6), 360–370.
Praetorius, A.-K., Lauermann, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education, 65*, 241–254. https://doi.org/10.1016/j.tate.2017.03.023.
Prenzel, M., Baumert, J., Blum, W., Lehmann, R., Leutner, D., Neubrand, M., … Schiefele, U. (2006a). *PISA 2003. Untersuchungen zur Kompetenzentwicklung im Verlauf eines Schuljahres*. Münster: Waxmann.
Prenzel, M., Baumert, J., Blum, W., Lehmann, R., Leutner, D., Neubrand, M., … Schiefele, U. (2013). *PISA-I-Plus 2003, 2004. Version: 1. Datensatz*. Berlin: IQB - Institut zur Qualitätsentwicklung im Bildungswesen. http://doi.org/10.5159/IQB_PISA_I_Plus_v1.
Prenzel, M., Carstensen, C. H., Schöps, K., & Maurischat, C. (2006b). Die Anlage des Längsschnittes bei PISA 2003 [The longitudinal design in PISA 2003]. In M. Prenzel, J. Baumert, W. Blum, R. Lehrmann, D. Leutner, M. Neubrand, et al. (Eds.), *PISA 2003. Untersuchungen zur Kompetenzentwicklung im Verlauf des Schuljahres [PISA 2003. Analyses of competence development in the course of a school year]* (pp. 29–62). Münster: Waxmann.
Rakoczy, K. (2008). *Motivationsunterstützung im Mathematikunterricht – unterricht aus der Perspektive von Lernenden und Beobachtern [Motivational support in class]*. Das Munster: Waxmann.
Renninger, A. K., & Hidi, S. (2016). *The power of interest for motivation and engagement*. New York: Routledge.
Rost, J. (2006). Latent-Class-Analyse [latent class analyses]. In F. Petermann, & M. Eid (Eds.), *Handbuch der psychologischen Diagnostik [Handbook of psychological diagnostics]* (pp. 275–287). Goettingen: Hogrefe.
Schiefele, U. (2017). Classroom management and mastery-oriented instruction as mediators of the effects of teacher motivation on student motivation. *Teaching and Teacher Education, 64*, 115–126. https://doi.org/10.1016/j.tate.2017.02.004.
Schwarz, G. (1978). Estimating the dimension of a model. *Annals of Statistics, 6*(2), 461–464.
Seidel, T. (2006). The role of student characteristics in studying micro teaching–learning environments. *Learning Environments Research, 9*(3), 253–271. https://doi.org/10.1007/s10984-006-9012-x.
Stipek, D., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education, 17*(2), 213–226. https://doi.org/10.1016/S0742-051X(00)00052-4.
Stronge, J. H., Ward, T. J., & Grant, L. W. (2011). What makes good teachers good? A cross-case analysis of the connection between teacher effectiveness and student achievement. *Journal of Teacher Education, 62*(4), 339–355. https://doi.org/10.1177/0022487111404241.
Titsworth, S., & Mazer, J. P. (2016). Teacher clarity: An analysis of current research and future directions. In P. Witt (Ed.), *Communication and learning* (Vol. 16, p. 105). Boston, Berlin: DeGruyter.
Tomlinson, C. A., Brighton, C., Hertberg, H., Callahan, C. M., Moon, T. R., Brimijoin, K., … Reynolds, T. (2003). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classrooms: A review of literature. *Journal for the Education of the Gifted, 27*(2–3), 119–145.
Tuominen-Soini, H. (2012). *Student motivation and well-being: Achievement goal orientation profiles, temporal stability, and academic and socio-emotional outcomes*. Finland, Helsinki: University of Helsinki (Doctoral dissertation (article-based)).
Tuominen-Soini, H., Salmela-Aro, K., & Niemivirta, M. (2012). Achievement goal orientations and academic well-being across the transition to upper secondary education. *Learning and Individual Differences, 22*(3), 290–305. https://doi.org/10.1016/j.lindif.2012.01.002.
Viljaranta, J., Aunola, K., & Hirvonen, R. (2016). Motivation and academic performance among first-graders: A person-oriented approach. *Learning and Individual Differences, 49*, 366–372. https://doi.org/10.1016/j.lindif.2016.06.002.
Viljaranta, J., Kiuru, N., Lerkkanen, M.-K., Silinskas, G., Poikkeus, A.-M., & Nurmi, J.-E. (2016). Patterns of word reading skill, interest, and self-concept of ability. *Educational Psychology*, 1–21. https://doi.org/10.1080/01443410.2016.1165798.
Viljaranta, J., Kiuru, N., Lerkkanen, M.-K., Silinskas, G., Poikkeus, A.-M., & Nurmi, J.-E. (2017). Patterns of word reading skill, interest and self-concept of ability. *Educational Psychology, 37*(6), 712–732. https://doi.org/10.1080/01443410.2016.1165798.
Walberg, H. J., & Paik, S. J. (2000). *Effective educational practices. Educational practices series–3*. Brussels: International Academy of Education.
Wang, M.-T. (2012). Educational and career interests in math: A longitudinal examination of the links between classroom environment, motivational beliefs, and interests. *Developmental Psychology, 48*(6), 1643–1657. https://doi.org/10.1037/a0027247.
Wentzel, K. R., Battle, A., Russell, S. L., & Looney, L. B. (2010). Social supports from teachers and peers as predictors of academic and social motivation. *Contemporary Educational Psychology, 35*(3), 193–202. https://doi.org/10.1016/j.cedpsych.2010.03.002.
Wigfield, A., & Eccles, J. S. (1994). Children's competence beliefs, achievement values, and general self-esteem: Change across elementary and middle school. *The Journal of Early Adolescence, 14*(2), 107–138.
Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68–81. https://doi.org/10.1006/ceps1999.1015.
Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In A. Wigfield, & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91–120). San Diego, CA: Academic Press.
Yli-Piipari, S., Watt, A., Jaakkola, T., Liukkonen, J., & Nurmi, J.-E. (2009). Relationships between physical education students' motivational profiles, enjoyment, state anxiety, and self-reported physical activity. *Journal of Sports Science and Medicine, 8*(3), 327–336.