The Unfolding of Students’ Motivation in the Natural Classroom Setting: The Role of Motivational Teaching Practices

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Cora Kristin Parrisius

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1. Betreuer:	PD Dr. Hanna Gaspard
2. Betreuer:	Prof. Dr. Benjamin Nagengast
3. Betreuer:	Prof. Dr. Ulrich Trautwein

Tag der mündlichen Prüfung:	08.10.2020
Dekan:	Prof. Dr. Josef Schmid
1. Gutachter:	PD Dr. Hanna Gaspard
2. Gutachter:	Prof. Dr. Richard Göllner

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ABSTRACT

For many adolescents, school is an inspiring place where they encounter materials that arouse their inherent joy or curiosity. However, school also inevitably comes along with expectations and requirements from others (e.g., teachers) who demand competencies and knowledge in domains, subjects, or tasks that do not fall within every student's scope of interest. Secondary education is thus typically characterized by a decline in students' motivation, especially in the domain of math (e.g., Gaspard et al., 2017; Jacobs et al., 2002; Watt, 2004). Consequently, one of the major challenges for educational practice is to facilitate the conditions "under which people can motivate themselves" (Reeve, 2010, p. 17) to counteract this typical decrease in students' motivation. Research has the responsibility to identify such conditions and to develop a sound understanding of how they come into effect with respect to students' motivation. In this regard, previous research has pointed to the important role of the quality of teaching (e.g., Eccles & Roeser, 2015; Pianta & Hamre, 2009; Rakoczy et al., 2008) and identified in particular teachers' motivational teaching behaviors in the natural classroom setting such as their autonomy support as auspicious tools that lie in the teachers' hands to support students' motivation (e.g., Hamre & Pianta, 2010; Reeve et al., 1999; Ryan & Deci, 2020; Stroet et al., 2013; Wentzel, 2009). However, several questions regarding this newly opened intersection between motivational science and research on teaching quality still need thorough consideration. Drawing on well-established theoretical frameworks (e.g., Deci & Ryan, 1985; Eccles et al., 1983; see also Hall & Lindzey, 1957; Vansteenkiste & Mouratidis, 2016; and particularly Pintrich, 2003), this dissertation raised three key substantive questions with regard to current and future research at this intersection: (a) *How consistent are motivational teaching behaviors?*, (b) *What are the antecedents of motivational teaching behaviors?*, and (c) *What are other external sources that target students' motivation and tend to accompany motivational teaching behaviors in the educational setting?* Within the scope of the current dissertation, certain aspects concerning these questions (namely, the stability of motivation and motivational teaching behaviors, teacher motivation as an antecedent of motivational teaching behaviors, and the joint impacts of motivational teaching behaviors and a relevance intervention during math class) were targeted by conducting three empirical studies.

In the first study (*The "situative nature" of competence and value beliefs and the predictive power of autonomy support: A multilevel investigation of repeated observations*), the

situative nature of students' motivation as well as its associations with time-consistent and occasion-specific factors of motivational teaching behaviors were investigated. Based on data from a large longitudinal study (Gaspard et al., 2020; Piesch et al., 2020) comprising repeated observations from five consecutive math lessons, multilevel modeling was applied to investigate, first, the stability of students' motivation and their perceptions of motivational teaching behaviors during math class and, second, the predictive power of time-consistent and occasion-specific factors of motivational teaching behaviors for students' motivation. The results revealed that both students' motivation and their perceptions of motivational teaching behaviors fluctuated substantially from lesson to lesson. Furthermore, students' perceptions of motivational teaching behaviors predicted the situational manifestation of their motivation, whereby time-consistent differences explained more variance than occasion-specific differences over time.

In the second study (*The transmission of values from math teachers to their ninth-grade students: Different mechanisms for different value dimensions?*), the prospective associations between teachers' motivation, teachers' motivational teaching behaviors, and students' motivation were examined. Using data from the same longitudinal trial as in Study 1 (Gaspard et al., 2020; Piesch et al., 2020), this study investigated teachers' motivation as an antecedent of their motivational teaching behaviors during class within the scope of the broader so-called value transmission concept. More precisely, in this study, the generalizability of this concept, according to which teachers' motivation affects students' motivation through motivational teaching behaviors during class, was examined. The results revealed that several aspects of teachers' motivation predicted students' perceptions of their teachers' motivational teaching behaviors during math class. Expanding upon previous research, *different* motivation dimensions were transmitted from teachers to their students through different motivational teaching behaviors, and, thus, the findings provided auspicious evidence of a broader generalizability of the value transmission concept. Yet, they also showed the need to differentiate between different value dimensions and the mechanisms through which they are transmitted from teachers to their students.

The third study (*Gleiche Wirkung in jedem Klassenzimmer? Moderationseffekte durch motivationale Unterrichtspraktiken am Beispiel einer Nützlichkeitsintervention im Mathematikunterricht und damit einhergehende Herausforderungen [Same effect in every classroom? Treatment by moderator effects of a relevance intervention as a function of motivational teaching practices, and methodological challenges]*) addressed the current discussion revolving around the question of “seed” and “soil” (Walton & Yeager, 2020) by investigating the joint effects of motivational teaching behaviors during regular class and a relevance intervention (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015) on students’ motivation. The results indicated that relevance interventions such as the one under investigation might—depending on the motivation dimension of interest—function as boosters of motivational teaching behaviors during class or as compensators for a lack thereof. Furthermore, notwithstanding the large sample size and the high-standard research design, this investigation also laid bare the idea that intervention studies comparable to the one under investigation are confronted with limitations in their statistical power to examine such interaction effects.

The findings of the three empirical studies are discussed with respect to the three key substantive questions that were raised within the scope of the current dissertation regarding the intersection of motivational science and teaching quality. Finally, implications for the theoretical conceptualization of motivation and for the future of this intersection, as well as implications for educational policy and practice are outlined with a particular emphasis on the professional development of teachers and the implementation and scaling of educational interventions.

ZUSAMMENFASSUNG

Für viele Heranwachsende ist die Schule ein inspirierender Ort, an dem sie Inhalten begegnen, die ihre inhärente Freude oder Neugierde wecken. Schule geht aber auch unweigerlich mit Erwartungen und Anforderungen von anderen (z.B. Lehrkräften) einher, die Kompetenzen und Wissen in Bereichen, Fächern oder Aufgaben verlangen, die nicht in den Interessenbereich jeder einzelnen Schülerin und jedes einzelnen Schülers fallen. Die Sekundarstufe ist daher typischerweise durch einen Motivationsabfall, insbesondere im Fach Mathematik, gekennzeichnet (e.g., Gaspard et al., 2017; Jacobs et al., 2002; Watt, 2004). Eine der größten Herausforderungen für die pädagogische Praxis besteht daher darin, Bedingungen zu schaffen, "unter denen Menschen sich selbst motivieren können" (Reeve, 2010, S. 17), um diesem Motivationsabfall entgegenzuwirken. Die Forschung hat die Verantwortung, solche Bedingungen zu identifizieren und ein fundiertes Verständnis dafür zu entwickeln, wie sie sich im Hinblick auf die Motivation der Schülerinnen und Schüler auswirken. In diesem Zusammenhang hat die bisherige Forschung auf die wichtige Rolle der Unterrichtsqualität (e.g., Eccles & Roeser, 2015; Pianta & Hamre, 2009; Rakoczy et al., 2008) hingewiesen und dabei insbesondere motivationale Verhaltensweisen von Lehrkräften in der natürlichen Unterrichtsumgebung als relevant identifiziert (e.g., Hamre & Pianta, 2010; Reeve et al., 1999; Ryan & Deci, 2020; Stroet et al., 2013; Wentzel, 2009), wie beispielsweise die Unterstützung der Autonomie der Schülerinnen und Schüler. Einige Fragen zu dieser damit neu eröffneten Schnittstelle zwischen Motivationswissenschaft und Forschung zur Unterrichtsqualität müssen jedoch noch tiefgreifender untersucht werden. Angelehnt an etablierte theoretische Rahmenmodelle und Überlegungen (e.g., Deci & Ryan, 1985; Eccles et al., 1983; see also Hall & Lindzey, 1957; Vansteenkiste & Mouratidis, 2016; and particularly Pintrich, 2003) wurden im Rahmen dieser Dissertation drei substantielle Fragen im Hinblick auf die gegenwärtige und zukünftige Forschung an dieser Schnittstelle aufgeworfen: (a) *Wie konsistent sind motivationale Verhaltensweisen der Lehrkraft*, (b) *Was sind die Vorläufer motivationaler Verhaltensweisen der Lehrkraft*, und (c) *Welche anderen externen Faktoren, die auf die Motivation der Schülerinnen und Schüler abzielen, begleiten motivationale Verhaltensweisen der Lehrkraft im Bildungsbereich?* Im Rahmen der vorliegenden Dissertation wurden zentrale Aspekte zu diesen Fragen (in Hinblick auf (a) die Stabilität der Motivation von Schülerinnen und Schülern sowie der motivationalen Verhaltensweisen der Lehrkraft, (b) die Motivation der Lehrkraft als Vorläufer ihrer motivationalen Ver-

haltensweisen und (c) die gemeinsame Auswirkung motivationaler Verhaltensweisen der Lehrkraft und einer Relevanzintervention im Matheunterricht) durch drei empirische Studien untersucht.

In der ersten Studie (*The „situative nature“ of competence and value beliefs and the predictive power of autonomy support: A longitudinal investigation of repeated observations*) wurde die situative Natur der Motivation von Schülerinnen und Schülern sowie Zusammenhänge mit stabilen und fluktuierenden Faktoren der motivationalen Verhaltensweisen der Lehrkraft untersucht. Basierend auf den Daten einer großen Längsschnittstudie (Gaspard et al., 2020; Piesch et al., 2020), die wiederholte Befragungen in fünf aufeinanderfolgenden Mathematikstunden umfasste, wurden Mehrebenen-Analysen angewandt, um erstens die Stabilität der Motivation von Schülerinnen und Schülern und die Stabilität ihrer Wahrnehmung motivationaler Verhaltensweisen der Lehrkraft während des Mathematikunterrichts und zweitens die Vorhersagekraft von stabilen und fluktuierenden Faktoren der motivationalen Verhaltensweisen der Lehrkraft für die Motivation der Schülerinnen und Schüler zu untersuchen. Die Ergebnisse zeigten, dass sich sowohl die Motivation der Schülerinnen und Schüler als auch ihre Wahrnehmungen motivationaler Verhaltensweisen der Lehrkraft von Stunde zu Stunde erheblich änderten. Darüber hinaus sagten die motivationalen Verhaltensweisen der Lehrkraft die situationsspezifische Manifestation der Motivation der Schülerinnen und Schüler voraus, wobei stabile Unterschiede zwischen Schülerinnen und Schülern sowie Klassen über die Zeit mehr Varianz erklärten als zeitpunktspezifische Abweichungen.

In der zweiten Studie (*The transmission of values from math teachers to their ninth-grade students: Different mechanisms for different value dimensions?*) wurden die prospektiven Zusammenhänge zwischen der persönlichen Motivation der Lehrkraft, den motivationalen Verhaltensweisen der Lehrkraft und der Motivation der Schülerinnen und Schüler untersucht. Unter Verwendung von Daten aus der gleichen Längsschnittuntersuchung wie in Studie 1 (Gaspard et al., 2020; Piesch et al., 2020) wurde in dieser Studie die Motivation der Lehrkraft als Vorläufer ihres motivationalen Verhaltens im Unterricht im Sinne des so genannten „Wertevermittlungs“-Prinzips untersucht. Genauer gesagt wurde in dieser Studie die Verallgemeinerbarkeit dieses Prinzips untersucht, wonach die Motivation von Lehrkräften die Motivation der Schülerinnen und Schüler vermittelt durch motivationale Verhaltensweisen der Lehrkraft im Unterricht beeinflusst. Die Ergebnisse zeigten, dass mehrere Aspekte der Lehrkraftmotivation die Motivation der Schülerinnen und Schüler vorhersagten, vermittelt über durch die von Schülerinnen und Schülern wahrgenommenen motivationalen Verhaltensweisen der Lehrkraft während des Mathematikunterrichts. In Ergänzung zu früherer Forschung zeigte sich, dass *verschiedene* Dimensionen der Lehrkräftemotivation durch unterschiedliche motivationale Verhaltensweisen der Lehrkraft an ihre Schülerinnen und Schüler weitergegeben wurden und somit lieferten die Ergebnisse vielversprechende Hinweise auf eine breitere Verallgemeinerbarkeit des „Wertevermittlungs"-Prinzips. Die Ergebnisse machten jedoch auch die Notwendigkeit deutlich, zwischen verschiedenen Motivationsdimensionen zu unterscheiden, sowie zwischen verschiedenen Mechanismen, durch die diese Motivationsdimensionen von den Lehrkräften an ihre Schülerinnen und Schüler jeweils „übertragen" werden.

Die dritte Studie (*Gleiche Wirkung in jedem Klassenzimmer? Moderationseffekte durch motivationale Unterrichtspraktiken am Beispiel einer Nützlichkeitsintervention im Mathematikunterricht und damit einhergehenden Herausforderungen*) befasste sich mit der aktuellen Diskussion um die Bedeutung von „Saatgut" und „Boden" („Seed" und „Soil"; Walton & Yeager, 2020), indem gemeinsame Effekte von motivationalen Verhaltensweisen der Lehrkraft im regulären Mathematikunterricht und einer Relevanzintervention (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015) auf die Motivation der Schülerinnen und Schüler untersucht wurden. Die Ergebnisse deuteten darauf hin, dass Relevanzinterventionen wie die hier untersuchte – je nach im Fokus stehender Motivationsdimension – als Verstärkung motivationaler Verhaltensweisen von Lehrkräften oder als Kompensator bei einem Mangel ebendieser wirken können. Darüber hinaus hat diese Studie trotz des großen Stichprobenumfangs und eines high-standard Forschungsdesigns auch offengelegt, dass Interventionsstudien, die mit der untersuchten vergleichbar sind, Limitation hinsichtlich ihrer statistischen Teststärke aufweisen, um vergleichbare Interaktionseffekte zu untersuchen.

Die Ergebnisse der drei empirischen Studien werden in Bezug auf die drei substantiellen Fragen diskutiert, die im Rahmen der aktuellen Dissertation hinsichtlich der Schnittstelle von Motivationswissenschaft und Unterrichtsqualität aufgeworfen wurden. Schließlich werden Implikationen für die theoretische Konzeptualisierung von Motivation und für die Zukunft dieser Schnittstelle, sowie Implikationen für Bildungspolitik und -praxis skizziert, wobei ein besonderer Augenmerk auf der Aus- und Weiterbildung von Lehrkräften sowie der breiten Implementation von Bildungsinterventionen liegt.

TABLE OF CONTENTS

1 INTRODUCTION AND THEORETICAL BACKGROUND 1

1.1 Motivation in School 5

1.1.1 Situated Expectancy-Value Theory (SEVT) 5

1.1.2 Research Findings on Expectancies and Values 9

1.1.3 Enriching SEVT with Concepts from Other Motivation Theories.................13

1.2 Teaching Quality: Creating Conditions Under Which Students Can Motivate Themselves 24

1.2.1 Conceptualization of Teaching Quality..24

1.2.2 Choosing a Referent for Teaching Quality Assessments 30

1.3 How do Motivational Teaching Behaviors Come into Effect?..........................32

1.3.1 Consistency of Motivational Teaching Behaviors: Stable Versus One-Time Beneficial Conditions 36

1.3.2 Antecedents of Motivational Teaching Behaviors: Teacher Motivation 43

1.3.3 Factors Accompanying Motivational Teaching Behaviors: Relevance Interventions as Boosters or Compensators 48

2 AIMS AND RESEARCH QUESTIONS 57

3 STUDY 1: The "Situative Nature" of Competence and Value Beliefs and the Predictive Power of Autonomy-Support: A Multilevel Investigation of Repeated Observations **..61**

4 STUDY 2: The Transmission of Values from Math Teachers to Their Ninth-Grade Students: Different Mechanisms for Different Value Dimensions? **...123**

5 STUDY 3: Gleiche Wirkung in jedem Klassenzimmer? Moderationseffekte durch motivationale Unterrichtspraktiken am Beispiel einer Nützlichkeits-intervention im Mathematikunterricht und damit einhergehende Herausforderungen **...227**

6 GENERAL DISCUSSION 263

6.1 Discussion of General Findings 265

6.1.1 Lessons Learned from Findings on the Consistency of Motivational Teaching Behaviors over Time 266

6.1.2 A More Comprehensive Perspective on Antecedents of Teachers' Motivational Teaching Behaviors During Class 268

6.1.3 Relevance Interventions: A Magic Bullet for Research on Motivation and Teaching Quality? 270

6.2 Strengths and Limitations 274

6.3 General Implications and Future Directions 277

6.3.1 Implications for Future Research 277

6.3.2 Implications for Educational Policy and Practice 280

6.4 Conclusion 282

REFERENCES 283

1

INTRODUCTION AND THEORETICAL BACKGROUND

"Don't ask how you can motivate other people! That's the wrong way to think about it. Instead, ask: How can you create the conditions within which other people will motivate themselves."[1]

– Edward L. Deci (2012)

Every day at school, students spend their time in a natural classroom setting learning and understanding the necessities that are expected to prepare them for a self-determined and responsible life. Oftentimes, students are confronted with domains, subjects, or tasks that arouse their curiosity and interest and allow them to be fully engaged in that task. However, school also inevitably comes along with expectations and requirements from others and the need to acquire competencies and knowledge in domains, subjects, or tasks that do not fall within every students' scope of interest. At the same time, the social (instructional) context substantially shapes the conditions under which students handle the expectations that were brought to them (Nolen, 2020; Pintrich, 2003) and might thus facilitate or undermine students' motivation in school. More generally, motivation is derived from the Latin verb *movere* and means to move—simultaneously implying the activities that a movement is directed toward (*direction*; Pintrich & Schunk, 2002) as well as the prerequisites that get individuals moving

[1] On the terminology of "motivating oneself": Typical motivation theorists ask questions about how to motivate others or how to foster someone's motivation. However, self-determination theorists prefer the question of "How can I create the conditions under which people can motivate themselves?" (Reeve, 2010, p. 17; see also Deci, 2012). Reeve argued that the former implies that one seeks to do something *to* the other, whereas the self-determination theorists' way of questioning implies doing something *for* the other. This argument is subject to the observation that motivation cannot be taught to or created for someone else. Applying the same logic, in the current dissertation, I aim to examine how teachers can create the conditions under which students can motivate themselves, and I use the term "supporting" motivation as proposed by Reeve (2010, p. 17).

(*energization*; Pintrich, 2003). In the educational context, achievement motivation comprises the energy students bring to academic tasks, their beliefs and values, as well as the goals that determine which tasks they choose to pursue or whether they persist in achieving them ("Handb. Motiv. Sch.," 2009). Hence, students' achievement motivation is likely to play a critical role in their success in school ("Handb. Motiv. Sch.," 2009) and—at least as important—to facilitate their psychological well-being, personal growth, and adjustment (Ryan & Deci, 2000b, 2020). Whereas students typically obtain high achievement motivation in their early years, it typically follows a steady decline throughout secondary school, and this decrease is particularly pronounced in the domain of math (e.g., Gaspard et al., 2017; Jacobs et al., 2002; Watt, 2004). This decrease might be a result of various circumstances ranging from a greater differentiation of individual preferences and interests within the school context (Eccles & Wigfield, 1995; Wigfield et al., 1997; Wigfield & Eccles, 1992), to an increasing mismatch between educational environments and students' individual needs initiated through transitions (Eccles et al., 1993), and to psychological and physiological changes during puberty (e.g., Blyth et al., 1983; for an overview, see Wigfield et al., 2009).

Given the decrease in students' motivation throughout school, much research in the last few decades has been dedicated to its energization (i.e., how to get individuals moving) in terms of motivation interventions that are designed to support students' motivation (for overviews, see Durik, Hulleman, et al., 2015; Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016). However, in the current dissertation, I follow in the footsteps of rich research traditions in the field of educational psychology that—apart from artificial, externally imposed interventions—focus on the natural classroom setting and particularly on the role of the teacher. This focus can offer unique insights into natural associations between regular class situations and students' development in the educational context and thus into the "natural" energization of student motivation. Consequently, this dissertation aims to shed more light on the educational environment that school takes place in by examining the conditions under which students can motivate themselves and the conditions that are contingent on the teacher, particularly their behaviors in class and students' perceptions thereof.

The overarching goal of this dissertation is to examine whether and how students' motivation is linked to their teachers' behaviors in the natural classroom setting (so-called *motivational teaching behaviors*), and to determine how such motivational teaching behaviors come into effect. The current dissertation is thus located at the intersection of motivational science and research on teaching quality. Subordinate to the overarching goal, this dissertation aims to address three key substantive questions that are meant to substantiate research that falls at the intersection of motivational science and teaching quality. These three questions are: *How consistent are motivational teaching behaviors?*, *What are the antecedents of motivational teaching behaviors?*, and *What are other external sources that target students' motivation and tend to accompany motivational teaching behaviors in the educational setting?*

In order to address these questions, the current dissertation draws on complementary concepts of other motivation theories (self-determination theory, control-value theory, and interest theories) to enrich the SEVT perspective on the unfolding of students' motivation in the educational setting. Thus, within the scope of this dissertation, I aim to substantiate the understanding of (a) how consistent motivational teaching behaviors are, (b) what affects motivational teaching behaviors, and (c) what other external impacts on student motivation accompany motivational teaching behaviors in the educational setting by examining (a) the stability and situation-sensitivity of motivation and motivational teaching behaviors, (b) teachers' motivation as antecedents of motivational teaching behaviors, and (c) the joint impact of motivational teaching behaviors and a relevance intervention in a math class. To this end, this dissertation makes use of three empirical studies.

The current dissertation is structured as follows: In the introductory chapter (Chapter 1), I outline the theoretical background that leads to the overarching goal of the present dissertation. Central to the theoretical background is the presentation of motivation in school (1.1), which I embed into one of the most prominent frameworks in research on motivation in school, namely, the situated expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2020). This theory constitutes the fundamental motivational framework for this dissertation. After reviewing the origins and current state of the situated expectancy-value theory and potential complementary aspects of other motivation theories, I introduce the concept of teaching quality and outline teachers' potential to use motivational teaching behaviors to create conditions under which students can motivate themselves (1.2). Subsequently, I consider the question of how motivational teaching behaviors may come into effect by focusing on the stability of motivation and motivational teaching behaviors, antecedents of motivational teaching behaviors, and the joint impact of motivational teaching behaviors and a relevance intervention during math class (1.3). This first chapter is followed by a brief summary and an outline of three guiding research questions (Chapter 2), which I subsequently deal with by conducting three empirical studies (Chapters 3 to 5). Finally (Chapter 6), I summarize the findings of the three empirical studies, discuss them on a more general level, and outline the strengths and limitations of this dissertation. The dissertation closes with implications for future research as well as for educational policy and practice.

1.1 Motivation in School

Why and under which conditions are students motivated? Researchers have been tackling these questions for decades, and these questions have stimulated the development of many theoretical traditions in motivational science. Initially focusing on drives and needs as the primary sources of motivation (see Wigfield et al., 2008), over the last 40 to 50 years, the field of research on student motivation has been dominated by social-cognitive theories ("Handb. Motiv. Sch.," 2009), which share the assumption that personal cognitions determine a person's behavior in a social context. One of the probably most important modern expectancy-value theories is Eccles et al.'s situated expectancy-value theory (SEVT; Eccles et al., 1983; Eccles & Wigfield, 2020), which constitutes the foundation of the current dissertation. In the following, I first present SEVT (1.1.1), followed by empirical evidence on the educational relevance of its main constructs, namely, expectancies and values (1.1.2). Finally, I provide insights into other motivation theories (i.e., self-determination theory, control-value theory, and interest theories; 1.1.3) to enrich the theoretical understanding of how students' motivation unfolds in the natural classroom setting.

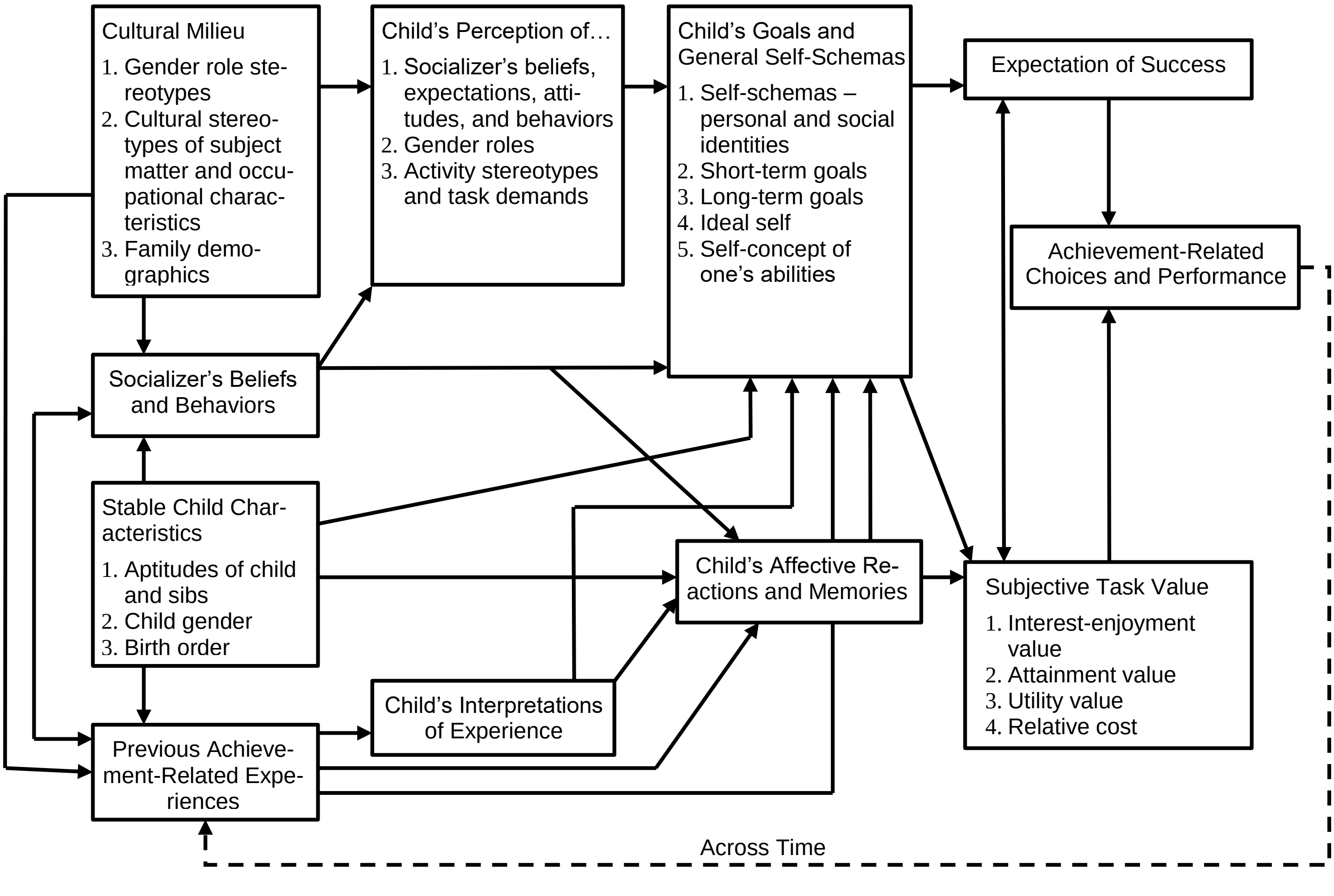
1.1.1 Situated Expectancy-Value Theory (SEVT)

Probably some of the most prominent and widely used theoretical approaches to understanding achievement motivation are expectancy-value theories. In the field of achievement motivation, Atkinson (1957, among others; see also, e.g., Feather, 1959; Vroom, 1964) adapted early cognitive models of animal behavior to human motivation and choice, and formulated one of the first formal expectancy-value models as an attempt to explain achievement-related behaviors (Wigfield et al., 2009). He built his theory on initial work on expectancies and values (Lewin, 1938; Tolman, 1932, 1948) as well as on Murray's (1938) notion of various human needs that guide behavior. Atkinson postulated that achievement motives, expectancies for success, and incentive values determine a person's achievement behaviors. Expectancies for success and incentive values, which are both still at the heart of contemporary updates of expectancy-value theories, are defined as a person's expected probability for success when executing a task (expectancies for success) and as the relative attractiveness of or the relative desire to succeed on an achievement task (incentive values). Atkinson furthermore argued that the value of an achievement task increases with the difficulty of the task. He thus assumed that there is a tight but also negative multiplicative relation between expectancies for success and incentive values.

In the early 1980s, Eccles and her colleagues (1983) transferred Atkinson's approach to understanding achievement-related motivation to the educational context and linked achievement performance, persistence, and choice to a person's expectancies for success and task values. Eccles and colleagues thus postulated their own expectancy-value theory of achievement-related choices, which they recently (re-)labeled the ***situated* expectancy-value theory** (**SEVT**; Eccles & Wigfield, 2020; Wigfield & Eccles, 2020). SEVT differs from Atkinson's expectancy-value theory as a result of the more holistic embedding of expectancies and values into a broader array of psychological, social, and cultural determinants (Wigfield et al., 2009).

Figure 1

Eccles et al.'s Situated Expectancy-Value Theory of Achievement-Related Choices (from Eccles & Wigfield, 2002[2])



[2] This figure was reprinted from Eccles & Wigfield (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*, 109-132. Page No. 119, Copyright 2002, with permission from Annual Reviews, Inc.

Theoretical Conceptualization of Expectancies for Success and Subjective Task Values

As depicted on the right side of the SEVT model in Figure 1, students' expectancies for success and subjective task values are the most proximal predictors of their achievement-related choices and performance. *Expectancies for success* reflect individuals' beliefs about their abilities to complete a task or their performance in a certain school subject; they revolve around the question of whether or not individuals think they can master a task (e.g., Eccles & Wigfield, 2002). Even though Eccles and colleagues and others (Bong & Skaalvik, 2003; Eccles et al., 1983; Eccles & Wigfield, 2020) conceptually distinguished expectancies for success from an individual's ability beliefs (e.g., self-concept of ability), prior research has found that these constructs are typically highly correlated (Eccles & Wigfield, 2002; Marsh et al., 2019; see also Hughes et al., 2011, for a discussion of differences and overlaps).

Values are defined with respect to the desirability of different tasks and are therefore related to the question of whether or not an individual wants to perform a task. Eccles and colleagues furthermore refined the term value by adding the features *subjective* and *task*, expanding it to the term *subjective task values*, which captures both the subjective nature of values (different individuals assign different values to the same task) and its task specificity (one might enjoy computational tasks but not geometry tasks, even though they can be grouped under the domain of math). The specificity characteristic of subjective task values is often ignored, leading to relatively broad and global conceptualizations and measurements of values in educational research (e.g., "I like doing math"; Gaspard et al., 2017; see also Wigfield & Cambria, 2010, for an overview). This is why Eccles and Wigfield recently re-emphasized the situative nature of subjective task values (Eccles & Wigfield, 2020; but see, e.g., Kovas et al., 2015). In fact, they noted that all aspects of SEVT are situative, although they acknowledged that this situative nature is not fully reflected in their model as depicted in Figure 1.

According to SEVT, subjective task values can furthermore be divided into four major components: intrinsic value, utility value, attainment value, and cost (Eccles, 2005). *Intrinsic value* (previously also labeled interest value or interest-enjoyment value) is the enjoyment one obtains from doing a task and can consequently be seen as a more affective component of subjective task values. *Utility value* refers to the usefulness of a task for enabling a person to reach their long-range goals or to obtain immediate or long-range external rewards. *Attainment value* comprises the personal importance of a task and the perception of how central it is for a person's personal identity. Finally, *cost* refers to the negative social or emotional consequences of engaging in a task as well as to the negative impact of engaging in other valued activities.

An individual's expectancies for success and subjective task values are postulated to have a direct impact on their task choices and performance. As depicted in the SEVT model in Figure 1, an individual's expectancies and values, in turn, are postulated to be influenced by a broad spectrum of individual factors, such as their prior experiences and resulting affective reactions and memories, as well as their self-schema and short- and long-term goals. Central to the current dissertation are contextual antecedents, which Eccles et al. (1983) brought into play on the left side of the SEVT model and which I describe in the following.

Contextual Antecedents of Expectancies and Values: The Left Side of the SEVT Model

Factors that constitute the most primal contextual antecedents of individuals' expectancies for success and subjective task values are represented at the far left side of the SEVT model. It is important to note that SEVT does not claim to be comprehensive in its list of antecedents of expectancies and values (Wigfield & Eccles, 2020). However, the most central aspects of SEVT include social and cultural factors such as socializers' (e.g., parents' or teachers') beliefs and behaviors and the cultural milieu that surrounds an individual.

In the history of SEVT, a particular focus in terms of socializers has been on the impact of parents on their children such as their own beliefs, values, and behaviors, (e.g., Eccles, 2007; Simpkins et al., 2015). According to Eccles (1993), parents assist their children in interpreting the children's own experiences. Such behaviors of the parents, in turn, are affected by their own underlying beliefs. Eccles' considerations regarding the impact of parents on their children eventually led to the development of Eccles and colleagues' parent socialization model (see also Simpkins et al., 2015).

Other important socializers, especially when it comes to the educational context, are teachers. In her contribution to the 1993 Nebraska Symposium on Motivation, Eccles laid out her theoretical ideas about the roles that teaching behaviors and teachers' characteristics play in determining student motivation. Eccles proposed that teachers' own beliefs affect their students' beliefs, motivation, and self-perceptions through many "messages." More precisely, teachers may indirectly communicate interpretations of the students' abilities to their students, consequently producing "expectancy effects" (Eccles, 1993, p. 177) in them. For instance, when teachers hold high expectancies about the abilities of certain students, the teachers may give these students more opportunities to answer questions in class or to correct themselves when they make mistakes. Teachers' implicit or explicit messages to their students furthermore lead to changes in students' motivation because, as Eccles and Wigfield (2020) stated, from a developmental perspective, individuals (e.g., students) strive to share perceptions about what is desired and appreciated with important adults (e.g., their parents and teachers). Given the high value placed on school success by many socializers (e.g., teachers who indirectly communicate its high value), students automatically learn to also value achievement even if this merely serves the purpose of gaining approval from their socializers.

Equally important to teachers' own beliefs, Eccles indicated that classrooms with a high level of teaching quality (e.g., indicated by teachers who create a warm and positive climate, efficiently organize and manage class, realize a sense of personal efficacy, focus on learning goals, and support autonomous learning behaviors) are beneficial for students' achievement, motivation, satisfaction, and self-concept (Eccles, 2007). Even though Eccles also assumed that the type and amount of material teachers use may affect students' self and task beliefs, Eccles also suggested that, even more importantly, the teachers' abilities to present the material lead to more positive responses in the students. Overall, Eccles concluded that teachers' attitudes and enthusiasm may be particularly important for affecting students' attitudes (Eccles, 1993). When elaborating on the impact of teachers' behaviors and attitudes on students' attitudes, Eccles particularly drew on Deci and Ryan's self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000b). Eccles and Wigfield (2020) themselves stated that, analogous to self-determination theorists, they "focused on those characteristics of classrooms that support feelings of competence, connectedness, and autonomy" (p. 9) and assumed that corresponding teaching behaviors are the ones affecting students' beliefs and attitudes the most (see Eccles, 2007, 2012).

Taken together, SEVT is a strong theoretical framework, which not only comprises extensive definitions of its proximal constructs, namely, expectancies and values (i.e., intrinsic value, utility value, attainment value, and cost). It also creates an understanding of expectancies and values in terms of their *direction* (achievement-related choices and performance) and *energization* (individual and contextual antecedents), which is why it is a framework that is well-suited for this dissertation.

1.1.2 Research Findings on Expectancies and Values

The Role of Students' Expectancies and Values in Academic Outcomes

The postulated associations between expectancies and values with academic outcomes have been tested in numerous empirical studies in authentic educational contexts. Overall, ample empirical evidence has supported the predictive power of expectancies and values for outcomes such as effort, persistence, task engagement, course enrollment, study choice, and achievement (e.g., Durik et al., 2006; Marsh et al., 2005; Musu-Gillette et al., 2015; Nagengast et al., 2011; Nagy et al., 2006; Trautwein & Lüdtke, 2007; Wille et al., 2020; for overviews, see also Wigfield et al., 2009; Wigfield & Eccles, 2020).

When considered separately, first, students' expectancies (sometimes also operationalized as competence beliefs, academic self-concept, or academic self-efficacy) have been confirmed as strong predictors of academic achievement in various subjects and domains (e.g., Marsh & Yeung, 1997; Trautwein et al., 2006; for meta-analyses, see also Möller et al., 2020; and Valentine et al., 2004). Even in longitudinal studies and even when additionally controlling for prior achievement, expectancies were found to be a strong predictor of subsequent achievement (e.g., Simpkins et al., 2006). In addition to achievement, such self-beliefs have also been found to predict, for instance, academic effort and engagement (e.g., Trautwein et al., 2009; Walker et al., 2006). A positive academic self-concept was furthermore associated with higher levels of positive (and lower levels of negative) academic emotions such as enjoyment or anger toward classroom learning (e.g., Goetz et al., 2010), with higher levels of school adjustment (e.g., Wouters et al., 2011), and even with higher levels of general psychological adjustment such as self-esteem (e.g., Trautwein, Lüdtke, Köller, et al., 2006).

Second, students' values (measured as one general construct, e.g., Jacobs et al., 2002; with composite measures of some of the values, e.g., Durik et al., 2006; measured separately, e.g., Trautwein et al., 2012; or even further differentiated into subfacets, e.g., Gaspard, Dicke, Flunger, Schreier, et al., 2015) have been found to predict students' performance and choices (e.g., Bong, 2001; Chow et al., 2012; Durik et al., 2006; Roeser et al., 2000; Simpkins et al., 2006). Students with positive values have furthermore been found to report higher levels of effort (e.g., Cole et al., 2008; Trautwein & Lüdtke, 2007), engagement (Chow et al., 2012; Durik et al., 2006; Simpkins et al., 2006; Trautwein, Lüdtke, Köller, et al., 2006; Walker et al., 2006), a more adaptive self-regulated learning profile (e.g., Metallidou & Vlachou, 2010), as well as lower levels of school problem behaviors and negative peer affiliations (e.g., Roeser et al., 2000).

Third, when simultaneously considering expectancies and values, they have shown the unique power to predict academic outcomes. Whereas students' expectancies have turned out to be stronger predictors of performance (e.g., Meece et al., 1990; Trautwein et al., 2012), students' values were particularly good predictors of their intentions to stick with and to actually choose different academic activities (e.g., Bong, 2001; Meece et al., 1990).

Finally, when additionally taking into consideration the originally proposed multiplicative term between expectancies and values (Atkinson, 1957; for a more recent discussion, see Trautwein et al., 2013), research findings revealed a small but reliable increase in the extent to which expectancies and values predicted students' (homework) engagement, course selection, career intentions, achievement, entrance into university, and maladaptive behavior (e.g., Guo et al., 2015, 2016; J. Lee et al., 2014; Nagengast et al., 2011, 2013; Trautwein et al., 2012). Such findings indicated synergistic effects with the most positive effects on the respective outcomes when both expectancies and values were high (Nagengast et al., 2011; Trautwein et al., 2012). More recent person-centered approaches to expectancies and values also revealed that expectancy-value profile membership (e.g., high levels of self-concept, importance, and intrinsic value vs. medium to high levels of self-concept and importance but low levels of intrinsic value) predicted (STEM) course choice, grades, as well as career aspirations and choices (e.g., Gaspard et al., 2019; Lazarides et al., 2020; Perez et al., 2019), supporting the synergistic perspective on expectancies and values.

Contextual Antecedents of Expectancies and Values

SEVT proposes multiple antecedents of expectancies and values (e.g., Eccles et al., 1983; Eccles & Wigfield, 2020), which range from more proximal factors such as individuals' goals and prior experiences to more primal antecedents such as students' characteristics (e.g., gender) as well as social and cultural influences (depicted at the far left side of the SEVT model; see Figure 1). As the focus of this dissertation is on the educational context and the role it plays in the unfolding of students' expectancies and values, in the following, I focus my considerations on social and cultural influences and provide an overview of research findings on such primal antecedents of students' expectancies and values. Thus, I briefly capture the parental environment and then outline evidence related to the educational environment.

Research on contextual influences on expectancies and values has provided extensive support for Eccles' (2007) parent socialization model by proposing influences on children's motivation and achievement. Empirical findings have revealed that family-level demographic characteristics, including family socioeconomic status or migration status (e.g., Benner et al., 2008; Fredricks et al., 2005), but also parent academic motivation, parent involvement with and monitoring of children's schoolwork, parenting styles such as autonomy support, and parent-child interactions predicted children's development (e.g., Häfner et al., 2018; Raftery et al., 2012; for an overview, see also Wigfield et al., 2015). According to Eccles and Roeser (2015), characteristics that are typical of "good parenting" (e.g., autonomy support and a positive parent-child interaction) have a great deal in common with "good teaching," and consequently, many of the assumed and tested associations between parenting style and student motivation might be transferrable to the educational context.

In fact, in several overview articles, Eccles and Wigfield compiled ample evidence on the relevance of the educational context with a particular focus on teaching behaviors for the socialization of student motivation (e.g., Eccles, 1993; Eccles & Roeser, 2015; Eccles & Wigfield, 2020; Wigfield & Eccles, 2020). They listed social dimensions such as classroom instructions as well as the teacher-student relationship and classroom climate (i.e., comparable to parenting style and parent-child interactions) as relevant influences on student motivation (e.g., Wigfield et al., 2015). For instance, regarding classroom instructions, Wang and Eccles (2013) showed that students' perceptions of the school environment (i.e., school structure and instructional behaviors such as teaching for relevance and teacher emotional support, as well as peer emotional support) positively predicted students' academic self-concept and values, which were subsequently linked to their behavioral, emotional, and cognitive engagement. By and large, however, such work was often not grounded in SEVT (Eccles & Wigfield, 2020), even though SEVT itself offers rich concepts regarding the centrality of the educational context for the unfolding of students' expectancies and values. This is not to imply that no research has taken place in this respect—on the contrary, research on the association between the educational context and student motivation is plentiful (e.g., Reeve et al., 2002; Stroet et al., 2013; Wentzel, 2009, see also Section 1.2.1), although most of it has been embedded in other motivation or educational theories (e.g., in self-determination theory; Deci & Ryan, 1985; but see, e.g., Eccles, 2012; Lazarides, Dietrich, et al., 2019; Wang & Eccles, 2013). Following Eccles and Wigfield's own references in SEVT (see also Section 1.1.1) and following recommendations from Pintrich (2003), it might be necessary to link motivation theories to each other to gain a better theoretical understanding of motivation and its antecedents. Such an understanding could facilitate substantial empirical investigations into the ontogeny of motivation. Thus, in the next section, I present self-determination theory, control-value theory, and interest theories with the aim to enrich SEVT perspectives on the ontogeny and socialization of expectancies and values in the educational context.

1.1.3 Enriching SEVT with Concepts from Other Motivation Theories

Compared with classical expectancy-value theories (e.g., Atkinson, 1957; Feather, 1959; Vroom, 1964), SEVT was the first to define expectancies and values as being *situated in a social context* (Eccles & Wigfield, 2020). For instance, Eccles and her colleagues postulated a wide range of contextual antecedents of the unfolding of students' expectancies and values such as socializers' beliefs and behaviors and students' interpretations of such behaviors (Eccles et al., 1983). In subsequent years, much research has been dedicated to parent characteristics and behaviors and their effects on children's expectancies and values. However, work in the educational context as an antecedent of students' expectancies and values framed in SEVT has always been underdeveloped (Eccles & Wigfield, 2020).

As I will outline next, elaborate conceptualizations of the impact of teachers on students' motivation and the particular focus on need support and self-relevance (in self-determination theory, Deci & Ryan, 1985; Ryan & Deci, 2020), the introduction of a value-induction concept (in control-value theory, Pekrun, 2006), and an exceptional conceptualization of motivation based on its stability and context sensitivity (in interest theories, e.g., Krapp et al., 1992) may enrich our understanding of expectancies and values as defined in SEVT. Hence, as starting points from which the SEVT's understanding of expectancies and values in relation to the educational context could be theoretically substantiated, these three theories (self-determination, control-value, and interest theories) are the focus of the following section. Other motivation theories such as attribution theory (Graham, 2020; Graham & Williams, 2009; Weiner, 1986), self-efficacy theory (Bandura, 1986; Schunk & DiBenedetto, 2020; Schunk & Pajares, 2009), achievement goal theory (Dweck, 1986; Elliot, 1997; Maehr & Zusho, 2009), and many more are thus not discussed in this dissertation. For more information on such theories, however, interested readers may want to consult a comprehensive compilation of theories on motivation in school from Wentzel and Miele (2016). In the following, a particular strong focus is on self-determination theory because it is—alongside SEVT—a central theme of this dissertation that I come across over and again in the following chapters.

Self-Determination Theory

Self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2000b, 2020) is a widespread, ever-growing theory of human behavior and personality development. SDT takes on a decisive role alongside SEVT in this dissertation because it focuses on the *quality* instead of the mere intensity of motivation, the process of *internalization*, the concept of *self-relevance*, and most importantly, the concept of basic psychological *needs.* I first outline these central concepts in SDT. Subsequently, I present congruent and complementary aspects of SDT regarding SEVT, which may help enrich the understanding of how students' expectancies and values unfold in the educational context.

In the beginning, SDT focused exclusively on intrinsic motivation, but it was later extended and developed "brick by brick" (Ryan & Deci, 2019) into a theory that "examines how biological, social, and cultural conditions either enhance or undermine the inherent human capacities for psychological growth, engagement, and wellness" (Ryan & Deci, 2017, p. 3). According to Ryan and Deci (2019), a person's motivation can be categorized into the intrinsic motivation category or into its heterogeneous contrast category: extrinsic motivation (see Figure 2; Ryan & Deci, 2020). Intrinsic motivation encompasses the motive to doing something for its own sake and is supported by affective aspects of motivation such as curiosity, interest, and enjoyment (e.g., Ryan & Deci, 2019). Extrinsic motivation, on the contrary, is defined as so-called instrumental motivation, which is the motive to do an activity that is not an end in and of itself but rather a means to a desired end (i.e., achieving an outcome that is separable from the activity).

Similar to other motivation theories that treat motivation as a unitary entity (e.g., cognitive theories of motivation such as SEVT), the intensity of motivation is pivotal to whether a person shows a behavior. However—and this is unique to SDT—not only the intensity but particularly the quality of motivation is posited to determine the outcome that can be expected from a person's motivation. As can be seen in Figure 2, a person's motivation can be located on an *autonomy-control continuum* (Ryan & Deci, 2017), including intrinsic motivation and multiple facets of extrinsic motivation. The more the motivation tends to be on the intrinsic motivation end of the continuum, the more a behavior is postulated to be experienced as autonomous or self-determined by the person (i.e., of high quality). By contrast, the more the motivation tends to be at the far left end of the continuum, the more the activity is perceived as controlled or non-self-determined. The quality of motivation is assumed to go hand in hand with the quality of expected outcomes (Ryan & Deci, 2020).

The Process of Internalization. Intrinsic motivation is considered the hallmark of autonomous or volitional motivation (Vansteenkiste et al., 2018). The fine-grained nuances along the autonomy-control continuum covering extrinsic motivation display increasing approximations to intrinsic motivation. This is called the *process of internalization* (e.g., Ryan & Deci, 2000b, 2020). This process is characterized by the active assimilation of behavioral regulations that originate from outside a person to the person's self (Ryan, 1995). Though extrinsic motivation does not achieve the autonomous nature and quality of intrinsic motivation, it may become more or less internalized to, and thus in conformity with, one's self.

Figure 2

Overview of the Autonomy-Control Continuum with Different Types of Regulation in Self-Determination Theory (Adapted from Vansteenkiste et al., 2018[3]; Originally Based on Ryan & Deci, 2000a)

	Controlled ————			————	Autonomous
Type of motivation	Extrinsic motivation				Intrinsic motivation
Type of regulation	External regulation	Introjected regulation	Identified regulation	Integrated regulation	Intrinsic regulation
Motivational force	Commands, rewards, punishments	Guilt, shame, ego-involvement	Personal significance and value, relevance	Harmony and coherence with other values, commitment	Interest, enjoyment, curiosity
Internalization	Lack of internalization	Partial	Full	Fullest	Not required
Perceived self-relevance	Low	Medium	High	Very high	-

In SDT, there are multiple conditions under which individuals are assumed to be extrinsically motivated to perform an activity or task. Individuals are extrinsically motivated if they do an activity because they seek to obtain or avoid external consequences such as rewards or punishments (*external regulation*) or because they seek to experience ego-enhancing pride or to avoid anxiety (*introjected regulation*). These two forms of extrinsic motivation (external regulation and introjection) are assumed to represent controlled forms of motivation; they are assumed to be associated with low levels of feelings of self-determination and task interest and negative feelings such as pressure and tension.

[3] This figure was adapted from Vansteenkiste, Aelterman, de Muynck, Haerens, Patall, & Reeve (2018). Fostering personal meaning and self-relevance: A self-determination theory perspective on internalization. *The Journal of Experimental Education*, *86*(1), 30-49. Page No. 31, Copyright 2018, with permission from Taylor & Francis, LLC.

Furthermore, SDT proposes more self-determined forms of extrinsic motivation. Behavior that is perceived as being regulated by reasons that are somewhat internal to the person because the person identifies with the value of the behavior or activity, this behavior can be found to be personally meaningful, albeit not necessarily interesting (*identified regulation*). Finally, at the stage of the highest approximation to intrinsic motivation (i.e., the fullest form of internalization), an extrinsically motivated behavior can be caused by rationales for the behaviors that are fully assimilated into the self (*integrated regulation*). This form of extrinsic motivation requires the alignment of the behavior in question with appropriate ideas about the person's life goals and relationships. The reasons for doing a task are thus not only personally meaningful (as is the case for identified regulation), but the task has been brought into alignment with the individual's deeply anchored values or interests (Vansteenkiste et al., 2018). Just like intrinsic motivation, identified and integrated regulation represent autonomous forms of motivation (Ryan & Deci, 2020).

From an SDT perspective, it is desirable to achieve autonomous forms of motivation because they are associated with higher quality outcomes (e.g., higher levels of engagement, learning, and wellness; Ryan & Deci, 2020). Thus, initializing a process of internalization is central to self-determination theory. As I outline in the upcoming paragraphs, two aspects have to be taken into account for the successful initiation of an internalization process, namely, the role of self-relevance and basic psychological needs.

The Role of Perceived Self-Relevance. Vansteenkiste et al. (2018) emphasized that, in a very general sense, *all* extrinsically motivated activities may be important to individuals. However, the process of internalization depends on the degree to which an activity is *self*-relevant to the individual. This means that in order to internalize a behavior so that it becomes autonomously regulated, an individual needs to recognize, accept, and/or identify with the personal significance of said behavior. This concept of personal meaning and relevance is closely linked to the concept of the self. Thus, if an activity is perceived as being in harmony with achieving personal short- or long-term life goals, inner desires, and objectives; or when an activity is perceived as being in harmony with projected self-views and how one wants to be or sees oneself, then this activity is self-relevant to the individual. Vansteenkiste and his colleagues (2018) continued that "it is only when the activity is perceived to be self-relevant [...] that learners would start owning (i.e., internalizing) the behavior" (p. 33). Self-relevance is thus considered an important precondition for internalizing the regulation of an activity. Identified and integrated regulation have in common that learners need to identify with the personal relevance of the activity; thus, activities are perceived as self-relevant, which is why they entail a greater volitional commitment and are the closest approximations to intrinsic regulation.

The Role of Need Satisfaction. Many human behaviors do not spontaneously provoke inherent enjoyment or curiosity. Nevertheless, these behaviors are often still required. The actual engagement in behaviors that are not intrinsically motivated conflicts with three basic needs that are postulated in SDT, namely, the needs for autonomy, competence, and relatedness (Deci & Ryan, 2002). The process of internalization represents a stepwise rededication of controlled regulation—which contradicts need satisfaction—to a more self-determined, autonomous regulation of behaviors. Autonomous regulation is thus not only considered an approximation of intrinsic motivation, but it also moves a person toward the fulfillment of the human needs to act autonomously, to perceive competence, and to feel belongingness and connectedness with others. SDT thus posits that contexts that support feelings of autonomy, competence, and relatedness also support the adoption of more autonomous forms of extrinsic regulation, or in other words, they energize the process of internalization. That said, the presence of self-relevant rationales only leads to an initiation of an internalization process if individuals (a) are also provided a sense of volition, autonomy, and psychological freedom when engaging in the activity (satisfaction of the need for autonomy); (b) feel capable of engaging in the required behavior or mastering the required activity (satisfaction of the need for competence); and (c) feel a strong connectedness to the person interlinked with the required behavior (satisfaction of the need for relatedness; Vansteenkiste et al., 2018). In a nutshell, supporting students' needs for autonomy, competence, and relatedness allows students to actively transform values into their own, which means internalizing global relevance as *self-relevance* (Ryan & Deci, 2000b). Hence, teachers' behaviors that target students' needs could be beneficial for supporting students' autonomous motivation.

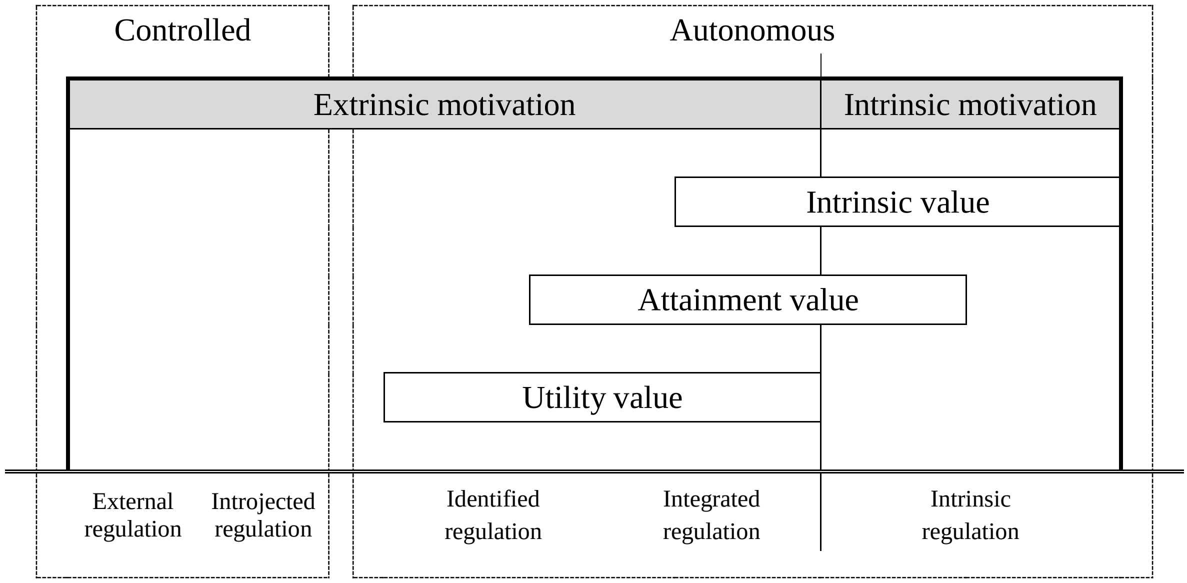
Congruent and Complementary Aspects of SDT Regarding SEVT. Even though SEVT and SDT developed their unique understandings and definitions of motivational constructs, namely, expectancies/values and intrinsic/extrinsic motivation, respectively, they still share some conceptual overlap (which sometimes also becomes apparent in jangle fallacies involving SEVT and SDT motivational measures, see, e.g., H. R. Lee et al., 2020; Wigfield & Cambria, 2010). This overlap offers the unique opportunity to identify *congruent* and *complementary* aspects of SDT and SEVT that may enrich our understanding of SEVT constructs and their ontogeny in the natural classroom setting.

Even though Eccles (2005) stressed that there are some fundamental differences in the underlying assumptions of SEVT and SDT (e.g., SEVT constructs jointly contribute to the cumulative value of a task, whereas intrinsic/extrinsic motivation depict two qualitatively opposing ends of the autonomy-control continuum), Eccles has tied SEVT values to Deci and Ryan's (1985) ideas of intrinsic/extrinsic motivation. According to Eccles, the nature of intrinsic value has a great deal of overlap with "internalized regulation" (p. 114), which covers intrinsic regulation in particular, but also to some extent integrated regulation. Attainment value with its notion of relevance for an individual's self and identity has the largest overlap with integrated regulation (Eccles, 2005), simultaneously flanking both intrinsic and identified regulation. Utility value covers the interesting intersection of being a means to an end rather than an end in and of itself, of reflecting the relevance of an activity for important goals that an individual holds deeply, and of the connection to personal goals and sense of self (Wigfield et al., 2009). Therefore, utility value unites features of identified and integrated regulation aspects. There is no counterpart for cost in SDT, nor are expectancies explicitly considered to be a component of motivation. However, it is possible to integrate intrinsic value, attainment value, and utility value into the SDT autonomy-control continuum as depicted in Figure 3. Thus, when applying SDT terminology to SEVT, the latter is concerned with individuals' autonomous motivation as it corresponds to the nature of choices. Analogous to intrinsic/extrinsic motivation and the process of internalization, increases in self-relevance may consequently entail increases in subjective task values (Priniski et al., 2018).

SEVT is particularly good in explaining students' choices, students' development of expectancies and values, and importance for their academic learning. However, SEVT's lacunae become apparent when diving deeper into the particular role of the school setting (e.g., the instructional context) for the unfolding of students' expectancies and values—the focus of the current dissertation. Yet this appears to be the explicit strength of SDT, which is why not only SEVT but also many other theories and domains in educational research explicitly borrow theoretical assumptions and processes regarding the school context from SDT (e.g., control-value theory, Pekrun, 2000; or the domain of teaching quality when it comes to the dimension of learning support; see Section 1.2 or, e.g., Klieme & Rakoczy, 2008; Praetorius et al., 2018). With the similarity of values and autonomous forms of motivation made explicit, it is worthwhile to consider mechanisms to support students' motivation as conceptualized in SDT, namely, the process of internalization, and to apply them to SVT constructs as well.

Figure 3

Integration of Subjective Task Values into the Autonomy-Control Continuum as an Expression of High Congruence between SEVT and SDT (for Analogous Considerations, see also Eccles, 2005)



When evaluating academic conditions that may support students' motivation, the SDT perspective on internalization—and, hence, the consideration of self-relevance (i.e., identification with the personal significance of an activity) and basic psychological needs (the needs for autonomy, competence, and relatedness)—is particularly important. Transferring these theoretical concepts to the perspective of SEVT, the focus on self-relevance points to the necessity to tie rationales to subjective perspectives and to support students' perceptions of self-relevance in order to support their values. Ultimately, self-relevance is proposed to initiate the process of internalization (i.e., to lead to a motivation with a high level of quality and to more value) and can be assumed to foster not only utility value (corresponding to identified and integrated regulation) but also attainment and intrinsic value (even corresponding in part to intrinsic motivation). In fact, a wide range of studies that tested so-called relevance interventions (e.g., Gaspard, Dicke, Flunger, Brisson, et al., 2015; see also Priniski et al., 2018, for an overview) showed that providing relevance arguments or stimulating students to self-generate relevance arguments supported students' utility value but also their attainment value, intrinsic value, and even their self-concept and performance in math (e.g., Brisson et al., 2017; Durik & Harackiewicz, 2007; Gaspard, Dicke, Flunger, Brisson, et al., 2015; Hulleman & Harackiewicz, 2009).

As I outlined above (see Section 1.1.3), a necessary precondition for making self-relevance arguments come into effect is the satisfaction of students' basic psychological needs for autonomy, competence, and relatedness (Deci & Ryan, 2002). Rooted in SDT, these basic needs can be fostered through adequate teaching behaviors, namely, by providing autonomy support and structure (Ryan & Deci, 2020). SDT provides concrete assumptions about (a) how student motivation can be promoted in school (through certain teaching behaviors) and (b) why these teaching behaviors affect student motivation (because they tackle students' basic psychological needs). Transferring these assumptions to SEVT constructs, it appears plausible that need-supportive teaching behaviors may facilitate the support of students' values as well. Though this assumption is also laid out in SEVT to a certain degree, the strong emphasis on need-supportive instructional contexts in SDT helps create greater awareness of its potential significance.

Control-Value Theory

In Section 1.1.1, I introduced the idea that situated expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2020) stems from a family of expectancy-value theories that have dominated school-related motivation research in the past few decades. Another expectancy-value theory is the control-value theory of achievement emotions (e.g., Pekrun, 2000, 2006), which focuses on the formation of emotions in educational settings. Though not explicitly considered a motivation theory, according to Pekrun (2006), achievement emotions are "seen as multi-component, coordinated processes of psychological subsystems including affective, cognitive, motivational, expressive, and peripheral physiological processes" (p. 316) directly tied to achievement activities, and thus, they have a certain proximity to classical motivation constructs. Achievement emotions can be conceptualized as momentary occurrences (e.g., test anxiety that occurs immediately before a math test) or as being habitual, recurring emotions (e.g., general test anxiety). In control-value theory, Pekrun (2006) postulated two groups of appraisals as proximal antecedents of students' achievement emotions in the classroom (*subjective control* over achievement activities and *subjective values* of these activities), which affect the manifestation of emotions in a certain situation (e.g., anxiety, confidence). Subjective control represents the extent to which students think they can master a situation (e.g., a math test), and subjective values indicate the extent to which students assign meaning to the situation (e.g., personal importance of doing well on the test).

According to control-value theory, aspects of the learning environment are seen as social and cultural antecedents of students' appraisals of control and value. These learning-environment-related antecedents include instructional quality, autonomy support, feedback and the consequences of achievement, achievement-related expectancies of significant others, as well as an induction of values (Pekrun, 2000, 2006). What stands out is, first, that analogous to self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2020), significant others such as teachers seem to play a highly significant role in the emergence of achievement emotions in the classroom (e.g., Becker et al., 2014; Frenzel et al., 2009, 2018; Goetz et al., 2019; Mainhard et al., 2018). Second, also analogous to SDT, autonomy support is explicitly stated as an antecedent of students' control and value perceptions. And third, over and above the mere influence of teaching behaviors (i.e., instructional quality, autonomy support, and feedback), features of significant others are explicitly listed as antecedents of control and value appraisals (i.e., the expectancies and values of others; Pekrun, 2000, 2006). For instance, in control-value theory, Pekrun (2000) explicitly proposed that teachers may "transmit" their achievement-related values to their students via the process of the induction of values.

Congruent and Complementary Aspects of Control-Value Theory Regarding SEVT. The concept of value induction is not completely new to situated expectancy-value theory (e.g., Eccles, 2007). In fact, with respect to Eccles' parent socialization model (Eccles, 2007), parents' beliefs and values are assumed to be expressed in their behavior toward their children, which, in turn, is proposed to affect students' own beliefs and values (see also Gniewosz & Noack, 2012; Jacobs & Eccles, 2000). Notwithstanding this congruent aspect, Eccles did not go so far as to assume similar induction or transmission processes from teachers to their students as Pekrun has done regarding emotions (Pekrun, 2000, 2006; see also, e.g., Frenzel et al., 2009, 2018). Thus, transferring Pekrun's complementary theoretical assumptions on value induction regarding emotions *from teachers to their students* to SEVT, it appears particularly appealing to investigate value transmission processes of SEVT constructs from teachers to their students as well.

Interest Theories

The concept of interest is as clear-cut and tangible (in everyday conversations) as it is also fuzzy and elusive (in scientific discourse). On the one hand, in everyday conversations, interest is a popular term, the meaning of which seems to be easily inferable for every interlocutor (e.g., "I am really interested in math"). On the other hand, in scientific discussions, interest seems to be interwoven with similar concepts such as intrinsic value (Eccles, 2005) or intrinsic motivation (Ryan & Deci, 2000b), leading to many different theoretical conceptualizations of the interest concept (see Renninger & Hidi, 2011, for an overview). Following the conceptual tradition from Krapp, Hidi, and Renninger (1992) as well as Schiefele (1991, 2009), interest is a relational concept that represents the unique relation between a person and an object (Krapp, 2002). It can be aroused either by situational stimuli or by relatively enduring preferences for certain objects (Schiefele, 1991). Interest develops out of novelty and complexity and an appraisal of coping potential (Silvia, 2005; see also Schiefele, 2009) rather than out of enjoyment. Interest reflects “the source of the activity’s value” (Eccles, 2005, p. 112) rather than the value itself (intrinsic value) or the motivation to engage in the activity that originates from it (intrinsic motivation). As such, interest can be understood as an antecedent of intrinsic value (or value in general) and intrinsic motivation. Furthermore, interest is commonly differentiated into two major conceptions: situational and individual interest (e.g., Hidi et al., 2004; Krapp, 2002; Schiefele, 2009). *Situational interest* can be described as an affective reaction or *state* and is primarily caused by external factors. *Individual interest*, on the other hand, is a relatively stable or enduring *trait*, that is, a tendency to engage with a certain object (Krapp, 2002). On the basis of these conceptualizations, interest theorists built new models concerning the development of interest from being situational to manifesting into a personal trait (e.g., the four-phase model of interest development; Hidi & Renninger, 2006). Without making it explicit, the integration of interest into the cosmos of motivation (in the early 1990s; Krapp et al., 1992) has simultaneously introduced the concept of states and traits into the field of educational psychology—concepts that had previously existed predominantly in personality and social psychology research (e.g., Eysenck, 1983; Nezlek, 2007; Roberts, 2018; Spielberger, 1966; Steyer et al., 1992, 1999). Despite the timid entry into education and motivation research, however, the concept of states and traits has not advanced much further in its triumphal journey.

Congruent and Complementary Aspects of Interest Theories Regarding SEVT. More recently, Eccles and Wigfield (2020) indicated that their definition of intrinsic value overlaps the most with situational interest because of their congruent foci on tasks. It could thus be possible that the idea of varying stability within one concept (reflected in situational and individual interest) could be transferred from interest theories to SEVT and could hence complement the understanding of expectancies and values and their stability and situation sensitivity. This idea is relatively new to SEVT, and only a little research has been done in this regard (e.g., Dietrich et al., 2017, 2019; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). By and large, it has yet to be determined whether expectancies and values are primarily constituted by affective spontaneous appraisals or instead reflect enduring individual characteristics (Rieger et al., 2017).

Recapping What Can be Learned from Other Motivation Theories

SEVT is a motivation theory that has historically focused primarily on effects of motivation on choices and has prioritized its investigative efforts on the primal antecedents of students' motivation as lying in the parent-child relationship. A glimpse at other motivation theories, namely, self-determination theory, control-value theory, and interest theories, allowed for the identification of potential starting points from which SEVT's understanding of expectancies and values in relation to the educational context could be theoretically substantiated and empirical research on the ontogeny of expectancies and values could be initiated. First and foremost, especially the outline of SDT exposed the idea that teachers' behaviors during instruction could be critical for the manifestation of students' expectancies and values. SDT particularly highlights the concept of self-relevance and corresponding need-supportive teaching behaviors. What has already been widely acknowledged in terms of relevance interventions that are grounded in SEVT (see also Section 1.3.3 and Priniski et al., 2018) still lacks a systematic examination from within the natural classroom setting, which is why I approach the concept of teaching (for self-relevance) as derived from SDT, its quality, and its impact on student motivation in the next section (1.2). Second, derived from control-value theory, another educational antecedent of students' expectancies and values could lie in the process of value transmission from teachers to their students via perceptible teaching behaviors (see also Section 1.3.2). And finally, taken from interest theories, a conceptualization of expectancies and values with regard to their stability (as an indicator of their context sensitivity) could deepen their understanding. Subsequently, linking this stability perspective to the impact of the natural classroom setting, sound knowledge about state and trait aspects of expectancies and values could facilitate the identification of the corresponding features of the educational environment that influence expectancies and values (see also Section 1.3.1).

1.2 Teaching Quality: Creating Conditions Under Which Students Can Motivate Themselves

In order to investigate the unfolding of students' motivation within the educational context, I place particular emphasis on teachers' behaviors during class. In the following, I first outline the conceptualization of teaching quality, including its three basic dimensions (cognitive activation, classroom management, and learning support; see also Section 1.2.1). The teaching quality dimension of learning support is particularly relevant for the undertaking of this dissertation because it has shown the broadest link to student motivation. Hence, I place particular emphasis on learning support and corresponding teaching behaviors, and I outline empirical evidence on its predictive power for student motivation. Finally, I discuss the measurement of teaching quality with the aim of choosing a referent to provide appraisals of teaching quality (1.2.2).

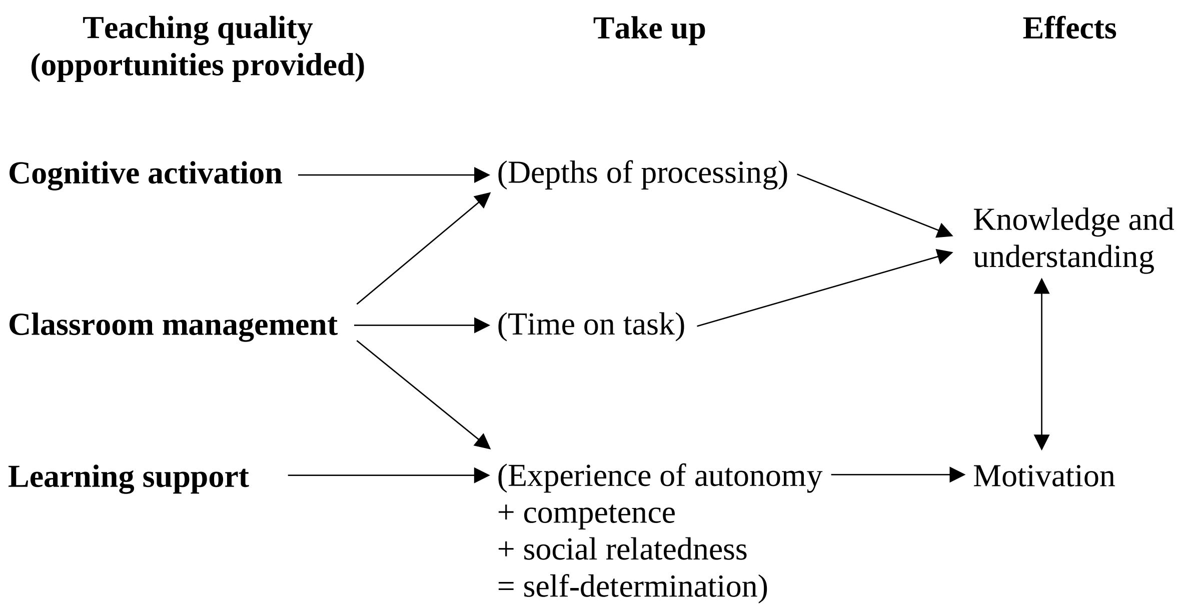
1.2.1 Conceptualization of Teaching Quality

Teaching is a complex endeavor, an "enterprise" (Hirst, 1971) that involves numerous activities. Optimally, good teaching leads to positive student outcomes. Consequently, research on teaching is driven by the question of its quality, that is, on the difference between good and poor teaching (Mujis & Reynolds, 2018). *Teaching quality* is widely understood and defined by the effectiveness of stable patterns of teaching behaviors and teacher-student interactions in facilitating desirable student outcomes such as student achievement (Weinert et al., 1989). Per definition, teaching quality is thus one of the major factors that influences student learning (for a subsequent meta-analysis of empirical support for this definitional claim, see Hattie, 2009). In the 1970s, 1980s, and 1990s, influential work by Brophy and Good (e.g., 1986; Good et al., 1975) shaped the field's view of effective teaching by generating lists of "effective teacher" characteristics. These lists included characteristics such as "clarity in teaching and in administrative routines," "class management that maximizes pupil attention," or "frequent feedback," all of which were seen as indicators of high teaching quality (taken from Mujis & Reynolds, 2018, pp. 1-2).

On the basis of these early beginnings of teaching quality research, educational researchers subsequently defined basic dimensions of teaching quality (e.g., Eccles & Roeser, 1999; Hamre & Pianta, 2010; Klieme et al., 2009; Klieme & Rakoczy, 2008; Pianta & Hamre, 2009; Stroet et al., 2013). Though their dimensions were for the most part defined independently from each other, considerable consensus remains with respect to three generic dimensions of teaching quality, which constitute the foundation of today's understanding of teaching quality in the field (Praetorius et al., 2017). These three basic dimensions of teaching quality are *cognitive activation*, *classroom management*, and *learning support* (see Figure 4; Klieme & Rakoczy, 2008). Klieme and Rakoczy chose a multicriterial approach to teaching quality and proposed their basic teaching quality dimensions, depending on the capacity to which they achieve understanding, attentiveness, and motivation in students, respectively (see also Diederich & Tenorth, 1997). Due to its pronounced relation to student motivation, I place particular emphasis on learning support in the following after briefly describing cognitive activation and classroom management.

Figure 4

Basic Dimensions of Teaching Quality and Their Proposed Effects on Student Learning and Motivation (Adapted from Klieme & Rakoczy, 2008[4])



Cognitive Activation and Classroom Management

Cognitive activation refers to teaching behaviors that are aimed at facilitating students' higher level thinking and is therefore similar to teaching for understanding (Cohen, 1993). It is based on constructivist learning theories (Staub & Stern, 2002) and has primarily been defined

[4] This figure was adapted and translated from Klieme & Rakoczy (2008). Empirische Unterrichtsforschung und Fachdidaktik. Outcome-orientierte Messung und Prozessqualität des Unterrichts. *Zeitschrift für Pädagogik*, *54*(2), 222-237. Page No. 228, Copyright 2002, with permission from the first author, Eckhard Klieme.

in correspondence with the educational context in math class. Consequently, teaching that encourages discussion and stimulates students' prior knowledge is assumed to facilitate the acquisition of conceptual mathematical knowledge (rather than just computing routines). In contrast to instruction that merely promotes the numbers of discussions and prior knowledge acquisitions per se, however, cognitive activation is characterized by the ability to encourage cognitive activity during these discussions or to the "degree to which they [the discussions] promote appropriate cognitive processing" (Mayer, 2004, p. 17). Successful cognitive activation is primarily associated with gains in student knowledge (e.g., Baumert et al., 2010; Fauth et al., 2014; Förtsch et al., 2016).

Classroom management is probably one of the best established dimensions of teaching quality and has been researched for decades (for a historical overview, see Brophy, 2006a). Widely shaped by Kounin's (1976) work, classroom management represents teaching behaviors concerning the management of students' behaviors, use of time, and attention focus in the classroom (Hamre & Pianta, 2010). Kounin paved the way for an understanding of classroom management as a necessary tool for preventing disturbances in the classroom (rather than reacting to disturbances after they already came to pass). It can be characterized by features such as "withitness," overlapping, group focus, or movement management. Classroom management was found to be beneficial not only for students' achievement outcomes but sometimes even for their motivation (e.g., Dorfner et al., 2018; Fauth et al., 2014; Kunter & Baumert, 2006; Schiefele, 2017; but see also Korpershoek et al., 2016, who found no effects on motivation in a meta-analysis).

Learning Support

Learning support (or supportive climate) is often described as the teachers' provision of a nurturing and supportive emotional environment (Hamre & Pianta, 2010), including the overall emotional tone and a genuine concern and respect for the students and their feelings (e.g., Aldrup et al., 2018; Wentzel, 2009; Wentzel et al., 2017). Thus, teaching behaviors are referred to as being supportive of learning if they represent an endeavor to respond to the students' needs and perspectives during class (Klieme & Rakoczy, 2008; Praetorius et al., 2017). This need-supportive perspective on learning support is widely embedded in and derived from self-determination theory (Deci & Ryan, 1985; for references to SDT with regard to learning support, see, e.g., Klieme & Rakoczy, 2008; Pianta & Hamre, 2009; Praetorius et al., 2018) and comprises a variety of distinct strategies and behaviors. Learning support can thus be understood as the connective link between motivational science and teaching quality research.

Both research fields evolved multiple subdimensions of learning support (in the field of teaching quality research; e.g., classroom climate, teacher sensitivity, and teachers' regard of student perspectives, Hamre & Pianta, 2010) or autonomy support (in the field of motivation research; e.g., providing meaningful rationales, nurturing students' inner motivational resources, acknowledging students' perspectives and feelings, offering choices, and using noncontrolling language, Su & Reeve, 2011). Research investigating the significance of learning support for student motivation has typically focused on either of these groups of subdimensions or on some composite measures (Dietrich et al., 2015; Rakoczy et al., 2008; Schenke et al., 2018; Su & Reeve, 2011; Wentzel, 2009; Wentzel et al., 2017). Other than cognitive activation and also classroom management,[5] learning support during class has been proposed (and empirically supported) to be linked to students' school adjustment, academic emotions, and achievement (Aldrup et al., 2018; H. Lei et al., 2018; Wagner et al., 2016), and most importantly, to students' motivation (e.g., Klieme & Rakoczy, 2008; Stroet et al., 2013). Hence, learning support is central to motivation, and thus, in the following, I delve deeper into its conceptualization. As this dissertation is particularly influenced by motivation research, I focus primarily on learning support as conceptualized from a self-determination perspective, focusing on the construct of autonomy support and its subdimensions. Furthermore, in this dissertation, I refer to concrete behavioral manifestations of learning support/autonomy support as motivational teaching behaviors and outline the most auspicious behaviors for supporting students' motivation in the following.

Autonomy support refers to a person's behaviors that enable the person to identify, nurture, and develop students' inner motivational resources (Reeve, 2009) by promoting (a) optional choice and a lack of coercion as well as (b) the formation and realization of an "inner compass" (i.e., "authentic, direction-giving values, goals, and interests"; Assor, 2012, p. 421). More broadly, autonomy support is seen as critical for an internalization process (Vansteenkiste et al., 2018), eventually leading to higher quality motivation (Ryan & Deci, 2020). Autonomy support can further be divided into multiple subdimensions. For instance, teachers can create an autonomy-supportive climate if they provide meaningful rationales, nurture the students' inner motivational resources, acknowledge perspective and feelings, offer choices, and make

[5] Even though classroom management is very likely a necessary condition for creating conditions under which students can motivate themselves, it is probably not sufficient for doing so. It therefore takes more of a secondary role (though still a relevant one) than being at the heart of motivation research and is thus not the focus of this dissertation.

use of noncontrolling language (see Assor, 2012; Su & Reeve, 2011, for overviews). An impressive body of research, including experimental studies, has stressed the importance of teachers' autonomy-supportive behaviors for students' motivation, expectancies, and engagement (e.g., Assor et al., 2002; Furtak & Kunter, 2012; Patall et al., 2008; Patall, Hooper, et al., 2018; Reeve et al., 2004; Reeve & Jang, 2006; Roth et al., 2007; Steingut et al., 2017; Stroet et al., 2015; Vansteenkiste et al., 2012), whereas some indicators of autonomy-support or motivational teaching behaviors turned out to be particularly critical for student motivation in research that was based on self-determination theory and beyond.

First, more recent research (e.g., Steingut et al., 2017; Vansteenkiste et al., 2018) has greatly stressed the **provision of authentic or meaningful rationales** as a subdimension of autonomy support because not only does it serve the purpose of satisfying students' inherent need for autonomy, but it also emphasizes the self-relevance of an activity for the students. This strategy comprises verbal explanations on the relevance and importance of a task for the students' current and future lives, thereby demonstrating the direct usefulness of the behavior for satisfying students' inner needs and goals (Su & Reeve, 2011). When students have the impression that their teachers provide meaningful rationales for why it is important to engage in a task, they seem to feel less coerced (e.g., Assor, 2012), value the subject more even after controlling for the students' initial values (e.g., Schmidt et al., 2019; Schreier et al., 2014), and show more intrinsic motivation, higher effort, and higher engagement (e.g., Assor et al., 2002; Lazarides & Rubach, 2017; Reeve et al., 2002; for a meta-analysis of experimental studies, see also Steingut et al., 2017). The provision of meaningful rationales has also found appreciation in the field of teaching effectiveness where it attracted attention, for instance, in the use of everyday life examples (Freudenthal, 1968; Rakoczy et al., 2008; van den Heuvel-Panhuizen & Drijvers, 2014).

Second, particular emphasis has been placed on the **nurturing of students' inner motivational resources** because it represents the core concern of autonomy support. According to Assor (2012), it is critical for students' motivation that teachers and parents persuade students not only of the relevance of an activity but also of other inherent values (e.g., enjoyableness) by demonstrating and exemplifying that such activities are indeed enjoyable or intrinsically worthy to students. Consequently, students would not feel coerced to adopt these values or behaviors but would automatically *want* to adopt them. Derived from teaching effectiveness research (e.g., Kunter & Holzberger, 2014), there is one concrete teaching behavior that has been emphasized over and over again as one such way to make content enjoyable: teachers' ability to teach enthusiastically (e.g., Brophy & Good, 1986; Frenzel et al., 2009, 2018; Keller, Goetz, et al., 2014; Kim & Schallert, 2014; Kunter et al., 2008, 2013; B. C. Patrick et al., 2000; H. Patrick et al., 2003; see also Keller et al., 2016, for an overview). Teachers' enthusiastic teaching reflects both a nonverbal expressiveness (e.g., using vivid facial expressions; often considered in terms of the so-called Dr. Fox effect, e.g., Frenzel et al., 2019; Marsh & Ware, 1982; Ware & Williams, 1975) and a teaching style that is lively, dynamic, and engaging (e.g., Brophy & Good, 1986; see also Keller et al., 2016). Not only is enthusiastic teaching suspected to be an element of supportive classroom climates (H. Patrick et al., 2003; Turner et al., 2002), but it was also found to be the only one out of nine teaching behaviors (e.g., clarity, enthusiasm, and rapport) that could distinguish highly from moderately rated college teachers in a study on teaching effectiveness by H. G. Murray (1983). Enthusiastic teaching has furthermore repeatedly been found to be positively associated with students' interest, intrinsic motivation, and intrinsic value (e.g., Frenzel et al., 2010; Keller, Goetz, et al., 2014; T. Kim & Schallert, 2014; Lazarides et al., 2018; Lazarides, Gaspard, et al., 2019; B. C. Patrick et al., 2000).

Third, in line with subdimensions postulated in research on teaching quality (regard for student perspective; e.g., Pianta & Hamre, 2009), Assor (2012) and others (for an overview, see Su & Reeve, 2011) stressed the **acknowledgment of perspectives and feelings** as another relevant aspect of autonomy support because it simultaneously also targets students' need for relatedness. This subdimension comprises the teachers' efforts to take the perspectives of their students, empathize with their students' feelings, and support their students emotionally. Teachers who engage in practices that demonstrate genuine concern and respect for their students and a desire to understand their students' feelings and perspectives are supportive of students' motivation and engagement (e.g., Cooper, 2014; H. Patrick et al., 2007; Song et al., 2015; Wentzel, 2009; Wentzel et al., 2017). This subdimension of autonomy support and learning support has also been referred to as emotional support and was found to predict students' interest and social goal pursuit (e.g., Wentzel et al., 2010).

Taken together, teaching quality fundamentally shapes students' lives in school. Though all of the dimensions constituting teaching quality are relevant for student learning, the teaching quality dimension of learning support appears to be particularly relevant when investigating teaching as an educational antecedent of the unfolding of students' expectancies and values. However, to examine whether and how teaching behaviors such as autonomy support come into effect (see Section 1.3), it is indispensable to decide which perspective teaching quality should be assessed from. As I outline next, the choice of referent has to be chosen carefully because it is inevitably linked to the research question of interest.

1.2.2 Choosing a Referent for Teaching Quality Assessments

Researchers draw on different sources of information to assess teaching quality such as information from the perspectives of (a) the teacher, (b) the student, (c) or an observer (Turner & Meyer, 2000). The teacher and student perspectives have been the most widely considered referents because they directly draw on information from the individuals who are involved, whereas observer ratings are often criticized because it might simply not be adequate to base global teaching quality appraisals on only one or a few occasions (which typically goes hand in hand with observer ratings; e.g., Brophy, 2006b; Clausen, 2002; but see Praetorius et al., 2014). Therefore, in the following, I focus on similarities and differences between student and teacher ratings as the most important referents for assessing teaching quality.

Even though the teacher and student perspectives are the core sources of information, their strengths and limitations are often the subjects of discussions, primarily because of low-to-moderate associations between referent-specific measures that are found over and over (e.g., Clausen, 2002; Fauth et al., 2014; Kunter & Baumert, 2006). For instance, Clausen (2002) showed that the correlations between teacher and student ratings of different teaching quality indicators in the German TIMSS 1995 video data (Baumert et al., 1997; Beaton et al., 1996) ranged from r = -.28 to .42 with an average of r = .16. Roughly similar findings were found in subsequent studies (for an overview, see Fauth, Göllner, et al., 2020). More precisely, whereas correlations among objectively observable behaviors such as classroom management seem to be relatively high, correlations among other indicators of teaching quality were found to be relatively low (i.e., cognitive activation and learning support; e.g., Kunter & Baumert, 2006). What seems to be an indicator of low psychometric quality for the respective rating perspective measures, however, could simply be an indicator of a differential *fit* of the respective perspectives to different research questions (potentially because teachers and students tend to base their appraisals of teaching quality on different perceptions and information; for an analogous argument, see Kunter & Baumert, 2006). This means that the teacher perspective might be more adequate for some research foci and the student perspective for others. In fact, different referent ratings of teaching-quality indicators had differential predictive power depending on the outcome of interest (e.g., student ratings were more predictive of students' motivation than observer ratings were; De Jong & Westerhof, 2001). Thus, it might be necessary to determine which source of information (i.e., which referent) is most adequate for the research question of interest (e.g., the association between motivational teaching behaviors and student motivation) rather than determining a general, objectively best referent (Clausen, 2002, p. 188).

A closer look at the particular strengths and limitations of both perspectives will help to identify the "best fitting" referent for the current aim to investigate associations between teaching-quality dimensions and student motivation. Teacher and student ratings are certainly subject to idiosyncrasies (Clausen, 2002; De Jong & Westerhof, 2001; Göllner et al., 2018, 2020; Kunter & Baumert, 2006), might reflect different understandings of the same construct even when using similar or parallel item wordings across the two perspectives (Kunter & Baumert, 2006), potentially emerge from different reference periods when asked to appraise teaching "in general" (for an analogous argument, see Clausen, 2002; and Wagner et al., 2016), are threatened by actor-observer biases (Lay et al., 1974; for an analogous argument, see Kunter & Baumert, 2006), and might additionally be affected by teaching ideals and self-serving strategies (teacher ratings; e.g., Wubbels et al., 1992; but see Kunter & Baumert, 2006) or teacher popularity and grading leniency (student ratings; e.g., Fauth et al., 2018; Griffin, 2004). However, at the same time, students are referred to as "experts on different modes of teaching" (Kunter & Baumert, 2006, p. 232) because they experience the same teachers over and over (within each school year and each subject) while simultaneously also being exposed to a variety of teachers (across subjects and also within the same subjects but across time). In fact, student ratings might be more important for their individual development (Clausen, 2002) because their subjective interpretations can be assumed to be focal for their inner attitudes and behaviors rather than any kind of objective indicator (for a similar argument, see Lüdtke et al., 2009). In the current dissertation, I am primarily interested in individual processes related to the ontogeny of motivation in the educational setting. Even though teacher ratings might be more adequate when one is interested in constructs that require an understanding of pedagogy (Clausen, 2002), the consideration of student ratings appears most auspicious regarding the investigation of the social (instructional) context as an indicator of conditions under which students can motivate themselves.

1.3 How do Motivational Teaching Behaviors Come into Effect?

In the previous section (1.2), I outlined the crucial role that motivational teaching behaviors play in creating conditions under which students can motivate themselves in the natural classroom setting. Thus, the previous section placed the present dissertation at the heart of the intersection between motivational science and research on teaching quality. However, theorizing on the interplay of motivation and teaching calls for even more substantiated insights into key operating principles underlying the impact of teaching on motivation. Drawing on well-established theoretical frameworks (e.g., Deci & Ryan, 1985; Eccles et al., 1983; see also Hall & Lindzey, 1957; Vansteenkiste & Mouratidis, 2016; and particularly Pintrich, 2003), I raise three key substantive questions that reflect current and future directions in this intersection of motivation and teaching in the educational setting: (1) *How consistent are motivational teaching behaviors?*, (2) *What are the antecedents of motivational teaching behaviors?*, and (3) *What are other external sources that target students' motivation and tend to accompany motivational teaching behaviors in the educational setting?*

Examining these questions follows the endeavor to identify conditions under which the effects of motivational teaching behaviors on student motivation could be (even more) pronounced. In the following, I elaborate on each of these questions from a particular motivational science perspective in line with the three concepts I identified in Section 1.1.3. These concepts come from interest theories (stability), control-value theory (value transmission), and self-determination theory (need support and self-relevance).

1. How consistent are motivational teaching behaviors?

The question of the consistency of constructs is fundamental to psychological research (Bloom, 1966; Conley, 1984). Previous research compiled convincing insights into different dimensions of the consistency of teaching-quality dimensions, which generated knowledge about the conditions under which these teaching behaviors might come into effect. These investigations have focused, for instance, on the consistency of appraisals of teaching quality and motivational teaching behaviors across differently pronounced compositions of classes with respect to students' gender and ethnicity (e.g., S. L. Campbell & Ronfeldt, 2018; Göllner et al., 2020). Other investigations have focused on the consistency of teaching quality and motivational teaching behaviors with respect to the consistency across classes and school subjects (e.g., Fauth, Wagner, et al., 2020; Gaertner & Brunner, 2018; X. Lei et al., 2018; Praetorius et al., 2016; Wagner et al., 2013), grade levels (e.g., Fauth, Wagner, et al., 2020; Gaertner & Brunner, 2018), the point of time during the school year (e.g., Wagner et al., 2016), or the experience level of the teachers (e.g., from the teacher education year until the first 2 years of professional practice; Malmberg et al., 2010).

When enriching the perspective on the consistency of motivational teaching behaviors with concepts from previously introduced interest theories (1.1.3), another aspect of the consistency of teaching behavior appears worthy of attention. More precisely, interest theories introduced the concept of consistency over time or *stability* to the world of motivation research (e.g., Hidi & Renninger, 2006; Knogler et al., 2015; Krapp, 2002; Schiefele, 2009), assuming that interest (and, thus, potentially motivation in general) brings together time-consistent components that are relatively stable within individuals, as well as highly fluctuating and occasion-specific components that vary across time. However, if student motivation varies from situation to situation and is simultaneously influenced by teachers' behaviors during instruction—does this consequently indicate that motivational teaching behaviors might "work" immediately in the moment rather than in the long run through consistently high levels? Investigating the stability of motivational teaching behaviors themselves as well as the "immediacy" of relations between motivational teaching behaviors and student motivation could provide further insights into how motivational teaching behaviors come into effect.

2. What are the antecedents of motivational teaching behaviors?

Identifying antecedents of motivational teaching behaviors could facilitate a better understanding of how they come into effect with regard to student motivation. Previous research has often and intensively investigated antecedents of teaching quality in general. For instance, compiled under the so-called Bright Person Hypothesis (e.g., Kennedy et al., 2008) and the Knowledgeable Teacher Hypothesis (Anderson et al., 1995; Shulman, 1987), aptitude-focused and knowledge-focused explanations for high teaching quality have been contrasted in the past. More recently, Kunter and colleagues (2013; see also Baumert & Kunter, 2013) proposed the concept of professional competence to overcome both of these relatively restricted approaches to antecedents of teaching quality. According to Kunter and her colleagues (2013), in addition to teachers' beliefs and self-regulation skills, teachers' motivational orientations represent a crucial aspect of their professional competence and are thus an important determinant of teacher success.

For the intersection of motivational science and teaching quality, however, a profound understanding of antecedents of motivational teaching behaviors (in contrast to teaching quality in general) must be developed. Drawing on the concept of value induction/transmission as introduced by control-value theory (e.g., Pekrun, 2000), teachers' emotions are assumed to be transmitted to students' emotions via perceptible behaviors. Transferring this concept to motivation, teachers' motivation might represent a pivotal antecedent of motivational teaching behaviors that can eventually explain the conditions under which the effect of motivational teaching behaviors on students' motivation could be even more pronounced. This triad—teacher motivation, perceptible behaviors, student motivation—is also the focus of research that is grounded in teaching effectiveness. For instance, Goe (2007) proposed a framework within which teacher characteristics (e.g., attitudes, attributes, beliefs, self-efficacy, race, and gender, but also teacher qualifications) are seen as *inputs* leading to *processes* within the classroom (i.e., teaching behaviors as indicators of teaching quality), which, in turn, lead to student *outcomes* (e.g., student achievement or student motivation). Thus, identifying inputs or antecedents of motivational teaching behaviors could facilitate a better understanding of how they come into effect with regard to student motivation. As a logical consequence, teacher characteristics that facilitate motivational teaching behaviors (and consequently affect the impact of motivational teaching behaviors on students' motivation) should be the focus of future research at the intersection of research on teaching and motivation.

3. *What other external sources that target students' motivation accompany motivational teaching behaviors in the educational setting?*

Motivational teaching behaviors take effect in the natural classroom setting and thereby do not operate in a contextual vacuum. Rather, current work points to the interdependency between teaching behaviors and its surrounding contextual factors. Beyond teachers' own characteristics (see previous question), contextual factors such as the composition of the class (e.g., Hornstra et al., 2015; Trautwein, Lüdtke, Marsh, et al., 2006), characteristics of the school (e.g., Fan & Williams, 2018; Scherer & Nilsen, 2016), or the cultural milieu (e.g., Halimi et al., 2020) accompany teachers' behaviors in the classroom. Consequently, effects of motivational teaching behaviors might be affected by these corresponding external sources, which could affect students' motivation in and of themselves.

Drawing on mechanisms posited by SDT, when determining the effect of motivational teaching behaviors on students' motivation, other external sources that target students' motivation through similar mechanisms (e.g., targeting self-relevance and satisfying students' basic psychological needs for autonomy, competence, or relatedness; see also Section 1.1.3) have to be taken into account. The concept of self-relevance is already widely implemented in terms of so-called relevance interventions, which were found to be supportive of students' motivation (for an overview, see Priniski et al., 2018). Relevance interventions seek to help participants see a connection between the subject matter or a task and their personal lives. They are typically developed on the basis of motivation theories and capitalize on psychological processes in order to help students see the self-relevance in certain tasks, topics, or even domains (and thus, can mostly be categorized as social-psychological or "wise" interventions; Yeager & Walton, 2011).

To date, research on teaching quality and its effects on student motivation as well as research on interventions that are aimed at supporting student motivation have been pursued largely independently. Given the mechanisms both motivational teaching behaviors and relevance interventions capitalize on, however, they can be seen as concurrent forces in the educational setting. It is largely unknown whether such different factors that reach (at least in part) for similar processes boost their respective effects or can at least compensate for each other; in the worst case, they might potentially even undermine the respective effects. Given this threat to student motivation, and given that, in recent decades, relevance interventions have been found to be particularly appealing for affecting students' average motivation in school (for overviews, see Harackiewicz et al., 2014; Lazowski & Hulleman, 2016; Priniski et al., 2018), the joint effects of motivational teaching behaviors and relevance interventions should be investigated further.

Taken together, the pursuit of the aforementioned three key substantive questions will further the understanding of how motivational teaching behaviors come into effect. Overall, they facilitate the development of:

1. an understanding of the consistency of motivational teaching behaviors, for instance, by examining the stability of motivational teaching behaviors and student motivation and their in-the-moment relation (see 01.3.1),
2. an understanding of the factors that affect motivational teaching behaviors, for instance, by examining teacher motivation as an antecedent of motivational teaching behaviors as already laid out in the concept of value transmission (see 1.3.2),
3. an understanding of other external factors that impact student motivation in the educational setting and that accompany motivational teaching behaviors, for instance, by examining the joint effects of motivational teaching behaviors and externally

imposed relevance interventions on students' motivation because they both capitalize on the concepts of need satisfaction and self-relevance (see 1.3.3).

In the following, I elaborate on the consistency of motivational teaching behaviors, on the antecedents of motivational teaching behaviors, and on factors accompanying motivational teaching behaviors and also impact students' motivation.

1.3.1 Consistency of Motivational Teaching Behaviors: Stable Versus One-Time Beneficial Conditions

Most recently, Eccles and Wigfield (2020) relabeled the expectancy-value theory of achievement-related choices as the situated expectancy-value theory. Thus, in line with other conceptualizations of motivation components, they argue that such components are situative in nature (e.g., situational interest; Schiefele, 2009, see also 1.1.3). Indeed, in the recent past, motivation research has gradually been developing an understanding of the consistency of motivational constructs over time and has pointed to their situation specificity (e.g., Dietrich et al., 2017; Patall et al., 2016; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). This situation specificity of motivation implies a certain *sensitivity* or susceptibility of motivation to situational conditions. Consequently, this raises the question of whether environmental features such as motivational teaching behaviors might come into effect situation-specifically, subsequently pointing to potential processes (e.g., immediacy) underlying the interrelation of motivational teaching behaviors and student motivation. For instance, motivational teaching behaviors could turn out to be most effective in terms of their stable components over time; at the same time, when certain lessons are perceived as particularly motivating, this could turn out to be even more supportive of students' motivation, irrespective of the typical level of motivational teaching behaviors during class.

In the following, I thus outline previous findings on the situation specificity of motivational constructs as well as of motivational teaching behaviors and their in-the-moment associations. Finally, I address two missing puzzle pieces in current research on the situation specificity of the association between motivational teaching behaviors and student motivation, which may enable a sophisticated investigation of the consistency of motivational teaching behaviors and their situation-specific impact.

Situation Specificity of Student Motivation

In their four-phase model of interest development, Hidi and Renninger (2006) posited that situational interest and individual interest (Krapp, 2000; Krapp et al., 1992; Schiefele, 2009, see also Section 1.1.3) can be further differentiated and embedded into a continuum of interest development ranging from triggered interest to well-developed interest. With gradually developing interest, they assumed that interest is less affected by environmental features such that *triggered* and *maintained situational interest* are assumed to be typically (but not exclusively) externally supported; that *emerging interest* requires some external support, but is typically (but not exclusively) self-generated; and that *well-developed individual interest* is typically (but not exclusively) self-generated whereby it still benefits from external support (Hidi & Renninger, 2006). However, when a person is asked for their current interest, this state of interest (or in-the-moment response) can carry information about both the situation (therefore being externally supported) and the individual person (therefore being internally supported and a manifestation of individual interest to a certain extent; see Knogler, 2017; for the same argument from latent state-trait theory, see Steyer et al., 1992, 1999).

Interestingly, this perspective has been widely supported by research findings on the stability or consistency of interest over time. For instance, Patall et al. (2016) found that 46% of the variance in **interest** was explained by occasion-specific factors in their study, Knogler et al. (2015) found that 46-62% was accounted for by occasion-specific factors, and Tanaka and Murayama (2014) showed that even 70% of the variance in interest could be attributed to occasion-specific factors in their study. Beyond interest, for other motivational constructs, too, a distribution that speaks of a substantial proportion of situation specificity between situation-specific and time-consistent factors was found. In terms of SEVT constructs, scholars found that occasion-specific factors accounted for 20-36% (Rieger et al., 2017) and 73-75% (Dietrich et al., 2017) of the variance in students' **expectancies.** They furthermore explained 36-45% (Tsai, Kunter, Lüdtke, & Trautwein, 2008), 45-52% (Rieger et al., 2017), and 45-82% (Dietrich et al., 2017) of the variance in students' **values**. Furthermore, Nett et al. (2017) found that occasion-specific factors accounted for 51% of the variance in **enjoyment**, and Moeller et al. (2016) found that 80% of the variance in **passion** was explained by an occasion-specific factor.

Taken together, findings regarding motivational constructs in general—but SEVT constructs, in particular—seem to speak of substantial situation specificity in motivation, though they are relatively inconsistent to date. In light of Eccles and Wigfield's (2020) recent emphasis on the situative nature of these constructs, more research on the situation specificity of expectancies and values is needed. However, notwithstanding these inconsistencies, the findings suggest that a wide range of variance in motivational constructs can be explained by time-invariant proportions of variance (e.g., relatively stable differences between individuals) and equally suggest a substantial situation specificity of motivational constructs. In some of the studies, the variance in motivational constructs was even widely explained by the person-in-the-situation rather than by stable differences between people (e.g., Dietrich et al., 2017; Moeller et al., 2016; Tanaka & Murayama, 2014).

As a consequence, environmental features that affect students' motivation in a situation must (a) encompass situation-specific factors (which vary to a great extent across situations) and (b) operate on a situation-specific basis. If motivational teaching behaviors disclose a certain situation specificity and reveal in-the-moment associations with students' motivation, this could offer initial hints about the operating mode of motivational teaching behaviors concerning their immediacy in supporting student motivation. Thus, in the following, I discuss the potential situation specificity of motivational teaching behaviors. This refers to the question of whether teachers' teaching behaviors appear to be largely consistent across time or whether their teaching behaviors vary a great deal from lesson to lesson.

The Situation Specificity of Motivational Teaching Behaviors

Analogous to interest theories in motivational science, scholars in the field of teaching quality have consistently assumed that teaching behaviors and consequently teaching quality—though certainly somehow consistent over time—might also vary across tasks, situations, subjects, and classrooms (e.g., Curby et al., 2011; Hamre & Pianta, 2005; Pianta et al., 2012; Pianta & Hamre, 2009; Praetorius et al., 2014; Seidel & Prenzel, 2006; Wagner et al., 2016). For instance, Curby and colleagues (2011) found that differences in teaching quality appraisals depended on the topic of the lesson, and this difference additionally seemed to depend on the dimension of teaching quality that was focused on (Praetorius et al., 2014). Thus, analogous to in-the-moment responses concerning students' interest, students' in-the-moment appraisals of teaching quality probably contain occasion-specific perceptions of teaching quality (which differ because of the specific task teachers are working with or because of the specific day, time, or other factors). In fact, Wagner et al. (2016) found that 38-69% of the variance in students' perceptions of **classroom management** and **goal clarity** and 44-74% of the variance in students' perceptions of **autonomy support** could be attributed to occasion-specific factors at the individual and class levels. Similar results were found regarding autonomy support, for which the occasion-specific factors explained 36-58% (Tsai, Kunter, Lüdtke, Trautwein, et al., 2008), 39-56% (Patall, Steingut, et al., 2018), and 45% (Patall, Hooper, et al., 2018) of the total variance in perceptions of autonomy support. Finally, Keller et al. (2018) showed that an occasion-specific factor accounted for 28% of the class-level variance in **enthusiastic teaching** as perceived by the students. Taken together, analogous to motivational constructs, students' appraisals of motivational teaching behaviors also seem to differ not only between individuals but also to a substantial extent from lesson to lesson. Findings on the stability of motivational teaching behaviors somehow appear even more consistent than on motivational constructs such as expectancies and values. Overall, a moderate proportion of the variance in students' perceptions of motivational teaching behaviors seemed to be accounted for by occasion-specific factors. Complementing findings that were based on between-person variation (as reported in Section 1.2.1), investigations into the situation specificity of perceptions of autonomy-supportive teaching behaviors revealed that high autonomy support in a situation as perceived by the students as well as the provision of meaningful rationales, choices, and responsiveness to student questions was associated with simultaneously high motivation and engagement within the same students and situations (e.g., Patall et al., 2016; Patall, Hooper, et al., 2018; Patall, Steingut, et al., 2018; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008; Wagner et al., 2016; Yu & Levesque-Bristol, 2020; see also Goetz et al., 2019).

So far, I have drawn a picture that represents both motivational teaching behaviors and student motivation as being situation-specific to a certain extent. Additionally, previous research findings have suggested that situation specificity is interrelated—thus, motivational teaching behaviors might come into effect through a direct immediacy. This means that the general level of teaching quality or the general level of motivational teaching behaviors within a class might be imperative for the unfolding of students' motivation—but that situational outliers such as particularly inspirational instructional hours or low points might additionally contribute to students' motivation. Previous study findings have suggested such an occasion-specific interrelatedness of motivational teaching behaviors and student motivation (e.g., Patall et al., 2016; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). However, methodological subtleties (more precisely, the need to acknowledge the clustering of data within educational psychology) that have gained importance in recent decades in educational research call for a more sophisticated investigation of the associations between time-consistent and occasion-specific factors of motivational teaching behaviors and students' motivation as I outline next.

Missing Puzzle Pieces in Previous Research

In the field of educational psychology, researchers are typically confronted with observations that follow a hierarchical structure (Raudenbush & Bryk, 2002). More precisely, students are typically nested within learning groups, classes, teachers, schools, neighborhoods, or even districts. Previous research interested in the consistency of student motivation and motivational teaching behaviors over time has gradually been considering time-consistent and occasion-specific factors of the respective variables (e.g., Dietrich et al., 2017; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008) and additionally started disentangling proportions of variance at the individual and class levels (e.g., Patall et al., 2016; Patall, Steingut, et al., 2018). However, as I outline next, two relevant puzzle pieces have been missing from this burgeoning understanding of how motivational teaching behaviors come into effect: first, the combined disentanglement of time-consistent and occasion-specific factors along with individual-level and class-level factors; and second, the disentanglement of level-specific effects due to their advantage over total effects.

The nesting of students within clusters (e.g., classrooms) can result in greater homogeneity *within* clusters regarding constructs of interest than *between* clusters due to the shared environment of the students. For instance, students' perceptions of teachers' autonomy-supportive behaviors during instruction might certainly be affected by the respective teachers, and consequently, student ratings of teachers may differ more extensively between classes (because they refer to different teachers) than within classes (because students within the same class refer to the same teacher and potentially even the same situation or time period). Ignoring the clustering of the data during analysis can lead to underestimated standard error estimates and ultimately to inflated Type-I error rates (McNeish & Stapleton, 2016). Thus, the consideration of clustering is crucial and can be achieved, for instance, by applying multilevel modeling (e.g., Raudenbush & Bryk, 2002; Snijders & Bosker, 1999).

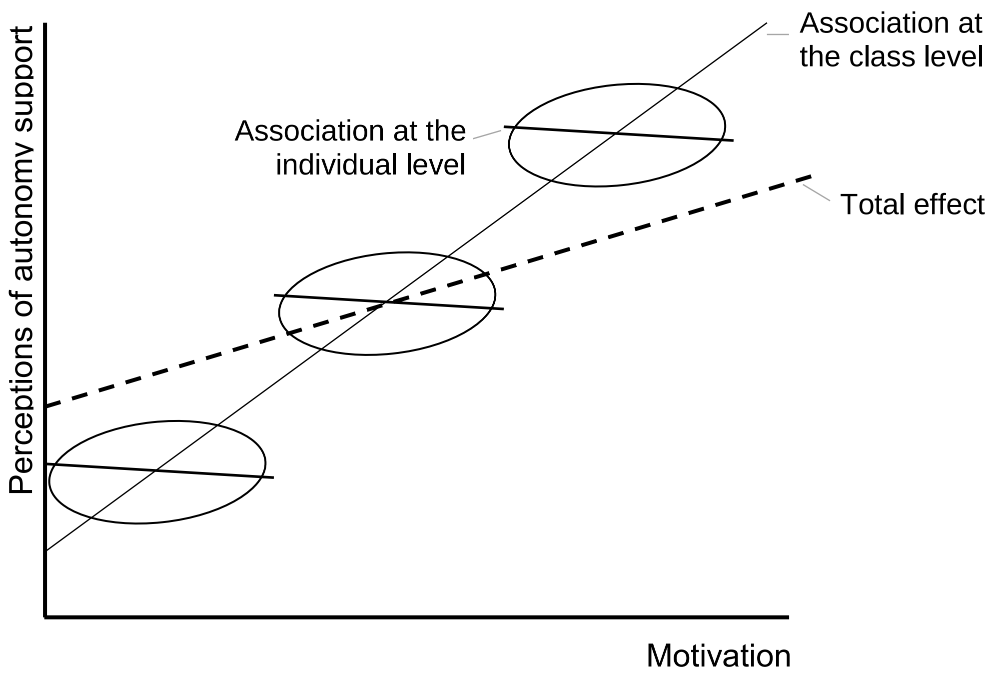
Even though previous research began considering the class level along with the individual level and additionally disentangled time-consistent and occasion-specific factors of motivational teaching behaviors and student motivation at the individual level, they usually did not do so for the class level, oftentimes because the sample size at the level of the class was not sufficient for this pupose (e.g., Dietrich et al., 2017; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). However, it is likely that students' shared perceptions of motivational teaching behaviors contain time-consistent and occasion-specific factors as well. For instance, a class might share a typically high level of perceptions regarding the autonomy support that their math teacher offers them; however, during single lessons, they might agree that the teacher supported their autonomy even more (or less) than is typical. Given that the neglect of certain proportions of variance (e.g., the occasion-specific variance at the class level) can lead to an overall biased decomposition of variance (e.g., Fielding, 2002; Luo & Kwok, 2009), future research should acknowledge the potential situation specificity of students' shared perceptions of motivational teaching behaviors at the class level. Thus, future research needs to disentangle time-consistent and fluctuating factors as well as consider the clustering of data.

Furthermore, teaching behaviors can have different meanings that depend on which level is being considered. Constructs such as teaching behaviors as perceived by the students refer to the person of the *teacher* using lower level responses (e.g., lesson-specific ratings from individual students), which are used to measure such a characteristic of the higher level (i.e., characteristics of the teacher; e.g., Marsh et al., 2012; Stapleton, Yang, et al., 2016). Simultaneously, student appraisals of teaching behaviors can also include valid information that reflects not only the teacher's qualities but also the student's unique or idiosyncratic perceptions of these qualities (Göllner et al., 2018). In fact, perceptions of teaching behaviors cannot easily be classified as *reflective* constructs (i.e., reflections of characteristics of the higher level itself, merely assessed at the lower level; e.g., teacher gender assessed via individual responses from the students) or *formative* constructs (i.e., aggregates of an actual construct at the lower level; e.g., the average achievement or average socioeconomic status of students in a classroom). They can rather be situated on a continuum, the extremes of which are represented by reflective and formative constructs (Lüdtke et al., 2008). For instance, when students are administered items such as "I felt that my teacher provided me choice and options," they are being asked to rate the teacher's behaviors, which are characteristics of the teacher at the class level assessed by individual students. Students' individual responses contain idiosyncratic, nonshared perceptions of each individual, which are potentially induced, for instance, by the individual behaviors of the teacher toward the respective students (Göllner et al., 2018). Furthermore, the aggregates of all student responses within the same classroom are assumed to reflect common opinions regarding the assessed behaviors *shared* by all students. As a consequence, associations of individual and shared perceptions with other constructs (e.g., expectancies or values) might have different qualities across levels, and effects of such constructs need to be studied on multiple levels to disentangle potentially concomitantly varying effects (Hamaker & Muthén, 2019; Raudenbush & Bryk, 2002; Snijders & Bosker, 1999) as illustrated in Figure 5. Even though this illustration might be an exaggerated example, it emphasizes the possibility that "there is not *one* relationship between x and y" (Hamaker & Muthén, 2019, p. 3). One must rather consider *how* the relations are distinctly formed. Consequently, the consideration of level-specific effects when investigating the associations between motivational teaching behaviors and students' motivation may provide more information than previous research that reported total effects (e.g., Goetz et al., 2019; Patall et al., 2016; Patall, Steingut, et al., 2018).

However, there has yet to be a comprehensive investigation that disentangles time-consistent and occasion-specific factors in students' perceptions of teachers' motivational teaching behaviors and students' motivation, disentangles individual and class levels, and additionally considers level-specific effects to facilitate a better understanding of the level-specific associations. Such an investigation could provide valuable insights into the immediacy of the impact of motivational teaching behaviors on students' motivation and could thus address the question of how motivational teaching behaviors might come into effect. Hence, I address this gap in this dissertation (see Chapter 3).

Figure 5

Illustration of Associations between Perceptions of Autonomy Support and Motivation at the Individual Level and the Class Level



1.3.2 Antecedents of Motivational Teaching Behaviors: Teacher Motivation

The previous section focused on a feature of motivational teaching behaviors (i.e., its stability) that may help to illuminate how motivational teaching behaviors work. In the current section, I go one step further and ask for third variables that teachers have control over and that might reflect antecedents of motivational teaching behaviors—and subsequently reflect conditions under which effects of motivational teaching behaviors on student motivation could be (even more) pronounced. Derived from the value transmission concept, I place particular emphasis on teachers' own motivation. I review empirical studies on the relevance of teacher motivation for their behaviors during instruction and close with the union of teacher motivation, motivational teaching behaviors, and student motivation in a final paragraph on value transmission in order to investigate how motivational teaching behaviors might come into effect as a function of teachers' underlying motivation.

Teacher Motivation as an Antecedent of Motivational Teaching Behaviors

According to Kunter and her colleagues (2013), teachers' motivational orientations represent a crucial aspect of their professional competence and are thus an important determinant of teacher success. Motivational orientations refer to teachers' deep-seated motivation, enjoyment, value, and beliefs that they hold with respect to their work. Previous research has long and extensively focused, on the one hand, on students' self-efficacy beliefs (e.g., Klassen et al., 2014; Tschannen-Moran & Woolfolk Hoy, 2001), and on the other, on teachers' enthusiasm (e.g., Brophy & Good, 1986; Keller et al., 2016) as expressions of teacher motivation. The concept of self-efficacy beliefs is rooted in Bandura's social-cognitive theory (Bandura, 1986, 1997). Teachers' self-efficacy beliefs refer to their beliefs about their abilities to successfully engage in the activity of teaching and to teach effectively; furthermore, they are assumed to affect students' achievement and motivation as well as teachers' instructional behaviors (Klassen et al., 2014). Teachers' enthusiasm is derived from research on teacher effectiveness (Kunter & Holzberger, 2014) and refers to a more affective component of teacher motivation, capturing teachers' relatively stable degree of enjoyment, excitement, and pleasure while engaging in their professional activities (Kunter et al., 2008). In a broader sense, enthusiasm represents a teacher's intrinsic orientation (Kunter & Holzberger, 2014), which has also been captured by other constructs from other research traditions and theories that have not yet been in the focus of research on teachers' professional competence as much as the construct of enthusiasm has so far. Such other constructs that reflect teachers' intrinsic orientation include, for instance, autonomous motivation (e.g., Pelletier et al., 2002; Roth et al., 2007), passion (e.g., Carbonneau et al., 2008; Fernet et al., 2014), individual interest (e.g., Long & Woolfolk Hoy, 2006; Retelsdorf et al., 2010; Schiefele et al., 2013), flow (e.g., Bakker, 2005; Tardy & Snyder, 2004), and intrinsic value (e.g., Watt & Richardson, 2007). Analogous to teachers' self-efficacy beliefs, their intrinsic orientation is assumed to affect students' learning and motivation as well as teaching quality (Kunter & Holzberger, 2014).

Intrinsic orientations in general can also more broadly be embedded in motivation theories such as the situated expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2020). Work on teacher motivation from an SEVT perspective has first and foremost been driven by Watt and Richardson (e.g., Richardson & Watt, 2006; Watt & Richardson, 2007, 2008a, 2015). They introduced the FIT-Choice framework (Factors Influencing Teaching Choice) within which they proposed a model that could explain why people choose teaching as their profession. Watt and Richardson (2007) proposed three constructs as proximal predictors for choosing teaching as a profession. These three constructs comprise values, self-perceptions, and teaching as a "fallback" career. Watt and Richardson derived these three proximal predictors of the choice of teaching as a profession, first, from a long tradition of research on teachers from the teacher education literature (e.g., Brookhart & Freeman, 1992; Brown, 1992; Moran et al., 2001) highlighting intrinsic, extrinsic, and altruistic motivation as important groups of motives for choosing a teacher career (e.g., Brookhart & Freeman, 1992). Second, the predictors were also derived from SEVT (Eccles et al., 1983; Wigfield & Eccles, 2020) as a theory of motivation and career choice. Combining these two theoretical backgrounds, Watt and Richardson (2007) focused specifically on teachers' "intrinsic," "extrinsic," and "altruistic" values, which, analogously to SEVT, they labeled intrinsic value, personal utility value, and social utility value. They further differentiated personal utility value into "job security," "time for family," and "job transferability," and they differentiated social utility value into "shape future of children/adolescents," "enhance social equity," "make social contribution," and "work with children/adolescents."

The FIT-Choice framework is widely used and has repeatedly proven helpful for investigating individuals' reasons for choosing the teaching profession over other professions (e.g., Watt et al., 2012, 2017; Watt & Richardson, 2008b). The motivation to choose the teaching profession (reported retrospectively from actual teachers) was also found to be associated with teachers' later teaching behaviors during instruction (Paulick et al., 2013, Study 2). However, it appears questionable whether experienced teachers hold the same motives for engaging in teaching as novices or completely inexperienced teacher students who are not so certain about their career aspirations. For instance, it is questionable whether reasons such as job security, time for family, or job transferability (i.e., personal utility value according to the FIT-Choice framework; Watt & Richardson, 2007) are reasons that keep teachers going, continuously putting effort into their lesson preparation and active teaching, or striving for intense relationships with their students. The conceptualization of teacher motivation as proposed in the FIT-Choice framework might thus have to be adapted to experienced teachers, focusing more on their current job situation and professional activities.

Empirical Relevance of Teacher Motivation for Their Motivational Teaching Behaviors

Teachers' motivation represents a core element of their professional competence (Kunter, Klusmann, et al., 2013). Thus, it is not surprising that teachers' motivation is assumed to play a pivotal role in determining teachers' behaviors during instruction and eventually in determining their level of teaching quality in class (Kunter et al., 2011; e.g., Kunter, Klusmann, et al., 2013; H. Patrick & Pintrich, 2001; Praetorius et al., 2017; Richardson & Watt, 2010; Zee & Koomen, 2016). Because research on teacher motivation (except for studies that focused on student teacher motivation) framed in SEVT is rare, in the following, I review empirical evidence on the relevance of teacher motivation for their motivational teaching behaviors by relying on studies that used different conceptualizations of teacher motivation. These studies focused primarily on intrinsic orientation (e.g., concepts such as enthusiasm, intrinsic motivation, or intrinsic value) but also on teachers' autonomous motivation and utility value.

Teachers' intrinsic orientation has been found to be predictive of teaching quality dimensions in general (e.g., Baier et al., 2018; Fauth et al., 2019; Holzberger et al., 2016; Kunter et al., 2008; Praetorius et al., 2017) but particularly for motivational teaching behaviors (e.g., Keller, Frenzel, et al., 2014; Kunter et al., 2008, 2011; Kunter, Klusmann, et al., 2013; H. Patrick et al., 2003; Retelsdorf et al., 2010; Roth et al., 2007; Schiefele et al., 2013), although most of the evidence stems from cross-sectional investigations. For instance, Kunter et al. (2008) showed that teachers' teaching enthusiasm positively predicted students' perceptions of the teaching quality dimensions monitoring, cognitive challenge, and social support (for similar findings, see also Kunter, Klusmann, et al., 2013). Furthermore, Kunter and her colleagues provided evidence that teachers' self-reported enthusiasm was associated with students' perceptions of their teachers' enthusiastic behavior (see also, e.g., Keller, Frenzel, et al., 2014;

Kunter et al., 2011). The associations that Kunter et al. (2008) reported were significantly higher when they considered teachers' *teaching* enthusiasm compared with teachers' *math* enthusiasm. Based on these findings, it therefore seems crucial to differentiate between teachers' teaching enthusiasm and math enthusiasm because Kunter et al. found different strengths not only for the associations with student-perceived enthusiastic behaviors (also supported by Kunter et al., 2011, Study 1 and Study 2) but also for the associations with other teaching quality dimensions.

Extending findings from research on teacher enthusiasm and interest, Pelletier and colleagues (2002) showed that the more teachers were autonomously motivated, the more likely they were to report that they teach autonomy supportive. Similar results were found for student (instead of teacher) reports of teachers' autonomy-supportive behaviors (Roth et al., 2007). These findings expand on findings regarding enthusiasm and interest insofar as they not only consider intrinsic and affective aspects of motivation but also teachers' external (though self-relevant) reasons to engage in teaching. Similarly, Han et al. (2019) found that students' perceptions of their teachers' utility value were positively linked to students' perceptions of teachers' emotional support in class.

In a longitudinal investigation, Praetorius et al. (2017) found no reciprocal effects between teachers' motivation (self-efficacy and teaching enthusiasm) and student-reported teaching quality dimensions (cognitive activation, classroom management, and learning support) over time. However, the enduring level of teacher motivation (i.e., when teachers had a high trait level of motivation) across the study period of one and a half years with three measurement points was positively associated with their typical level of teaching quality as reported by the students, therefore reinforcing findings from cross-sectional investigations.

Overall, previous research has consistently indicated that teachers' intrinsic orientation seems to be relevant for students' perceptions of teaching quality in general and for their teachers' motivational teaching behaviors in particular. Findings from autonomously motivated teachers (e.g., Pelletier et al., 2002; Roth et al., 2007) and from student perceptions of teachers' utility value (Han et al., 2019) provided the first hints of analogous associations. However, there is a gap in research on associations between extrinsic (though potentially self-relevant) reasons to engage in teaching and teaching behaviors. To recap the section on motivational teaching behaviors and the current section on teacher motivation, I laid out the crucial role of motivational teaching behaviors for the unfolding of students' motivation because they represent and build conditions under which students can motivate themselves (see Section 1.2). Furthermore, I outlined firm evidence that teachers' own motivation (in terms of their intrinsic orientation and partly in terms of more extrinsic forms of their motivation, namely, autonomous forms and utility value) is an essential antecedent of their behavior during instruction. Consequently, in the following, I consider teachers' motivation and their motivational teaching behaviors as joint forces that may support students' motivation.

Enhancing Student Motivation through Teacher Motivation via Motivational Teaching Behaviors

Indeed, like a puzzle, there are multiple indications spread across different strands of research (e.g., Eccles, 2007; Goe, 2007; Hatfield et al., 1993; Pekrun, 2000, 2006) that jointly draw a clear picture, according to which teachers' motivation might affect their students' motivation through teachers' motivational teaching behaviors during instruction (e.g., Fauth et al., 2019; Kunter, Klusmann, et al., 2013; Roth et al., 2007; Schiefele, 2017; Schiefele & Schaffner, 2015). The current approaches to studying the associations between socializers' and students' motivation via displayed behavior have been, according to their self-disclosure, primarily informed by two lines of research: First, these approaches have been informed by research on parent-child relationships and the concept of *value transmission* (e.g., Eccles, 2007; Gniewosz & Noack, 2012), which reflects the potential transmission of values from parents to children. Second, and more important for the educational setting, they have been informed by research on the concept of *value induction* (see Pekrun, 2000, and also Section 1.1.3). Value induction has received more attention under the name of *emotional contagion* (e.g., Hatfield et al., 1993; also known as emotional crossover, Bakker, 2005; or emotion transmission, Frenzel et al., 2009, 2018), which emphasizes the transmission of emotions (e.g., enjoyment) from teachers to their students via enthusiastic behaviors during instruction.

Regarding the school context, findings from research on emotional contagion appear particularly intriguing though they are primarily based on investigations of teacher and student *emotions* (e.g., enjoyment) instead of their motivation. However, the concept of enjoyment is strongly related to intrinsic orientation (Keller et al., 2016; see Kunter & Holzberger, 2014). Emotional contagion comprises an individual's emotional expression that can be "caught" by another person, eventually leading these two people to converge emotionally (see Hatfield et al., 1992, 1993; Hsee et al., 1990). Several studies have demonstrated emotional contagion in situations involving a teacher-learner relationship (see Frenzel et al., 2019; and Hsee et al., 1990, for laboratory studies; and Radel et al., 2010, for a quasi-experimental field study), whereas Bakker (2005) was among the first to provide evidence for the process of emotional contagion within instructor-learner pairings. He found correlational associations between teachers' intrinsic work motivation and students' experience of flow during out-of-school music class. Furthermore, several cross-sectional studies (e.g., Frenzel et al., 2009; Keller, Goetz, et al., 2014) have provided evidence for the associations between teachers' and students' (rather affective, intrinsic) motivation via students' perceptions of their teachers' enthusiastic behavior, which has also been supported by findings from a longitudinal investigation (Frenzel et al., 2018).

Taken together, findings on emotional contagion can be seen as support for a broader value transmission concept that also holds for the pairing of teachers and their students. However, these previous investigations have been restricted to affective and intrinsic motivational aspects, even though research on associations between teacher motivation and their motivational teaching behaviors, as well as between such behaviors and student motivation, have suggested that many more aspects of motivation and teaching behaviors may be involved in such a transmission process (see previous sections and Section 1.2). A systematic investigation of whether multiple aspects of teacher motivation affect student motivation through motivational teaching behaviors would thus not only substantiate the assumption that beneficial conditions for students' motivation (i.e., motivational teaching behaviors) could be consolidated through conducive underlying teacher motivation. Such an investigation could also illuminate discussions and assumptions about the generalizability of the value transmission concept. Consequently, I address this gap in this dissertation (see Chapter 4).

1.3.3 Factors Accompanying Motivational Teaching Behaviors: Relevance Interventions as Boosters or Compensators

Correlational studies have provided profound evidence that motivational teaching behaviors are promising for creating conditions under which students can motivate themselves (see Section 1.2). In this section, I explain that motivation interventions can do the same. Especially in the past decade, classroom-based interventions that have been designed to boost students' motivation have been developed, implemented, and often (successfully) tested (for overviews, see Hulleman et al., 2016; Karabenick & Urdan, 2014; Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016). Thus, such interventions are other factors in the educational setting that accompany motivational teaching behaviors and can affect their impact on students' motivation.

In the following, I first provide an overview of successfully tested so-called relevance interventions (Priniski et al., 2018) that can be integrated into a broader category of motivation interventions. Second, to understand the processes initiated by such interventions, I elucidate relevant components and mechanisms of an exemplary relevance intervention. Finally, I pursue the question of how processes initiated by motivational teaching behaviors during regular instruction and relevance interventions, which accompany regular motivational teaching behaviors in the educational setting, potentially interact.

Classroom-Based Relevance Interventions

Only a few years ago, Lazowski and Hulleman (2016) evaluated theory-based motivation interventions that were aimed at fostering "authentic" educational outcomes (e.g., achievement or motivation) in natural settings and found an average effect size of 0.49. However, in an introductory statement to their meta-analysis, Lazowski and Hulleman claimed that "over the past two decades, intervention research in the field of education has been on the decline" (p. 602). They substantiated their claim by meta-analyzing 74 published and unpublished papers of 92 field studies spanning a time period of 38 years (from 1976 to 2014), whereas most of the studies they considered stemmed from the first half of this period (rather than from the second half or uniformly spread). Whether or not this was a reaction to Lazowski and Hulleman's critique on the decline in the number of attempts to test motivation theory experimentally in the two decades before their meta-analysis, an overwhelming number of intervention studies that have been aimed at fostering student motivation has been published in the years since Lazowski and Hulleman's meta-analysis. This large number of studies offers convincing evidence for the success of many interventions, particularly those based on situated expectancy-value theory (to name some of them, e.g., Canning et al., 2018, 2019; Canning & Harackiewicz, 2015; Durik et al., 2018; Durik, Shechter, et al., 2015; Gaspard et al., 2020; Gaspard, Dicke, Flunger, Schreier, et al., 2015; Harackiewicz, Canning, et al., 2016; Hecht et al., 2020; Hulleman et al., 2017; Kosovich et al., 2019; Lindeman et al., 2018; Priniski et al., 2019; Rosenzweig et al., 2020; Rosenzweig, Harackiewicz, et al., 2019; Rosenzweig, Hulleman, et al., 2019; Shin et al., 2019—17 unique studies within the last 5 years alone, whereas this list of exemplary studies is not exhaustive).

One of the major accomplishments of motivation intervention studies is that they have provided evidence that the promotion of students' relevance perceptions can lead to an enhancement of subsequent interest in and motivation to engage with the subject matter (e.g., Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015; Harackiewicz, Smith, et al., 2016; Hecht et al., 2020; Hulleman & Harackiewicz, 2009; for overviews, see also Durik, Hulleman, et al., 2015; Harackiewicz & Priniski, 2018; and Rosenzweig & Wigfield, 2016). For motivation interventions that have explicitly focused on the relevance for students, the umbrella term *relevance intervention* is often used (e.g., Gaspard, Dicke, Flunger, Brisson, et al., 2015; though in the literature, other terms such as value-reappraisal interventions or utility-value interventions are also common; e.g., Acee & Weinstein, 2010; Harackiewicz, Canning, et al., 2016; see also Priniski et al., 2018, for an overview). Relevance interventions seek to help participants see a connection between the subject matter or a task and their personal lives. Historically, relevance interventions can be divided into two different approaches: either *directly communicating* the relevance of a task (e.g., Durik & Harackiewicz, 2007; Vansteenkiste et al., 2004, Studies 1 and 2) or encouraging students to *self-generate* personal connections (e.g., Hulleman et al., 2010; Hulleman & Harackiewicz, 2009). Both attempts have been tested successfully in the laboratory, and these laboratory studies have provided a solid starting point for moving research on relevance interventions into the field (e.g., Hulleman & Cordray, 2009), where they were found to positively affect, for instance, high-school students' autonomous motivation, interest, grades, and test performance (e.g., Hulleman & Harackiewicz, 2009; Vansteenkiste et al., 2004, Study 3). Similar results were obtained from investigations of college students (e.g., Canning et al., 2018; Harackiewicz, Canning, et al., 2016; Hecht et al., 2019; Hulleman et al., 2010, Study 2, 2017, Study 2; Priniski et al., 2019; Reeve et al., 2002; Rosenzweig et al., 2020; Rosenzweig, Harackiewicz, et al., 2019; Vansteenkiste et al., 2004, Studies 1 and 2).

Along with a multitude of other relevance interventions, the intervention "motivation in mathematics" (MoMa) was developed by combining and refining promising aspects of previous approaches (e.g., Acee & Weinstein, 2010; Canning & Harackiewicz, 2015; Durik, Shechter, et al., 2015; Hulleman et al., 2010; Hulleman & Cordray, 2009; Hulleman & Harackiewicz, 2009). The MoMa intervention was aimed at boosting students' task values and was designed as a 90-min session that took place during regular classes in ninth-grade math classrooms. It combined the provision and the self-generation of relevance arguments as this has been shown to be particularly effective (e.g., Canning & Harackiewicz, 2015). The MoMa intervention played a prominent role in the subsequent dissertation, which is why I present it in more detail in the following.

This 90-min relevance intervention comes in two parts. The first part comprises a psychoeducational presentation with information on the roles of effort, talent, and self-concept (as previous interventions have worked best when participants thought they were able to complete the target task; e.g., Durik, Shechter, et al., 2015) and on different frame-of-reference effects (as previous research has indicated the important role of social and temporal comparisons; Möller & Marsh, 2013; Trautwein & Möller, 2016; Wolff et al., 2018). Additionally, an instructor highlights the relevance of math for a broader range of potential study majors, vocational trainings, and jobs. In the second half of the 90-min relevance intervention, students work individually on relevance-inducing tasks. In its original version, there were two different implementations of the intervention, which resulted in two different intervention conditions. In the first condition, students were asked to write an essay on why math could be relevant for themselves (text condition); in the second condition, students were asked to read and evaluate six written quotations on the relevance of math from young adults (quotations condition; Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015). In a later update on the MoMa intervention (Gaspard et al., 2020; Piesch et al., 2020), the text condition was skipped because, on average, it had been found to be less effective than the quotations condition in promoting students' motivation (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015; but see Nagengast et al., 2017).

The efficacy and effectiveness (see Gottfredson et al., 2015, for the difference) of the MoMa intervention have been tested in two cluster-randomized controlled field trials (*MoMa 1*, Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015; and *MoMa 2*, Gaspard et al., 2020; Piesch et al., 2020). In both cases, two intervention conditions (text vs. quotations in MoMa 1; quotations implemented by the regular math teacher vs. by trained master's students in MoMa 2) were tested against a waitlist control condition. Classes that were randomly assigned to the waitlist control condition experienced business as usual while the intervention was implemented in the intervention condition classrooms. Yet, to provide fairness across conditions, the classrooms from the waitlist control condition received the intervention after the data had been collected. Results of the two cluster-randomized controlled field trials showed that classes in the intervention conditions reported higher average utility value in comparison with the waitlist control classes (in both studies consistent across all intervention conditions and in part up until 5 months after the intervention; Gaspard et al., 2020; Gaspard, Dicke, Flunger, Brisson, et al., 2015). Additionally, in the MoMa 1 study, students reported higher attainment value, intrinsic value, and self-concept and had better math test scores when exposed to the quotations condition compared with students in the waitlist control condition up to 5 months after the intervention (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015). By and large, students with higher conscientiousness and higher math-related prior values and achievement as well as girls (compared with boys) were more responsive to the relevance task in the MoMa 1 study (Brisson et al., 2020). Accordingly, stronger effects were found for female students than for male students (Gaspard, Dicke, Flunger, Brisson, et al., 2015). In the MoMa 2 study, and in contrast to MoMa 1, students who experienced the intervention surprisingly also reported higher subjective cost and in part reported enjoying math less compared with the waitlist control students (Gaspard et al., 2020).

Setting off Psychological Processes with the MoMa Intervention

Setting the unintended, negative side effects in the MoMa 2 study aside (on cost and intrinsic value) and concentrating on the primary outcome (utility value), the question that arises is: How was it possible that such a brief, minimally invasive relevance intervention such as the MoMa intervention was able to have such long-lasting effects (in part up to 5 months after the intervention)? Overall, the MoMa intervention focused on the personal relevance of math for students (in general and not limited to concrete tasks), particularly for their current and future education as well as for their future career paths. Thus, the MoMa intervention is an example of social-psychological interventions that target students' psychology rather than academic content (also referred to as "wise" interventions, Yeager & Walton, 2011). By linking math on an abstract level with students' potential goals and needs (through its psychoeducational presentation and relevance-inducing tasks), the MoMa intervention might have been able to inspire a "eureka moment" (i.e., an abrupt realization of such links) in the students, thereby changing the way students perceive and understand math, themselves (e.g., their individual goals), and their interrelatedness. Derived from SDT, however, such a change in students' relatively fixed attitudes toward and motivation to do math can only be achieved by paving the way by targeting students' inherent basic needs (need for autonomy, competence, and relatedness; see Section 1.1.2 and, e.g., Ryan & Deci, 2017). This may have been the case through several mechanisms the MoMa intervention initiates. First, the MoMa intervention might target students' need for autonomy by referring to a broad spectrum of study majors, vocational training programs, and jobs; by providing students with choices when evaluating the quotations or by writing down self-generated relevance arguments; by aiming to stress the self-relevance of math for the students; and even by the pure fact that the teachers apparently aimed to support their students by participating in such an intervention program. Second, the MoMa intervention might target students' competence perceptions by emphasizing the relevance of temporal references (instead of, e.g., social references), and by drawing their attention to the relevance of their own effort (instead of talent) as a determinant of performance ("everyone can become better in math independent of one's talent"). As a consequence, students may feel an actual satisfaction of their need for competence. Finally, the MoMa intervention utilizes not only instructor-focused presentations and relevance-inducing tasks students are supposed to work on individually; students are also encouraged to share their opinions and feelings about math and to discuss their perspectives on the presented material. Thus, the MoMa intervention may also address students' inherent need for relatedness. By satisfying the needs for autonomy, competence, and relatedness, the MoMa intervention might have been able to prepare students to absorb the intervention message and to appreciate the arguments that were presented about how math is self-relevant.

Addressing such basic psychological processes is the core concern of social-psychological interventions, even though the underlying mechanisms and processes are not always evident. The challenge of such interventions, however, is that participants must meet certain psychological criteria (Binning & Browman, 2020). For instance, regarding the MoMa intervention, some students could already have been aware of the direct applicability of the subject matter for potential study majors or careers (i.e., they would not experience a "eureka moment" and would thus consequently also not experience an effect of the intervention), or the provided rationales might not apply to their individual career goals (i.e., they would potentially not see self-relevance in the intervention messages). Interventions other than MoMa might aim to target and change students' growth mindset (e.g., Yeager et al., 2019) or sense of belonging (e.g., Walton & Cohen, 2011), which would not work if the targeted students had already internalized the message (My brain is "like a muscle" that can grow, e.g., Blackwell et al., 2007), or if there had been no socially marginalized groups that needed an intervention, respectively. Thus, the efficacy of social-psychological interventions such as the MoMa intervention are conditional, and heterogeneous effects are very likely (Binning & Browman, 2020).

A Question of "Seed" and "Soil"

Similar processes as described in the previous section are targeted when teachers teach in a motivating way during regular class. More precisely, in Section 1.1.3, I derived from self-determination theory that teaching behaviors that tie rationales to students' subjective perspectives (to support their perceptions of self-relevance) and that support students' basic psychological needs for autonomy, competence, and relatedness are the most promising for supporting students' motivation. In Section 1.2, I introduced corresponding motivational teaching behaviors, namely, autonomy support, the provision of meaningful rationales via the use of everyday life examples, the nurturing of students' inner motivational resources via enthusiastic teaching, and the acknowledgment of perspectives and feelings via emotional support. When teachers taught in such a way that supported students' needs, their students reported higher motivation (for a review, see Stroet et al., 2013). Similar strategies were used in the MoMa intervention in which the instructors tackled students' needs for autonomy, competence, and relatedness in different ways, for instance, by referencing the usefulness of math for students' potentially concrete career goals, by triggering high competence perceptions, and by getting students to interact with each other. By and large, relevance interventions such as the MoMa intervention were found to be successful at promoting student outcomes (for an overview, see Priniski et al., 2018). Consequently, relevance interventions such as the MoMa intervention and motivational teaching behaviors equally bear the potential to support students' motivation and achievement. However, this inevitably raises the question of how these two supportive approaches are *jointly* related to student motivation. Can interventions add to the potentially cumulative positive effects of motivational teaching behaviors during regular class? Can interventions at least potentially compensate for negative teaching behaviors? Or do interventions ultimately undermine the positive effects of regular class by "overdoing" positive intentions? In one way or another, all of these questions address the concern of the extent to which classroom-based social-psychological interventions interact with regular motivational teaching behaviors in school or whether such social-psychological interventions work independently of the context they are implemented in (Kaplan et al., 2020).

In educational intervention research, scholars started addressing such potential interdependencies of the social context in school and intervention effects through the metaphor of "seed" and "soil" (e.g., Gueron, 2002; Walton & Yeager, 2020). Interventions are viewed as seeds that are sown in soil (the context); when an intervention metaphorically grows into good plants (outcomes), the intervention is seen as successful. However, as is always the case with cultivation, growth is a question of soil quality and harvesting. Consequently, Gueron (2002) stated:

> There is soil that is more or less fertile and some that should be off-limits, but, to continue the metaphor, the key to success lies in how one tills the soil and does the hard work of planting and harvesting. One has to understand the context and clear away potential land mines. (p. 17)

In the same vein, Walton and Yeager (2020) explained that the efficacy of a social-psychological intervention is contingent upon contextual features that afford the assimilation of the intervention message (labeled psychological affordances). They argue that a context has to be "fertile" in the sense that it affords the proffered belief system that is also being addressed through the intervention. For instance, growth-mindset interventions were found to work best in contexts comprising peers or teachers with a corresponding mindset (Yeager et al., 2019) and a social-belonging intervention in contexts in which the general perception of belonging is low (Walton et al., 2020). Transferring the assumptions of "fertile" soil to conditions for successful relevance interventions, educational contexts would have to afford the endorsement of the importance, utility, and relevance of math while simultaneously addressing students' inherent needs for autonomy, competence, and relatedness (as outlined in the previous section).

Taking the metaphor of seed and soil a little further, one can also open up a discussion about the quality of beneficial soil: Is it really "fertile" soil that affords success for a social-psychological intervention; or is it rather "parched" soil that craves water (i.e., some kind of input)? For instance, Rosenzweig and Wigfield (2016) stated that if teachers frequently used motivational teaching behaviors during instruction, "an intervention might have less of an effect than it would in classrooms where teachers do not provide any support for this construct" (p. 158)—and correspondingly, the opposite could be true if teachers barely used such practices (for similar reasoning, see Acee & Weinstein, 2010). Analogously, Pinger and colleagues (2018) concluded from their investigation of a formative assessment intervention (though this was an instructional rather than a social-psychological intervention) that this intervention could compensate for low-quality regular instruction in terms of process orientation and effective time use. However, more research on the interrelatedness of relevance interventions and motivational teaching behaviors is scarce if it exists at all.

In the current section, I explained that relevance interventions have demonstrated success in promoting students' motivation. In addition to motivational teaching behaviors during regular instruction, such relevance interventions may thus also be able to create conditions under which students motivate themselves. I argued that the processes that are initiated by a relevance intervention (e.g., MoMa) do not seem so different from the processes that are initiated by motivational teaching behaviors after all. Given their overlap, there is a clear need to investigate the interrelatedness of classroom-based relevance interventions and motivational teaching behaviors during regular instruction. If an intervention were to add to the positive effects of motivational teaching behaviors, this would be indicative of how motivational teaching behaviors could come into effect (even more). Such an investigation could thus clarify whether relevance interventions can boost motivational teaching behaviors that are already present, or whether they can at least compensate for a lack thereof.[6] I thus address this gap in this dissertation (see Chapter 5).

[6] Interactions such as the one described between relevance interventions and motivational teaching behaviors can always be approached from two sides of the story. For instance, the question "Can a relevance intervention boost or compensate for (a lack of) motivational teaching behaviors?" can be translated into the question "Does a relevance intervention work equally well irrespective of the motivational teaching behaviors students are exposed to during regular class?" A corresponding analysis provides evidence that supports both questions and, for instance, can be interpreted either from the perspective of a practitioner seeking additional support from the regular motivating potential during class or from the perspective of a politician who wants to know whether a newly developed relevance intervention can be implemented in every classroom without hesitation.

2

AIMS AND RESEARCH QUESTIONS

The present dissertation investigates the unfolding of students' motivation in the natural classroom setting. School can be an inspiring place where students are confronted by subjects or tasks that arouse their inherent joy or curiosity. School typically comprises subjects and tasks that are all meant to facilitate students to become mature and self-determined members of society but that are simultaneously not always in every students' scope of interest. Additionally, empirical findings have consistently shown that students' motivation follows a steady decline during secondary education, which is particularly pronounced in the domain of math (e.g., Gaspard et al., 2017; Jacobs et al., 2002; Watt, 2004). Hence, it is of high relevance to investigate conditions under which students can motivate themselves in the educational context, particularly in the domain of math. This dissertation is based on situated expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2020) and conceptualizes students' motivation as a function of the person and the person's environment. Substantiated by self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2020), the present dissertation brings the ontogeny of motivation in relation to the educational context to the fore. More precisely, in the present dissertation, I explicitly focus on the educational context with respect to indicators of teaching quality during math class (namely, motivational teaching behaviors) in relation to students' motivation to do math.

Adding to previous research at the intersection of motivational science and research on teaching quality, namely, on the impact of motivational teaching behaviors on students' motivation, the present dissertation aims to improve the understanding of how motivational teaching behaviors come into effect in the natural classroom setting and more precisely during math class. In this light, I raised three key substantive questions for current and future research at the intersection of motivational science and research on teaching quality, which I aim to address within the scope of this dissertation. These three key substantive questions are *How consistent* *are motivational teaching behaviors?*, *What are the antecedents of motivational teaching behaviors?*, and *What are other external sources that target students' motivation and tend to accompany motivational teaching behaviors in the educational setting?*

Drawing on interest theories, control-value theory, and self-determination theory, I laid out starting points from which these three questions could be approached and that could eventually facilitate a better understanding of the unfolding of students' motivation in the natural classroom setting. First, drawing on interest theories (e.g., Krapp et al., 1992), the understanding of the consistency of motivational teaching behaviors could be substantiated by examining the stability and situation specificity of motivational teaching behaviors and student motivation, as well as their situation-specific relation (see also 1.3.1). Second, drawing on control-value theory (e.g., Pekrun, 2000), the understanding of what affects motivational teaching behaviors could be substantiated by examining teacher motivation as an antecedent of motivational teaching behaviors as laid out in the concept of value transmission (see also 1.3.2). Finally, drawing again on self-determination theory (e.g., Deci & Ryan, 1985), a better understanding of other external impacts on students' motivation in the educational setting that accompany motivational teaching behaviors could be facilitated by examining joint effects of motivational teaching behaviors and externally imposed relevance interventions because they both capitalize on the concepts of need support and self-relevance. Such an investigation would provide insights into whether relevance interventions can boost or at least compensate for (a lack of) motivational teaching behaviors (see also 1.3.3).

Taken together, the current dissertation is aimed at substantiating the understanding of students' motivation as framed by SEVT by examining the impact of motivational teaching behaviors during math class and by addressing three substantive and related questions for the current research located at the intersection of motivational science and teaching quality (namely, the stability of motivation and motivational teaching behaviors, antecedents of motivational teaching behaviors, and the joint impacts of motivational teaching behaviors and a relevance intervention during math class). To address the key substantive questions in the present dissertation, I build upon three empirical studies:

In **Study 1**, titled *The "situative nature" of competence and value beliefs and the predictive power of autonomy support: A multilevel investigation of repeated observations*, the situative nature of students' expectancies and values as well as their susceptibility to time-consistent and occasion-specific factors of motivational teaching behaviors is investigated. Based on data from the MoMa 2 study (Gaspard et al., 2020; Piesch et al., 2020) comprising repeated observations from five consecutive math lessons, we apply multilevel modeling, first, to investigate the stability of motivational teaching behaviors as well as expectancies and values and whether their empirical features correspond to their theoretical definition (Eccles & Wigfield, 2020); and second, to examine the predictive power of time-consistent and occasion-specific factors of motivational teaching behaviors for students' expectancies and values.

In **Study 2**, titled *The transmission of values from math teachers to their ninth-grade students: Different mechanisms for different value dimensions?*, the prospective associations between teachers' motivation, teachers' motivational teaching behaviors, and students' motivation are examined. Using data from the MoMa 2 study (Gaspard et al., 2020; Piesch et al., 2020), this study examines the transferability and generalizability of the value transmission concept to the construct of motivation and thus investigates teachers' motivation as an antecedent of their motivational teaching behaviors during class. With the goal of investigating whether teachers can "transmit" their motivation to their students, a broad spectrum of teacher and student values as well as of motivational teaching behaviors is the focus of this study.

In **Study 3**, titled *Gleiche Wirkung in jedem Klassenzimmer? Moderationseffekte durch motivationale Unterrichtspraktiken am Beispiel einer Nützlichkeitsintervention im Mathematikunterricht und damit einhergehende Herausforderungen [Same effect in every classroom? Treatment by moderator effects of a relevance intervention as a function of motivational teaching practices, and methodological challenges]*, the joint effects of motivational teaching behaviors during regular class and an exemplary relevance intervention (MoMa 1; Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015) on students' motivation and achievement are investigated. This study thus addresses the question of "seed" and "soil" (Walton & Yeager, 2020). It simultaneously provides insights into whether external factors that influence students' motivation other than motivational teaching behaviors can operate as boosters of or compensators for (a lack of) motivational teaching behaviors that students are frequently exposed to in class. Study 3 particularly addresses these questions while taking into consideration the statistical power of typical motivation intervention studies.

In the field of educational psychology, researchers are typically confronted with a hierarchical structure of their observations (Raudenbush & Bryk, 2002). More precisely, students are typically nested within learning groups, classes, teachers, schools, or even districts. All of the three empirical studies in this dissertation are conducted in educational settings in which a natural clustering of the data occurs (namely, students nested in classes). Thus, in all of the studies, both the analytical level of the individual student and of the class are simultaneously taken into account by means of multilevel modeling (Hamaker & Muthén, 2019; Raudenbush & Bryk, 2002; Snijders & Bosker, 1999; Stapleton, McNeish, et al., 2016). In line with the overarching goal of the present dissertation, special attention is given to the impact of the environment on students' motivation (Lüdtke et al., 2009; Marsh et al., 2012; Stapleton, Yang, et al., 2016).

3

STUDY 1: THE "SITUATIVE NATURE" OF COMPETENCE AND VALUE BELIEFS AND THE PREDICTIVE POWER OF AUTONOMY-SUPPORT: A MULTILEVEL INVESTIGATION OF REPEATED OBSERVATIONS

Parrisius, C., Gaspard, H., Zitzmann, S., Trautwein, U., & Nagengast, B. (revise and resubmit). The "situative nature" of competence and value beliefs and the predictive power of autonomy support: A multilevel investigation of repeated observations. *Journal of Educational Psychology*.

A pre-print of this manuscript is available at the following link: https://psyarxiv.com/p2zfr

Abstract

In their situated expectancy-value theory, Eccles et al. (2020) assume students' competence and value beliefs to be situation-specific and thereby to be "situative" in nature. Even though motivation research has gradually been developing an understanding of this situative nature, for instance, by disentangling time-consistent and fluctuating proportions of competence and value beliefs at the analytical level of the individual, most studies still have not disentangled them at the class level. The present study sought to close this gap by applying a multilevel modeling approach based on data from 1,617 ninth-grade students in 78 classrooms across five consecutive math lessons. Our findings revealed significant proportions of trait variance and state residual variance in students' competence beliefs, value beliefs, and their perceptions of autonomy-supportive teaching behaviors at the individual and class levels. The largest amount of variance could be attributed to the individual level (compared with the class level) with more or less equal amounts of proportions of trait variance and state residual variance. Furthermore, students' perceptions of autonomy-supportive teaching behaviors predicted the situational manifestation of their competence and value beliefs, whereby time-consistent differences, both between students and between classes, explained more variance than differences within students and within classes. Thus, our findings supported the situative nature of competence and value beliefs but also revealed that, by and large, interindividual differences had more predictive power for students' competence and value beliefs than intraindividual fluctuations over time.

Keywords: situated expectancy-value theory · situational competence and value beliefs · autonomy support · state-trait theory · multilevel states and traits

Introduction

There has been a clear and persistent call for research on student motivation that is aimed at extending the understanding of *intra*individual motivational processes that take place in the classroom (e.g., Eccles & Wigfield, 2020; Pintrich, 2003), but only recently has this call been heard (e.g., Patall et al., 2016; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). Such research, which looks at situation-specific and intraindividual differences rather than only at *inter*individual differences between students and over time, is valuable because it goes beyond research that generates knowledge about students' average levels of motivation and the general predictors and general consequences of these average levels. It is particularly important because "average" and "general" might not be the focal point of teachers' reality in school: For them, deviations from the mean are not exceptions but rather represent the reality of teachers' daily lives. For instance, some students might "typically" be unconvinced of their ability to master math, its relevance, or its inherent interestingness; still there might be certain lessons in which their motivation to do math tasks is very high—and the same can equally be true for whole classrooms. Consequently, it is important to identify the contextual factors that are under the control of the teachers and that explain systematic variation in students' and classrooms' situational competence and value beliefs and eventually enable teachers to facilitate positive enduring motivational levels and to counteract motivational low points. The aim of the present investigation is to examine the extent to which competence and value beliefs are situative (i.e., their "situative nature") and to determine whether time-consistent and fluctuating components of competence and value beliefs are systematically predicted by students' perceptions of their teachers' autonomy-supportive teaching behaviors in class.

According to the situated expectancy-value theory (Eccles & Wigfield, 2020; see also Eccles et al., 1983), competence beliefs ("Can I do it?") and value beliefs ("Why should I do it") about a specific task are the most proximal predictors of students' effort, persistence, and achievement on this task. They are furthermore assumed to be subjective, which means that individual students as well as whole classrooms (indicated by the average levels of competence and value beliefs of the students) may differ from one another in their (shared) competence and value beliefs, and they are assumed to be situative in nature (Eccles & Wigfield, 2020). Indeed, different situations do not always arouse the same motivation within students, and whole classrooms do not report the same level of shared motivation in every situation (e.g., Dietrich et al., 2017; Patall et al., 2016; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). However, research has yet to establish a better understanding of the extent to which motivation is really "situative" in nature and to what extent it reverberates with variations in teaching quality.

Using a repeated-measures design over the course of five consecutive math lessons in 78 math classrooms with 1,617 ninth-graders, the current study was aimed at broadening the understanding of the situative nature of students' competence and value beliefs (Eccles & Wigfield, 2020). Using a three-level cross-classified modeling approach, we sought to identify the extent to which students' situational competence and value beliefs fluctuate around their typical levels of competence and value beliefs (individual-level state residual variance) and how much students differ in their typical levels of competence and value beliefs from one another (individual-level trait variance). Importantly, we additionally took the class level into account and expanded on previous research by aiming to identify the extent to which students' shared competence and value beliefs within classrooms fluctuated around their typical levels of shared competence and value beliefs (class-level state residual variance) and the extent to which classrooms differed from one another in their typical levels of shared competence and value beliefs (class-level trait variance), analogous to the individual level. Finally, to better understand how teachers may promote students' situational and global levels of competence and value beliefs, we examined whether situational perceptions of autonomy-supportive teaching behaviors predicted why the competence and value beliefs of students and classrooms differed within situations and across situations.

Students' Competence and Value Beliefs

Almost 40 years ago, Eccles and her colleagues adapted classical expectancy-value theories (e.g., Atkinson, 1957; Vroom, 1964) to the educational context and described expectancy and value beliefs as a function of an interaction between individual characteristics and the environment (Eccles et al., 1983). Since then, this theory has triggered an enormous amount of research (see Wigfield & Eccles, 2020). The most recent account of expectancy-value theory has used the label "situated expectancy-value theory" (SEVT; Eccles & Wigfield, 2020) to highlight the situative nature of expectancy and value beliefs, a term we will use throughout this article. According to SEVT, students' expectancy and value beliefs are the most proximal predictors of their engagement in a task as well as of their achievement-related choices and, eventually, their performance (Eccles et al., 1983; Wigfield & Eccles, 2020). Students' expectancies are defined as students' beliefs about how well they will do in an upcoming task. Expectancies are conceptually closely related to other constructs that are related to evaluations of competence, such as self-concept and self-efficacy. Although theoretically separable (Bong &

Skaalvik, 2003; Eccles et al., 1983; Eccles & Wigfield, 2020), prior research has found that these constructs are typically highly correlated (Eccles & Wigfield, 2002; Marsh et al., 2019). In the current study, we use the term *competence beliefs* as an umbrella term for these different constructs. Students' *value beliefs* refer to the value an individual attributes to an activity or task. Eccles and colleagues (1983; see also Eccles, 2005) furthermore differentiated between multiple components of students' value beliefs: students' utility value (i.e., the personal usefulness of a task for an individual's current or future life), attainment value (i.e., the relevance of a task for a person's identity), intrinsic value (i.e., the value of a task due to the enjoyment it arouses in a person), and cost (i.e., the negative value that is attached to a task due to subjectively perceived negative consequences from engaging in it). Elaborate instruments with many items tapping the four proposed components of value beliefs have empirically supported their differentiability (e.g., Conley, 2012; Gaspard et al., 2015; Trautwein et al., 2012). However, some or all of the components that positively contribute to value beliefs (i.e., utility value, attainment value, intrinsic value) have also often been collapsed into a single measure when assessed via short batteries (e.g., Durik et al., 2006; Lauermann et al., 2017; Watt et al., 2012).

In recent decades, Eccles et al.'s SEVT model has found wide appreciation in educational psychology, not least of all because many aspects of the model (e.g., the dependency of competence and value beliefs on environmental influences; the predictive power of competence and value beliefs for effort, engagement, and achievement) have been confirmed by a wide range of longitudinal investigations (e.g., Lazarides et al., 2019; Marsh et al., 2005; Meece et al., 1990; Simpkins et al., 2006). Such longitudinal studies have come along with a particular emphasis on global appraisals of competence and value beliefs in a particular domain (e.g., "I like doing math"; Gaspard et al., 2015; see also Wigfield & Cambria, 2010, for an overview), which seems appropriate in view of the long time intervals studied (oftentimes spanning multiple years or even decades; such as the Childhood and Beyond Project, http://garp.education.uci.edu/cab.html). When measured in this way, students' competence and value beliefs have typically shown high stabilities across time (e.g., Rieger et al., 2017; Wigfield et al., 1997). However, as a result of the global measures that have been used, the situational nature of competence and value beliefs as defined in SEVT (e.g., Eccles & Wigfield, 2020) has often gone unstudied.

Additionally, the focus on global measures of students' competence and value beliefs has typically been accompanied by a focus on interindividual associations—which means that previous research has mainly been based on the analysis of between-person variation. However, as Voelkle et al. (2014) pointed out and as is the case when recapitulating basic assumptions of most motivation theories (e.g., within SEVT, Eccles et al., 1983), mechanisms that are specified by psychological theories typically refer to interindividual *and* intraindividual mechanisms. As such, the consideration of repeated measures of situational competence and value beliefs within the same students can prove helpful as it allows for the additional investigation of intraindividual associations (e.g., Berry & Willoughby, 2017; Hamaker et al., 2015; Molenaar, 2004), for example, with situation-specific teaching behaviors.

Disentangling States and Traits at the Individual and Class Levels

According to SEVT, students develop “typical” manifestations of competence and value beliefs in different academic domains through childhood into adolescence (for an overview, see Wigfield et al., 2015). These typical levels of motivation are described in the literature as, for instance, “dispositions,” “enduring” levels, or “individual” levels of competence and value beliefs and interest (e.g., Eccles et al., 1983; Hidi & Renninger, 2006; Wigfield & Cambria, 2010), whereby these terms are used to denote the relatively stable expressions of competence and value beliefs or interest. Although the terms traits and dispositions imply that these constructs are not easily affected by single, specific situations, by no means do these expressions imply that motivation would be unchangeable over time. In addition, Eccles and Wigfield (e.g., 2002, 2020) also proposed that students’ competence and value beliefs are sensitive to situations, and this sensitivity will probably even increase “with increasing social and cognitive maturity” (Wigfield & Eccles, 2020, p. 173). We address such “typical” levels and situation-specific deviations from a state-trait perspective in this article.

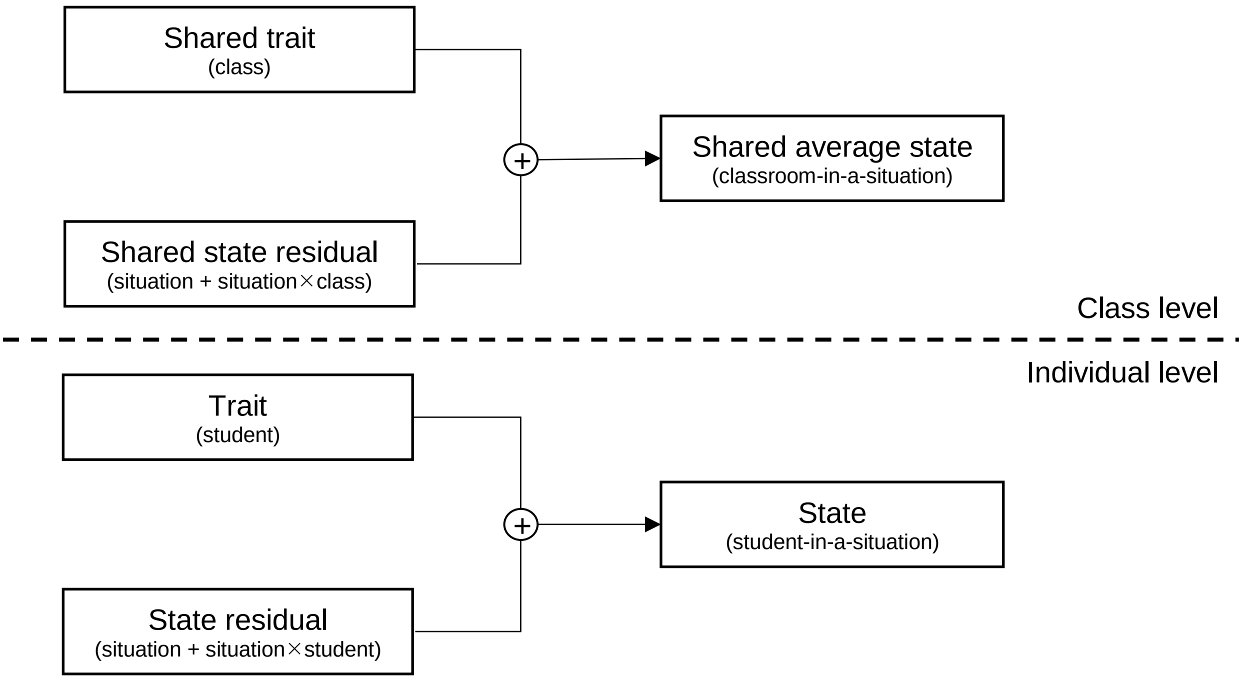
According to latent state-trait theory (LST theory; Steyer et al., 1992, 1999; see also, e.g., Geiser et al., 2017) and as depicted in the lower part of Figure 1, a student’s situational manifestation of a certain construct such as their competence or value beliefs (i.e., their situational answering behavior, the “student-in-a-situation,” or *state*) is constituted by a composite of a time-consistent part (a *trait*) and a fluctuating aspect, that is, a part that comprises aspects of the situation and the interaction of the student with this situation (a *state residual*).[7] Thus, the trait is assumed to determine the average level of a student’s states (e.g., a student typically has high competence beliefs about math), but the situation (e.g., a very difficult math task) and

[7] Strictly speaking, the composite of the trait and the state residual reflects the true score of an observed variable. According to LST, any observed variable can be decomposed into such a true score (latent state variable) and an error variable (Steyer et al., 1999), which we do not take into account in the present study.

the student’s interaction with this situation (e.g., tasks of this difficulty level are nevertheless a problem for this student) add to the actual manifestation of competence and value beliefs (e.g., the student has lower competence beliefs in this certain situation than they usually do). Though Wigfield and Eccles (2020) stressed that processes involving competence and value beliefs are “situationally sensitive (that is, influenced by the immediate situation)” (p. 166), they did not further specify the extent to which students’ competence and value beliefs are a function of time-consistent and situation-specific fluctuating aspects. In contrast to global measures, situation-sensitive or situational measures (e.g., “I like these contents”, Dietrich et al., 2017) allow researchers to capture such situation-specific fluctuations more precisely and consequently facilitate the investigation of the proportions of trait variance and state residual variance.

Figure 1

Simplified Illustration of the Constitution of States at the Individual Level and the Class Level



Examining SEVT constructs from the perspective of states and traits provides important insights into the susceptibility of competence and value beliefs to the social context they are embedded in (e.g., Is their variance driven more by differences between individuals or by the learning situation?). By using repeated measures and variance decomposition analyses, one can estimate the extent to which traits vary between persons (*trait variance*) and the extent to which the state residual naturally fluctuates around the trait (*state residual variance*). To achieve such a decomposition of variance, it is common in educational research to apply multilevel modeling that considers observations nested within students (Nezlek, 2007).

For instance, in one of the first studies to systematically examine the situative nature of interest experience (measured by items tapping situation-specific intrinsic, utility, and attainment value), Tsai, Kunter, Lüdtke, Trautwein, et al. (2008) investigated the proportions of trait variance and state residual variance in students' value beliefs. Depending on the domain (math, German, or second foreign language), 55% to 64% of the variance in students' value beliefs could be attributed to between-person differences (i.e., trait variance), and 36% to 45% of the variance could be attributed to intraindividual, situation-specific fluctuations (i.e., state residual variance). Since then, similar investigations were also made regarding students' competence beliefs (e.g., Tsai, Kunter, Lüdtke, & Trautwein, 2008), interest (e.g., Patall et al., 2016; Tanaka & Murayama, 2014), control and value (e.g., Goetz et al., 2019), emotions (e.g., Becker et al., 2014; Goetz et al., 2013; Mainhard et al., 2018), and (dis)engagement (e.g., Park et al., 2012; Patall et al., 2016; Patall, Steingut, et al., 2018). Thus, these authors overcame the shortcomings of global measures and between-person variation analyses by using situation-sensitive measures, repeated observations, and multilevel modeling. Yet decomposing the variances of students' competence and value beliefs into time-consistent and fluctuating proportions disregards the classroom context and can thus be only a first step toward approximating their situative nature as we outline next.

In educational research, the nesting of students in classrooms calls for an even more sophisticated approach to the decomposition of variance in students' competence and value beliefs. When the nested data structure (along with students within the same class being more similar than students between classrooms in the constructs of interest due to the fact that they share the same educational environment) is ignored, independence assumptions are violated, which may lead to incorrect variance partitioning results (e.g., Raudenbush & Bryk, 2002; Snijders & Bosker, 1999). Even though the consideration of students nested in classrooms via multilevel modeling has become "one of the central research methods for applied researchers in the social sciences" (Lüdtke et al., 2008, p. 203) in recent decades, variance decomposition approaches to studying students' motivation have not always considered such clustering, oftentimes because the sample size at the level of the clusters was not sufficient for doing so (e.g., Dietrich et al., 2017; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008).

Only in recent years has educational research interested in the situative nature of motivation started to consistently consider the class level in addition to the individual level. For instance, Patall et al. (2016) showed that students' interest varied substantially not only from one student to another (i.e., a substantial proportion of *individual-level trait variance*; 43%)

and from day to day (i.e., a substantial proportion of *individual-level state residual variance*; 46%) but also between classrooms (11%). Thus, the situational manifestation of students' interest appeared to be made up not only of time-consistent and fluctuating aspects of the individual but also individual aspects and shared aspects of the classroom (see also, e.g., Patall, Hooper, et al., 2018; Patall, Steingut, et al., 2018; Yu & Levesque-Bristol, 2020). This is particularly relevant as it reveals that teachers' behaviors have the potential to affect their classrooms as a whole over and above individual students.

However, an easy-to-miss though potentially relevant other aspect has commonly been neglected (but see Kärner et al., 2017; Moeller et al., 2020; Wagner et al., 2016): Whereas an individual student's competence and value beliefs may be composed of traits and state residuals, this might equally be true for the average competence and value beliefs of all students within a classroom, meaning that the average level of beliefs of all students within a class may also naturally fluctuate over time around a typical level of shared beliefs (see the upper part of Figure 1). Thus, the composition of the individual-level state as a function of individual-level traits and state residuals can equally be transferred to the class level, meaning that class-level or shared average states might also be composed of class-level traits and state residuals. So far, only a few studies have acknowledged this aspect. For instance, Wagner and colleagues (2016) investigated the proportions of trait and state residual variance in students' perceptions of teaching behaviors (assessed with global measures of autonomy support, classroom management, and goal clarity) at the individual and class levels and predicted both students' achievement and their self-concept with the time-consistent proportions of variance at the class level. Other studies that focused on students' motivation either left out the individual level (e.g., Keller et al., 2018) or did not disentangle states at the class level into traits and state residuals (e.g., Stroet et al., 2015). When applying only such a multilevel structure (disentangling states and traits only at the individual but not at the class level), proportions of neglected class-level state residual variance are dispersed across the other three components, most likely leading to an underestimated individual-level trait variance component and overestimated proportions of variance for the remaining components (e.g., Fielding, 2002; Luo & Kwok, 2009).

Taken together, motivation research has gradually been approximating a sound understanding of the situative nature (Eccles & Wigfield, 2020) of students' competence and value beliefs by (a) disentangling their variances into time-consistent and fluctuating proportions (e.g., Dietrich et al., 2017; Tsai, Kunter, Lüdtke, & Trautwein, 2008; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008) and by (b) additionally considering the level of the class along with the individual level (e.g., Patall et al., 2016). However, prior research has typically not analogously disentangled proportions of trait and state residual variance at the class level. Yet from a practical point of view it would be informative to know whether teachers can impact the shared motivation of the class over time or rather in single situations. With the aim of closing this gap in the current literature, we sought to clarify the question of what aspects drive variation in students' situational competence and value beliefs (i.e., trait vs. state residual aspects crossed with individual vs. shared aspects).

Motivational Teaching: Strategies from SDT

In order to provide teachers with contextual factors that explain systematic variation in their students' individual and shared situational manifestations of competence and value beliefs and that eventually enable them to facilitate positive enduring motivational levels, disentangling the proportions of variance in students' competence and value beliefs can only be a first step. Additionally, it is important to identify factors that both lie in the teachers' hands and are *systematically linked* to such variation. Self-determination theory (SDT) defines a clear set of teaching strategies that can be used to foster students' motivation and that have garnered wide empirical support (Ryan & Deci, 2020). Accordingly, within the scope of this study, we borrow motivational teaching behaviors as defined in SDT as potential factors for explaining systematic variation in students' situational competence and value beliefs (for a similar approach, see, e.g., Tsai, Kunter, Lüdtke, Trautwein, et al., 2008).

In SDT, Ryan and Deci (2000, 2020) particularly emphasized the teaching strategy of autonomy support, which refers to a teacher's ability to identify, nurture, and develop students' inner motivational resources (Reeve, 2009). Teachers can create an autonomy-supportive climate if they are attentive and considerate to students' feelings and thoughts in the classroom, make use of non-controlling language, offer meaningful choices, or nurture students' inner motivational resources (see Su & Reeve, 2011, for an overview). An impressive body of research, including experimental studies, has stressed the importance of teachers' autonomy-supportive teaching behaviors for supporting students' motivation, competence beliefs, and engagement (Assor et al., 2002; Patall et al., 2008; Patall, Hooper, et al., 2018; Reeve et al., 2004; Reeve & Jang, 2006; Steingut et al., 2017).

Autonomy-supportive teaching behaviors can be differentiated into multiple strategies such as providing meaningful rationales or providing choices, which have been the focus of previous research (for rationales, see Steingut et al., 2017; and Vansteenkiste et al., 2018; for choices, see Patall et al., 2008). It can be particularly important to provide meaningful rationales when intrinsic motivation is missing (Vansteenkiste et al., 2018). This strategy comprises verbal explanations of the relevance and importance of a task for students' current and future lives, thereby demonstrating the direct usefulness of the behavior for satisfying students' inner needs and goals (Su & Reeve, 2011). When students perceive that their teachers are providing more meaningful rationales, they show increases in value beliefs (e.g., Parrisius et al., 2020; Schmidt et al., 2019; Schreier et al., 2014) and higher effort and engagement (e.g., Assor et al., 2002; Reeve et al., 2002). In the current study, next to the general autonomy-supportive climate of the classroom (created through attention to and consideration of students' feelings and thoughts in the classroom, the provision of meaningful choices, and the nurturing of the inner motivational resources of the students), we thus pay special attention to the strategy of rationale provision.

Such perceptions of teaching behaviors can have different meanings, depending on which levels are considered (Göllner et al., 2018). Climate constructs such as teaching behaviors as perceived by the students typically refer to the characteristics of the class or to the person of the *teacher* using lower level responses (e.g., situation-specific ratings from individual students; e.g., Stapleton et al., 2016; Stapleton & Johnson, 2019). However, student ratings of autonomy-supportive teaching behaviors can also include valid information that reflects not only the teacher's qualities but also the student's unique or idiosyncratic perceptions of these qualities (Göllner et al., 2018), potentially induced by, for instance, individual needs or the teacher's behaviors toward the respective student. Consequently, the relationships of individual and shared perceptions with other variables (e.g., competence or value beliefs) might have different qualities on the respective levels, and effects of such constructs need to be studied on all levels to disentangle potentially concomitantly varying effects (Hamaker & Muthén, 2019; Raudenbush & Bryk, 2002; Snijders & Bosker, 1999; Stapleton et al., 2016).

Autonomy-supportive teaching behaviors seem promising for affecting students' competence value beliefs because they nurture students' inherent needs—needs that may vary widely between students even within the same classroom (e.g., Yu & Levesque-Bristol, 2020). Thus, a consideration of autonomy-supportive teaching behaviors appears critical not only regarding specific situations but also separately at the individual and class levels (Wagner et al., 2016). Yet a full investigation that includes situational measures of students' competence beliefs, value beliefs, and autonomy-supportive teaching behavior perceptions and that considers traits and state residuals for all constructs at the individual *and* class levels is still pending.

The Present Study

In the SEVT (Eccles et al., 1983; Eccles & Wigfield, 2020), students' competence and value beliefs are assumed to be highly situation-sensitive and thereby likely to vary from one situation to another. Hence, in recent years, more and more research has been dedicated to the situative nature of competence and value beliefs and has uncovered the variability of students' motivation as a function of traits and state residuals (e.g., Dietrich et al., 2017; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008) and even of the individual and the class (e.g., Patall et al., 2016). However, by and large, previous research has neglected to consider that the classrooms' shared competence and value beliefs could also vary as a function of time-consistent and fluctuating levels of their shared competence and value beliefs (i.e., class-level traits and state residuals). Additionally, as situational manifestations of students' competence and value beliefs result not only from characteristics of the person but also from the situation and the unique interaction of the situation and the person, it is of particular interest whether and to what extent features of the social context (e.g., an autonomy-supportive climate created through corresponding teaching behaviors) contribute to the systematic variation of students' situational competence and value beliefs.

To address these gaps in the literature, we used a repeated-measures design to assess students' situational competence and value beliefs during five consecutive math lessons from a large-scale longitudinal study including 78 classrooms with 1,617 ninth-grade students. This study thus offered the unique opportunity to apply a multilevel modeling approach that allowed us to disentangle the interwoven aspects of traits and state residuals at the individual and class levels, which ultimately constitute the situational manifestation of students' competence and value beliefs. Thus, in the present study, first, we examined the amount of variance in students' situational competence and value beliefs (i.e., importance, intrinsic value, and cost) that could be attributed to time-consistent or fluctuating components at the individual level (e.g., Dietrich et al., 2017; Patall et al., 2016; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). Second, we disentangled time-consistent and fluctuating aspects at the class level. By considering states and traits at the class level, we expanded upon typical studies on students' motivation (see Moeller et al., 2020, for a similar suggestion). Similarly, we also applied this approach to students' perceptions of autonomy-supportive teaching behaviors. Finally, we were interested in whether students' perceptions of their teachers' autonomy-supportive teaching behaviors contributed to the variation in students' situational competence and value beliefs (e.g., Patall, Hooper, et al., 2018; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). We therefore considered teachers' autonomy support in terms of the situation-specific autonomy-supportive learning climate as reported by the students (Su & Reeve, 2011) and the provision of meaningful rationales (Reeve et al., 2002).

When predicting the situational manifestation of students' situational competence and value beliefs, we additionally controlled for their dispositional competence and value beliefs, as well as their gender and prior achievement (analogous to previous research, e.g., Patall et al., 2016; Patall, Steingut, et al., 2018; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). These individual characteristics of the students were previously found to predict students' competence and value beliefs in math (e.g., Dietrich et al., 2019; Gaspard et al., 2018; Marsh et al., 2005; Nagy et al., 2006).

Consequently, we posed the following research questions:

RQ1: How much of the variance in students' situational competence and value beliefs as well as in their perceptions of autonomy-supportive teaching behaviors can be attributed to time-consistent or fluctuating aspects at the individual level?

RQ2: Analogously, how much of the variance in students' situational competence and value beliefs as well as in their perceptions of autonomy-supportive teaching behaviors can be attributed to time-consistent or fluctuating aspects at the class level?

RQ3: Are time-consistent and fluctuating proportions of variance in autonomy-supportive teaching behavior perceptions associated with the situational manifestation of students' competence and value beliefs?

Method

Sample

Data for this study stemmed from the large-scale cluster-randomized trial study "Motivation in mathematics" (MoMa 2; Gaspard, Parrisius, et al., 2020) [8] in ninth-grade math classrooms in academic-track schools in the German state of Baden-Württemberg. Approval for this

[8] In addition to the Gaspard, Parrisius, et al. (2020) study, part of these data were also used by Gaspard and Lauermann (2020), Parrisius et al. (2020), and Piesch et al. (2020). However, none of the previous studies specifically investigated students' situational competence beliefs, situational value beliefs, or students' situational perceptions of their teachers' autonomy-supportive teaching behaviors, even though Gaspard and Lauermann (2020) had some minor overlap regarding the items used for competence beliefs and intrinsic value (see Appendix A for more information). However, their focus was on teachers' and students' shared motivational climate as indicated by teachers' and students' perceptions of teacher enthusiasm and student engagement during class, and they disregarded the variance in students' perceptions at the individual level.

study was obtained from the Ministry of Education in Baden-Württemberg with respect to data security matters (date of approval: July 26, 2017) and from the responsible ethics committee at University of Tübingen, Germany, with respect to ethical matters (date of approval: August 1, 2017).

A total of 57 academic-track schools were contacted and asked to participate. On behalf of their schools, 28 headmasters agreed to support the study and forwarded the recruitment information to their math teachers (for more information on the planning of the study and the recruitment process, see also Gaspard, Parrisius, et al., 2020). A total of 70 math teachers from these 28 schools decided to participate with their 78 ninth-grade classes (1 to 5 per school). There was no financial incentive for participation for the teachers or classes. One of the participating classes, which usually comprised the same group of students in each subject, was divided into two math learning groups that were taught by two different teachers. Because we sought to examine the role of students' perceptions of the teaching behaviors of their actual math teacher, we treated these two learning groups as separate classes. Additionally, in one of the classrooms, the correct allocation of individual questionnaires failed because the teacher did not hand out these questionnaires to the students as indicated by a post-it on the questionnaire, and this incorrect allocation could not be solved in retrospect, which is why we decided to exclude this class from the analyses. Our sample thus comprised a subsample of 78 classrooms.

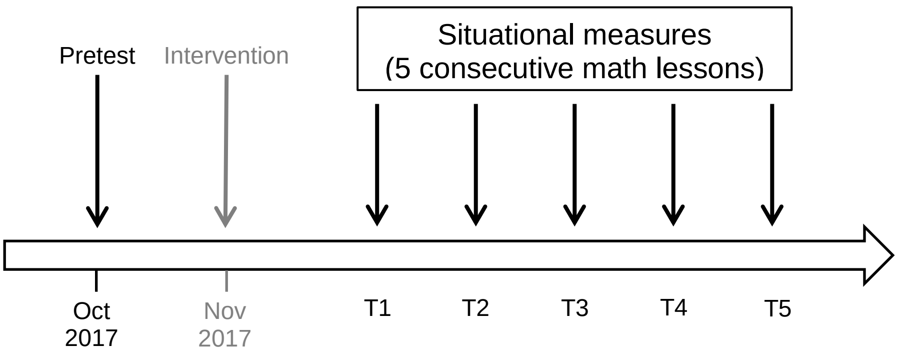
A total of 1,744 students (88.7% participation rate) and their parents provided written consent and therefore participated in the MoMa 2 study. We used a subsample of 78 classrooms with a total of N = 1,617 students (92.7%) in our analyses, which resulted from excluding the class with the incorrect allocation of questionnaires (reducing the sample to 1,722 students) and from handling missing data (see the Statistical Analyses section for more information). At the beginning of the study, students' mean age was 14.62 years (SD = 0.46) in our subsample, and 54% of the students were female adolescents. Of the students, 31.1% had a migration background (i.e., the students or one of their parents were not born in Germany), and 73% had at least one parent who obtained a general university entrance qualification.

Procedure

The MoMa 2 study consists of several time points. For the current investigation, we used data from a pretest in October 2017 and from subsequent repeated measures during regular instruction (T1 through T5; see Figure 2). For the pretest, trained research assistants handed out questionnaires in which students were asked to indicate their dispositional competence and value beliefs; at the same time point, demographics were provided by the school. After the pretest, in November 2017, two randomly selected thirds of the classrooms received an intervention that was aimed at fostering students' perceived relevance of math. Data for the current investigation were taken from a cluster-randomized controlled field trial investigating the effectiveness of this relevance intervention (for more information, see Gaspard, Parrisius, et al., 2020). The intervention was either implemented by the regular math teachers (condition 1; for one third of the classrooms) or by trained master's students (condition 2; for the other third of the classrooms); the delivery mode was decided randomly.

Figure 2

Time Points from the MoMa 2 Study Design



Note. For the current investigation, data from the pretest and the five consecutive lessons (T1 to T5) were used. Some students experienced an intervention between pretest and T1, which we controlled for in our statistical analyses.

The 90-min relevance intervention in these intervention condition classrooms was aimed at fostering students' relevance of math and included a psychoeducational presentation and an individual relevance-inducing task. However, the evaluation of the efficacy of the intervention was not the focus of the current study, and results for intervention effects at posttest and follow-up can be obtained from Gaspard, Parrisius, et al. (2020) and Piesch et al. (2020). In order to control for potential intervention effects, we used two dummy variables for the intervention conditions as covariates in our analyses (see the Statistical Analyses section). To ensure that our results were not affected by the intervention, we additionally tested for whether our results were moderated by the intervention conditions (see Table S2 in the supplemental material). For this purpose, we tested for interactions between each variable and the two intervention conditions in our models. Our results indicated that only four out of the 112 interactions that we tested were statistically significant (3.6%), which is even below what can be expected by chance.

After the intervention, teachers in all participating classes were handed a set of five lesson-specific repeated questionnaires for the students who were asked to indicate their situational competence and value beliefs as well as their situational perceptions of the teachers' autonomy-supportive teaching behaviors. Teachers were instructed to hand these to their students at the end of five consecutive math lessons (T1 through T5) but to skip the respective lesson when there were special events (e.g., a test took place). Each of the participating classes had a total of four math lessons per week (45 min each). However, because the lessons were often combined into a 90-min double session, the classes regularly had between two and four sessions per week. In this case, teachers were instructed to only administer the questionnaires at the end of a double session. Some classes were not able to complete all five questionnaires because the time frame in which teachers were able to do so was finite due to another wave of data collected in December before Christmas break. On average, the classes completed 4.62 questionnaires (*SD* = 0.76) for which it took on average 14.12 days (*SD* = 3.98, Range: 7 to 23). In the online supplemental material (Table S1), we provide the average time lags between the respective data collection time points. From the 1,617 students who answered these questionnaires, we obtained a total of 7,023 observations.

Instruments

At T1 through T5, students were asked to report their situational competence beliefs, value beliefs, and situational perceptions of the autonomy-supportive teaching behaviors of their teachers with the introductory question "How was today's math lesson for you?" We furthermore considered multiple predictor measures at pretest (dispositional measures of students' competence and value beliefs, gender, prior achievement). The complete set of items are presented in Appendix A. All items were assessed with a 4-point Likert-type scale ranging from 1 (*completely disagree*) to 4 (*completely agree*). We used mean scores on the respective scales for our analyses. Mean scores were computed on the valid responses under the condition that at least one item had a valid response.[9] Descriptive statistics and intercorrelations are reported in Table 1.

[9] In other studies based on the MoMa 2 data (Gaspard, Parrisius, et al., 2020; Gaspard & Lauermann, 2020; Parrisius et al., 2020; Piesch et al., 2020), mean scores were computed under the condition that at least *half of the items* had a valid response. For the present study, we chose a different approach as a way to handle missing data because we were not able to use the full-information maximum likelihood approach or multiple imputation (for more information, see the Missing Data section). However, the corresponding results of our analyses for

Table 1

Means, Standard Deviations, and Bivariate Correlations among the Measures of Interest at the Levels of the Observation, Student, Lesson, and Class

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
Observation level														
1. Competence beliefs			—											
2. Importance			.41	—										
3. Intrinsic value			.55	.61	—									
4. Cost			-.55	-.12	-.32	—								
5. Autonomy-supportive learning climate			.46	.50	.52	-.26	—							
6. Meaningful rationales			.21	.49	.35	-.03	.45	—						
Student level														
1. Competence beliefs	2.97	0.56	—											
2. Importance	2.68	0.53	.45	—										
3. Intrinsic value	2.68	0.58	.59	.69	—									
4. Cost	1.96	0.54	-.66	-.13	-.33	—								
5. Autonomy-supportive learning climate	2.93	0.54	.52	.57	.60	-.32	—							
6. Meaningful rationales	2.25	0.62	.26	.61	.47	-.04	.56	—						
7. Dispositional competence beliefs	2.78	0.77	.48	.22	.30	-.36	.23	.16	—					
8. Dispositional importance	2.85	0.49	.34	.49	.39	-.15	.31	.26	.44	—				
9. Dispositional intrinsic value	2.48	0.86	.42	.35	.46	-.29	.28	.23	.71	.57	—			
10. Dispositional cost	2.12	0.69	-.46	-.20	-.30	.45	-.27	-.14	-.72	-.34	-.64	—		
11. Gender (m = 0)	0.54	0.50	-.06	-.05	*-.02*	-.03	.05	-.11	-.17	-.06	-.07	.07	—	
12. Prior achievement	4.23	0.98	.34	.14	.19	-.27	.21	.10	.59	.23	.41	-.50	.08	—
Lesson level														
1. Competence beliefs			—											
2. Importance			.42	—										
3. Intrinsic value			.67	.72	—									
4. Cost			-.77	-.12	-.42	—								
5. Autonomy-supportive learning climate			.51	.61	.62	-.32	—							
6. Meaningful rationales			.22	.59	.42	-.05	.53	—						
Class level														
1. Competence beliefs			—											
2. Importance			.36	—										
3. Intrinsic value			.61	.77	—									
4. Cost			-.78	*.01*	-.29	—								
5. Autonomy-supportive learning climate			.53	.62	.63	-.33	—							
6. Meaningful rationales			.27	.71	.51	-.03	.66	—						

Note. m = male. For prior achievement, higher values indicate better achievement. Bivariate correlations in italics are not significant at $p < .05$. All other correlations are significant at $p < .05$.

which we chose the half-of-the-items condition to compute the mean scores are reported in the supplemental material (Tables S3 and S4).

Situational Competence and Value Beliefs

Students' *situational competence beliefs* were measured with two items (sample item: "I could follow the lesson without any problems"; self-generated). Students' *situational value beliefs* were assessed in terms of students' *importance* with four items tapping the utility and attainment dimensions of values (e.g., "It was important to me that I thoroughly understood the material that was covered"; partly adapted from Tsai, Kunter, Lüdtke, Trautwein, et al., 2008, partly self-generated). Results from two-level confirmatory factor analyses (considering situational measures nested in students and constraining the factor loadings to be equal across levels) with separate factors for utility value, attainment value, intrinsic value, and cost revealed high correlations between attainment and utility value ($r_{\text{within}} = .869$, $r_{\text{between}} = .997$). These two value dimensions are also conceptually closely related (Eccles, 2009), which is why we ultimately collapsed them into a single importance factor in line with previous research (e.g., Durik et al., 2006; Lauermann et al., 2017; Watt et al., 2012; though they are sometimes separable when using elaborate instruments with many items, e.g., Conley, 2012; Gaspard et al., 2015; Trautwein et al., 2012). Furthermore, we assessed students' *intrinsic value* with two items, for instance, "The material was interesting to me" (adapted from Patall, Steingut, et al., 2018; and Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). We also assessed students' subjective *cost* with two items, for example, "I was upset because I needed to deal with this material (e.g., annoyed, anxious, and/or nervous)" (adapted from Dietrich et al., 2017; and Gaspard et al., 2015). Overall, analogous two-level confirmatory factor analyses considering only these three factors pointed to the separability of importance, intrinsic value, and cost ($\chi^2 = 812.21$, $df = 39$, CFI = .935, TLI = .907, RMSEA = .053), and the internal consistency of the scales was acceptable to good at each time point (competence beliefs: α = .82 to .83; importance: α = .75 to .79; intrinsic value: α = .82 to .88; cost: α = .63 to .68).

Situational Perceptions of Autonomy-Supportive Teaching Behaviors

Students' perceptions of their teachers' autonomy-supportive teaching behaviors during math class were reported by the students on seven items. We partly relied on a short version of the Learning Climate Questionnaire scale to assess autonomy-supportive teaching behavior perceptions (e.g., "I felt that my teacher provided me choice and options"; e.g., Williams & Deci, 1996), which we reduced to three items as they seemed to be most appropriate for our context of ninth-grade math classrooms. Given the relevance in previous research on teaching quality (e.g., Pianta & Hamre, 2009), we partly replaced the skipped items with two items tapping the specific nurturing of students' feelings of acknowledgment (e.g., "Our teacher treated us with appreciation and respect"; self-generated). Furthermore, we aimed to consider the important role of meaningful rationales for students' perceptions of autonomy-supportive teaching behaviors, which we assessed with two items (e.g., "Our teacher explained to us why the topic of today's lesson can be relevant for us"), representing an adapted and shortened version from Flunger et al.'s (2019) scale to measure the provision of rationales. Results from two-level confirmatory factor analyses (situational measures nested in students and factor loadings constrained to be equal across levels) that considered the set of seven items revealed that *providing meaningful rationales* built a separate factor next to an *autonomy-supportive learning climate* factor (χ^2 = 399.49, *df* = 32, CFI = .959, TLI = .947, RMSEA = .041; r_{within} = .45, r_{between} = .66).[10] The internal consistencies for the two scales were satisfactory (autonomy-supportive learning climate: α = .81 to .86; meaningful rationales: α = .68 to .74).

Covariates

In our analyses, we considered students' dispositional competence and value beliefs as well as their gender and prior achievement in math as covariates. Students' *dispositional competence and value beliefs* were assessed at pretest. Their dispositional competence beliefs were measured with four items (e.g., "I am good at math"; e.g., Marsh et al., 2005). Students' dispositional value beliefs were measured with Gaspard et al.'s (2015) scale, which was consequently refined in several studies (Gaspard et al., 2017; Gaspard, Jiang, et al., 2020) and slightly shortened for use in this study. The instrument allowed us to differentiate between students' importance (i.e., analogous to the situational measures, the utility and attainment dimensions were collapsed into one factor; based on 18 items; e.g., "It is important to me to be good at math"), their intrinsic value (three items; e.g., "Math is fun to me"), and their subjective cost (nine items; e.g., "Doing math makes me really nervous"). All scales showed good internal consistency (competence beliefs: α = .91; importance: α = .91; intrinsic value: α = .93; cost: α = .91). We furthermore received information about students' *gender* and *prior achievement* (final math grades from the last report cards at the end of the previous grade level) as reported by the school. In Germany, grades range from 1 to 6 with lower values indicating better achievement. To facilitate interpretation, however, we recoded students' grades so that higher values indicated better achievement.

[10] When computing this model without further constraints, results revealed for one indicator a nonsignificant, negative residual variance. We thus decided to fix this residual variance to 0. The new model did not lead to estimation problems.

Statistical Analyses

For all of our analyses, we specified multilevel regression models in R (R Core Team, 2019) using the lme4 package (Bates et al., 2015). The data analysis scripts are available at the Open Science Framework https://osf.io/c9yze/?view_only=ca5c1a7196f740b79811a858df569a45.

Disentangling Proportions of Variance

To determine the proportions of trait and state residual variance at the individual level (RQ1) and the class level (RQ2) in students' situational competence beliefs, importance, intrinsic value, and cost during math class, as well as in students' perceptions of the autonomy-supportive learning climate and the provision of meaningful rationales, we first ran a series of multilevel regression models (without predictors). More precisely, we applied multilevel modeling in order to handle the clustering of observations in students and in lessons; additionally, we used multilevel modeling to meet the demands from students being nested in classes. Taken together, this resulted in a three-level cross-classified data structure as depicted in Figure 3, which we considered by explicitly modeling the observation level (Level 1), the student and lesson levels (which are crossed; Level 2), and the class level (Level 3; for a similar approach, see, e.g., Kärner et al., 2017). This modeling approach allowed us to disentangle proportions of individual-level trait and state residual variance (i.e., the residual variances at the levels of the student and the observation, respectively) as well as to separate proportions of class-level trait and state residual variance (i.e., the residual variances at the levels of the class and the lesson, respectively) with respect to the total variance.

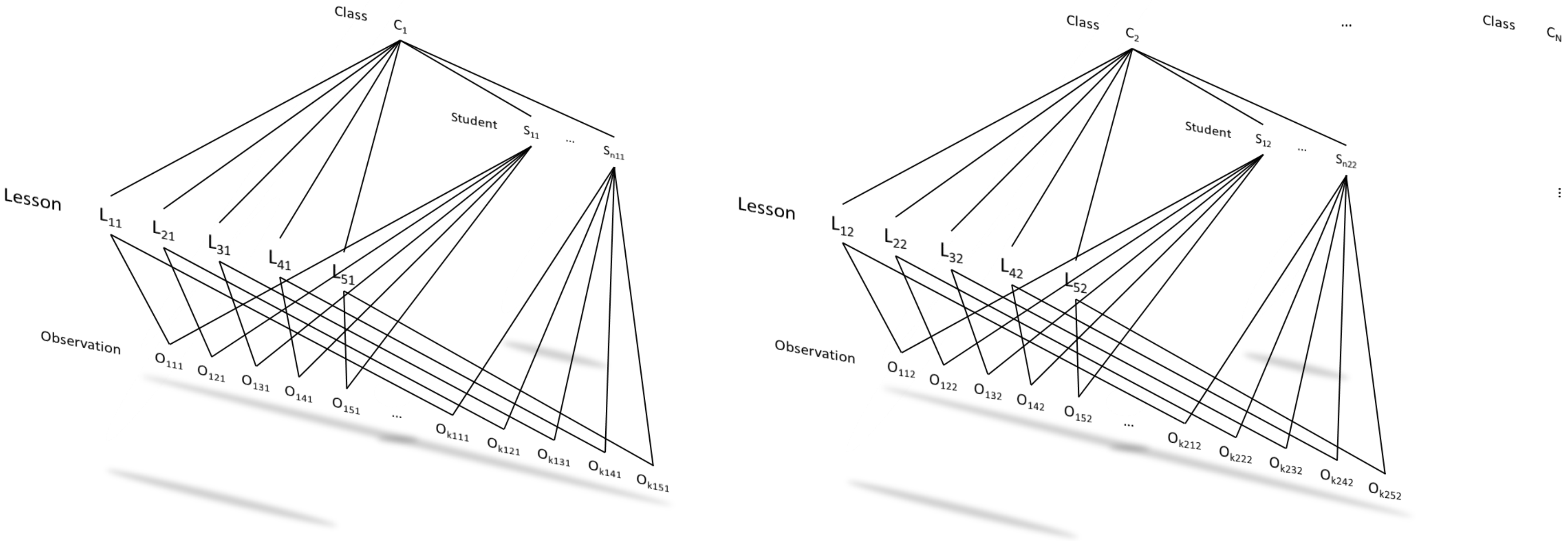
Following recommendations on the transparency of model specifications (Foster, 2010), the mathematical equation underlying the analyses can be found in Appendix B. We computed variance partition coefficients (VPC) to gauge the relative distributions of variance in the four motivation dimensions and in students' perceptions of the two autonomy-supportive teaching behaviors to the respective levels of interest.

Predicting the Situational Manifestation of Competence and Value Beliefs

In a next step, we aimed to examine the predictive power of the autonomy-supportive teaching behavior perceptions for students' situational competence and value beliefs (RQ3). Thus, we first entered the covariates (i.e., dispositional competence and value beliefs, gender, and prior achievement) and the dummy variables for the intervention conditions into the model (Model 1). Subsequently, we entered students' perceptions of an autonomy-supportive learning

Figure 3

Diagram Depicting the Structure of the Three-Level Cross-Classified Data



Note. C = class, S = student, L = lesson, O = observation.

climate and the provision of meaningful rationales as predictors (Model 2). Analogous to students' situational competence and value beliefs, we sought to consider their perceptions of autonomy-supportive teaching behaviors at each level (i.e., at the observation, student, lesson, and class level) in order to disentangle the proportions of trait and state residual variance at both the individual level and the class level. To do so, we applied manifest disaggregation of the autonomy-supportive teaching behavior variables to the levels of interest. This means that, in addition to the autonomy-supportive teaching behavior states at the level of the observation, we added level-specific aggregates of these variables, which comprise (a) the average state or average ratings of autonomy-supportive teaching behaviors for each student across the five lessons (i.e., students' *individual-level trait*), (b) the shared state or average ratings of autonomy-supportive teaching behaviors regarding a specific lesson across all students within the same class (i.e., the *class-level state*), and (c) the shared average state or average ratings of autonomy-supportive teaching behaviors across all students and across the five lessons within each class (i.e., the *class-level trait*). Furthermore, we applied cluster-mean centering for the autonomy-supportive teaching behavior variables at the levels of the observation, the student, and the lesson as described in Equation 2 in Appendix B. Additionally, we applied grand-mean centering for the class-level aggregates as well as for the covariates (i.e., dispositional competence and value beliefs, gender, and prior achievement). All continuous variables were standardized across individuals and across time points before we ran the analyses so that all regression coefficients can be understood as standardized regression coefficients with respect to the total variance in the outcome variables. Unstandardized results are reported in the supplemental material (see Table S5).

Finally, we obtained the proportions of outcome variance explained by the respective level-specific predictors. Following suggestions by Rights and Sterba (2019b), for Model 1 (i.e., when including only the covariates and the two dummy variables), we estimated the proportions of both *level-specific* outcome variance and *total* outcome variance explained by entering this group of predictors into our models. Inspired by Rights and Sterba, who handled within- and between-outcome variance, we refer to the proportions of explained level-specific outcome variance as R_l^2 and to the proportions of explained total outcome variance as R_t^2. The larger R_l^2 and R_t^2, the more outcome variance could be explained by entering the respective predictors into the model. For Model 2 (i.e., when additionally entering the perceptions of autonomy-supportive teaching behaviors), we report the *incremental* (i.e., additional) level-specific and total outcome variance that was explained by the level-specific predictors (ΔR_l^2 and

ΔR_t^2), which we obtained by subtracting the R_l^2 and R_t^2 values in Model 1 from the corresponding R_l^2 and R_t^2 values in Model 2, respectively (Rights & Sterba, 2019a).

Missing Data

As is common in longitudinal designs, missing data occurred for many reasons. The amount of missing data due to the absence of individual students at single time points (while only considering the classes that had been administered the questionnaires at the respective time points) ranged from 3.1% to 8.0%. Additionally, 0.4% to 5.4% of the missing data resulted from nonresponses to single items (considering the students who had been administered the questionnaires). The amount of missing data for individual information that was reported by the school was 0% (gender) and 2.6% (prior achievement). We are not aware of any statistical implementations of the full-information maximum-likelihood approach or multiple imputation that are able to handle missing data with a three-level cross-classified data structure. Due to the negligible rates of missing data, we thus decided to use listwise deletion across all our analyses, which resulted in an overlapping sample of 1,617 students who constituted the basis of our analyses.

Results

In the current study, we aimed to investigate the situative nature of students' competence and value beliefs as well as of students' perceptions of their teachers' autonomy-supportive teaching behaviors during math class. We were furthermore interested in the predictive power of students' perceptions of the autonomy-supportive learning climate and of the provision of meaningful rationales for the situational manifestation of students' competence and value beliefs within the same lesson.

Disentangling Proportions of Variance

In a first step, we were interested in the stability of students' situational competence beliefs, value beliefs, and perceptions of autonomy-supportive teaching behaviors over time. Thus, we disentangled the proportions of trait and state residual variance in the variables of interest that could be attributed to the individual level (for RQ1) and to the class level (for RQ2) using a multilevel modeling approach with the levels of the observation (individual-level state), student (individual-level trait), lesson (class-level state), and class (class-level trait). As the results revealed (see Table 2), students' competence beliefs, importance, intrinsic value, and cost regarding math could mainly be attributed to the individual level, with between 40% and

56% of the variance that could be attributed to fluctuating aspects over time (i.e., individual-level state residual variance) and between 36% and 47% that could be attributed to time-consistent aspects of the students, that is, between-person differences (i.e., individual-level trait variance). Compared with the other motivational constructs, importance was the only one for which most of the variance was a function of fluctuating rather than time-consistent components over time at the individual level. Overall, only a little variance could be attributed to shared aspects, with between 4% and 7% of the variance that could be attributed to fluctuating aspects over time (i.e., class-level state residual variance) and between 4% and 8% that could be attributed to stable aspects of the shared perceptions of the class, that is, to between-classroom differences (i.e., class-level trait variance).

The variance in students' perceptions of the autonomy-supportive learning climate could mainly be attributed to time-consistent aspects at the individual level (46%), with an additional 37% due to fluctuations at the individual level, only 3% due to fluctuations at the class level, and 13% due to time-consistent aspects at the class level. Variance in students' perceptions of the provision of meaningful rationales, however, was mainly due to fluctuations at the individual level (45%), with an additional 30% due to time-consistent aspects at the individual level, 11% due to fluctuations at the class level, and 13% due to time-consistent aspects at the class level.

Table 2

Absolute Proportions of Variance, Variance Partition Coefficients, and the Total Variance in Students' Competence Beliefs, Value Beliefs, and Perceived Autonomy-Supportive Teaching Behaviors

Variable	Individual level				Class level				Total
	State residual		Trait		State residual		Trait		
	Var	VPC	Var	VPC	Var	VPC	Var	VPC/ICC	Var
Competence beliefs	0.29	0.52	0.22	0.38	0.03	0.05	0.03	0.05	0.57
Importance	0.17	0.40	0.20	0.47	0.02	0.04	0.04	0.08	0.43
Intrinsic value	0.30	0.49	0.24	0.39	0.04	0.07	0.04	0.06	0.62
Cost	0.32	0.56	0.20	0.36	0.03	0.05	0.02	0.04	0.57
Autonomy-supportive learning climate	0.16	0.37	0.20	0.46	0.02	0.03	0.06	0.13	0.44
Meaningful rationales	0.34	0.45	0.23	0.30	0.08	0.11	0.10	0.13	0.75

Note. Var = variance; VPC = variance partition coefficient; ICC = intraclass correlation coefficient.

Overall, the results from the decomposition of variance revealed considerable proportions of variance located at the individual level, more or less evenly distributed among state residuals and traits. This means that students fluctuated considerably in their competence beliefs, value beliefs, and teaching behavior perceptions around their typical levels of competence beliefs, value beliefs, and perceptions of autonomy-supportive teaching behaviors. They also varied considerably from one another in their time-consistent levels across the time span of the five consecutive math lessons we considered. Additionally, whole classes fluctuated in their shared competence beliefs, value beliefs, and teaching behavior perceptions around their typical levels of shared beliefs and perceptions of teaching behavior. They also differed from one another (though less than at the individual level). This was particularly the case in terms of students' typical shared perceptions of autonomy-supportive teaching behaviors.

Predicting the Situational Manifestation of Competence and Value Beliefs

For RQ3, we were interested in the predictive power of autonomy-supportive teaching behavior perceptions while controlling for individual predictors of students' competence and value beliefs (i.e., dispositional competence and value beliefs, gender, and prior achievement). Thus, we first entered these individual covariates along with the two dummy variables for the intervention conditions into our model (Model 1 in Table 3) before entering the actual predictors of interest (i.e., students' perceptions of autonomy-supportive teaching behaviors; Model 2).

When considering only the covariates in our model (i.e., dispositional competence and value beliefs, gender, prior achievement, and intervention conditions), we were able to explain between 10% and 13% of the total outcome variance with predictors at the student level and between 1% and 2% of the total outcome variance with predictors at the class level. Taken together, the individual characteristics and intervention conditions accounted for 11% to 15% of the total outcome variance in students' situational competence and value beliefs (though mostly through predictors at the student level).

In a final step, we examined the predictive power of students' perceptions of autonomy-supportive teaching behaviors (i.e., autonomy-supportive learning climate and provision of meaningful rationales). We therefore considered students' individual perceptions (disentangled into states and traits) and shared perceptions (disentangled into states and traits) of autonomy-supportive teaching behaviors as predictors of the situational manifestation of students' competence and value beliefs (see Model 2 in Table 3).

First, students' perceptions of the autonomy-supportive learning climate significantly and positively (and for cost, negatively) predicted students' competence beliefs and value beliefs at all levels. The regression coefficients at the observation level ($|0.17| \leq b_{observation} \leq |0.39|$, *p*s < .001) mean that students who perceived a more autonomy-supportive learning climate than usual and who perceived a more autonomy-supportive learning climate than their classmates within the same lesson also reported higher competence and value beliefs (and lower cost) than usual and differed more from their typical level compared with their classmates within the same lesson when controlling for their perceptions of the provision of meaningful rationales. At the student level, the regression coefficients ($|0.27| \leq b_{student} \leq |0.42|$, *p*s < .001) indicated that students who typically perceived a more autonomy-supportive learning climate than their classmates also usually had higher competence and value beliefs (and lower cost) compared with the other students in their class when controlling for their perceptions of the provision of meaningful rationales. For students' shared perceptions, the results at the lesson level ($|0.41| \leq b_{lesson} \leq |0.83|$, *p*s < .001) revealed that when students shared a higher level of autonomy-supportive learning climate perceptions than usual, then they also shared a higher level of competence and value beliefs (and a lower level of cost) than usual when controlling for their shared perceptions of the provision of meaningful rationales. The coefficients at the class level ($|0.46| \leq b_{class} \leq |0.82|$, *p*s < .001) revealed that students who typically shared the perceptions of an autonomy-supportive learning climate also usually shared a higher level of competence and value beliefs (and lower costs) when controlling for their usual shared perceptions of the provision of meaningful rationales.

Second, the results for the provision of meaningful rationale perceptions were less consistent. At the level of the observation, we found significant and positive regression coefficients for students' competence beliefs, importance, intrinsic value, and—in contrast to the autonomy-supportive learning climate—also for cost ($0.04 \leq b_{observation} \leq 0.20$, *p*s ≤ .007). Students' typical perceptions of the provision of meaningful rationales were additionally significantly and positively associated with students' value beliefs (again, including higher costs; $0.18 \leq b_{student} \leq 0.42$, *p*s < .001) but not with their competence beliefs ($b_{student,cb} = -0.04$, $p = .122$). Furthermore, shared perceptions of the provision of meaningful rationales within a certain lesson were only significantly and positively associated with students' value beliefs in terms of their importance and intrinsic value ($0.09 \leq b_{lesson} \leq 0.17$, *p*s ≤ .020) but not with their competence beliefs or cost ($b_{lesson,cb} = 0.04$, $p = .373$, $b_{lesson,cost} = 0.00$, $p = .954$). Finally, the typical shared perceptions of the provision of meaningful rationales were significantly and positively associated with students' value beliefs (including higher costs; $0.19 \leq b_{class} \leq 0.59$, ps $\leq .033$) but not with their competence beliefs ($b_{class,cb} = -0.09$, $p = .380$).

By entering the autonomy-supportive teaching behavior perceptions into our model, we were able to account for a total of additional 23 up to 33 percentage points of the total variance in students' situational competence and value beliefs, with the exception of cost, for which the autonomy-supportive teaching behaviors only accounted for additional 6 percentage points of the total variance. Broken down into the respective levels, we were able to account for 6% up to 7% (except for cost: 1%) of the total outcome variance with predictors at the observation level; for 6% up to 11% (except for cost: 2%) of the total outcome variance with predictors at the student level; for 1% up to 3% of the total outcome variance with predictors at the lesson level; and for 8% up to 14% (except for cost: 2%) of the total outcome variance with predictors at the class level.

The results for RQ3 can be summarized in the following way. First, perceptions of an autonomy-supportive learning climate consistently predicted all outcomes of interest at all levels. This means that both fluctuating aspects within students and differences between students—as well as fluctuations within classes over time and differences between classes with respect to perceptions of the autonomy-supportive learning climate—coincided with fluctuating and time-consistent aspects of students' situational competence and value beliefs at the individual and class levels, respectively. Second, over and above perceptions of an autonomy-supportive learning climate, students' perceptions of the provision of meaningful rationales predicted students' competence and value beliefs. However, this was mainly the case for their value beliefs (compared with their competence beliefs and including positive regression coefficients for cost as an outcome) and primarily (but not exclusively) at the individual level for both fluctuating and time-consistent aspects. Third, the simultaneous consideration of the two autonomy-supportive teaching behavior perceptions (a) had the highest explanatory power for students' importance perceptions and the least for their subjective costs and (b) explained more variance between students and between classes compared with the variance within students and within classes (with the amount of explained variance being more or less equally distributed across the individual and class levels).

Table 3

Multilevel Models Regressing Students' Competence or Value Beliefs on Students' Individual Characteristics and the Intervention Conditions (Model 1) and Additionally on the Perceptions of Autonomy-Supportive Teaching Behaviors (Model 2)

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Fixed effects															
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Intercept	-0.01	0.06	-0.02	0.05	-0.12	0.06 *	-0.10	0.04 *	-0.03	0.06	-0.03	0.05	-0.06	0.05	-0.05	0.05
Observation level																
Autonomy-sup. learning climate [a]			0.39	0.02 ***			0.26	0.01 ***			0.35	0.02 ***			-0.17	0.02 ***
Meaningful rationales [a]			0.05	0.02 ***			0.20	0.01 ***			0.09	0.01 ***			0.04	0.02 **
Student level																
Autonomy-sup. learning climate [a]			0.42	0.02 ***			0.27	0.02 ***			0.40	0.02 ***			-0.27	0.03 ***
Meaningful rationales [a]			-0.04	0.03			0.42	0.03 ***			0.20	0.03 ***			0.18	0.03 ***
Respective dispositional measure	0.33	0.02 ***	0.25	0.02 ***	0.37	0.02 ***	0.24	0.02 ***	0.33	0.02 ***	0.23	0.02 ***	0.31	0.02 ***	0.27	0.02 ***
Gender (m = 0)	-0.04	0.03	-0.08	0.03 *	-0.03	0.04	0.02	0.03	0.00	0.03	0.01	0.03	-0.04	0.03	0.00	0.03
Prior achievement	0.06	0.02 **	0.05	0.02 **	0.03	0.02	0.00	0.01	0.01	0.02	-0.02	0.02	-0.04	0.02	-0.03	0.02
Lesson level																
Autonomy-sup. learning climate [a]			0.62	0.06 ***			0.53	0.05 ***			0.83	0.06 ***			-0.41	0.07 ***
Meaningful rationales [a]			0.04	0.04			0.17	0.03 ***			0.09	0.04 *			0.00	0.05
Class level																
Autonomy-sup. learning climate			0.82	0.10 ***			0.48	0.08 ***			0.73	0.09 ***			-0.46	0.09 ***
Meaningful rationales			-0.09	0.10			0.59	0.08 ***			0.19	0.09 *			0.26	0.09 **
Teacher condition	-0.04	0.08	-0.04	0.07	0.19	0.09 *	0.14	0.06 *	0.05	0.08	0.03	0.07	0.11	0.07	0.10	0.07
Master's student condition	0.01	0.08	0.04	0.07	0.17	0.08 *	0.15	0.06 *	-0.02	0.08	0.00	0.07	0.11	0.07	0.08	0.07
	Random effects															
	Est.		Est.		Est.		Est.		Est.		Est.		Est.		Est.	
σ^2_e (individual-level state residual)	.520		.455		.404		.344		.487		.428		.557		.545	
$\sigma^2_{r(2)}$ (individual-level trait)	.248		.181		.334		.197		.280		.166		.252		.225	
$\sigma^2_{r(3)}$ (class-level state residual)	.048		.031		.043		.023		.071		.033		.048		.041	
σ^2_u (class-level trait)	.059		.044		.061		.027		.048		.033		.033		.031	
Number of observations	6987		6914		7001		6922		6998		6922		6993		6915	

Table 3 *(continued)*

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Explained variance [b]															
	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2
Observation level	.00	.00	.14	.07	.00	.00	.17	.06	.00	.00	.14	.06	.00	.00	.02	.01
Student level	.34	.13	.19	.06	.29	.13	.30	.11	.27	.10	.30	.10	.28	.10	.07	.02
Lesson level	.00	.00	.36	.02	.00	.00	.45	.02	.00	.00	.51	.03	.00	.00	.15	.01
Class level	.17	.01	.54	.08	.22	.02	.65	.14	.14	.01	.66	.11	.28	.01	.25	.02
Total		.14		.23		.15		.33		.11		.30		.11		.06

Note. m = male; Est. = estimated regression coefficient; R_l^2 = proportion of *level-specific* outcome variance explained by level-specific predictors; R_t^2 = proportion of *total* outcome variance explained by level-specific predictors. All continuous variables were standardized beforehand across individuals and across time points, and thus, all regression coefficients can be understood as standardized regression coefficients. For prior achievement, higher values indicate better achievement. Results were based on the analysis of 1,617 students, 360 separate lessons, and 78 classrooms. Unstandardized results are reported in Table S5 in the Supplemental Material.

[a] Scales were centered on the cluster means.

[b] Explained variance (R_l^2 and R_t^2) was estimated by using the model-implied total variance by following the recommendations of Rights and Sterba (2019b, 2019a). Incremental explained variance (ΔR_l^2 and ΔR_t^2) was obtained by subtracting the proportions of variance explained by Model 1 from the corresponding proportions of variance explained by Model 2.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

In a recent review of their model, Eccles and Wigfield (2020) re-emphasized the "situative nature" of competence and value beliefs and newly labeled it the *situated* expectancy-value theory. In the present study, we aimed to develop a sound understanding of this situative nature by examining time-consistent and fluctuating components of students' individual and shared competence and value beliefs and their sensitivity to situation-specific contextual characteristics. To do so, we drew on repeated measures from five consecutive math lessons from 1,617 ninth-grade students and explicitly modeled the three-level cross-classified data structure. In the current study we considered states and traits at both the individual *and* class levels, and hence, we expanded upon previous research by revealing a more comprehensive picture of the distributions of the proportions of variance at all levels.

The present study revealed three major findings. First, the largest amount of variance in students' competence beliefs, value beliefs (importance, intrinsic value, and cost), and perceptions of autonomy-supportive teaching behaviors (autonomy-supportive learning climate and provision of meaningful rationales) as indicators of contextual characteristics was attributed to the individual level rather than to the class level. Second, notwithstanding the dissimilar dispersions of variance between the individual level and the class level, the variance was more or less equally explained by time-consistent (i.e., due to differences between students/classrooms) and fluctuating factors (i.e., due to differences within students/classrooms over time) at the two levels. Third, our results showed that time-consistent and fluctuating components of students' perceptions of autonomy-supportive teaching behaviors predicted students' competence and value beliefs over and above dispositional measures of competence and value beliefs. However, at both the individual and class levels, time-consistent factors had higher explanatory power than fluctuating factors.

The Situative Nature of Competence and Value Beliefs

Our findings on the decomposition of the variance in students' competence and value beliefs *at the individual level* into time-consistent and fluctuating components reinforce the findings from previous studies that have shown that motivation varies substantially between students and within students (e.g., Dietrich et al., 2017; Patall et al., 2016; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008). Thus, students seem to differ substantially from one another in terms of their typical levels of motivation, and, furthermore, their situation-specific manifestation of competence and value beliefs fluctuates substantially around students' typical level. Along with only a few other studies that have explicitly (e.g., Dietrich et al., 2017) or implicitly (e.g., Tsai, Kunter, Lüdtke, Trautwein, et al., 2008) studied the situative nature of SEVT constructs, this finding substantiates Eccles and Wigfield's (2020) proposition of the situative nature of competence and value beliefs. In line with SEVT, the striking amount of variance in students' competence and value beliefs that was accounted for by a fluctuating factor points to the situation sensitivity of these beliefs (see also Wigfield & Eccles, 2020). To achieve such findings, in contrast to the often-used global or "trait-like" measures of students' motivation, which are typically highly stable across time (e.g., Rieger et al., 2017; Wigfield et al., 1997), we relied on situational measures of students' competence and value beliefs. In our study, situation-specific factors were more pronounced than findings from such studies that have relied on "trait-like" measures, thus stressing the benefit of using situational measures to examine the situative nature of constructs in further research and thereby also providing a way to investigate how the learning context affects competence and value beliefs in the situation.

Furthermore, our findings provided justification for both the task- or situation-specificity and the subjectivity of value beliefs and thus SEVT's conceptualization of value beliefs as "subjective task values" (Eccles et al., 1983; Eccles, 2005). From this task- or situation-specificity, Eccles and Wigfield (2020) derived a high level of similarity between intrinsic value and situational interest as defined in Hidi and Renninger's (2006) four-phase model of interest development. Indeed, analogous to situational measures of interest, our situational measures of intrinsic value reflected a high degree of susceptibility to situation-specific environmental features. Additionally, and also analogous to situational measures of interest, students' intrinsic value in our study reflected a situational manifestation of students' dispositional intrinsic value (for an analogous observation and argument, see Knogler, 2017). Thus, situational measures of intrinsic value such as the measure we used in our study might capture both a situation-sensitive, not far-developed form of students' motivation and an internalized, enduring form that might be similar to individual interest as defined in interest theories (e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 2009). In light of the remarkable situation-specificity of the other competence and value beliefs, the analogy likening intrinsic value to situational interest (Eccles & Wigfield, 2020) could probably even be extended, and it might be reasonable to adapt it to encompass students' competence beliefs, importance, and cost.

Whereas students' intrinsic value and importance differed only slightly in their proportions of time-consistent and fluctuating components at the individual level, this seemed to be more pronounced regarding their competence beliefs and cost. The amount of intraindividual (situation-specific) variation in students' competence beliefs and cost was higher than the interindividual (time-consistent) variation. This result could speak of a differential situation-sensitivity of competence beliefs and students' subjective costs compared with their intrinsic value and importance. Although such differences could also be a result of unintended marginal differences in the framing of the items, it appears plausible that students' experiences of competence and costs are sensitive to situation-specificities to different degrees. For instance, they might be more strongly tied to familiarity with the material (e.g., whether teachers introduced a new topic vs. instructed their students to work on familiar topics), which easily varies between lessons; by contrast, students' intrinsic value and importance might be more strongly tied to the actual content matter, which tends to be rather constant across multiple lessons in a row. The differential dispersion of variance could be an indicator of such a susceptibility to different features of the educational context, distinguishing students' competence beliefs and subjective costs from their intrinsic value and importance. Dietrich et al. (2017) also found that competence beliefs were the most situation-specific compared with values (but different from our results, cost was the least situation-specific), and Goetz et al. (2019) also found similar differences in the situation-specificity of competence beliefs compared with values.

In relation to the individual level, less variance in students' competence and value beliefs was situated *at the class level* (between 9% and 13%). By and large, these proportions of variance were equally accounted for by time-consistent and fluctuating components. This means that students' typical level of shared competence and value beliefs differed substantially between classes due to common time-consistent characteristics; additionally, their shared perceptions shifted to a certain extent in sync from lesson to lesson due to common situation-specific characteristics that all students from the same classroom experienced. The findings regarding the time-consistency of students' shared intrinsic value in particular are aligned with Keller et al.'s findings regarding the decomposition of variance in students' enjoyment at the class level (40% of the class-level variance due to differences between classes and 60% due to differences within classes over time). Overall, these findings draw a highly relevant picture for educational practice as they reveal remarkable consequences for the reality of math teachers: First, students are not identical in terms of their competence and value beliefs and consequently might differ in what they need to support their motivation—needs that can additionally also differ from lesson to lesson. Second, the motivational climate within a classroom is not identical, neither from classroom to classroom, nor from lesson to lesson. Teachers are thus confronted with changing conditions within class in every situation, and a maximum level of sensitivity might be needed to adapt appropriately to changes in individual and shared motivation during math class.

The Situation-Specificity and Predictive Power of Teaching Behaviors

In order to explain systematic variation in students' competence and value beliefs, we considered students' perceptions of their teachers' autonomy-supportive behaviors. Our findings revealed that students' perceptions of the provision of meaningful rationales as well as an autonomy-supportive learning climate were highly situation-specific as a substantial amount of their variance was explained by a situation-specific factor. This contradicts previous findings from Wagner et al. (2016), who found that variance in students' shared perceptions of autonomy support was predominantly due to differences between students and between classes and only marginally due to differences within students and within classes over time. However, Wagner et al. used "trait-like" instead of situation-sensitive measures (which in itself can already be a reason for different proportions of variance; Braun et al., 2020; Lance et al., 2019), and consequently, the differences in the findings are not that surprising after all. Our findings additionally revealed that students' perceptions of the provision of meaningful rationales was more situation-specific than their perceptions of an autonomy-supportive learning climate (created through attention to and consideration of students' feelings and thoughts in the classroom, the provision of meaningful choices, and the nurturing of the inner motivational resources of the students). This somehow differed from previous research (e.g., Patall, Steingut, et al., 2018) that revealed a tendency for the provision of meaningful rationales to be less situation-specific than other autonomy-supportive teaching behaviors. This could indicate a specificity of math classes, in which the provision of rationales could hinge more on the actual topic of the respective lesson compared with other subjects. Math teachers in particular might provide more rationales when introducing a new topic compared with lessons that students must engage in predominantly to consolidate their knowledge. Our findings could reflect such variation between the focus of the math lessons accompanied by a varying amount of rationale provision.

For educational research and practice, it is highly relevant to know how teachers' behaviors during instruction come into effect. Thus, one of the major aims of this investigation was to answer the question of the levels on which students' situation-specific perceptions of autonomy-supportive teaching behaviors work. Overall, our results revealed that the regression coefficients for students' *shared* perceptions of autonomy-supportive teaching behaviors were usually higher than—and sometimes even double the size of—the coefficients at the observation and student levels. This was also reflected in large proportions of *level-specific* variance that was explained by time-consistent and fluctuating aspects of autonomy-supportive teaching behaviors at the class level (between 15% and 66%). Consequently, an increase in students' shared perceptions of autonomy-supportive teaching behaviors coincided with an on average *higher* deviation in their competence and value beliefs than an equally large increase in students' individual perceptions. This was true for both time-consistent and situation-specific factors.

However, the decomposition of the variance in students' perceptions of autonomy-supportive teaching behaviors (with a large proportion of variance explained by time-consistent factors) revealed that whether such an increase in their perceptions occurred depended on the component (time-consistent vs. fluctuating and at the individual vs. class levels), ultimately leading to a different result pattern when focusing on the proportions of *total* variance that were explained. Namely, time-consistent components of students' perceptions of autonomy-supportive teaching behaviors explained more total variance in their competence and value beliefs (except for cost) than fluctuating components—at both the individual and class levels. This means that, irrespective of the systematically higher regression coefficients concerning both time-consistent and situation-specific components at the class level compared with the individual level, by and large, time-consistent components accounted for more variance in students' competence and value beliefs (except for cost) compared with fluctuating, situation-specific components. Consequently, students' typical individual and shared perceptions of teaching behaviors were more predictive of their competence and value beliefs than single-time deviations from their individual and shared means. This finding is in line with previous research that found that higher proportions of variance were explained by time-consistent rather than fluctuating factors in students' motivation (e.g., Tsai, Kunter, Lüdtke, Trautwein, et al., 2008).

Regarding cost, students' perceptions of autonomy-supportive behaviors seemed to be only slightly relevant overall (irrespective of the level). On a conceptual level, students' cost shares a great deal of overlap with students' disaffection as measured in the study by Patall, Steingut, et al. (2018, e.g., "When I was in science class today, I felt bad"). With the small amount of variance in students' costs that was explained by autonomy-supportive teaching behaviors in the current study, our pattern of results was similar to Patall, Steingut, et al.'s (2018). Analogous to their study, the mere absence of autonomy-supportive teaching behaviors was not automatically reflected in higher levels of cost/disaffection. Rather, on the basis of Patall, Steingut, et al.'s findings, we speculate that, in particular, demotivating teaching behaviors such as autonomy-thwarting teaching (indicated by controlling messages, suppression, and uninteresting activities) might have explained the variance in students' cost perceptions. Investigating this potential link is a task for further research.

Furthermore, students' perceptions of the provision of meaningful rationales mostly offered additional predictive power over and above the autonomy-supportive learning climate (apart from cost). This was especially the case when predicting students' importance perceptions. Our findings thus reiterate previous results from within-person (e.g., Patall, Steingut, et al., 2018) and between-person analyses that pointed to the significance of meaningful rationales for students' motivation (e.g., Assor et al., 2002; Reeve et al., 2002; Schmidt et al., 2019; Schreier et al., 2014). Importantly, expanding upon this research, our findings also provided initial evidence that students' perceptions of the provision of meaningful rationales and their importance perceptions covary not only regarding students' typical individual and shared level over time but also within students and classrooms at each time point. This points to a particular match between the importance construct and the provision of meaningful rationales and indicates that students' importance perceptions are particularly sensitive to teaching behaviors that are tailored to their needs.

Taken together, teachers' *situation-specific* autonomy-supportive teaching behaviors (particularly creating an autonomy-supportive learning climate) but also their *general level* of autonomy support as perceived by the students predicted students' competence and value beliefs. This was equally true for students who deviated from the average perceptions of their class as well as for students' shared perceptions. Our findings thus substantiate the existing implications and reveal novel implications for educational practice. First, given that the general level of autonomy-supportive behaviors during class was on average associated with the individual and shared levels of competence and value beliefs, it appears desirable to establish a stable climate of autonomy support in math classes. Results from studies that have evaluated theory-based training programs to enhance teachers' autonomy support have suggested that teachers can be supported to create such a climate in school (e.g., Aelterman et al., 2014; Cheon et al., 2018; Cheon & Reeve, 2015) and, thus, our findings reinforce the benefit of the goals that such training programs pursue. Second, though explaining less of the variance in students' competence and value beliefs, their teaching behavior perceptions regarding *single* lessons should not be neglected. Not only does every lesson (whether assessed as autonomy supportive or not) contribute to the general level of perceptions of autonomy-supportive teaching behaviors (at least from a mathematical perspective), but such deviations from the mean also still explain substantial variance in students' competence and value beliefs. Consequently, even when teachers typically instruct in an autonomy-supportive way, it could be important to prevent one-time low points in their autonomy support as this could substantially affect students' competence and value beliefs. Future training programs might adjust their operating mode by differentiating between teaching strategies that target teachers' overall autonomy support and their behaviors during single lessons.

Limitations and Future Research

Despite its novel approach to the situative nature of students' competence and value beliefs, our study also has several limitations, some of which might constitute starting points for future research. First, we interpreted the associations between students' competence and value beliefs with autonomy-supportive teaching behaviors in line with theory, assuming that students' perceptions of the learning context affected their motivation (e.g., Eccles, 1993; Ryan & Deci, 2000). However, even though we controlled for relevant covariates, the interpretation that students' motivation affected their appraisals of their teachers' behaviors during instruction cannot be excluded.

Second, this study was based on student reports not only of their motivation but also of autonomy-supportive teaching behaviors. Students are seen as "experts on different modes of teaching" (Kunter & Baumert, 2006, p. 232), and their ratings can be assumed to be more important for their individual development (Clausen, 2002) because their subjective interpretations are focal for their inner attitudes and behaviors rather than any kind of objective indicator. In our opinion, students' self-reports were therefore best suited for the purposes of this study. Student reports are particularly with respect to the research focus of the current study—intraindividual associations between students' teaching appraisals and their motivation—indispensable. However, future research might try additionally capturing teacher (or also observer) ratings of autonomy-supportive teaching behaviors in order to subsequently link them to students' competence and value beliefs (but see, e.g., Stroet et al., 2015, who did not find any associations between observer ratings of autonomy-supportive teaching behaviors and students' self-reported motivation).

Finally, our study relied on data from an intervention study, which was aimed at fostering students' motivation. However, other studies investigating similar research questions have also drawn on data from intervention studies (e.g., Wagner et al., 2016) and have handled this circumstance similarly (i.e., by controlling for the intervention in all models). Even though an impact of the intervention on the study results can never be ruled out completely, our robustness checks did not indicate differences in the associations between perceptions of autonomy-supportive teaching behaviors and students' competence and value beliefs in the different intervention groups.

Conclusion

Are students' competence and value beliefs sensitive to situation specificities? And what constitutes the situation specificities that eventually lead to the manifestation of students' situational competence and value beliefs during class? Answering these questions is key for both research and educational practice as they provide valuable information about whether and how teaching might be linked to students' competence beliefs, beliefs about the importance of math, their intrinsic value, and the subjective costs of engaging in math. With the current study, we provided evidence of the situative nature of high-school students' math competence and value beliefs and pointed to the highly predictive power of teachers' autonomy-supportive teaching behaviors as reported by the students. Our findings furthermore revealed that especially differences in time-consistent perceptions of teaching behaviors between students and between classes contributed to the variance in students' competence and value beliefs (rather than situation-specific differences within students or classrooms). Thus, our findings supported the situative nature of competence and value beliefs but also revealed that, by and large, inter-individual differences in perceptions of teaching behaviors are more predictive of students' competence and value beliefs than intraindividual differences over time are.

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Appendix A

Measures Used to Assess Students' Situational Competence Beliefs, Value Beliefs, Perceptions of the Autonomy-Supportive Learning Climate, and Perceptions of the Provision of Meaningful Rationales

Scale Items	**Source**
Competence beliefs	
I had the impression that I could handle the demands well. [a]	Self-generated
I could follow the lesson without any problems. [a]	Self-generated
Importance	
What we learned today has meaning for me.	Self-generated
It was important to me that I thoroughly understood the material that was covered.	Adapted from Tsai, Kunter, Lüdtke, Trautwein, et al. (2008)
The material can be useful for me.	Adapted from Tsai, Kunter, Lüdtke, Trautwein, et al. (2008)
What we learned today will be useful elsewhere.	Self-generated
Intrinsic value	
The material was interesting to me. [a]	Adapted from Tsai, Kunter, Lüdtke, Trautwein, et al. (2008)
I enjoyed dealing with the material. [a]	Adapted from Patall, Steingut, et al. (2018)
Cost	
Dealing with the material was exhausting to me.	Adapted from Gaspard et al. (2015)
I was upset because I needed to deal with this material (e.g., annoyed, anxious, and/or nervous).	Adapted from Dietrich et al. (2017)
Autonomy-supportive learning climate as perceived by the students	
I felt that my teacher provided me choice and options.	Adapted from Williams & Deci (1996)
I felt understood by my instructor.	Adapted from Williams & Deci (1996)
My instructor conveyed confidence in my ability to do well in the course.	Williams & Deci (1996)
Our teacher tried to understand how we see things when we had any questions or complaints.	Self-generated
Our teacher treated us with appreciation and respect.	Self-generated

(continued)

Scale Items	Source
Provision of meaningful rationales as perceived by the students	
Our teacher explained to us how the material is related to our everyday lives.	Adapted from Flunger et al. (2019)
Our teacher explained to us why the topic of today's lesson can be relevant for us.	Adapted from Flunger et al. (2019)

Note. Dispositional measures of students' competence and value beliefs can be retrieved from Gaspard, Parrisius, et al. (2020).
[a] Item was also used by Gaspard and Lauermann (2020) as part of the *student engagement* scale.

Appendix B

Equations Underlying (1) the Decomposition of Variance and (2) the Multilevel Regression Models with Separate Regression Coefficients for Each Level (Observation, Student, Lesson, Class)

Disentangling Proportions of Variance

Applying Beretvas' (2011) notation, the model reads:

$$Y_{i(j_1,j_2)k} = \gamma_{0(0,0)0} + e_{i(j_1,j_2)k} + r_{0(j_1,0)k} + r_{0(0,j_2)k} + u_{0(0,0)k}, \quad (1)$$

where $Y_{i(j_1,j_2)k}$ represents the outcome score of the ith observation reported by student j_1 in lesson j_2 for class k; $\gamma_{0(0,0)0}$ represents the overall mean outcome score; $e_{i(j_1,j_2)k}$ is the random effect associated with the ith observation reported by student j_1 in lesson j_2 for class k (and the state residual variance, σ_e^2, represents how much students fluctuate around their individual trait over time and how much students fluctuate around the class mean in the respective lesson); $r_{0(j_1,0)k}$ is the random effect associated with the j_1th student in class k (and the trait variance, $\sigma_{r_2}^2$, represents how much students within the same class differ from one another in their traits); $r_{0(0,j_2)k}$ is the random effect associated with the j_2th lesson in class k (and the state residual variance, $\sigma_{r_3}^2$, represents how much a class fluctuates around the class mean over time); $u_{0(0,0)k}$ is the random effect associated with the kth class (and the trait variance, σ_u^2, represents how much classes differ from one another in their traits).

Predicting the Situational Manifestation of Competence and Value Beliefs

$$\begin{aligned} Y_{i(j_1,j_2)k} = {} & \gamma_{0(0,0)0} + \\ & \textstyle\sum_{l=1}^{2} \gamma_{0(0,0)l}^{b} Z_{l,..k} + \sum_{l=3}^{4} \gamma_{0(0,0)l}^{b} (\bar{X}_{l,..k} - \bar{X}_{l,...}) + \\ & \textstyle\sum_{p=1}^{2} \gamma_{0(0,p)0}^{b} (\bar{X}_{p,.(0,j_2)k} - \bar{X}_{p,..k}) + \\ & \textstyle\sum_{m=1}^{2} \gamma_{0(m,0)0}^{b} (\bar{X}_{m,.(j_1,0)k} - \bar{X}_{m,..k}) + \sum_{m=3}^{5} \gamma_{0(m,0)0}^{b} (W_{m,.j_1k} - \bar{W}_{m,...}) + \\ & \textstyle\sum_{n=1}^{2} \gamma_{n(0,0)0}^{w} (X_{n,i(j_1,j_2)k} - \bar{X}_{n,.(j_1,j_2)k}) + \\ & e_{i(j_1,j_2)k} + r_{0(j_1,0)k} + r_{0(0,j_2)k} + u_{0(0,0)k}, \end{aligned} \quad (2)$$

where $\gamma_{0(0,0)0}$ represents the situational individual score of a student who was in the waitlist control condition with average scores on the individual student characteristics and an average level of perceptions of autonomy-supportive teaching behaviors; $\gamma_{0(0,0)l}$ (for $l = 1{,}2$) are the effects associated with the dummy-coded intervention conditions, $Z_{1,..k}$ and $Z_{2,..k}$ (with the control condition as reference group); $\gamma^{b}_{0(0,0)l}$ (for $l = 3{,}4$) are the between-effects associated with the grand-mean-centered class-level aggregates of the predictor variables, $\bar{X}_{l,..k}$ (i.e., class-level aggregates of autonomy-supportive teaching behaviors), and $\bar{X}_{l,...}$ is the corresponding grand mean. Furthermore, $\gamma^{b}_{0(0,p)0}$ (for $p = 1{,}2$) are the between-effects associated with the cluster-mean-centered aggregates of the predictor variables at the level of the lesson, $\bar{X}_{p,.(0,j_2)k}$ (i.e., aggregates of autonomy-supportive teaching behaviors at the level of the lesson), and $\bar{X}_{p,..k}$ is the corresponding cluster mean in class k; $\gamma^{b}_{0(m,0)0}$ (for $m = 1{,}2$) are the between-effects associated with the cluster-mean-centered student-level aggregates of the predictor variables; $\bar{X}_{m,.(j_1,0)k}$ (i.e., student-level aggregates of autonomy-supportive teaching behaviors), and $\bar{X}_{m,..k}$ is the corresponding cluster mean in class k; $\gamma^{b}_{0(m,0)0}$ (for $m = 3, \dots, 5$) are the between-effects associated with the grand-mean-centered individual characteristics; $W_{m,.j_1k}$ (i.e., dispositional measure of the respective outcome, gender, and achievement), and $\bar{W}_{m,...}$ is the corresponding grand mean; and $\gamma^{w}_{n(0,0)0}$ (for $n = 1{,}2$) are the within-effects associated with the cluster-mean-centered predictors at the level of the observation, $X_{n,i(j_1,j_2)k}$ (i.e., autonomy-supportive teaching behaviors), and $\bar{X}_{n,.(j_1,j_2)k}$ is the corresponding cluster mean of student j_1 in lesson j_2 and in class k.

Supplemental Material

Table S1

Average Time Lags between the Intervention and the Five Consecutive Math Lessons (in Days)

From – to	*N*	ΔMin	ΔMax	Δ*M*	Δ*SD*
Intervention – T1	52	1	20	4.44	3.73
T1 – T2	77	1	12	3.60	2.13
T2 – T3	73	1	15	4.11	2.62
T3 – T4	68	0	7	3.49	1.86
T4 – T5	57	1	9	3.68	2.06
Intervention – T5	37	9	35	18.54	5.48
T1 – T5	57	7	23	14.12	3.98

Note. T = time point.

Table S2

Multilevel Models with Additional Interaction Terms between all Considered Variables and the Two Dummy-Coded Intervention Conditions

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Fixed effects															
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Intercept	-0.01	0.06	-0.02	0.05	-0.12	0.06	-0.09	0.05 *	-0.03	0.06	-0.03	0.05	-0.06	0.05	-0.05	0.05
Observation level																
Autonomy-sup. learning climate [a]			0.39	0.03 ***			0.23	0.03 ***			0.36	0.03 ***			-0.17	0.03 ***
Meaningful rationales [a]			0.06	0.03 *			0.17	0.02 ***			0.08	0.03 **			0.05	0.03
Student level																
Autonomy-sup. learning climate [a]			0.41	0.04 ***			0.26	0.04 ***			0.39	0.04 ***			-0.27	0.05 ***
Meaningful rationales [a]			-0.04	0.05			0.46	0.05 ***			0.24	0.05 ***			0.10	0.05
Respective dispositional measure	0.36	0.04 ***	0.28	0.03 ***	0.41	0.03 ***	0.28	0.03 ***	0.36	0.03 ***	0.24	0.03 ***	0.36	0.03 ***	0.30	0.03 ***
Gender (m = 0)	-0.10	0.06	-0.10	0.05	-0.08	0.06	-0.01	0.05	0.02	0.06	0.06	0.05	-0.03	0.06	-0.02	0.06
Prior achievement	0.04	0.04	0.03	0.03	0.04	0.03	0.00	0.03	0.00	0.03	-0.02	0.03	0.00	0.03	0.01	0.03
Lesson level																
Autonomy-sup. learning climate [a]			0.68	0.12 ***			0.47	0.10 ***			0.97	0.11 ***			-0.58	0.13 ***
Meaningful rationales [a]			0.08	0.07			0.14	0.06 *			0.07	0.07			-0.06	0.08
Class level																
Autonomy-sup. learning climate			0.98	0.15 ***			0.34	0.13 *			0.68	0.14 ***			-0.65	0.14 ***
Meaningful rationales			-0.08	0.16			0.55	0.14 ***			0.22	0.15			0.20	0.15
Teacher condition	-0.04	0.08	-0.03	0.07	0.19	0.09 *	0.14	0.06 *	0.05	0.08	0.04	0.07	0.12	0.07	0.10	0.06
Master's student condition	0.01	0.08	0.03	0.07	0.17	0.08	0.15	0.06 *	-0.02	0.08	-0.01	0.07	0.12	0.07	0.10	0.06
	Interaction with Condition 1 (i.e., variable × cond1)															
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Observation level																
Autonomy-sup. learning climate [a]			0.01	0.04			0.04	0.04			0.00	0.04			-0.03	0.04
Meaningful rationales [a]			-0.04	0.04			0.05	0.03			0.04	0.04			0.03	0.04

Table S2 *(continued)*

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
Interaction with Condition 1 (i.e., variable × cond1)																
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Student level																
Autonomy-sup. learning climate [a]			0.02	0.06			0.03	0.06			0.04	0.05			-0.04	0.06
Meaningful rationales [a]			0.02	0.07			-0.07	0.07			-0.11	0.06			0.11	0.07
Respective dispositional measure	-0.04	0.05	-0.06	0.05	-0.06	0.04	-0.06	0.04	-0.02	0.04	-0.02	0.04	-0.11	0.05 *	-0.09	0.05 *
Gender (m = 0)	0.03	0.08	-0.02	0.07	0.05	0.09	0.04	0.07	-0.04	0.08	-0.09	0.07	-0.07	0.08	-0.01	0.08
Prior achievement	0.02	0.05	0.03	0.05	0.00	0.04	-0.01	0.04	0.00	0.05	0.00	0.04	-0.05	0.05	-0.05	0.05
Lesson level																
Autonomy-sup. learning climate [a]			-0.15	0.17			0.05	0.14			-0.28	0.17			0.16	0.19
Meaningful rationales [a]			-0.06	0.11			0.06	0.09			0.06	0.10			0.05	0.12
Class level																
Autonomy-sup. learning climate			0.06	0.26			0.25	0.22			0.32	0.24			-0.04	0.23
Meaningful rationales			-0.37	0.26			0.02	0.23			-0.29	0.24			0.53	0.23 *
Interaction with Condition 2 (i.e., variable × cond2)																
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Observation level																
Autonomy-sup. learning climate [a]			-0.02	0.04			0.04	0.04			-0.02	0.04			0.01	0.04
Meaningful rationales [a]			0.01	0.04			0.05	0.03			0.01	0.04			-0.03	0.04
Student level																
Autonomy-sup. learning climate [a]			0.00	0.06			-0.02	0.06			0.00	0.05			0.04	0.06
Meaningful rationales [a]			-0.03	0.06			-0.05	0.06			-0.01	0.06			0.09	0.07
Respective dispositional measure	-0.04	0.05	-0.02	0.05	-0.06	0.04	-0.05	0.04	-0.05	0.04	-0.02	0.04	-0.03	0.05	0.00	0.05
Gender (m = 0)	0.15	0.08	0.10	0.07	0.10	0.09	0.05	0.07	-0.01	0.08	-0.06	0.07	0.03	0.08	0.04	0.08
Prior achievement	0.04	0.05	0.02	0.04	-0.01	0.04	0.01	0.04	0.01	0.04	0.00	0.04	-0.05	0.05	-0.05	0.04
Lesson level																
Autonomy-sup. learning climate [a]			-0.06	0.15			0.09	0.13			-0.14	0.15			0.30	0.16
Meaningful rationales [a]			-0.07	0.09			0.02	0.08			0.02	0.09			0.11	0.10
Class level																
Autonomy-sup. learning climate			-0.37	0.22			0.17	0.19			-0.03	0.20			0.43	0.20 *
Meaningful rationales			0.23	0.22			0.05	0.19			0.06	0.21			-0.21	0.20

Table S2 *(continued)*

Variable	Competence beliefs		Importance		Intrinsic value		Cost	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	Random effects							
	Est.	Est.	Est.	Est.	Est.	Est.	Est.	Est.
σ^2_e (individual-level state residual)	.520	.455	.404	.344	.487	.428	.557	.545
$\sigma^2_{r(2)}$ (individual-level trait)	.248	.181	.334	.198	.281	.167	.250	.224
$\sigma^2_{r(3)}$ (class-level state residual)	.048	.032	.043	.023	.071	.033	.048	.041
σ^2_u (class-level trait)	.059	.040	.061	.028	.049	.034	.035	.023
Number of observations	6987	6914	7001	6922	6998	6922	6993	6915

Note. m = male; Est. = estimated regression coefficient. All continuous variables were standardized beforehand across individuals and across time points, and thus, all regression coefficients can be understood as standardized regression coefficients. All continuous variables were standardized beforehand across individuals and across time points, and thus, all regression coefficients can be understood as standardized regression coefficients. For prior achievement, higher values indicate better achievement. Results were based on the analysis of 1,617 students, 360 separate lessons, and 78 classrooms.

[a] Scales were centered on the cluster means.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table S3

Absolute Proportions of Variance, Variance Partition Coefficients, and the Total Variance in Students' Competence Beliefs, Value Beliefs, and Perceived Autonomy-Supportive Teaching Behaviors Based on Scales That Were Built under an Alternative Rule (Half of the Items Must Have a Valid Response)

Variable	Individual level				Class level				Total
	State residual		Trait		State residual		Trait		
	Var	VPC	Var	VPC	Var	VPC	Var	VPC/ICC	Var
Competence beliefs	0.29	0.51	0.22	0.38	0.03	0.05	0.03	0.05	0.57
Importance	0.17	0.40	0.20	0.47	0.02	0.04	0.04	0.08	0.43
Intrinsic value	0.30	0.49	0.24	0.39	0.04	0.07	0.03	0.06	0.62
Cost	0.31	0.55	0.20	0.36	0.03	0.05	0.02	0.04	0.57
Autonomy-supportive learning climate	0.16	0.37	0.20	0.46	0.02	0.03	0.06	0.13	0.43
Meaningful rationales	0.34	0.45	0.23	0.31	0.08	0.11	0.10	0.13	0.74

Note. Var = variance; VPC = variance partition coefficient; ICC = intraclass correlation coefficient.

Table S4

Multilevel Models Where Scales Were Built under an Alternative Rule (Half of the Items Must Have a Valid Response)

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Fixed effects															
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Intercept	-0.02	0.06	-0.03	0.05	-0.12	0.06 *	-0.10	0.04 *	-0.03	0.06	-0.02	0.05	-0.06	0.05	-0.05	0.05
Observation level																
Autonomy-sup. learning climate [a]			0.40	0.02 ***			0.26	0.02 ***			0.36	0.02 ***			-0.17	0.02 ***
Meaningful rationales [a]			0.05	0.02 ***			0.21	0.01 ***			0.09	0.02 ***			0.05	0.02 **
Student level																
Autonomy-sup. learning climate [a]			0.41	0.02 ***			0.27	0.02 ***			0.39	0.02 ***			-0.27	0.03 ***
Meaningful rationales [a]			-0.04	0.03			0.41	0.03 ***			0.20	0.03 ***			0.18	0.03 ***
Respective dispositional measure	0.33	0.02 ***	0.26	0.02 ***	0.37	0.02 ***	0.24	0.02 ***	0.33	0.02 ***	0.23	0.02 ***	0.31	0.02 ***	0.27	0.02 ***
Gender (m = 0)	-0.03	0.03	-0.07	0.03 *	-0.03	0.04	0.02	0.03	0.01	0.03	0.02	0.03	-0.05	0.03	0.00	0.03
Prior achievement	0.06	0.02 **	0.05	0.02 **	0.04	0.02 *	0.01	0.02	0.01	0.02	-0.02	0.02	-0.04	0.02	-0.03	0.02
Lesson level																
Autonomy-sup. learning climate [a]			0.61	0.06 ***			0.56	0.05 ***			0.81	0.06 ***			-0.42	0.07 ***
Meaningful rationales [a]			0.04	0.04			0.16	0.03 ***			0.10	0.04 *			0.01	0.05
Class level																
Autonomy-sup. learning climate			0.83	0.10 ***			0.47	0.08 ***			0.74	0.09 ***			-0.45	0.09 ***
Meaningful rationales			-0.09	0.10			0.60	0.08 ***			0.18	0.09 *			0.26	0.09 **
Teacher condition	-0.03	0.09	-0.02	0.08	0.19	0.09 *	0.15	0.06 *	0.06	0.08	0.04	0.07	0.11	0.07	0.10	0.07
Master's student condition	0.02	0.08	0.05	0.07	0.17	0.08 *	0.15	0.06 *	-0.01	0.08	0.01	0.07	0.12	0.07	0.09	0.07
	Random effects															
	Est.		Est.		Est.		Est.		Est.		Est.		Est.		Est.	
σ^2_e (individual-level state residual)	.516		.451		.405		.345		.488		.429		.554		.539	
$\sigma^2_{r(2)}$ (individual-level trait)	.246		.179		.334		.196		.281		.167		.253		.225	
$\sigma^2_{r(3)}$ (class-level state residual)	.050		.034		.044		.021		.070		.032		.050		.045	
σ^2_u (class-level trait)	.061		.046		.060		.028		.046		.032		.034		.033	
Number of observations	6728		6532		6843		6626		6801		6595		6770		6566	

Table S4 *(continued)*

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Explained variance [b]															
	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2
Observation level	.00	.00	.15	.07	.00	.00	.17	.06	.00	.00	.15	.07	.00	.00	.02	.01
Student level	.35	.13	.18	.05	.29	.13	.30	.10	.27	.10	.30	.10	.28	.10	.07	.02
Lesson level	.00	.00	.34	.02	.00	.00	.49	.02	.00	.00	.52	.03	.00	.00	.15	.01
Class level	.16	.01	.54	.08	.22	.02	.65	.14	.15	.01	.67	.11	.27	.01	.24	.02
Total		.14		.22		.15		.33		.11		.30		.11		.06

Note. m = male; Est. = estimated regression coefficient; R_l^2 = proportion of *level-specific* outcome variance explained by level-specific predictors; R_t^2 = proportion of *total* outcome variance explained by level-specific predictors. All continuous variables were standardized beforehand across individuals and across time points, and thus, all regression coefficients can be understood as standardized regression coefficients. For prior achievement, higher values indicate better achievement. Results were based on the analysis of 1,583 students, 360 separate lessons, and 78 classrooms.

[a] Scales were centered on the cluster means.

[b] Explained variance (R_l^2 and R_t^2) was estimated by using the model-implied total variance by following the recommendations of Rights and Sterba (2019b, 2019a). Incremental explained variance (ΔR_l^2 and ΔR_t^2) was obtained by subtracting the proportions of variance explained by Model 1 from the corresponding proportions of variance explained by Model 2.

* *p* < .05. ** *p* < .01. *** *p* < .001.

Table S5

Unstandardized Results from Multilevel Models

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Fixed effects															
	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*	Est.	*SE*
Intercept	3.00	0.05 ***	4.39	0.07 ***	2.60	0.04 ***	3.70	0.05 ***	2.67	0.05 ***	4.08	0.07 ***	1.87	0.04 ***	1.39	0.07 ***
Observation level																
Autonomy-sup. learning climate [a]			0.44	0.02 ***			0.26	0.01 ***			0.42	0.02 ***			-0.20	0.02 ***
Meaningful rationales [a]			0.05	0.01 ***			0.15	0.01 ***			0.08	0.01 ***			0.04	0.01 **
Student level																
Autonomy-sup. learning climate [a]			0.48	0.03 ***			0.27	0.02 ***			0.47	0.03 ***			-0.31	0.03 ***
Meaningful rationales [a]			-0.03	0.02			0.31	0.02 ***			0.18	0.02 ***			0.15	0.03 ***
Respective dispositional measure	0.32	0.02 ***	0.25	0.02 ***	0.50	0.02 ***	0.33	0.02 ***	0.31	0.02 ***	0.21	0.01 ***	0.34	0.02 ***	0.30	0.02 ***
Gender (m = 0)	-0.03	0.03	-0.06	0.02 *	-0.02	0.02	0.02	0.02	0.00	0.03	0.01	0.02	-0.03	0.03	0.00	0.02
Prior achievement	0.05	0.02 **	0.04	0.01 **	0.02	0.01	0.00	0.01	0.01	0.02	-0.02	0.01	-0.03	0.01	-0.02	0.01
Lesson level																
Autonomy-sup. learning climate [a]			0.70	0.07 ***			0.53	0.05 ***			1.00	0.07 ***			-0.47	0.08 ***
Meaningful rationales [a]			0.03	0.03			0.13	0.03 ***			0.08	0.04 *			0.00	0.04
Class level																
Autonomy-sup. learning climate			0.94	0.11 ***			0.47	0.08 ***			0.87	0.11 ***			-0.53	0.11 ***
Meaningful rationales			-0.07	0.08			0.44	0.06 ***			0.17	0.08 *			0.22	0.08 **
Teacher condition	-0.03	0.06	-0.03	0.06	0.12	0.06 *	0.09	0.04 *	0.04	0.06	0.03	0.05	0.09	0.05	0.08	0.05
Master's student condition	0.01	0.06	0.03	0.05	0.11	0.06 *	0.10	0.04 *	-0.01	0.06	0.00	0.05	0.08	0.05	0.06	0.05
	Random effects															
	Est.		Est.		Est.		Est.		Est.		Est.		Est.		Est.	
σ^2_e (individual-level state residual)	.293		.257		.174		.148		.302		.265		.319		.312	
$\sigma^2_{r(2)}$ (individual-level trait)	.140		.102		.144		.085		.173		.103		.144		.129	
$\sigma^2_{r(3)}$ (class-level state residual)	.027		.018		.019		.010		.044		.020		.027		.024	
σ^2_u (class-level trait)	.033		.025		.026		.012		.030		.020		.019		.018	
Number of observations	6987		6914		7001		6922		6998		6922		6993		6915	

Table S5 *(continued)*

Variable	Competence beliefs				Importance				Intrinsic value				Cost			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Explained variance [b]															
	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2	R_l^2	R_t^2	ΔR_l^2	ΔR_t^2
Observation level	.00	.00	.14	.07	.00	.00	.17	.06	.00	.00	.14	.06	.00	.00	.02	.01
Student level	.34	.13	.19	.06	.29	.13	.30	.11	.27	.10	.30	.10	.28	.10	.07	.02
Lesson level	.00	.00	.36	.02	.00	.00	.45	.02	.00	.00	.51	.03	.00	.00	.15	.01
Class level	.17	.01	.54	.08	.22	.02	.65	.14	.14	.01	.66	.11	.28	.01	.25	.02
Total		.14		.23		.15		.33		.11		.30		.11		.06

Note. m = male; Est. = estimated regression coefficient; R_l^2 = proportion of *level-specific* outcome variance explained by level-specific predictors; R_t^2 = proportion of *total* outcome variance explained by level-specific predictors. For prior achievement, higher values indicate better achievement. Results were based on the analysis of 1,617 students, 360 separate lessons, and 78 classrooms.

[a] Scales were centered on the cluster means.

[b] Explained variance (R_l^2 and R_t^2) was estimated by using the model-implied total variance by following the recommendations of Rights and Sterba (2019b, 2019a). Incremental explained variance (ΔR_l^2 and ΔR_t^2) was obtained by subtracting the proportions of variance explained by Model 1 from the corresponding proportions of variance explained by Model 2.

* p < .05. ** p < .01. *** p < .001.

4

STUDY 2: THE TRANSMISSION OF VALUES FROM MATH TEACHERS TO THEIR NINTH-GRADE STUDENTS: DIFFERENT MECHANISMS FOR DIFFERENT VALUE DIMENSIONS?

Parrisius, C., Gaspard, H., Trautwein, U., & Nagengast, B. (2020). The transmission of values from math teachers to their ninth-grade students: Different mechanisms for different value dimensions? *Contemporary Educational Psychology*, *62*, Article 101891. https://doi.org/10.1016/j.cedpsych.2020.101891

Abstract

Teachers can transmit their class-related values to their students and thus affect their students' academic development in regular classes. This so-called value transmission has mostly been examined with respect to emotional contagion, that is, the transmission of rather affective values (e.g., enjoyment) from teachers to their students through teachers' enthusiastic behavior during instruction. However, other transmission processes might also be at play, including other value dimensions and mediation through other instructional practices. In this study, we therefore aimed to systematically test the generalizability of such value transmission effects by examining a broad spectrum of (a) teacher values, (b) instructional practices, and (c) student values. Based on longitudinal data from 1,744 students and their 70 math teachers, cross-level mediation analyses revealed that teachers' teaching enthusiasm, math enthusiasm, as well as math utility value affected their students' values (i.e., intrinsic and utility values). Teachers' teaching enthusiasm was transmitted to students' values through both student-perceived enthusiastic behavior during instruction and through relevance-related instructional practices. Teachers' subject-related values (i.e., math enthusiasm and utility value) primarily affected students' utility value, but this transmission could not be explained by the instructional practices under investigation. Overall, our findings reveal auspicious evidence for a broader generalizability of the value transmission concept and yet also show the need to differentiate between different value dimensions and the mechanisms through which they are transmitted from teachers to their students.

Keywords: value transmission · teacher values · instructional practices · student values · cross-level mediation

Introduction

Adolescents' task values (i.e., the subjective value they attach to a task as defined in expectancy-value theory; Eccles et al., 1983) are essential predictors of successful learning in school (e.g., Wigfield et al., 2016). Given their importance, the decrease in students' values during the school years, which is particularly pronounced in the domain of math (e.g., Gaspard et al., 2017), has attracted attention in research (e.g., Scherrer & Preckel, 2019; Wigfield et al., 2015). It has been argued that teachers can provide important resources that can work against the decline in student values as they shape their students' everyday school life (Eccles & Roeser, 2009; Seidel & Shavelson, 2007; Wentzel, 2009). For instance, students may be captivated by their teachers' passionate and enthusiastic behavior during instruction and may subsequently enjoy that class more (Frenzel et al., 2009, 2018). Teachers may also be capable of persuading their students that the class has value by emphasizing the usefulness of the content (e.g., Assor et al., 2002; Schmidt et al., 2019; Schreier et al., 2014). Indeed, previous research has shown that student values are affected by different teacher behaviors during instruction (e.g., Dietrich et al., 2015; Schmidt et al., 2019), which, in turn, strongly depend on teachers' own values (Kunter et al., 2008; Richardson & Watt, 2010).

Ultimately, this implies that teacher values can affect student values (e.g., Frenzel et al., 2009, 2018; Pekrun, 2006; Schiefele, 2017), which can be subsumed under *value transmission*. Underlying processes (e.g., the transmission through teachers' behavioral expressions of their values) have yet almost exclusively been studied in the realm of emotional contagion (e.g., Frenzel et al., 2009, 2018; for exceptions, see, e.g., Kunter et al., 2013; and Schiefele, 2017). Emotional contagion comprises the transmission of rather affective value dimensions (e.g., enjoyment) from teachers to their students through teachers' enthusiastic behavior during instruction as a mediating variable. However, research focusing on other predictors of student values has additionally indicated links between different dimensions of teacher and student values, which might also be explained by instructional practices other than enthusiastic behavior (e.g., Paulick et al., 2013; Schiefele, 2017; Schmidt et al., 2019). A full investigation of the effects of teacher values on student values and their underlying processes has yet to be conducted.

We thus aimed to address the questions of *whether* and *how* the transmission of multiple value dimensions from teachers to their students occurs. To do so, first, we conceptually replicated work on emotional contagion processes (see Frenzel et al., 2018). Second, we expanded this restricted view on value transmission by also investigating the potential transmission of affective value dimensions through other instructional practices (i.e., presenting everyday life examples and relevance support). Third, we additionally examined the (indirect) impacts of other dimensions of teacher values (subject enthusiasm as well as utility value) on dimensions of student values (intrinsic and utility value) based on expectancy-value theory (EVT; Eccles et al., 1983) and research on teacher enthusiasm (e.g., Keller et al., 2016). On the basis of EVT, we thereby provide a first systematic approach for a broader investigation of value transmission effects in math classrooms by investigating different value dimensions and potential underlying mechanisms.

Conceptualization of Teacher and Student Values

To conceptualize and examine different dimensions of teacher and student values, we relied on expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2002), which is a prominent framework for explaining differences in both teacher (e.g., Watt & Richardson, 2007) and student motivation (e.g., Watt et al., 2012). EVT posits that a person's values ("Do I want to do it?") and expectancies ("Can I do it?") are the most proximal predictors of a person's effort, achievement performance, and choices (e.g., Wigfield et al., 2016). Eccles and colleagues furthermore postulated a comprehensive set of constructs that affect a person's values and expectancies including individual and contextual features. Values and expectancies have been shown to differentially impact achievement-related outcomes, such that values seem to be more important for choices, and expectancies seem to be more important for achievement (see, e.g., Wigfield et al., 2017). Previous research mainly focused on student motivation, but EVT provides a model that can also be fruitfully applied to investigate teachers' motivation insofar as teachers can be assumed to be highly motivated when they value their subject and their teaching, and when they expect to be good at teaching (Watt & Richardson, 2007). Importantly, teachers' own values can be important antecedents of student values (e.g., Keller et al., 2014; Lazarides, Gaspard, et al., 2019). In this study, we focus on student and teacher values.

Student Values

According to EVT, student values are influenced by socializers' (e.g., teachers') beliefs and behaviors and especially students' interpretations of this behavior (e.g., Eccles, 2007). Eccles (2005) differentiated between four task value dimensions: intrinsic value, utility value, attainment value, and cost. In this study, we focused on *intrinsic value* because it was previously most commonly investigated in terms of transmission processes. Intrinsic value is mostly affective and reflects a person's enjoyment of a task (Eccles, 2005). It seems to be highly susceptible to a positive class context (e.g., high teacher support, see Assor et al., 2002; or positive teacher-student relations, see Wentzel, 2009), which is why we considered it to be promising for an investigation of associations between teacher variables and student values. Second, we focused on *utility value* because it is assumed to be most malleable compared with the other value components (Trautwein et al., 2013; Wigfield et al., 2017). Utility value refers to the instrumental value of a task in terms of its relevance and usefulness for achieving short-term and long-term goals (Eccles & Wigfield, 2002). Utility value is described as a means to an end rather than an end in itself and is therefore more similar to extrinsic motivation than the other value components (though it is also related to personal goals and therefore to one's sense of self; Eccles, 2005). This makes utility value also highly susceptible to external influences (Harackiewicz et al., 2014) that are of personal importance for the student (Eccles, 2005). The conceptualizations of intrinsic and utility values thus include contrasting features. Although students' intrinsic and utility values are typically positively correlated, they can be empirically separated (Gaspard, Dicke, Flunger, Schreier, et al., 2015). Furthermore, it has been shown that students' intrinsic and utility values can be affected through targeted interventions (e.g., Gaspard, Dicke, Flunger, Brisson, et al., 2015; Hulleman et al., 2010; Hulleman & Harackiewicz, 2009). Thus, both students' intrinsic and utility values are malleable. We therefore aimed to examine whether they are susceptible to similar or different value transmission processes.

Teacher Values

In line with the conceptualization of teacher motivation within the FIT-choice framework (Watt & Richardson, 2007) and our conceptualization of student values, we also focused on teachers' intrinsic and utility values as predictors of student values. Besides their relevance in previous research, we also aimed to include teacher value scales that are as close as possible to the student scales of interest to be able to investigate value transmission processes.

Teachers' intrinsic value captures their positive affect regarding teaching. It therefore overlaps a great deal with teacher enjoyment (mostly considered in research on emotional contagion; e.g., Frenzel et al., 2009, 2018) and enthusiasm (mostly considered in research on teacher effectiveness; e.g. Kunter & Holzberger, 2014; see also Keller et al., 2016). Teacher enthusiasm has been defined as reflecting "the degree of enjoyment, excitement and pleasure that teachers typically experience in their professional activities" (Kunter et al., 2008, p. 470), which is why we view enthusiasm as an operationalization of a rather affective dimension of teacher values, similar to intrinsic value. Teacher enthusiasm can be differentiated into teachers' valuing of teaching (*teaching enthusiasm*) and of the subject (*math enthusiasm*; Kunter et al., 2008). Teachers' teaching and math enthusiasm were found to be differentially predictive of student-reported and teacher-reported quality of instructional behavior (Kunter et al., 2008), with teaching enthusiasm being a stronger predictor for both student- and teacher-reported quality of instruction, and math enthusiasm being only related to teachers' self-reports. Kunter and colleagues thus claimed for a differentiated approach to enthusiasm, which is why we consider both dimensions of enthusiasm in this study. Overall, teacher enthusiasm has shown positive associations with students' intrinsic value (see, e.g., Carmichael et al., 2017; Fauth et al., 2019; or Keller et al., 2016, for an overview).

Teachers' math utility value, on the other hand, can be understood as the perceived value of math with respect to its usefulness for one's daily and future life. In their FIT-choice framework, Watt and Richardson (2008) postulated and empirically separated multiple facets of teachers' utility value (e.g., personal and social utility value). However, the FIT-choice framework was developed and successfully implemented to investigate a person's motivation to become a teacher (e.g., Watt et al., 2012, 2017; Watt & Richardson, 2008). It thus focuses on the usefulness of teaching rather than that of the subject, and furthermore taps multiple utility-value facets that cannot be rated in a meaningful way by persons who chose this profession for the long-term, such as the sample of experienced math teachers in our study. Besides work regarding teachers' teaching utility value, empirical evidence for teachers' utility value for the subject matter and its potential associations with student values has remained scarce (for an exception, see Han et al., 2019). Nevertheless, we assume that teachers who are convinced of the relevance and usefulness of a subject will intensify their emphasis on the subject's relevance during instruction and thus support their students in seeing the relevance of the subject for their personal goals (Harackiewicz et al., 2014; Roth, 2014). In a first attempt to examine teachers' utility value and its relevance for students' values, in a sample of 219 eighth-grade students, Han et al. (2019) found that history teachers' perceived utility value was associated with students' own utility value of history reported 6 weeks later. Hence, there is still a need for longitudinal investigations with longer time lags on the association between teachers' actual (i.e., self-reported) utility value and their students' values in adequately sized samples that would allow researchers to investigate such value transmission processes not only at the student level but also at the class level.

Value Transmission in the Classroom: Emotional Contagion

Previous findings thus indicate that teachers can transmit their values to their students. However, the mechanisms through which such value transmission processes in the classroom can be explained are still not fully understood. For values to be transmitted, it is probably necessary for teachers to enact their values and for students to perceive this behavior (see Eccles, 2007). This would mean that it is the *perception* of the teachers' behavior (Lüdtke et al., 2009) and students' conclusions about teachers' conjectural motivational states that provoke this behavior that ultimately leads to an assimilation of values.

Indeed, students' perceptions of their teachers' enthusiastic behavior during instruction have often been investigated in association with teachers' and students' affective value dimensions (e.g., enjoyment; Frenzel et al., 2009, 2018). In contrast to the teacher's motivational inner state, that is, (experienced) teacher enthusiasm, *student-perceived* teacher enthusiasm emphasizes the behavioral and observable component of enthusiasm. The aforementioned overall phenomenon—that is, the association between teacher and student values via student-perceived enthusiasm—attracted substantial attention under the term *emotional contagion*. It comprises an individual's emotional expression that can be "caught" by another person, eventually leading these two people to converge emotionally (see Hatfield et al., 1992, 1993; Hsee et al., 1990). Several studies have demonstrated emotional contagion in situations involving a teacher-learner relationship (see Frenzel et al., 2019; and Hsee et al., 1990, for laboratory studies; and Radel et al., 2010, for a quasi-experimental field study). In cross-sectional studies, Frenzel et al. (2009) and Keller et al. (2014) showed that teachers' affective value dimensions (enjoyment in the case of Frenzel et al. and experienced enthusiasm in the case of Keller et al.) were indirectly linked to students' own affective value dimensions (again, enjoyment in the case of Frenzel et al. and interest in the case of Keller et al.) through students' perceptions of teacher enthusiasm. Even though they found no total effect from teachers' to students' enjoyment, Frenzel et al. (2018) found that these indirect associations also held longitudinally: In classrooms in which students had not already known the teachers from previous years, teachers' enjoyment of teaching in this class and their students' enjoyment of math classes were indirectly related over time. More precisely, students' enjoyment at the beginning of the school year was associated with their teachers' enjoyment in the middle of the year through teacher-perceived student engagement, and teachers' enjoyment was additionally indirectly associated with students' later enjoyment through student-perceived teacher enthusiasm.

Overall, several studies have consistently indicated the positive association between, on the one hand, student-perceived teacher enthusiasm and, on the other, students' own level of intrinsic value (e.g., Brigham et al., 1992; Frenzel et al., 2010; Kim & Schallert, 2014; B. C. Patrick et al., 2000) or enjoyment (e.g., Keller et al., 2018; Kunter et al., 2011). Besides its relevance for students' intrinsic value, student-perceived teacher enthusiasm can also affect students' utility value: A cross-sectional study by Lazarides et al. (2018) showed that students' perceptions of their teachers' enthusiastic behavior during teaching predicted their own utility value on the individual and class levels.

Value Transmission Explained Through Instructional Practices Other Than Student-Perceived Enthusiasm

Considering previous findings, emotional contagion seems to be a well-documented phenomenon that describes one aspect of value transmission processes. Yet, value transmission could also occur through other processes than students' perception of teacher enthusiasm, including other instructional practices. Furthermore, next to the transmission of affective value dimensions, a transmission between other value dimensions such as utility value has not been in the focus of prior research.

Another instructional practice through which teachers may transmit their values to their students involves emphasizing the relevance of the material, which has been shown to be a powerful strategy for motivating students (Assor et al., 2002; Brophy, 1986; Keller et al., 2016; Kunter et al., 2008; H. Patrick et al., 2003; Wang, 2012). Teachers can try to persuade their students of the relevance and usefulness of a task or learning process by helping them to draw connections to their personal interests, goals, and values (Assor et al., 2002; Reeve et al., 2002). Previous research has supported the importance of highlighting the relevance of the material during class for students' own values. For instance, students' utility value was found to be predicted by students' concurrent perceptions of their teachers' emphasis on relevance during class (Schreier et al., 2014), and this effect remained significant when changes in utility value were investigated longitudinally. Additionally, Lazarides, Dietrich, et al. (2019) found that students with a low math motivation profile (characterized by low levels of self-concept, interest, and intrinsic and utility values) were more likely to change to a more adaptive profile if they perceived that their teacher was emphasizing relevance during class. Wang (2012) also found that instructional practices such as emphasizing relevance were associated with changes in students' task values (investigating a global measure of task values).

In a mixed-method study with four teachers and 306 students, Schmidt et al. (2019) demonstrated that the extent to which teachers pointed out the specific relevance of the material they were teaching differed substantially. Whereas some teachers frequently made statements to support the relevance of the topic they were teaching, others almost never emphasized the relevance of the content for their students' lives. The quantity of relevance-inducing statements during class was linked to students' perceived global science utility, even when students' perceived levels of competence and interest were controlled for.

Overall, previous research has supported the ideas that teachers' enthusiastic behavior while teaching and their emphasis on the relevance of the material are valuable instructional practices that teachers can use to affect their students' values in class. Considerable strands of research rooted both in realistic mathematics education (providing everyday life examples; Freudenthal, 1968; van den Heuvel-Panhuizen & Drijvers, 2014) as well as in self-determination theory (relevance support; Ryan & Deci, 2000) have focused on emphasizing the relevance as a motivating instructional practice.

But what prerequisites are necessary for teachers to show such behavior? What kinds of values do teachers need in order to teach enthusiastically and to regularly and authentically emphasize the relevance of the content? Regarding oftentimes investigated features of teaching quality (classroom management, learning support, and cognitive activation; for an overview, see Seidel & Shavelson, 2007), an impressive body of research already investigated similar questions on antecedents of teachers' behavior during instruction (for an overview, see Praetorius et al., 2017). In terms of teacher behavior that is conceptually and empirically more closely related to students' motivation such as teachers' enthusiastic behavior during instruction, previous research has argued that teachers' own underlying affective values (e.g., experienced enthusiasm) are associated with their enthusiastic behavior during class (e.g., Keller et al., 2014; Kunter et al., 2008). Such congruency between personal values and actual behavior is described as a feature of authenticity (e.g., Kreber et al., 2010). However, being authentic—and, eventually, persuasive—in a classroom setting can be expressed in different ways than just congruency; being authentic equally involves behavior that is "in the important interest of students" (Kreber et al., 2010, p. 385). We assume that teachers' enthusiasm is an important force that makes them more perceptive of their students' needs and of what is on their students' minds—that is, what their students actually consider relevant, and to act accordingly. Teachers might thus be perceived as authentically encouraging meaningfulness in the subject matter when they themselves are enjoying it in addition to believing in its usefulness (for a similar reasoning, see Schiefele, 2009). In line with this assumption, teachers' enthusiasm has been proposed (Woolfolk Hoy, 2008) and shown to be associated with higher quality of various instructional practices as perceived by the students (Kunter et al., 2008; also in the terminology of self-determined motivation: Roth et al., 2007).

Analogously to teachers' enthusiasm and in line with the concept of authenticity, we suspect that teachers' math utility value is a critical predictor of why teachers engage in instructional practices that are conceptually close to this underlying value—such as emphasizing the relevance of content (see Roth, 2014). Furthermore, we assume that teachers who perceive a high usefulness of math for their students not only put emphasis on relevance and importance for their students, but that it might also be easier for them to show enthusiasm while teaching math. In addition, their authentic attempts to motivate their students due to their personal perceived usefulness of math might lead to an overall high engagement during class, which might be perceived as enthusiastic teaching by the students (in fact, emphasizing relevance has previously also been conceptualized as perceived enthusiasm; e.g., H. Patrick et al., 2003; for the overall associations of different value types of teachers and their motivational strategies use during class, see, e.g., Roth et al., 2007).

Taking Students' Individual and Shared Perceptions into Account

When examining the transmission of teacher values to their students, it seems to be most appropriate to consider students' own reports of their teachers' instructional practices as mediating variables rather than other sources of data (see Lüdtke et al., 2009; see also Eccles, 2007). Although students' perspectives were taken into account in past research (e.g., Frenzel et al., 2009, 2018; Schiefele, 2017), students' idiosyncratic perceptions of the teaching were mostly neglected by reducing investigations of mediational associations to the class level (i.e., by using the class-aggregated perceptions as is done by commonly used class-level only mediation approaches; e.g., Frenzel et al., 2018; see also Preacher et al., 2010).

However, it is important to distinguish between effects of the students' individual perceptions and the additional effects of the shared perceptions of the class over and above the effects via the individual level, because they can carry different information (e.g., the shared perceptions can carry information about group norms; see "normative effects" in Raudenbush & Bryk, 2002; see also Stapleton et al., 2016). The distinction between the individual and class levels within mediation analyses can be realized using the cross-level mediation approach proposed by Pituch and Stapleton (2012), which allows disentanglement of different sources of the indirect associations between teacher and student values: whether this indirect association is essentially equal to the indirect effect through the individual-level perceptions of instructional practices, or whether there is an additional indirect impact through the shared perceptions of the class on student values over and above the indirect effect via the individual perceptions. In other words, when simultaneously considering the individual and shared perceptions, it is possible to answer two questions: First, do teacher values affect student values through students' individual perceptions of the instructional practices? And second, is there an additional effect of the shared perceptions of the classroom that—over and above the individual perceptions—explains the indirect association between teacher and student values?

The Present Study

In the present study, we were interested in whether and how teachers transmit different values to their students in math classrooms. To answer our questions, we drew on data from a large longitudinal study in math classrooms in which we considered both the teachers' and students' perspectives. Drawing on evidence for emotional contagion, we first aimed to conceptually replicate previous research on the associations between teachers' and students' affective value dimensions, which focused on the mediational role of student-perceived teacher enthusiasm (see Frenzel et al., 2018). We hereby focused on teachers' self-reported (experienced) enthusiasm as an operationalization of the affective value dimensions and distinguished between their teaching and math enthusiasm because they were found to affect student ratings of teaching behavior differently (Kunter et al., 2008).

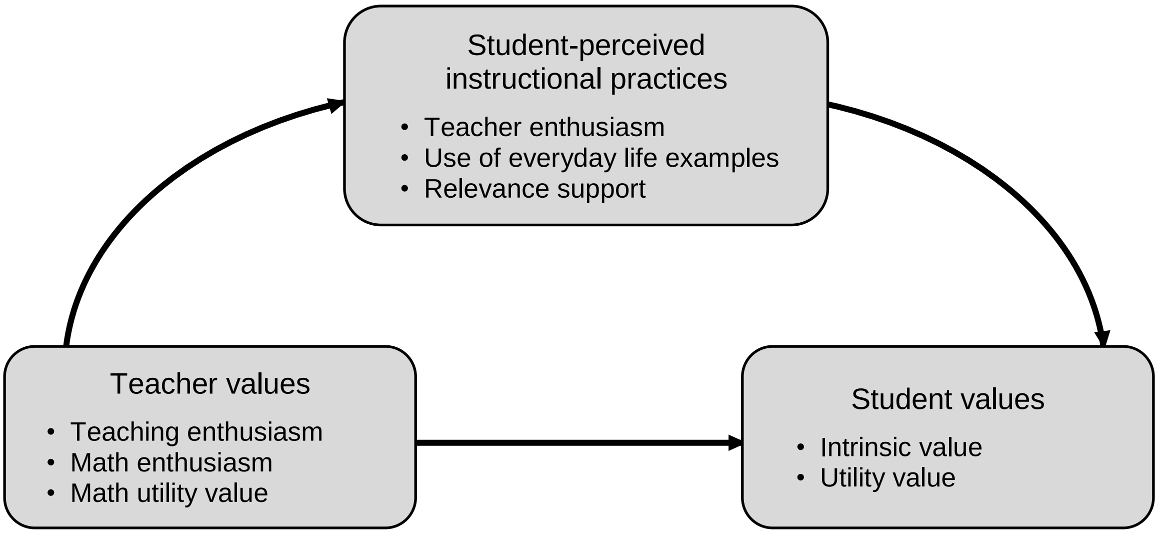
Second, extending research on emotional contagion, we furthermore investigated value transmission effects through other instructional practices than perceived teacher enthusiasm. Previous research suggested that emphasizing the relevance of the material that is being taught affects student values (e.g., Schmidt et al., 2019; Schreier et al., 2014; Wang, 2012). Relying on different research traditions (realistic mathematics education and self-determination theory), we therefore examined the mediational roles of two relevance-related instructional practices (use of everyday life examples and relevance support). Even if students do not initially value the content intrinsically or see its relevance and usefulness, we expect them to be more likely to adopt the given rationales and finally to more likely intrinsically value the content if the teacher repeatedly points out its relevance for students' lives (Hidi & Renninger, 2006).

Finally, we extended our focus from enthusiasm and intrinsic value to teachers' utility value as well as to students' utility value on the basis of its high susceptibility to external influences compared with other task values. When teachers are convinced of the relevance of math, they might more intensively provide rationales to their students and encourage their students to internalize the same values. The students, in turn, might adopt the given rationales and ultimately see a higher usefulness in math. To our knowledge, this is the first longitudinal study to empirically explore the transmission of teachers' self-reported utility value to their students' utility value through various instructional practices (for an investigation of the transmission of student-perceived teacher utility value to their students without considering potential mediation through instructional practices, see Han et al., 2019).

Overall, we expected relations between teacher and student values as suggested in our heuristic working model in Figure 1. Given that we investigated enthusiasm, intrinsic value, and utility value, we tested for mediational associations through instructional practices that are conceptually most closely related to these value dimensions, namely, student-perceived teacher enthusiasm as well as the use of everyday life examples and relevance support.

Figure 1

Heuristic Working Model in Which Teacher Values are Expected to Affect Student Values and Student-Perceived Instructional Practices are Hypothesized to Mediate this Link



With regard to the constructs and mechanisms under investigation, we tested the following research questions in which we first focused on the mediational model based on emotional contagion (Research Question 1), and then one at a time, we substituted different elements of this model, that is, we included other instructional practices (Research Question 2), other predictors (Research Question 3), and other outcomes (Research Question 4):

1. *Conceptually replicating findings on emotional contagion* (see Frenzel et al., 2018): Are teachers' teaching enthusiasm and students' intrinsic value prospectively related, and is this link mediated by student-perceived teacher enthusiasm?
2. *Examining transmission processes through other instructional practices:* Are the associations between teachers' teaching enthusiasm and students' intrinsic value also mediated through relevance-related instructional practices (i.e., student-perceived use of everyday life examples and relevance support)?
3. *Broadening value transmission to include other dimensions of teacher values:* Are teachers' math enthusiasm and math utility value prospectively associated with students' intrinsic value? Are these links mediated by the three student-perceived instructional practices under investigation (i.e., teacher enthusiasm, use of everyday life examples, relevance support)?
4. *Broadening value transmission to include other dimensions of student values:* Are the three dimensions of teacher values prospectively associated with students' utility value? Are these links mediated by the three student-perceived instructional practices under investigation?

Method

Approval for this study was obtained from the Ethics Committee for Psychological Research at the University of Tübingen, Germany (#2017/0724/75).

Participants and Procedure

Sample

The data stemmed from the large intervention study "Motivation in Mathematics" conducted in the 2017/2018 school year (Gaspard et al., 2020). For recruitment, 57 academic track schools (*Gymnasien*) in the German state of Baden-Württemberg and the teachers at these schools teaching math in ninth-grade classes were contacted and asked to participate in the study, and 28 schools agreed. The headmasters usually decided on behalf of their school whether they wanted to support the study. As a consequence, oftentimes, all of the teachers teaching math in ninth-grade classes at the respective schools participated in the study rather than only one teacher per school (for further information on the recruitment process, see Gaspard et al., 2020). N_T = 70 math teachers (44.3% female; M_{age} = 38.7 years, SD_{age} = 9.8, at the first measurement wave [T1]; M = 10.4 years of teaching experience, SD = 8.5) teaching 78 ninth-grade classes decided to participate. Only the students who had written parental consent (N_S = 1,744; 53.8% female adolescents; M_{age} = 14.63 years, SD_{age} = 0.48, at T1) were allowed to participate (88.7% participation rate). One of the participating classes, which was usually comprised of the same group of students in each subject, was divided into two math learning groups that were taught by two different teachers. Because our focus in this study was to examine teacher-student interactions, we treated these two learning groups as separate classes, resulting in 79 clusters on the class level. Thirty-five of these classes (44.3%) had been instructed by the same math teacher in the previous school year or even for several years.

Study Design

The study involved three measurement waves throughout the school year. Participants were assessed a few weeks into the school year in October 2017 (T1), an average of 8 weeks later in December 2017 (T2), and an average of another 2.5 months later in February/March 2018 (T3). Between T1 and T2, some of the students received an intervention that was aimed at fostering students' motivation regarding math. Thus, data stemmed from a cluster-randomized intervention study investigating the effectiveness of this relevance intervention in the classroom. However, several robustness checks indicated that our results were not affected by the intervention (see the Results section for robustness checks). Before T1, participating teachers (and their classes) were randomly assigned to one of two intervention conditions or to a waitlist control condition. In the two intervention conditions, identical interventions were implemented; they only differed in terms of the person delivering the intervention (either the regular math teacher or trained master's students). The intervention comprised a 90-min session on the relevance of math, including a psychoeducational presentation and an individual relevance-inducing task. In this task, students were asked to evaluate quotes from interviews with young adults on the relevance of math for their current job and daily life (for more information on the intervention, see Gaspard et al., 2020). This intervention was found to foster students' utility value, whereas the math teachers and master's students differed only a little in their effectiveness in delivering the intervention (Gaspard et al., 2020). We therefore controlled for the intervention conditions in all of our analyses (see the Statistical Analyses section for more detail).

Teacher values (T1), students' perceptions of their teachers' instructional practices (T2), and student values (T1 and T3) were assessed via student and teacher questionnaires at the respective time points. Students completed their questionnaires during regular 45-min math lessons in the presence of trained research assistants. Teachers were asked to fill out the questionnaire at the same time as their students. If they were not able to fill out the questionnaire during that time, they were asked to complete their questionnaire separately and send it via mail to the researchers conducting the study. Five of the 79 participating classes experienced a change in teachers between T2 and T3. Even though these new teachers might have had different kind of values and might have engaged in different instructional practices, we included these five classes in our analyses and used data from the teachers at T1. Students in these five classes were taught by their first teacher for at least half a school year, whereas the new teacher at T3 had only taught on average for 3.5 weeks in their class (less than half of the time period between T2 and T3). A robustness check revealed that the results were not affected by these five classes (see the Results section).

Measures

The wordings of all of the items are presented in the supplemental material (Table S1), and their descriptive statistics, the proportion of variance between classes (ICC_1), and the reliabilities of the class means (ICC_2) are summarized in Table 1. All items were measured with a 4-point Likert-type scale ranging from 1 (*completely disagree*) to 4 (*completely agree*).

Table 1

Overview of Measures, Descriptive Statistics, Proportions of Variance between Classes (ICC_1), and the Reliabilities of the Class Means (ICC_2) for the Variables of Interest

Variable	*M*	*SD*	Range	ICC_1/ ICC_2	Skew-ness	Kur-tosis
Teacher values [a]						
T1 teachers' teaching enthusiasm	3.55	0.41	2.33–4.00	—	-.74	-.05
T1 teachers' math enthusiasm	3.15	0.51	2.00–4.00	—	-.03	-.78
T1 teachers' math utility value	3.51	0.47	2.00–4.00	—	-.97	.66
Student-perceived instructional practices						
T2 student-perceived teacher enthusiasm	2.87	0.74	1.00–4.00	.27/.89	-.48	-.23
T2 student-perceived use of everyday life examples	2.24	0.77	1.00–4.00	.22/.86	.11	-.65
T2 student-perceived relevance support	2.32	0.67	1.00–4.00	.16/.81	-.12	.12
Student values						
T1 students' intrinsic value	2.47	0.86	1.00–4.00	.03/.36	.06	-.85
T3 students' intrinsic value	2.41	0.85	1.00–4.00	.04/.46	.10	-.78
T1 students' utility value	2.83	0.50	1.00–4.00	.04/.47	-.11	-.11
T3 students' utility value	2.77	0.51	1.00–4.00	.03/.42	-.05	.00

Note. T in T1 to T3 = Time. ICC_1 = proportion of variance between classes. ICC_2 = reliability of class mean. — = not applicable. The possible range for all scales was 1-4.
[a] It is common for teachers not to exploit the entire range in research on teacher values (e.g., Watt & Richardson, 2007) but to report high values on average (e.g., Paulick et al., 2013), accompanied by high kurtosis and skewness values for the measures (e.g., Schiefele et al., 2013). In fact, the range for teachers' teaching enthusiasm reported in this study was nearly identical to Frenzel et al.'s (2018) T1 teacher enjoyment scale.

Teacher Values (T1)

To assess *teachers' teaching enthusiasm* (six items) and *math enthusiasm* (five items), we used two scales that were adapted from previous studies (e.g., Baumert et al., 1997; Kunter et al., 2011). To assess *teachers' math utility value*, we asked teachers to respond to four items that were adapted from the utility value scale for students. All three scales were internally consistent (McDonald's omega $\omega_{\text{teaching enthusiasm}} = 0.81$, $\omega_{\text{math enthusiasm}} = 0.73$, $\omega_{\text{utility value}} = 0.69$).

Student-Perceived Instructional Practices (T2)

Students were asked to report their *perceived teacher enthusiasm, perceived use of everyday life examples,* and *perceived relevance support*. Students' perceptions of teacher enthusiasm were measured with three items that were adapted from previous studies (e.g., Baumert et al., 2009). To assess students' perceptions of teachers' use of everyday life examples (three items), we used a student-reported scale from Baumert et al. (2009) with small adaptions of the wording. Students' perceptions of teachers' relevance support during class were assessed with five items that were partly taken from Flunger et al.'s (2019) scale to measure student-perceived provision of meaningful rationales by their teachers and partly newly developed to refer to the usefulness of math for everyday life situations and for future life specifically. All three scales showed good internal consistency (McDonald's omega $\omega_{enthusiasm} = 0.78$, $\omega_{examples} = 0.79$, $\omega_{relevance\ support} = 0.85$).

Student Values (T1 and T3)

We used a reduced 3-item version of the intrinsic-value scale from Gaspard et al. (2017) to assess students' *intrinsic value*. In addition, we used a slightly adapted 12-item utility-value scale from Gaspard et al. (2017) tapping multiple subfacets of utility value (general utility, utility for job, utility for daily life, and utility for school; for more information, see Gaspard, Dicke, Flunger, Schreier, et al., 2015) to assess students' *utility value*. The scales showed good internal consistency (McDonald's omega $\omega_{intrinsic,T1} = 0.92/\omega_{intrinsic,T3} = 0.93$, $\omega_{utility,T1} = 0.86/\omega_{utility,T3} = 0.88$).

Confirmatory Factor Analyses

To test for the separability of all the different constructs under investigation, we used a multilevel confirmatory factor analysis (CFA) with students nested within classrooms using the robust maximum likelihood estimator. For the two student values, residuals of identical items were allowed to correlate over time (Cole et al., 2007). For students' utility value in particular, residuals of the items indicating the same subfacets of utility value were also allowed to correlate (see Gaspard, Dicke, Flunger, Schreier, et al., 2015). Results from measurement invariance tests across time (for student values at T1 and T3) indicated support for weak measurement invariance (see Table S2 in the supplemental material), which is why we constrained the item loadings for these variables to be equal across time. Following recommendations from Stapleton et al. (2016), we furthermore constrained the factor loadings for identical student-reported variables (i.e., instructional practices and student values) to be equal across levels. The multilevel CFA yielded an acceptable fit (CFI = .931, TLI = .925, RMSEA = .033, $SRMR_{within} = .065$, $SRMR_{between} = .147$) and supported the assumed factor structure of the measures we used. Results for separate CFAs for teacher values, student-perceived instructional practices, and student values, can be found in the supplemental material (Table S3).

Statistical Analyses

We aimed to investigate whether and how (i.e., through which instructional practices) teachers transmit their values to their students. We include an example analysis script for our statistical approach to multilevel mediation analyses in the supplemental material. The complete set of analysis scripts that we actually used can be accessed from the Open Science Framework (https://osf.io/ekcyz/).

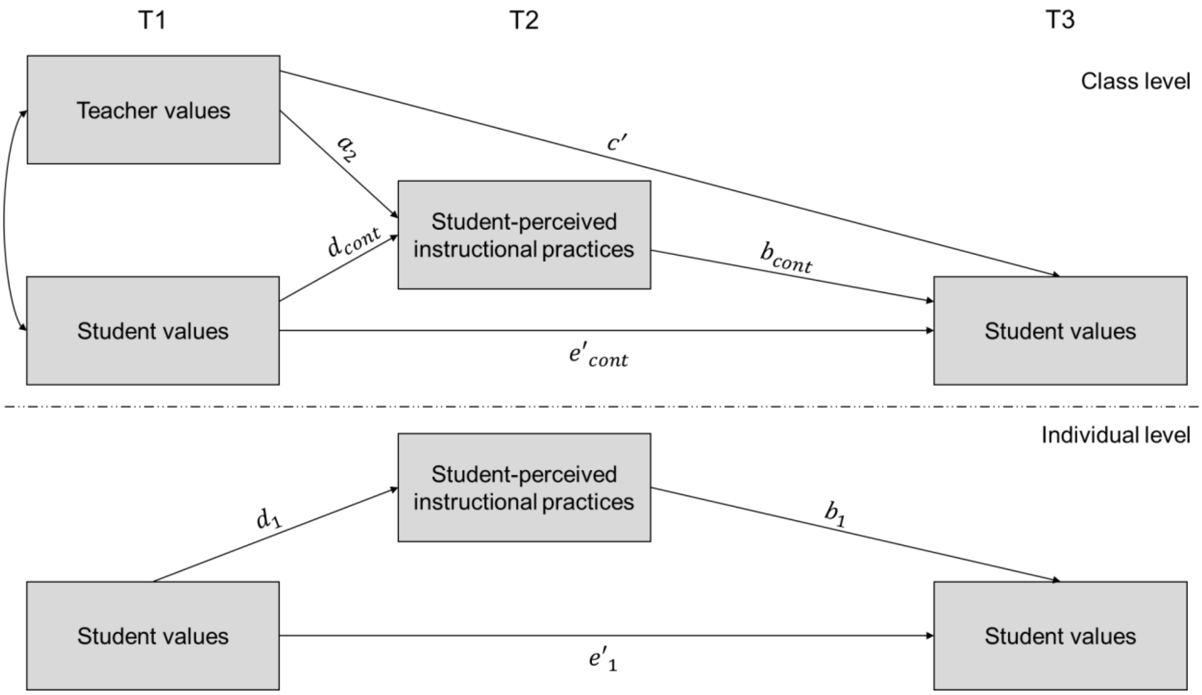
Multilevel Mediation Analyses

To examine the transmission of value from teachers to their students through students' perceptions of their teachers' instructional practices as suggested in our heuristic working model (Figure 1), we set up a series of multilevel mediation models. We investigated the links between class-level (L2) predictors (i.e., teacher values) and individual-level (L1) outcomes (i.e., student values) mediated by variables measured at the individual level (i.e., student-perceived instructional practices). More precisely, following the approach suggested by Pituch and Stapleton (2012), we specified *cross-level mediation* models (2–1–1 models with cross- and unique cluster-level mediation; see Pituch & Stapleton, 2012) in Mplus 7.31 (Muthén & Muthén, 1998-2015) via MplusAutomation 0.7-3 (Hallquist & Wiley, 2018). In contrast to commonly used class-level-only mediation approaches (see Pituch & Stapleton, 2012, for a discussion; and Preacher, Zyphur, & Zhang, 2010, for an application), cross-level mediation models are able to take both students' individual and shared perceptions into account when testing for mediational associations. Results of such models thereby provide information on whether (a) the L2 predictor has an indirect effect on the L1 outcome through a L1 mediator (cross-level indirect effect); and whether (b) there is an additional indirect impact of the L2 predictor on the outcome over and above the indirect effects via the L1 mediator (unique class-level indirect effect). That is, the latter effect contains information about the indirect impact of the environment (e.g., normative qualities of the shared perception) on the student outcome of interest that the individual perceptions of the mediator do not capture—it could be a unique function of the respective environment (Pituch & Stapleton, 2012).

In the cross-level mediation model as depicted in Figure 2, path a_2 represents the unique impact of the class-level predictor (teacher values) on the class-level mediator (i.e., the class-level aggregate of student-perceived instructional practices). At the same time, it also represents the unique impact of the class-level predictor on the individual-level mediator (i.e., these paths are equal; see Pituch & Stapleton, 2012, for an expanded explanation). Path b_1 represents

Figure 2

Cross-Level Mediation Model for the Association between Teacher and Student Values Mediated Through Student-Perceived Instructional Practices, Controlling for Prior Levels of Student Values and the Intervention Condition Students were Assigned to (not Depicted for the Sake of Clarity)



Note. The total indirect effect from teacher to student values through student-perceived instructional practices is estimated by $a_2b_1 + a_2b_{cont}$ and the total effect by $c' + a_2b_1 + a_2b_{cont}$. Subscripts: $_1$ = individual-level path, $_2$ = class-level path, $_{cont}$ = contextual effect. Apostrophe: mediated direct paths between the T1 and T3 variables.

the unique impact of the individual-level mediator on the outcome (student values); and b_{cont} represents the corresponding contextual effect (i.e., the class-level effect controlled for the effect of the individual-level mediator, that is, b_1). We present the contextual effects that resulted from the cross-level mediation approach (see Pituch & Stapleton, 2012). The contextual effect represents the effect of students' shared perception of the contextual variable while holding constant students' idiosyncratic perceptions of the same variable. This therefore provides insight into how being in a certain context influences student values over and above their individual perception of the teacher (e.g., students in classrooms with teachers who are perceived as teaching enthusiastically by the class report higher intrinsic values irrespective of their individual perceptions of enthusiastic teaching). The composite of the contextual effect (b_{cont}) and the corresponding individual-level effect (i.e., the effect of students' tendency to perceive the contextual variable in a more or less positive light compared with their classmates; or b_1) provides the class-level effect (i.e., $b_1 + b_{cont}$; see, e.g., Lüdtke et al., 2009).

The direct effect of the class-level predictor on the outcome is represented by *c*’. The indirect effect, also referred to as the *total indirect effect*, is a composite of two separate indirect effects that simultaneously occur through the individual level (i.e., the cross-level indirect effect) and the class level (i.e., the unique class-level indirect effect). The cross-level indirect effect is represented by the product $a_2 * b_1$ (see Pituch & Stapleton, 2012, for an expanded explanation). The additional unique class-level indirect effect in this model (i.e., the indirect effect through the class-level mediator when controlling for the indirect effect through the individual-level mediator) is represented by the product $a_2 * b_{\text{cont}}$. The total indirect effect is then given by $a_2b_1 + a_2b_{\text{cont}}$, and the total effect of the class-level predictor on the outcome is $c' + a_2b_1 + a_2b_{\text{cont}}$.

To answer our research questions, we ran a total of 18 cross-level mediation models. First, we looked at the effect of teachers’ teaching enthusiasm on students’ *intrinsic* value mediated by student-perceived teacher enthusiasm (i.e., one model). Second, we tested for mediational associations through student-perceived use of everyday life examples and relevance support during class, respectively (i.e., two models). Third, we ran the same analysis with math enthusiasm or math utility value as predictors (i.e., six models due to 2 predictor variables x 3 mediator variables x 1 outcome). Finally, we ran the same set of analyses with students’ *utility* value as the outcome (another nine models). Student-reported individual-level covariates (i.e., student values at T1) and mediators were grand-mean centered, and we used manifest aggregation for their class-level counterparts (see Enders & Tofighi, 2007; Pituch & Stapleton, 2012, for centering; and Marsh et al., 2009, for manifest aggregation). In order to ensure that potential associations could not be traced to the intervention, we additionally regressed student values at T3 and student-perceived instructional practices at T2 on two class-level dummy variables, each indicating one of the two intervention conditions with the waitlist control condition as the reference group.

In contrast to Frenzel et al. (2018), who reported standardized results from the Mplus output, in which between-level effects are standardized with respect to the between-level variances, we standardized all continuous variables before running the analyses so that all paths could be understood as standardized effects with respect to the *total variance* of the outcome variables (Marsh et al., 2009; Rights & Sterba, 2019). Additionally, we computed contextual effects (i.e., the unique effect of being in a class with a teacher who is more or less enthusiastic than a teacher with an average level of enthusiasm as reported by the students when controlling for students’ interindividual differences in their perceptions of their teachers’ enthusiasm), whereas the coefficients depicted by Frenzel et al. (2018) at the between level are L2 effects (i.e., not taking into account whether a student differs from the class-average perception of how enthusiastic their teacher's teaching is). In testing our mediation models, we controlled for the prior levels of the respective outcomes (i.e., students' intrinsic or utility value, represented by paths d_1 and d_{cont} in Figure 2) in contrast to Frenzel et al., who freely estimated the covariance between the mediator (perceived enthusiasm) and students' enjoyment at T1 due to their cross-lagged structure at the class level. These differences between our specification of multilevel mediation analyses and those used by Frenzel et al. (2018) imply that the coefficients are not directly comparable. In order to make comparability easier, we additionally ran the analyses described above regarding teachers' teaching enthusiasm, student-perceived teacher enthusiasm, and students' intrinsic value with specifications that were identical to Frenzel et al. (i.e., a doubly latent approach with covariances between the mediator and the covariates; reporting standardized results from Mplus output).

Missing Data

Despite the longitudinal design of the present study, the amount of missing data only ranged from 3.7% to 12.5% for the student variables and from 0.0% to 2.5% for the teacher variables. Missing data occurred due to the absence of individual students at single measurement waves and nonresponses to single items. Following recommendations by Graham (2009), we used the full information maximum likelihood method implemented in Mplus, which takes all available information into account.

Results

In order to expand the understanding of value transmission effects, we examined the associations between different teacher values, student-perceived instructional practices, and student values. We report the intercorrelations resulting from the manifest variables in Table 2. In the following, we will first present the results from predicting students' intrinsic value (Table 3), followed by results for their utility value (Table 4). We will describe the respective models (labeled M1 to M18 for Models 1 to 18) in the order in which they appear in the tables.

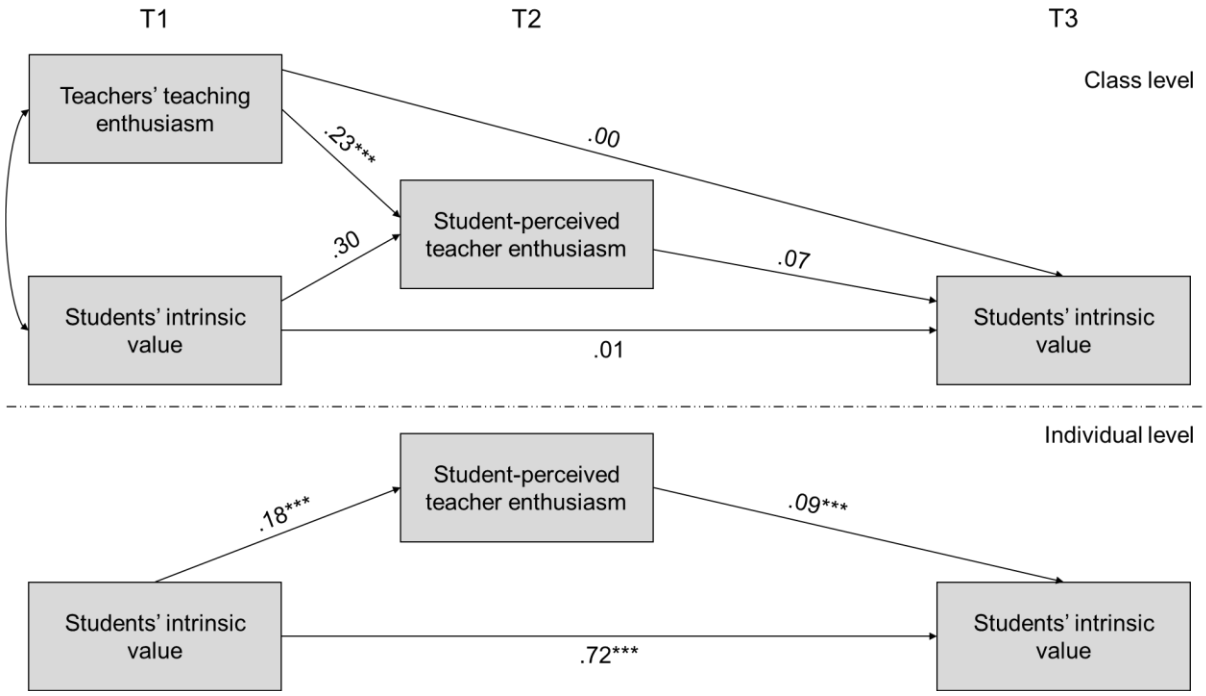
Predicting Students' Intrinsic Value

Emotional Contagion

Our first research question addressed the replication of previous findings on emotional contagion, that is, the association between teachers' teaching enthusiasm and students' intrinsic value through students' perceptions of their teachers' enthusiastic behavior during instruction (see Frenzel et al., 2018). As demonstrated in Figure 3, teachers' teaching enthusiasm was significantly related to student-perceived teacher enthusiasm (β_{a2} = 0.23, p < .001), which in turn was significantly linked to students' intrinsic value at T3 at the individual level (β_{b1} = 0.09, p < .001; see M1 in Table 3). There was no further contextual effect associated with student-perceived teacher enthusiasm at L2 ($\beta_{b\text{cont}}$ = .07, p = .175), indicating that the association between students' shared perception and students' intrinsic value did not significantly differ from the association between students' individual perception and intrinsic value. In contrast to Frenzel et al. (2018), we furthermore found a marginally significant positive total effect of teachers' teaching enthusiasm on students' intrinsic value (β_{total} = 0.04, p = .063).

Figure 3

Results from the Cross-Level Mediation Analysis Replicating Findings on Emotional Contagion, that is, the Indirect Associations between Teachers' Teaching Enthusiasm and Students' Intrinsic Value Through Students' Perceptions of their Teachers' Enthusiasm in Class



Note. See M1 in Table 3 for further results.
*** p < .001.

Table 2

Bivariate Correlations among the Manifest Variables under Investigation on the Individual and Class Levels

	1	2	3	4	5	6	7	8	9	10
1. T1 Teachers' teaching enthusiasm		—	—	—	—	—	—	—	—	—
2. T1 Teachers' math enthusiasm	.36		—	—	—	—	—	—	—	—
3. T1 Teachers' math utility value	.29	.29		—	—	—	—	—	—	—
4. T2 Student-perceived teacher enthusiasm	.37	(.06)	(.06)		.45	.47	.18	.24	.19	.23
5. T2 Student-perceived use of everyday life examples	.31	(.03)	.26	.61		.70	.18	.24	.23	.29
6. T2 Student-perceived relevance support	.38	(.00)	.25	.62	.91		.26	.33	.32	.41
7. T1 Students' intrinsic value	(-.05)	(.02)	(-.03)	(.10)	.21	(.18)		.74	.48	.41
8. T3 Students' intrinsic value	(.10)	(.01)	(-.01)	.34	.29	.27	.68		.39	.52
9. T1 Students' utility value	.21	(.06)	.29	.30	.35	.36	.41	.44		.61
10. T3 Students' utility value	.24	(.18)	.34	.34	.43	.46	.36	.53	.71	

Note. Correlations for the individual-level variables are presented above the diagonal, and correlations for the class-level variables are presented below the diagonal. Correlations in parentheses were not statistically significant. All other correlations were significant at $p < .05$. — = not applicable.

Table 3

*Standardized Estimates and 95% Confidence Intervals for Selected Path Coefficients, Indirect Effects, Total Indirect Effects, and Total Effects in the Nine Cross-Level Mediation Models for Students' **Intrinsic Value** for Different Predictors (Teachers' Teaching Enthusiasm, Math Enthusiasm, and Math Utility Value) and Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' IV → T3 students' IV	.72*** [.69,.76]	.72*** [.68,.76]	.70*** [.66,.74]	.72*** [.69,.76]	.72*** [.68,.76]	.70*** [.66,.74]	.72*** [.69,.76]	.72*** [.68,.76]	.70*** [.66,.74]
T1 students' IV → Mediator	.18*** [.14,.23]	.18*** [.13,.23]	.26*** [.21,.32]	.18*** [.14,.23]	.18*** [.13,.23]	.26*** [.21,.32]	.18*** [.14,.23]	.18*** [.13,.23]	.26*** [.21,.32]
Mediator → T3 students' IV	.09*** [.05,.13]	.11*** [.07,.14]	.14*** [.10,.18]	.09*** [.05,.13]	.11*** [.07,.14]	.14*** [.10,.18]	.09*** [.05,.13]	.11*** [.07,.14]	.14*** [.10,.18]
Class level									
T1 students' IV → T3 students' IV	.01 [-.17,.18]	.01 [-.17,.20]	.03 [-.16,.21]	.01 [-.16,.18]	.00 [-.18,.18]	.02 [-.16,.20]	.01 [-.17,.18]	.00 [-.19,.18]	.01 [-.17,.20]
T1 students' IV → Mediator	.30 [-.07,.66]	.49* [.10,.88]	.42* [.09,.75]	.23 [-.13,.59]	.43* [.05,.80]	.35* [.03,.67]	.23 [-.13,.60]	.45* [.07,.82]	.37* [.04,.69]
Mediator → T3 students' IV	.07 [-.03,.17]	.01 [-.08,.10]	-.01 [-.11,.09]	.07 [-.02,.16]	.02 [-.06,.11]	.00 [-.09,.10]	.07 [-.02,.16]	.03 [-.06,.12]	.01 [-.09,.11]
T1 teacher values → Mediator	.23*** [.13,.33]	.19*** [.09,.28]	.20*** [.11,.28]	.02 [-.09,.14]	.02 [-.09,.13]	.01 [-.09,.11]	.04 [-.06,.15]	.14** [.04,.25]	.12** [.04,.21]
T1 teacher values → T3 students' IV	.00 [-.04,.04]	.02 [-.02,.05]	.01 [-.02,.05]	-.01 [-.04,.03]	.00 [-.04,.03]	-.01 [-.04,.03]	.00 [-.04,.04]	-.01 [-.06,.03]	-.01 [-.05,.03]

Table 3 *(continued)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Indirect, total indirect, and total effects									
Cross-level indirect effect (a_2b_1)	.02**	.02**	.03***	.00	.00	.00	.00	.02*	.02**
	[.01,.04]	[.01,.03]	[.01,.04]	[-.01,.01]	[-.01,.01]	[-.01,.02]	[-.01,.01]	[.00,.03]	[.00,.03]
Unique class-level indirect effect (a_2b_{cont})	.02	.00	.00	.00	.00	.00	.00	.00	.00
	[-.01,.04]	[-.02,.02]	[-.02,.02]	[-.01,.01]	[.00,.00]	[.00,.00]	[-.01,.01]	[-.01,.02]	[-.01,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.04*	.02*	.03*	.00	.00	.00	.01	.02*	.02*
	[.01,.07]	[.00,.04]	[.00,.05]	[-.01,.02]	[-.01,.02]	[-.01,.02]	[-.01,.02]	[.00,.04]	[.00,.04]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.04†	.04†	.04*	.00	.00	.00	.00	.01	.01
	[.00,.07]	[.00,.08]	[.00,.08]	[-.04,.03]	[-.04,.04]	[-.04,.03]	[-.04,.04]	[-.04,.05]	[-.04,.05]

Note. Enthusiasm = student-perceived teacher enthusiasm. Examples = student-perceived use of everyday life examples. Relevance = student-perceived relevance support. CI = 95% confidence interval. IV = intrinsic value. T1 teacher values = teachers' teaching enthusiasm, math enthusiasm, and math utility value, respectively. Results are controlled for the intervention conditions. Extended results, including the effects of the intervention conditions and covariances, can be found in the supplemental material (Table S4).

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4

Standardized Estimates and 95% Confidence Intervals for Selected Path Coefficients, Indirect Effects, Total Indirect Effects, and Total Effects in the Nine Cross-Level Mediation Models for Students' ***Utility Value*** *for Different Predictors (Teachers' Teaching Enthusiasm, Math Enthusiasm, and Math Utility Value) and Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	M10	**M11**	**M12**	**M13**	**M14**	**M15**	**M16**	**M17**	**M18**
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' UV → T3 students' UV	.58***	.57***	.53***	.58***	.57***	.53***	.58***	.57***	.53***
	[.54,.62]	[.52,.61]	[.48,.57]	[.54,.62]	[.52,.61]	[.48,.57]	[.54,.62]	[.52,.61]	[.48,.57]
T1 students' UV → Mediator	.19***	.23***	.32***	.19***	.23***	.32***	.19***	.23***	.32***
	[.13,.25]	[.18,.29]	[.27,.37]	[.13,.25]	[.18,.29]	[.27,.37]	[.13,.25]	[.18,.29]	[.27,.37]
Mediator → T3 students' UV	.14***	.16***	.25***	.14***	.16***	.25***	.14***	.16***	.25***
	[.08,.20]	[.11,.21]	[.20,.31]	[.08,.20]	[.11,.21]	[.20,.31]	[.08,.20]	[.11,.21]	[.20,.31]
Class level									
T1 students' UV → T3 students' UV	.06	.05	.07	.06	.04	.07	.02	.03	.05
	[-.09,.22]	[-.11,.21]	[-.08,.23]	[-.09,.21]	[-.11,.20]	[-.08,.21]	[-.13,.18]	[-.14,.19]	[-.11,.20]
T1 students' UV → Mediator	.43*	.53*	.47**	.57**	.63**	.58**	.58**	.54**	.50**
	[.07,.79]	[.13,.93]	[.14,.80]	[.19,.94]	[.23,1.03]	[.24,.92]	[.22,.93]	[.14,.95]	[.16,.84]
Mediator → T3 students' UV	-.04	-.03	-.08	-.04	-.03	-.09	-.04	-.04	-.10†
	[-.14,.06]	[-.13,.07]	[-.20,.04]	[-.14,.06]	[-.13,.07]	[-.20,.02]	[-.14,.06]	[-.13,.06]	[-.21,.02]
T1 teacher values → Mediator	.20***	.15**	.16**	.01	.01	.00	-.01	.09†	.08†
	[.09,.31]	[.04,.25]	[.06,.26]	[-.09,.12]	[-.10,.11]	[-.10,.09]	[-.10,.09]	[-.02,.20]	[-.01,.16]
T1 teacher values → T3 students' UV	.00	.00	-.01	.05*	.05*	.05*	.04†	.03	.04
	[-.05,.05]	[-.05,.05]	[-.05,.04]	[.01,.08]	[.01,.08]	[.01,.08]	[.00,.09]	[-.01,.08]	[-.01,.08]

Table 4 *(continued)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	M10	**M11**	**M12**	**M13**	**M14**	**M15**	**M16**	**M17**	**M18**
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Indirect, total indirect, and total effects									
Cross-level indirect effect (a_2b_1)	.03**	.02*	.04**	.00	.00	.00	.00	.02	.02
	[.01,.04]	[.01,.04]	[.02,.07]	[-.01,.02]	[-.02,.02]	[-.02,.02]	[-.01,.01]	[.00,.03]	[.00,.04]
Unique class-level indirect effect (a_2b_{cont})	-.01	.00	-.01	.00	.00	.00	.00	.00	-.01
	[-.03,.01]	[-.02,.01]	[-.03,.01]	[-.01,.00]	[.00,.00]	[-.01,.01]	[.00,.00]	[-.01,.01]	[-.02,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.02†	.02*	.03*	.00	.00	.00	.00	.01	.01
	[.00,.04]	[.00,.04]	[.00,.05]	[-.01,.01]	[-.01,.01]	[-.02,.02]	[-.01,.01]	[.00,.03]	[.00,.03]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.02	.02	.02	.05*	.05*	.05*	.04†	.05†	.05*
	[-.03,.07]	[-.03,.07]	[-.03,.07]	[.01,.09]	[.01,.09]	[.01,.08]	[.00,.09]	[.00,.09]	[.00,.09]

Note. Enthusiasm = student-perceived teacher enthusiasm. Examples = student-perceived use of everyday life examples. Relevance = student-perceived relevance support. CI = 95% confidence interval. UV = utility value. T1 teacher values = teachers' teaching enthusiasm, math enthusiasm, and math utility value, respectively. Results are controlled for the intervention conditions. Extended results, including the effects of the intervention conditions and covariances, can be found in the supplemental material (Table S5).

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

The significant links between teachers' teaching enthusiasm and student-perceived teacher enthusiasm as well as student-perceived teacher enthusiasm and students' intrinsic value at T3 resulted in a significant positive total indirect effect from teachers' teaching enthusiasm to students' intrinsic value through perceived teacher enthusiasm ($\beta_{\text{total indirect}} = 0.04$, $p = .018$). This finding supported our hypothesis from Research Question 1, and replicated the findings from Frenzel et al. (2018). Our findings furthermore revealed that this total indirect effect was primarily due to the indirect effect through students' individual perception of teacher enthusiasm; there was no additional indirect impact through the shared perception of teacher enthusiasm over and above the indirect effect via the individual-level mediator. Thus, teachers' teaching enthusiasm was indirectly associated with students' intrinsic value through teachers' enthusiastic behavior during instruction as individually reported by the students.

When we evaluated the same association by applying multilevel structural equation modeling with model specifications equivalent to Frenzel et al. (2018), we mostly found results that were comparable to Frenzel and colleagues regarding both the size and the direction of the coefficients (for the coefficients, see the supplemental material, Table S6). Importantly, in line with Frenzel et al., we found a statistically significant indirect effect from teachers' teaching enthusiasm to students' intrinsic value through student-perceived teacher enthusiasm in this model ($\beta = 0.24$, 95% CI [.01, .47], $p = .040$).

The Impact of Other Instructional Practices

We further expected the link between teachers' and students' affective value dimensions to also be mediated through relevance-related instructional practices (see Research Question 2). That is, we were interested in whether teachers' enthusiasm about teaching became evident not only in enthusiastic behavior during instruction but also in relevance-related strategy use (i.e., use of everyday life examples and relevance support). We furthermore tested whether these relevance-related instructional practices, in turn, were prospectively associated with students' own intrinsic value. Students' perceptions of teachers' use of everyday life examples (e.g., $\beta_{\text{total indirect}} = 0.02$, $p = .044$) and relevance support (e.g., $\beta_{\text{total indirect}} = 0.03$, $p = .023$) also mediated the link between teachers' teaching enthusiasm and students' intrinsic value (see M2 and M3), meaning that these results were similar to those for the transmission via enthusiastic behavior. Again, these total indirect effects were mainly driven by the indirect effects via the individual level rather than a contextual indirect effect through the additional information students' shared perceptions hold in comparison to individual ratings.

Examining Other Teacher Values

To address our third research question, we investigated teachers' math enthusiasm as well as math utility value as potential predictors of students' intrinsic value, thereby checking each association for a mediational relation through student-perceived teacher enthusiasm, use of everyday life examples, or relevance support. We therefore tested six additional models. We found no significant total effects from teachers' math enthusiasm to students' intrinsic value at T3 in any of the three models in which we investigated teachers' math enthusiasm as the predictor (M4 to M6). There were also no significant paths from teachers' math enthusiasm to the three instructional practices we investigated, nor were there total indirect effects from teachers' math enthusiasm to students' intrinsic value at T3 through any of the three mediators under investigation.

For teachers' math utility value, we also found no significant total effects on students' intrinsic value at T3 (M7 to M9). However, the results indicated significant effects of teachers' utility value on students' perceptions of both relevance-related instructional practices ($\beta_{a2,\text{M8}} = 0.14$, $p = .007$; $\beta_{a2,\text{M9}} = 0.12$, $p = .004$) when controlling for students' initial intrinsic value, leading to significant total indirect effects on students' intrinsic value at T3 ($\beta_{\text{total indirect,M8}} = 0.02$, $p = .047$; $\beta_{\text{total indirect,M9}} = 0.02$, $p = .027$). This means that the more teachers perceived math to be relevant and useful, the more they emphasized its relevance during class as perceived by the students, which in turn affected how much students intrinsically valued math class.

Predicting Students' Utility Value

For Research Question 4, we tested the predictive value of teachers' teaching enthusiasm, math enthusiasm, and math utility value on students' *utility* value (see Table 4). There were substantial paths from teachers' teaching enthusiasm to all of the three student-perceived instructional practices (M10 to M12; $0.15 \leq \beta_{a2} \leq 0.20$, $p\text{s} \leq .005$). They led to significant total indirect effects (but for student-perceived teacher enthusiasm, there was only a marginally significant effect) on students' utility value ($0.02 \leq \beta_{\text{total indirect}} \leq 0.03$, $p_{\text{M11,M12}} \leq .031$, $p_{\text{M10}} = .078$), even though there was no significant total effect from teachers' teaching enthusiasm to students' utility value ($\beta_{\text{total}}\text{s} = 0.02$, $p\text{s} \geq .387$). The total indirect effects were completely explained by the significant cross-level indirect effects ($0.02 \leq \beta_{a2b1} \leq 0.04$, $p\text{s} \leq .012$). Consequently, students' individual perceptions of their teachers' relevance-related instructional practices were relevant for their change in utility value, and the context (i.e., the shared perceptions of the class) did not additionally contribute to the indirect effect.

Regarding teachers' math enthusiasm, we found a significant total effect on students' utility value (M13 to M15; β_{total}s = 0.05, *p*s ≤ .022). Additionally, we found that teachers' math enthusiasm significantly directly predicted students' utility value ($\beta_{c'}$s = 0.05, *p*s ≤ .014), but there were no further substantial links between teachers' math enthusiasm and any of the three mediators ($0.00 \leq \beta_{a2} \leq 0.01$, *p*s ≥ .795). Reflecting on these nonsignificant relations, we found no total indirect effect from teachers' math enthusiasm to students' utility value ($\beta_{total\ indirect}$s = 0.00, *p*s ≥ .790).

The same also applied for the last three models (M16 to M18) for which there were marginal to significant total effects from teachers' math utility value to students' utility value ($0.04 \leq \beta_{total} \leq 0.05$, *p*s ≤ .069) but no further total indirect effects ($0.00 \leq \beta_{total\ indirect} \leq 0.01$; *p*s ≥ .101). However, we found at least marginally significant paths from teachers' math utility value to the student-perceived relevance-related instructional practices ($\beta_{a2,M17} = 0.09$, $p = .098$; $\beta_{a2,M18} = 0.08$, $p = .086$).

Taken together, teachers' teaching enthusiasm was indirectly related to students' utility value through both relevance-related instructional practices. Furthermore, teachers' math enthusiasm and (at least in one model) teachers' math utility value were associated with students' utility value, even though the instructional practices under investigation could not explain these total effects.

Robustness Checks

We carried out various robustness checks in order to draw more reliable conclusions from our findings. The overall pattern of results from the main analyses and the robustness checks were fairly consistent (see Figures S1 and S2 in the supplemental material) with only marginal variations, therefore emphasizing the robustness of the main results.

Familiarity With the Teacher

When students were already familiar with their math teachers, their initial values reported at T1 might have been affected by their teachers' values and the instructional practices students were exposed to in the previous school year. We therefore tested all our reported models with the sample split into a first group of classes that had a new math teacher at the beginning of the school year ("new teacher") and a second group of classes that had been instructed by the same teacher in the previous school year or even for multiple years (“known teacher”). As a consequence, the composition of the “new teacher” subsample was more like the Frenzel et al. (2018) study’s sample composition. Results are reported in the supplemental material (Tables S7 to S12). Our findings revealed that there were no statistically significant differences in any of the reported total indirect effects or total effects between the two groups.

Effects of Changing Teachers throughout the Study

To ensure that our findings were not affected by the five classes in which students experienced a change in teachers between T2 and T3, we additionally ran all analyses with a subsample of students who did not experience a change in teachers (N = 1,635). Results are reported in the supplemental material (Tables S13 to S14). Correlating all 22 coefficients from the main results with the corresponding coefficients from the teacher-change results (considering one model at a time) revealed high consistencies and suggested that there were no substantial differences ($Mdn\ r$ = .99).

Were the Results Affected by the Intervention?

To ensure that our results were not affected by the intervention (which occurred during T1 and T2 in the classes from the two intervention conditions), we additionally ran all analyses with the respective mediators assessed at T1 (instead of T2, i.e., before the intervention and therefore at the same time point as our predictors). Results are reported in the supplemental material (Tables S15 to S16) and showed overall high consistency with the main results ($Mdn\ r$ = .95).

We additionally tested whether our results were moderated by the experimental conditions using multigroup models in which the two intervention conditions and the control condition represented the three groups (see Tables S17 to S22 in the supplemental material). We tested for statistical differences between the three groups regarding the total indirect and total effects, respectively, in each model. Only 4 out of the 108 (18 models x 3 groups x 2 coefficients) differences we tested turned out to be statistically significant.

Discussion

Drawing on an increasing body of research investigating emotional contagion as the mechanism underlying the transmission of value from teachers to their students (e.g., Frenzel et al., 2009; Lazarides et al., 2018; Lazarides, Gaspard, et al., 2019), we investigated the transmission of different value dimensions and how such transmission processes work in the classroom. Using data from a large longitudinal study in math classrooms, we were able to replicate previous findings on the process of emotional contagion (see Frenzel et al., 2018). We found indirect longitudinal associations between teachers' teaching enthusiasm at the beginning of the school year and their students' intrinsic value throughout the school year through students' perceptions of their teachers' enthusiasm during instruction. Extending previous research, we found that the indirect association between teaching enthusiasm and intrinsic value was also explained by relevance-related instructional practices, namely, students' perceptions of their teachers' use of everyday life examples and relevance support.

We additionally extended this research by investigating other dimensions of teacher and student values. Not only teachers' math enthusiasm but also their math utility value at the beginning of the school year positively predicted students' utility value later on. Furthermore, teachers' teaching enthusiasm was indirectly related to students' utility value, and teachers' utility value was indirectly related to students' intrinsic value through different instructional practices. This study therefore makes a valuable contribution to the understanding of value transmission by expanding the focus to include important and hitherto neglected motivational and instructional constructs. In addition to emotional contagion, we were able to identify relevance-related strategies as a technique that teachers can use to promote their students' values in a meaningful way during class.

Replicating Research on Emotional Contagion

Our study results indicate a transmission of teachers' teaching enthusiasm to students' intrinsic value during math class through the process of emotional contagion, that is, a transmission through students' perceptions of their teachers' enthusiasm in class. Thus, we conceptually replicated the findings by Frenzel et al. (2018) using data that share several similarities with their study: We were able to incorporate the same number of assessments following a similar time line within 1 school year, relied on a similar sample in terms of sample size and context (i.e., students from intact classes from German secondary schools), and incorporated both student and teacher reports. Regarding the analyses of teachers' impact on students' intrinsic value, we conceptually replicated the mediational approach used by Frenzel et al. (2018), including controlling for the student pretest measure. However, we used a different statistical approach in order to apply multilevel mediation (i.e., cross-level mediation), which has been recommended in the literature because of its higher power and its potential to disentangle individual and contextual effects (Pituch & Stapleton, 2012), that is, the contributions of students' individual and shared perceptions of the context to the respective indirect effects. When comparing our findings with the Frenzel et al. (2018) study, it is still important to keep in mind that the studies differed slightly in terms of age, track, and the framing of the measures that were used: Frenzel et al. relied on a more heterogeneous sample, that is, different grade levels (vs. only ninth graders) and different track schools (vs. only academic track schools). Students in the Frenzel et al. study did not know their teachers from previous school years (vs. some knew their math teachers already, others did not). Additionally, their enjoyment measures were focused on perceptions during lessons in specific classrooms only (e.g., "I enjoy teaching these students", vs. teaching in general, e.g. "I really enjoy teaching"). Thus, it seems that similar transmission processes apply to our sample of adolescents in ninth-grade math classrooms and their math teachers and that such transmission processes can also be found for teachers' general teaching enthusiasm (irrespective of the particular group of students).

Value Transmission: Different Mechanisms for Different Value Dimensions?

Overall, this study supports the value transmission processes from socializers to children, which was postulated by EVT (Eccles, 2007). Even though previous research has provided solid evidence for the transmission of values from teachers to their students in terms of emotional contagion (e.g., Frenzel et al., 2009, 2018; Keller et al., 2014), there was a clear need to broaden these findings for further value dimensions and other potential underlying mechanisms that can explain value transmission. As our findings show, the transmission of values applied to both teachers' intrinsic value represented by their enthusiasm and math utility value. We furthermore differentiated between two instructional practices that drive the transmission of values from teachers to their students: students' perceptions of teachers' enthusiastic behavior during instruction and students' perceptions of relevance-related instructional practices (i.e., use of everyday life examples or relevance support). Even though the two relevance-related instructional practices are based in different research traditions and can be distinguished theoretically (Ryan & Deci, 2000; van den Heuvel-Panhuizen & Drijvers, 2014), our findings reveal that the students did not seem to clearly distinguish between the constructs, which is reflected both in their high correlations and the consistency in result patterns. As a consequence, we discuss them jointly in the following.

First, value transmission through the *enthusiastic behavior* during instruction applied exclusively to teachers' teaching enthusiasm. In line with Keller et al. (2014), teachers' teaching enthusiasm was evident in their enthusiastic behavior in class, meaning that teachers who were enthusiastic about the teaching-related aspects of their profession were also more likely perceived to teach with enthusiasm. In turn, this affected not only students' own intrinsic value (emotional contagion) but also their utility value. It seems that the "perceived emotional climate" (Lazarides et al., 2018, p. 7) created through teachers' enthusiastic teaching during math class played a key role in the development of various value dimensions. The association between teachers' enthusiastic behavior and students' *intrinsic* value has been the focus of prior research (see Keller et al., 2016, for an overview). However, the association between teachers' enthusiastic behavior and students' *utility* value expands upon previous research because we directly linked this instructional practice with students' utility value while simultaneously (a) testing for the impact of teacher values on these constructs and (b) adjusting for students' initial utility value (but see Lazarides et al., 2018). We assume that the perceived positive climate created through enthusiastic expressiveness during instruction led students to be more open to and more engaged in the learning process overall (H. Patrick et al., 2003) and teachers' reasoning in particular—ultimately leading to a greater acceptance that math could indeed be useful.

Second, value transmission trough the *relevance-related instructional practices* also applied to teachers' teaching enthusiasm. This means that teachers' personal, inner teaching-related motivational states were related to their active behavior such as providing rationales for the relevance of a task, as already often assumed in the literature (e.g., Schmidt et al., 2019). Our finding that students' perceptions of the relevance-related instructional practices were related to their own values furthermore confirm previous findings (Assor et al., 2002; Reeve et al., 2002; Schmidt et al., 2019; Schreier et al., 2014; Wang, 2012). As expected, students reported higher utility values when they perceived that their teachers were emphasizing the relevance of the content, even when we controlled for students' initial utility value. This finding extends previous correlational and qualitative research (e.g., Schmidt et al., 2019; Schreier et al., 2014), showing that such associations also hold longitudinally. The direct communication of relevance or guiding students to make their own connections to relevance are well established ways to foster student values through targeted interventions (for an overview, see

Harackiewicz et al., 2014). Our findings indicate that similar processes also apply to natural classroom settings and lead to a higher appreciation of the content (see also Brophy, 2008).

Teachers' relevance-related instructional practices were furthermore associated with an increase in students' intrinsic value, which supports previous findings stemming from research grounded in self-determination theory (SDT; e.g., Ryan & Deci, 2017). In SDT, providing meaningful rationales is conceptualized as part of an autonomy-supportive motivational teaching style (e.g., Ryan & Deci, 2000; see also Su & Reeve, 2011), which is related to higher quality of student motivation (e.g., Assor et al., 2002). By establishing connections between students' needs and goals on the one hand and the content on the other, teachers might provide their students with rationales for engaging in a task. This can trigger an internalization process, which is ultimately reflected in enhancements of students' personal and intrinsic valuing of the content (e.g., Deci et al., 1991; see also Vansteenkiste et al., 2018). Even though this was not the focus of this study, we nevertheless speculate that the increase in students' intrinsic value could serve as evidence for a successful internalization process in relation to teachers' relevance-related instructional practices. The repeated emphasis of the relevance of the content can additionally function as a trigger for situational interest, which in the long run can develop into individual interest (Hidi & Renninger, 2006). Emphasizing the relevance of a task thereby seems to be particularly promising when a task is uninteresting (Steingut et al., 2017).

Despite the indirect associations between teachers' enthusiasm to teach and student values, as well as between teachers' math utility value and students' intrinsic value through the instructional practices under investigation, it is important to note that the corresponding total associations between teacher values and student values were not always significant (regarding teaching enthusiasm and students' intrinsic value) or not significant (regarding teaching enthusiasm/math utility value and students' utility value/intrinsic value). In the study by Frenzel et al. (2018) that we aimed to conceptually replicate, the authors also observed positive indirect effects on students' enjoyment through student-perceived enthusiasm in combination with non-significant total effects of teacher enjoyment. In their study, the positive indirect effects were even accompanied with a negative direct effect. Although we did not observe significant negative direct effects opposing the positive indirect effects as Frenzel et al. (2018) did, the pattern of results was similar to the Frenzel et al. (2018) study and thus seems not only to apply to students' intrinsic value or enjoyment, but also to their utility value as an outcome and teachers' utility value as a predictor. Several reasons might underlie such a missing direct link between teacher and student values.

Frenzel et al. (2018) and subsequently Taxer and Frenzel (2018) provided first evidence that the non-existence of total effects from teacher enthusiasm to student values may be due to a missing congruency between experienced and displayed motivations in some teachers. When teacher values and perceptions of their instructional practices match, positive effects on student values could indeed be observed (Keller et al., 2018). However, when the perceived instructional behavior is not aligned with the teachers' actual motivations, students may experience their teachers as being inauthentic (Kreber et al., 2010), ultimately leading to students enjoying the class less (Keller et al., 2018).

In our data, we observed only small to moderate associations between teacher values and the instructional practices under investigation (including student-perceived enthusiasm), which could indicate that the teacher was perceived as being not authentic in some classrooms. Inauthentic teaching might have arisen out of two different reasons (Frenzel et al., 2018; Keller et al., 2018). On the one hand, teachers might have up-regulated their enthusiastic or relevance-inducing behaviors compared to their actual underlying values. On the other hand, teachers' might have over-rated their actual teaching enthusiasm and math utility value due to social desirability, which would not be reflected in their teaching practices as reported by the students (for similar reasoning, see supplemental material from Frenzel et al., 2018). That is, for teaching values to be able to affect student values, they have to translate into observable behavior first (see Eccles, 2007). It appears likely that discrepancies in teacher-reported values and student-perceived instructional practices underlie the missing total associations in our study, even though other reasons for missing total links between teacher values and student values cannot be ruled out as is always the case for mediation analyses (VanderWeele & Vansteelandt, 2009); for instance, non-observed instructional practices may explain a counterbalancing negative indirect association, ultimately leading to an apparent non-association between teacher and student values.

Besides associations through the instructional practices under investigation, we also found total associations between teachers' and students' utility value. These findings regarding conceptually more cognitive constructs were in line with previous findings on the association of rather cognitive motivational beliefs. For instance, Oppermann et al. (2019) found that teachers' science self-efficacy—the cognitive evaluation of and their confidence in their own abilities to teach science—was associated with preschool children's self-efficacy in science. However, we could not explain the associations between teachers' math values and students' utility value through the instructional practices under investigation. Hence, the mechanisms underlying this transmission process are unclear. However, as teachers' underlying beliefs regarding the usefulness of math were linked to students' utility value, they might be necessary in order to persuade their students of the usefulness, though potentially not sufficient. Recent findings from Han et al. (2019) suggest that students' perceptions of their teachers' utility value of the subject are higher when they also perceive their teachers to be emotionally supportive—that is, when the teacher behavior is also perceived as being directed to the student needs. An additional student-directed behavior (e.g., emotional support) might therefore be necessary for teachers' subject-related values to come into effect. On the other hand, teachers' utility value itself might indeed be relevant for the quality of their relevance support, whereas our measures might have just covered the mere quantity of relevance-inducing behavior—neglecting the quality thereof. It appears plausible that a single thus very convincing relevance argument (triggering a eureka moment) can initiate psychological processes leading to a change in students' utility value (a mechanisms that so called "wise interventions" also capitalize on; Yeager & Walton, 2011). Teachers who are convinced of the usefulness of math might more likely be able to initiate such a process, even though this high quality instructional behavior is not reflected in students' perceptions of their teachers' relevance support. Finally, further characteristics of the teacher (e.g., their professional knowledge) could also function as a third variable that affects both teachers' and students' perceptions of the usefulness of math (see Praetorius et al., 2017).

Next to the instructional practices that might function as a mediator between teacher values and student values, a closer look at the associations between teacher values and teachers' instructional practices is necessary to gain a complete picture about value transmission processes in the classroom. Several mechanisms might underlie the associations found in our data, which differ between teacher values regarding teaching (i.e., teaching enthusiasm) and regarding the subject matter (i.e., math enthusiasm and math utility value). According to Roth et al. (2007), a more affective motivation for *teaching* (they used the term autonomous motivation for teaching) involves deep understanding and leads to a deeper processing of a topic. A reason could be that teachers who are motivated to teach are also more willing to engage, to invest more effort and time preparing, and to attend in-service training (e.g., Kunter & Holzberger, 2014; Praetorius et al., 2017)–potentially also resulting in a higher awareness of what is relevant for their students. This could lead them to provide their students with more convincing and meaningful rationales to engage in math.

Regarding teachers' *subject-related values*, we speculate that teachers who experienced the actual subject matter to be useful and enjoyable, consequently (consciously or unconsciously) want their students to have similar experiences because "they understand that these types of motivations lead to a high quality of learning and increased appreciation of the subjects they teach and love" (Roth et al., 2007, p. 764). However, this reasoning for engaging in motivating instructional practices lacks one important item in the equation: the needs and goals of the students who are the actual target of the motivating behavior. Math enthusiasm and math utility value—as valuable as they are—rather focus on the self-satisfying motives for engaging in an activity. Teaching, however, involves by definition the student as the target of action, meaning that who is enthusiastic about teaching itself more likely holds motives that are directed to stimulate something within another person. These differently oriented values might be a reason for why we observed different associations between teaching enthusiasm, on the one hand, and math values, on the other, with students' perceptions of instructional practices (see also Kunter et al., 2008).

Taken together, we conclude that a transmission of value from teachers to their students takes place when teachers on the basis of their teaching enthusiasm are able to create an authentic, positive motivational climate in the classroom through their enthusiastic behavior, which, in turn, affects students' intrinsic value; and when teachers on the basis of their teaching enthusiasm correspondingly put more effort into teaching and motivating their students, leading to an overall higher quality of teaching and the application of relevance-related instructional practices (see also Praetorius et al., 2017), which, in turn, also affects students' values. Our findings furthermore provide support for the transmission of utility value from teachers to their students, although the underlying processes need to be investigated in future research. In general and for this reason in particular, more research is needed to put these speculations on a solid empirical basis, including in regard to mediating processes between teacher values and their behavioral display during instruction.

Value Transmission in the Classroom: Effect Sizes and Practical Relevance

Our findings oftentimes revealed fairly small effect sizes. However, we identified some factors that might have decreased the probability to find such effects. First, it is noteworthy that we found rather small intraclass correlations along with simultaneously high stabilities in student values throughout the school year. These stabilities provided a first indication of whether student values underwent change (the higher the stabilities, the more set), whereas the intraclass correlation indicated the maximum proportion of variance in student values that could be explained through class-level variables—in this case, through teacher values and students' shared perceptions of instructional practices. The teacher values themselves, however, were limited in variance—which is not very surprising for this specific sample of individuals who chose to become teachers after all. This is also commonly reflected in high means for teacher values (e.g., Frenzel et al., 2018; Paulick et al., 2013; Schiefele et al., 2013). With the small variances for teacher values, the high stabilities in student values, and the low intraclass correlations we found, it is all the more remarkable that our findings indicated systematic relations between the constructs under investigation. At the same time, however, they might have covered further associations on the class level and led to supposedly small effect sizes, although it should be kept in mind that we reported contextual and not class-level effects, a difference that needs to be considered when interpreting the sizes of the coefficients (see, e.g., Lüdtke et al., 2009, for explanation). As our findings revealed, the indirect links between teacher values and student values via perceptions of instructional practices were consistently found for students' *individual* perceptions. We found no additional indirect impact of the context (i.e., the shared perceptions of the class) on student values over and above the impact of these individual perceptions.

Even though the effect sizes presented in this study appeared to be small in absolute terms, their relative meaning should be taken into account. For instance, students in classrooms with a teacher whose enthusiastic behavior was rated within the 10th percentile compared with the 90th percentile had an average difference in their change in intrinsic value of 0.38 of a standard deviation (when teachers' teaching enthusiasm was controlled for)—and this was the case after only 4 to 5 months into the school year. If these effects accumulated over time, the differences in their intrinsic value could potentially be expected to increase even more. Testing this is a task for further research.

Practical Implications

This study has several implications for educational practice. First, our investigation stresses the importance of teacher values as a dimension of professional competence already emphasized by Baumert and Kunter (2013). Not only did different dimensions of teacher values predict their strategy use during math class; these instructional practices furthermore predicted changes in students' values for math.

In motivation research, one constant concern is the question of what motivates individuals to become teachers (e.g., Richardson & Watt, 2014). Instead of asking what dimensions of motivation are relevant for making a person aspire to join the teaching profession while implicitly assuming that higher motivation leads to better outcomes, however, we were able to shed light on the more fundamental question of which values might actually be relevant for which student learning outcomes later on. As a consequence of our findings, we conclude that being and staying motivated is one of the core concerns regarding the teaching profession. For educational practice, it appears promising to make teachers' own values a subject of discussion in teacher education and professional development, including a critical discussion of the impact and relevance of (future) teachers' values and authenticity.

Second, we identified different instructional practices that can successfully be implemented to foster student values. Both teachers' expressed enthusiasm and their emphasis on content relevance in class appeared promising for the promotion of student values. Intentionally disclosing their own values might thus help teachers reduce their students' potential inner resistance to math, initialize higher acceptance, and eventually start a motivational internalization process. Even though not new (indeed long recognized by research on effective teaching, e.g. Brophy, 2000; within the research field of modeling in math education, e.g., Greefrath & Vorhölter, 2016; by self-determination theory, Su & Reeve, 2011; or by teaching didactics in terms of realistic mathematics education, e.g., van den Heuvel-Panhuizen & Drijvers, 2014), especially the provision of meaningful rationales turned out to be beneficial for student values. Based on these findings, it seems important to focus on strategy use, including different instructional practices during teacher training and in-service training.

Limitations and Future Research

Although our study provides new insights into the transmission of value from teachers to their students on the basis of high-quality longitudinal data, it also harbors some limitations that should be kept in mind when our findings are interpreted. First, our data stemmed from an intervention study. During the intervention, students were confronted with information about the relevance of math for their current and future lives. Although this could potentially have led to different processes occurring in the classrooms in the different intervention conditions, our robustness checks did not show such differences. However, future research might still want to investigate whether our findings can be replicated when there is no intervention.

Second, causal interpretations from mediation analyses can only be made with caution (e.g., Valeri & VanderWeele, 2013). To draw causal conclusions, the so-called *no unmeasured* *confounders assumption* has to hold, meaning that the predictor and further (potentially unobserved) covariates have to be uncorrelated after controlling for the mediator (VanderWeele & Vansteelandt, 2009; see also Mayer, Thoemmes, Rose, Steyer, & West, 2014). The violation of this precondition could otherwise lead to biased results. To reduce this threat, we considered baseline measures of the respective outcome variables (as recommended by Steiner et al., 2010). Despite the high stabilities of student values, we were still able to find associations between the mediator and predictor variables. However, longitudinal studies with longer time lags and potentially lower stabilities might be preferable for uncovering value transmission effects.

Third, whereas we investigated a range of instructional practices as mediators that have previously been found to be associated with student values and that are conceptually related to the value dimensions we investigated, other instructional practices (e.g., cognitive activation, supportive climate, and classroom management; see Fauth et al., 2019; Kunter et al., 2013) might also explain the relations we found. Due to our aim to systematically examine transmission processes, we opted to test for mediational associations through instructional practices that are conceptually close to the value dimensions of interest. Nevertheless, researchers conducting future studies might want to examine whether further instructional practices explain the associations between teachers' and students' utility value.

Fourth, we were not able to investigate reciprocal associations between teacher and student values (i.e., whether student values also affect teacher values) as Frenzel et al. (2018) did because we could not draw on teacher-reported values in the middle of the semester. Nevertheless, we would generally expect teachers' values to be affected by their students' values in the long run—especially those values regarding teaching and especially when teachers experience similar motivational conditions in different classrooms. Although a few studies have examined the predictors of teacher values (e.g., Sorge, Keller, Neumann, & Möller, 2019), more research is needed on the prerequisites of teachers' own values.

Fifth, we drew our conclusions from the analysis of a rather homogeneous sample in terms of its achievement level due to the fact that we conducted the study only in German academic track schools. Frenzel et al. (2018) already provided evidence for the process of emotional contagion in middle track students, and other research has also indicated consistent associations between teaching quality constructs and students' motivation across different grades and countries (Blömeke & Olsen, 2019). Nevertheless, more research is needed on the transmission of values in environments with different levels of achievement.

Finally, the extent to which our findings generalize to other domains has yet to be determined. We were interested in math because the decline in student values during secondary school is especially prominent in this domain (e.g., Gaspard et al., 2017). Even though links between teaching quality constructs and student values seem to be consistent between subjects from similar domains (Blömeke & Olsen, 2019), it would be compelling to investigate whether our findings on value transmission also apply to other subject domains, as done by Frenzel et al. (2018) for emotional contagion.

Conclusion

The findings of this study provide support for the transmission of multiple value dimensions from teachers to their students in ninth-grade math classes and that such transmissions occur—at least regarding teaching-related teacher values—through perceptions of both teachers' enthusiastic behavior during instruction and their relevance support as reported by the students. However, teacher and student values were differently associated with these rather affective versus cognitive instructional practices under investigation, leading to different mechanisms underlying the transmission effects for different value dimensions. Whereas student-perceived teacher enthusiasm exclusively explained the transmission of teachers' teaching enthusiasm to students' intrinsic value (also known as emotional contagion), student-perceived relevance-related instructional practices explained the transmission of both teachers' teaching enthusiasm to students' intrinsic and utility values, as well as teachers' utility value to students' intrinsic value. However, we could not explain the associations between subject-related teacher values and students' utility value through the instructional practices under investigation. Nevertheless, we were able to identify effective instructional strategies and motivational prerequisites for the promotion of student values during class, which appear to be promising for the future development of and implementation during teacher education.

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Supplemental Material

1. Example Mplus Syntax

1.1. Cross-Level Mediation Analysis

```
DATA: FILE = "data.dat";
VARIABLE:
NAMES = Class_ID predictor mediator mediatora
      outcomeT3 outcomeT1 outcomeT1a cond1 cond2;
MISSING=.;
USEVAR = Class_ID
                  predictor !class-level predictor
                          !(either teachers' teaching enthusiasm, math enthusiasm, or utility value)
mediator mediatora !individual-level mediator and its aggregate
                        !(either student-perceived teacher enthusiasm, use of everyday
                        !life examples, or relevance support)
outcomeT3 !outcome
                !(either students' intrinsic or utility value at T3)
outcomeT1 outcomeT1a !corresponding pretest measure and its aggregate
                              !(either students' intrinsic or utility value at T1)
cond1 cond2; !dummy-coded intervention conditions with waitlist
                 !control condition as reference
CLUSTER = Class_ID;
WITHIN = outcomeT1 mediator;
BETWEEN = predictor outcomeT1a mediatora cond1 cond2;

DEFINE:
      CENTER outcomeT1 mediator (GRANDMEAN);

ANALYSIS: TYPE = TWOLEVEL;

MODEL:
%WITHIN%
      outcomeT3 ON outcomeT1
                        mediator (bL1);
      mediator ON outcomeT1;

outcomeT1 mediator;


%BETWEEN%
outcomeT3 ON outcomeT1a
                  mediatora (bcont)
                  predictor (cL2)
                  cond1
                  cond2;
mediatora ON outcomeT1a
                predictor (aL2)
                cond1
```

```
                    cond2;

predictor outcomeT1a mediatora cond1 cond2;

predictor outcomeT1a cond2 cond1 WITH
predictor outcomeT1a cond2 cond1;

MODEL CONSTRAINT:
NEW(bL2 a1b1 a2b2 a2bcont indirect total);
bL2=bcont+bL1;
a1b1=aL2*bL1; !cross-level indirect effect
a2b2=aL2*bL2; !class-level only indirect effect
a2bcont=aL2*bcont; !unique class-level indirect effect
indirect=a1b1+a2bcont; !composite of cross-level and unique class-level indirect
                                 !effects, i.e., total indirect effect
total=indirect+cL2; !total effect

OUTPUT: TECH1 CINTERVAL;
```

1.2. ML-SEM

```
DATA: FILE = "data.dat";
VARIABLE:
NAMES = Class_ID
        asmvin1 asmvin2 asmvin3
        dsment2 dsment3 dsmmot3
        esmvin1 esmvin2 esmvin3
        atentt1 atentt2 atentt3 atentt4 atentt5 atentt6
        cond1 cond2;
MISSING=.;
USEVAR = Class_ID
        asmvin1 asmvin2 asmvin3 !Indicators of students' intrinsic value at T1
        dsment2 dsment3 dsmmot3 !Indicators of student-perceived teacher enthusiasm
        esmvin1 esmvin2 esmvin3 !Indicators of students' intrinsic value at T3
        atentt1 atentt2 atentt3 atentt4 atentt5 atentt6 !Indicators of teachers' teaching
                                                        !enthusiasm
        cond1 cond2; !dummy-coded intervention conditions with waitlist
                     !control condition as reference
CLUSTER = Class_ID;
WITHIN = ;
BETWEEN = atentt1 atentt2 atentt3 atentt4 atentt5 cond1 cond2;

ANALYSIS: TYPE = TWOLEVEL;

MODEL:
%WITHIN%
asmvin BY asmvin1 (vinlo1) !Constraining all item loadings to be
          asmvin2 (vinlo2) !invariant across T1&T3
          asmvin3 (vinlo3); !and across levels
dsment BY dsment2 (mentlo1)
          dsment3 (mentlo2)
               dsmmot3 (mentlo3);
esmvin BY esmvin1 (vinlo1)
          esmvin2 (vinlo2)
          esmvin3 (vinlo3);

!Allowing residuals of identical items to correlate over time:
asmvin1 WITH esmvin1;
asmvin2 WITH esmvin2;
```

```
asmvin3 WITH esmvin3;

!Within-level mediation model:
esmvin ON asmvin;
esmvin ON dsment;
dsment ON asmvin;

%BETWEEN%
atentm BY atentm1 atentm2 atentm3 atentm4 atentm5;
asmvina BY asmvin1 (vinlo1)
                asmvin2 (vinlo2)
                asmvin3 (vinlo3);
dsmenta BY dsment2 (mentlo1)
                dsment3 (mentlo2)
                dsmmot3 (mentlo3);
esmvina BY esmvin1 (vinlo1)
                esmvin2 (vinlo2)
                        esmvin3 (vinlo3);

!Allowing residuals of identical items to correlate over time:
asmvin1 WITH esmvin1;
asmvin2 WITH esmvin2;
asmvin3 WITH esmvin3;

!In line with Frenzel et al. (2018), the item’s residual variances for
!aggregated student intrinsic value and aggregated student-perceived teacher
!enthusiasm were set to zero to reduce model complexity:
asmvin1-esmvin3@0;

!Between-level mediation model:
esmvina ON asmvina
                atentm (c)
                dsmenta (b)
                        cond1 cond2;
dsmenta ON atentm (a)
                cond1 cond2;

!Estimating correlations between variables within T1:
atentm asmvina cond1 cond2 WITH
```

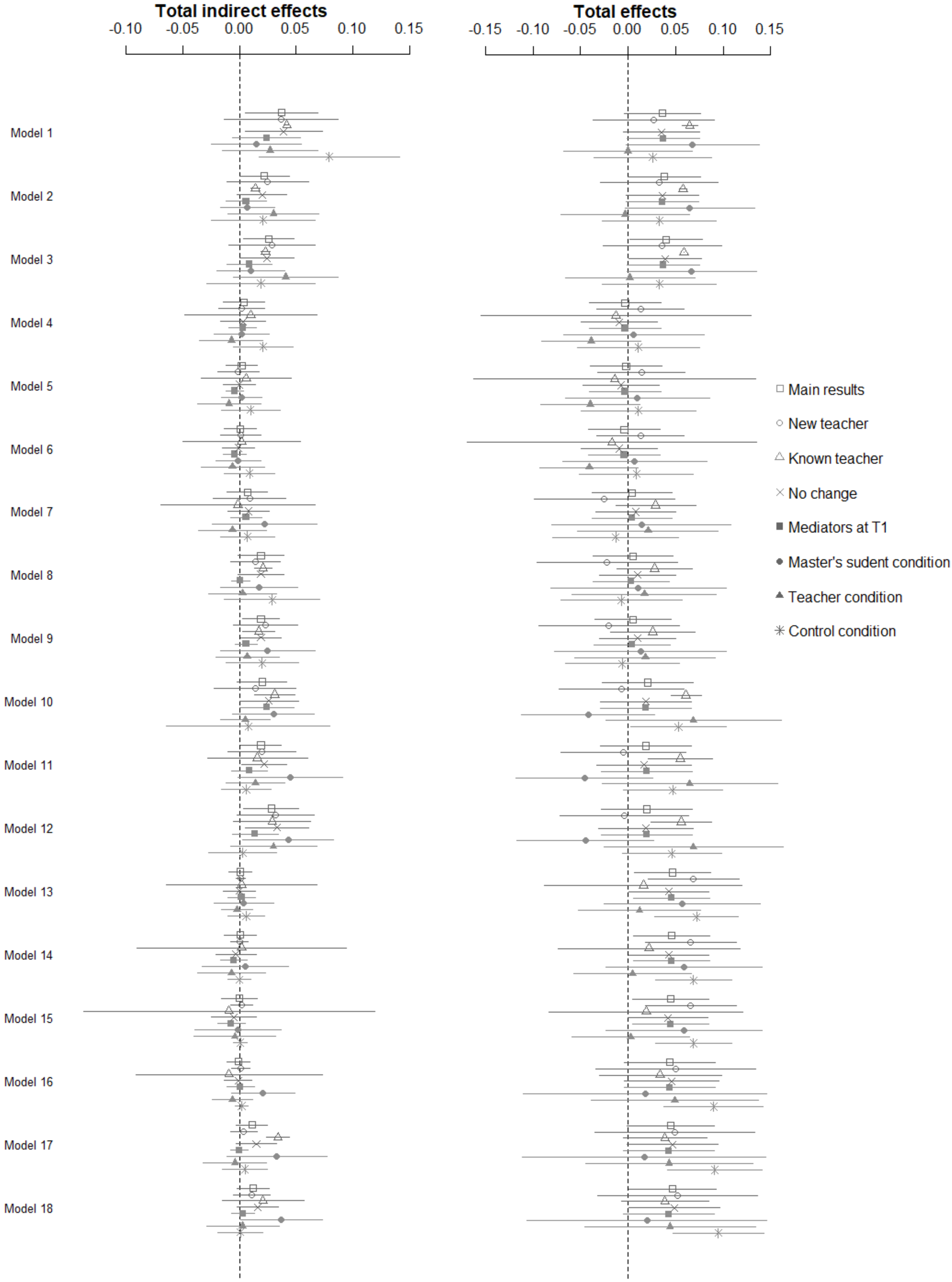
```
atentm asmvina cond1 cond2;

!Estimating correlation between T1 students' intrinsic value and T2 student-
!perceived teacher enthusiasm:
asmvina WITH dsmenta;

MODEL INDIRECT:
esmvina IND dsmenta atentm;

OUTPUT: TECH1 TECH8 CINTERVAL STDYX;
```

2. Figures S1 – S2



Figures S1 and S2. Total indirect effects (left) and total effects (right) for the 18 models predicting students' intrinsic value (Models 1 to 9) and students' utility value (Models 10 to 18) in eight different specifications and their 95% confidence limits. Models are labeled and reported in line with Models 1 to 18 in the main results. Main results = Results from main analyses also reported in Tables 2 and 3; New teacher = Results for classes that had a new math teacher at the beginning of the school year; Known teacher = Results for classes that had been instructed by the same teacher in the previous school year or even multiple years; No change = Results for classes that did not experience a change in teachers between T2 and T3; Mediators at T1 = Using mediators that were assessed at T1 instead of T2; Master's student condition = Results for students from the master's student condition; Teacher condition = Results for students from the teacher condition; Control condition = Results for students from the control condition.

3. Tables S1 – S22

Table S1

Items Assessing Teacher Values, Student-Perceived Instructional Practices, and Student Values

	Original German item wording	English translation
Teachers' teaching enthusiasm		
Item 1	Ich unterrichte mit Begeisterung.	I teach with great enthusiasm.
Item 2	Lehren gehört zu meinen Lieblingstätigkeiten.	Engaging in teaching is one of my favorite activities.
Item 3	Es macht mir immer wieder Spaß, den Schülerinnen und Schülern etwas beizubringen.	I always enjoy teaching students new things.
Item 4	Es macht mir Freude zu unterrichten.	I am enthusiastic about teaching.
Item 5	Der Umgang mit den Schülerinnen und Schülern ist für mich einer der schönsten Aspekte des Lehrberufs.	Dealing with students is one of the most beautiful aspects of the teaching profession for me.
Item 6	Mir macht Unterrichten großen Spaß.	I really enjoy teaching.
Teachers' math enthusiasm		
Item 1	Ich finde Mathematik spannend.	Math is exciting to me.
Item 2	Wenn ich in Mathematik etwas Neues dazulernen kann, bin ich bereit, auch Freizeit dafür zu verwenden.	If I can learn something new in math, I am willing to use my free time for it.
Item 3	Wenn ich mich mit Mathematik beschäftige, vergesse ich manchmal alles um mich herum.	When I'm doing math, I sometimes forget everything around me.
Item 4	Mathematik ist mir persönlich sehr wichtig.	Math is very important to me personally.
Item 5	Ich bin von Mathematik begeistert.	I am enthusiastic about the subject of mathematics.

Table S1 *(continued)*

	Original German item wording	English translation
Teachers' math utility value		
Item 1	Wissen bezüglich Mathematik bringt im täglichen Leben viele Vorteile.	Knowledge of math brings many advantages in everyday life.
Item 2	Mathematik-Kenntnisse kann man im Alltag und in der Freizeit gut gebrauchen.	Math comes in handy in everyday life and leisure time.
Item 3	Mathematik-Kenntnisse sind in vielen Berufen hilfreich.	Knowing contents in math is helpful for many careers.
Item 4	Für viele Berufe zahlt es sich aus, gut in Mathematik zu sein.	
Student-perceived teacher enthusiasm		
	Unsere Mathelehrerin/unser Mathelehrer…	Our math teacher...
Item 1	… unterrichtet mit Begeisterung.	… teaches with enthusiasm.
Item 2	… scheint großen Spaß am Unterrichten zu haben.	… really seems to take pleasure in teaching.
Item 3	… kann uns manchmal richtig begeistern.	… gets us really excited sometimes.
Student-perceived use of everyday life examples		
Item 1	Unsere Mathelehrerin/unser Mathelehrer zeigt uns an Beispielen aus dem täglichen Leben wozu man Mathe brauchen kann.	Our math teacher uses examples from daily life to show us why math can be useful.
Item 2	Unsere Mathelehrerin/unser Mathelehrer nimmt oft ein Beispiel aus dem täglichen Leben, um uns etwas Mathematisches zu erklären.	Our math teacher often uses examples from everyday life to explain mathematical concepts to us.
Item 3	Wenn wir in Mathe etwas Neues erarbeiten, gehen wir meistens von unseren eigenen Erfahrungen und Alltagsbeispielen aus.	When we work on something new in math class, we usually start with our own experiences and examples from everyday life.

Table S1 *(continued)*

	Original German item wording	English translation
Student-perceived relevance support		
	Ich habe das Gefühl, dass wir im Allgemeinen im Matheunterricht...	I have the feeling that in general in our math lessons, we ...
Item 1	… gezeigt bekommen, wo wir den Lerninhalt konkret anwenden können.	… are shown where we can directly apply the learning material.
Item 2	… aufgezeigt bekommen, wie der Lerninhalt für uns persönlich relevant ist.	… are shown how the learning content is personally relevant to us.
Item 3	… gezeigt bekommen, wie der Lerninhalt in Verbindung zu unserem Alltag steht.	… are shown how the content is related to our everyday lives.
Item 4	… ermutigt werden, darüber nachzudenken, in welchen Situationen Mathematik eingesetzt werden kann.	… are encouraged to think about situations in which mathematics can be used.
Item 5	… erklärt bekommen, welche Relevanz Mathematik in unserer Zukunft hat.	… are told about the relevance of mathematics for our future.
Students' math intrinsic value		
Item 1	Mathematik macht mir Spaß.	Math is fun to me.
Item 2	Ich mache Mathematik gerne.	I like doing math.
Item 3	Mathematik mag ich einfach.	I simply like math.
Students' math utility value		
Item 1	Das Wissen aus dem Fach Mathe bringt mir im täglichen Leben viele Vorteile.	Knowing about the subject of math brings me many advantages in my daily life.
Item 2	Mathekenntnisse kann man im Alltag und in der Freizeit gut gebrauchen.	Knowledge in math comes in handy during everyday life leisure time.
Item 3	Was wir in Mathe lernen, ist im Alltag direkt anwendbar.	What we learn in math is directly applicable in everyday life.
Item 4	Gute Mathekenntnisse werden mir in meinem späteren Beruf helfen.	A good knowledge of math will help me in my future job.

Table S1 *(continued)*

	Original German item wording	English translation
Item 5	Für meine berufliche Zukunft wird es sich auszahlen, gut in Mathe zu sein.	For my future working life it will pay off to be good in math.
Item 6	Kenntnisse aus dem Fach Mathe werden mir bei meiner späteren Karriere behilflich sein.	Subject knowledge in math will be helpful for my future career.
Item 7	In Mathe gut zu sein wird mir in der restlichen Schulzeit helfen.	Being good at math will help me in the remaining years at school.
Item 8	In Mathe gut zu sein lohnt sich, weil man es in der Schule einfach braucht.	Being good at math is worthwhile because it is simply needed at school.
Item 9	Mich in Mathe anzustrengen wird mir in den nächsten Jahren eine Menge Ärger in der Schule ersparen.	Making an effort in math will save me a lot of trouble at school in the next years.
Item 10	Mathe zu können bringt in der Schule viele Vorteile.	Doing well in math brings many advantages at school.
Item 11	Mathe ist sehr nützlich für mich.	Math is very useful to me.
Item 12	Dinge, die ich in Mathe lerne, finde ich für mein Leben im Allgemeinen nützlich.	I find the things I learn in math useful for my life in general.

Table S2

Model Fit Statistics for Models Testing Configural Variance (M1) and Weak Invariance (M2) for Student Values Across Time

Model	χ^2	*df*	CFI	TLI	RMSEA	SRMR
M1: configural invariance	1813.40	373	.949	.940	.047	.073
M2: weak invariance	1833.53	386	.948	.942	.047	.073

Note. χ^2 = chi-square test of model fit; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual. Design-based correction of standard errors and fit statistics were used for the CFAs involving items assessed at the individual level (i.e., student-perceived instructional practices and student values).

Table S3

Model Fit Statistics for Confirmatory Factor Analyses

Model	CFI	TLI	RMSEA	SRMR
Teacher values at T1	.766 [a]	.717 [a]	.022	.125
Student-perceived instructional practices at T2	.947	.929	.084	.082
Student values at T1 and T3	.955	.948	.044	.071

Note. CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual. Design-based correction of standard errors and fit statistics were used for the CFAs involving items assessed at the individual level (i.e., student-perceived instructional practices and student values).

[a] CFI and TLI are not satisfying most likely due to negatively skewed distribution of data which is very common for teacher self-reports (e.g., Schiefele et al., 2013), along with on average high values (e.g., Paulick et al., 2013) or that teachers commonly do not exploit the entire range of values in research on teacher values (e.g., Watt & Richardson, 2007).

Table S4

Standardized Estimates and 95% Confidence Intervals for the Path Coefficients, Covariances, Indirect Effects, Total Indirect Effects, and Total Effects in the Nine Cross-Level Mediation Models for Students' ***Intrinsic Value*** *for Different Predictors (Teachers' Teaching Enthusiasm, Math Enthusiasm, and Math Utility Value) and Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' IV → T3 students' IV	.72***	.72***	.70***	.72***	.72***	.70***	.72***	.72***	.70***
	[.69,.76]	[.68,.76]	[.66,.74]	[.69,.76]	[.68,.76]	[.66,.74]	[.69,.76]	[.68,.76]	[.66,.74]
T1 students' IV → Mediator	.18***	.18***	.26***	.18***	.18***	.26***	.18***	.18***	.26***
	[.14,.23]	[.13,.23]	[.21,.32]	[.14,.23]	[.13,.23]	[.21,.32]	[.14,.23]	[.13,.23]	[.21,.32]
Mediator → T3 students' IV	.09***	.11***	.14***	.09***	.11***	.14***	.09***	.11***	.14***
	[.05,.13]	[.07,.14]	[.10,.18]	[.05,.13]	[.07,.14]	[.10,.18]	[.05,.13]	[.07,.14]	[.10,.18]
Class level									
T1 students' IV → T3 students' IV	.01	.01	.03	.01	.00	.02	.01	.00	.01
	[-.17,.18]	[-.17,.20]	[-.16,.21]	[-.16,.18]	[-.18,.18]	[-.16,.20]	[-.17,.18]	[-.19,.18]	[-.17,.20]
T1 students' IV → Mediator	.30	.49*	.42*	.23	.43*	.35*	.23	.45*	.37*
	[-.07,.66]	[.10,.88]	[.09,.75]	[-.13,.59]	[.05,.80]	[.03,.67]	[-.13,.60]	[.07,.82]	[.04,.69]
Mediator → T3 students' IV	.07	.01	-.01	.07	.02	.00	.07	.03	.01
	[-.03,.17]	[-.08,.10]	[-.11,.09]	[-.02,.16]	[-.06,.11]	[-.09,.10]	[-.02,.16]	[-.06,.12]	[-.09,.11]
T1 teachers' V → Mediator	.23***	.19***	.20***	.02	.02	.01	.04	.14**	.12**
	[.13,.33]	[.09,.28]	[.11,.28]	[-.09,.14]	[-.09,.13]	[-.09,.11]	[-.06,.15]	[.04,.25]	[.04,.21]
T1 teachers' V → T3 students' IV	.00	.02	.01	-.01	.00	-.01	.00	-.01	-.01
	[-.04,.04]	[-.02,.05]	[-.02,.05]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.04]	[-.06,.03]	[-.05,.03]
Master's student condition → Mediator	-.27*	-.02	.06	-.24†	.01	.09	-.25†	-.01	.07
	[-.52,-.03]	[-.27,.23]	[-.14,.26]	[-.51,.04]	[-.26,.28]	[-.13,.31]	[-.53,.04]	[-.26,.24]	[-.13,.28]
Master's student condition → T3 students' IV	-.05	-.09	-.10†	-.06	-.09	-.10†	-.05	-.09	-.10†
	[-.16,.06]	[-.20,.03]	[-.21,.02]	[-.16,.05]	[-.20,.03]	[-.21,.01]	[-.16,.05]	[-.20,.03]	[-.21,.01]
Teacher condition → Mediator	-.06	.12	.23†	-.12	.07	.18	-.13	.07	.18
	[-.35,.22]	[-.17,.40]	[-.01,.47]	[-.42,.18]	[-.22,.37]	[-.07,.44]	[-.43,.17]	[-.21,.35]	[-.06,.43]
Teacher condition → T3 students' IV	-.05	-.06	-.08	-.05	-.07	-.09	-.05	-.07	-.09
	[-.15,.05]	[-.17,.05]	[-.18,.03]	[-.15,.05]	[-.18,.04]	[-.19,.02]	[-.15,.05]	[-.18,.04]	[-.19,.02]

Table S4 *(continued)*

Covariances									
T1 teachers' V WITH...									
T1 students' IV	-.02	-.02	-.02	.01	.01	.01	-.01	-.01	-.01
	[-.07,.04]	[-.07,.04]	[-.08,.04]	[-.05,.06]	[-.05,.06]	[-.05,.06]	[-.07,.06]	[-.07,.06]	[-.07,.06]
Master's student condition	.06	.06	.06	-.02	-.02	-.02	.03	.03	.03
	[-.05,.16]	[-.05,.16]	[-.05,.16]	[-.12,.09]	[-.12,.09]	[-.12,.09]	[-.07,.12]	[-.07,.12]	[-.07,.12]
Teacher condition	-.07	-.07	-.07	-.04	-.04	-.04	-.01	-.01	-.01
	[-.17,.03]	[-.17,.04]	[-.17,.04]	[-.14,.06]	[-.14,.06]	[-.14,.06]	[-.11,.09]	[-.11,.09]	[-.11,.09]
T1 students' IV WITH...									
Master's student condition	.01	.01	.01	.01	.01	.01	.01	.01	.01
	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]
Teacher condition	-.02	-.02	-.02	-.02	-.02	-.02	-.02	-.02	-.02
	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]
Master's student condition WITH...									
Teacher condition	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***
	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]
Indirect, total indirect, and total effects									
Cross-level indirect effect (a_2b_1)	.02**	.02**	.03***	.00	.00	.00	.00	.02*	.02**
	[.01,.04]	[.01,.03]	[.01,.04]	[-.01,.01]	[-.01,.01]	[-.01,.02]	[-.01,.01]	[.00,.03]	[.00,.03]
Unique class-level indirect effect (a_2b_{cont})	.02	.00	.00	.00	.00	.00	.00	.00	.00
	[-.01,.04]	[-.02,.02]	[-.02,.02]	[-.01,.01]	[.00,.00]	[.00,.00]	[-.01,.01]	[-.01,.02]	[-.01,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.04*	.02*	.03*	.00	.00	.00	.01	.02*	.02*
	[.01,.07]	[.00,.04]	[.00,.05]	[-.01,.02]	[-.01,.02]	[-.01,.02]	[-.01,.02]	[.00,.04]	[.00,.04]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.04†	.04†	.04*	.00	.00	.00	.00	.01	.01
	[.00,.07]	[.00,.08]	[.00,.08]	[-.04,.03]	[-.04,.04]	[-.04,.03]	[-.04,.04]	[-.04,.05]	[-.04,.05]

Note. Enthusiasm = student-perceived teacher enthusiasm. Examples = student-perceived use of everyday life examples. Relevance = student-perceived relevance support. CI = 95% confidence interval. IV = intrinsic value. T1 teacher values = values, i.e., teaching enthusiasm, math enthusiasm, and math utility value.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S5

*Standardized Estimates and 95% Confidence Intervals for the Path Coefficients, Covariances, Indirect Effects, Total Indirect Effects, and Total Effects in the Nine Cross-Level Mediation Models for Students' **Utility Value** for Different Predictors (Teachers' Teaching Enthusiasm, Math Enthusiasm, and Math Utility Value) and Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, Relevance Support)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	M10	**M11**	**M12**	**M13**	**M14**	**M15**	**M16**	**M17**	**M18**
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β	β	β	β	β	β	β	β	β
	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
	Path coefficients								
Individual level									
T1 students' UV → T3 students' IV	.58***	.57***	.53***	.58***	.57***	.53***	.58***	.57***	.53***
	[.54,.62]	[.52,.61]	[.48,.57]	[.54,.62]	[.52,.61]	[.48,.57]	[.54,.62]	[.52,.61]	[.48,.57]
T1 students' UV → Mediator	.19***	.23***	.32***	.19***	.23***	.32***	.19***	.23***	.32***
	[.13,.25]	[.18,.29]	[.27,.37]	[.13,.25]	[.18,.29]	[.27,.37]	[.13,.25]	[.18,.29]	[.27,.37]
Mediator → T3 students' UV	.14***	.16***	.25***	.14***	.16***	.25***	.14***	.16***	.25***
	[.08,.20]	[.11,.21]	[.20,.31]	[.08,.20]	[.11,.21]	[.20,.31]	[.08,.20]	[.11,.21]	[.20,.31]
Class level									
T1 students' UV → T3 students' UV	.06	.05	.07	.06	.04	.07	.02	.03	.05
	[-.09,.22]	[-.11,.21]	[-.08,.23]	[-.09,.21]	[-.11,.20]	[-.08,.21]	[-.13,.18]	[-.14,.19]	[-.11,.20]
T1 students' UV → Mediator	.43*	.53*	.47**	.57**	.63**	.58**	.58**	.54**	.50**
	[.07,.79]	[.13,.93]	[.14,.80]	[.19,.94]	[.23,1.03]	[.24,.92]	[.22,.93]	[.14,.95]	[.16,.84]
Mediator → T3 students' UV	-.04	-.03	-.08	-.04	-.03	-.09	-.04	-.04	-.10†
	[-.14,.06]	[-.13,.07]	[-.20,.04]	[-.14,.06]	[-.13,.07]	[-.20,.02]	[-.14,.06]	[-.13,.06]	[-.21,.02]
T1 teachers' V → Mediator	.20***	.15**	.16**	.01	.01	.00	-.01	.09†	.08†
	[.09,.31]	[.04,.25]	[.06,.26]	[-.09,.12]	[-.10,.11]	[-.10,.09]	[-.10,.09]	[-.02,.20]	[-.01,.16]
T1 teachers' V → T3 students' UV	.00	.00	-.01	.05*	.05*	.05*	.04†	.03	.04
	[-.05,.05]	[-.05,.05]	[-.05,.04]	[.01,.08]	[.01,.08]	[.01,.08]	[.00,.09]	[-.01,.08]	[-.01,.08]
Master's student condition → Mediator	-.26*	.00	.08	-.22†	.03	.10	-.23	.01	.09
	[-.50,-.02]	[-.24,.24]	[-.11,.27]	[-.49,.04]	[-.22,.28]	[-.10,.31]	[-.50,.05]	[-.23,.26]	[-.10,.29]
Master's student condition → T3 students' UV	.12*	.10†	.09	.13*	.11*	.10†	.12*	.10†	.09†
	[.01,.22]	[-.01,.20]	[-.02,.19]	[.03,.23]	[.01,.21]	[.00,.20]	[.02,.22]	[-.01,.20]	[-.02,.20]
Teacher condition → Mediator	-.09	.08	.20†	-.13	.05	.16	-.14	.05	.16
	[-.37,.19]	[-.19,.35]	[-.03,.43]	[-.42,.16]	[-.23,.32]	[-.08,.41]	[-.43,.16]	[-.23,.32]	[-.08,.41]
Teacher condition → T3 students' UV	.08	.07	.05	.09†	.08†	.07	.08†	.07	.06
	[-.02,.17]	[-.03,.17]	[-.05,.15]	[-.01,.18]	[-.01,.18]	[-.03,.16]	[-.01,.17]	[-.02,.17]	[-.04,.15]

Table S5 *(continued)*

				Covariances					
T1 teachers' V WITH...									
T1 students' UV	.06*	.06*	.06*	.02	.02	.02	.08*	.08*	.08*
	[.01,.11]	[.00,.11]	[.00,.11]	[-.05,.08]	[-.05,.08]	[-.05,.08]	[.02,.15]	[.02,.15]	[.02,.15]
Master's student condition	.06	.06	.06	-.02	-.02	-.02	.03	.03	.03
	[-.05,.17]	[-.05,.17]	[-.05,.17]	[-.12,.09]	[-.12,.09]	[-.12,.09]	[-.07,.12]	[-.07,.12]	[-.07,.12]
Teacher condition	-.07	-.07	-.07	-.04	-.04	-.04	-.01	-.01	-.01
	[-.17,.03]	[-.17,.03]	[-.17,.04]	[-.14,.06]	[-.14,.06]	[-.14,.06]	[-.11,.09]	[-.11,.09]	[-.11,.09]
T1 students' UV WITH...									
Master's student condition	.00	.00	.00	.00	.00	.00	.00	.00	.00
	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]
Teacher condition	.00	.00	.00	.00	.00	.00	.00	.00	.00
	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]
Master's student condition WITH...									
Teacher condition	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***
	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]
				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.03**	.02*	.04**	.00	.00	.00	.00	.02	.02
	[.01,.04]	[.01,.04]	[.02,.07]	[-.01,.02]	[-.02,.02]	[-.02,.02]	[-.01,.01]	[.00,.03]	[.00,.04]
Unique class-level indirect effect (a_2b_{cont})	-.01	.00	-.01	.00	.00	.00	.00	.00	-.01
	[-.03,.01]	[-.02,.01]	[-.03,.01]	[-.01,.00]	[.00,.00]	[-.01,.01]	[.00,.00]	[-.01,.01]	[-.02,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.02†	.02*	.03*	.00	.00	.00	.00	.01	.01
	[.00,.04]	[.00,.04]	[.00,.05]	[-.01,.01]	[-.01,.01]	[-.02,.02]	[-.01,.01]	[.00,.03]	[.00,.03]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.02	.02	.02	.05*	.05*	.05*	.04†	.05†	.05*
	[-.03,.07]	[-.03,.07]	[-.03,.07]	[.01,.09]	[.01,.09]	[.01,.08]	[.00,.09]	[.00,.09]	[.00,.09]

Note. Enthusiasm = student-perceived teacher enthusiasm. Examples = student-perceived use of everyday life examples. Relevance = student-perceived relevance support. CI = 95% confidence interval. UV = utility value. T1 teacher values = values, i.e., teaching enthusiasm, math enthusiasm, and math utility value.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S6

Standardized Estimates and 95% Confidence Intervals for the Path Coefficients and Covariances in the ML-SEM Involving Teachers' Teaching Enthusiasm, Student-Perceived Teacher Enthusiasm, and Students' Intrinsic Value (Conceptual Replication of Frenzel et al., 2018)

Variable (Frenzel et al., 2018)	β [CI]	β [CI]	Variable
	Path coefficients		
Individual level			**Individual level**
T3 students' enjoyment on...			T3 students' intrinsic value on...
T1 students' enjoyment	.41** [.35,.47]	.79*** [.76,.82]	T1 students' intrinsic value
T2 student-perceived teacher enthusiasm	.23** [.17,.29]	.05** [.02,.09]	T2 student-perceived teacher enthusiasm
T2 student-perceived teacher enthusiasm on...			T2 student-perceived teacher enthusiasm on...
T1 students' enjoyment	.40** [.34,.46]	.16*** [.11,.22]	T1 students' intrinsic value
Class level			**Class level**
T3 students' enjoyment on...			T3 students' intrinsic value on...
T1 teachers' enjoyment	-.28* [-.53,-.03]	-.07 [-.35,.21]	T1 teachers' teaching enthusiasm
T1 students' enjoyment	.40** [.11,.69]	.64*** [.30,.97]	T1 students' intrinsic value
T2 student-perceived teacher enthusiasm	.61** [.37,.85]	.49** [.13,.84]	T2 student-perceived teacher enthusiasm
		-.12 [-.41,.18]	Master's student condition
		-.14 [-.43,.15]	Teacher condition
T2 student-perceived teacher enthusiasm on...			T2 student-perceived teacher enthusiasm on...
T1 teachers' enjoyment	.44** [.24,.64]	.50*** [.27,.73]	T1 teachers' teaching enthusiasm
		-.32** [-.55,-.09]	Master's student condition
		-.09 [-.34,.15]	Teacher condition
	Covariances		
T1 teachers' enjoyment with...			T1 teachers' teaching enthusiasm with...
T1 students' enjoyment	.47** [.22,.72]	.09 [-.31,.50]	T1 students' intrinsic value
		.18 [-.07,.43]	Master's student condition
		-.19 [-.44,.07]	Teacher condition

Table S6 *(continued)*

T1 students' enjoyment with...			T1 students' intrinsic value with...
T2 student-perceived teacher enthusi-asm	.45** [.21,.69]	-.06 [-.41,.30]	T2 student-perceived teacher enthusi-asm
		.15 [-.21,.51]	Master's student condition
		-.24 [-.59,.12]	Teacher condition
			Master's student condition with...
		-.52*** [-.64,-.40]	Teacher condition

Note. ML-SEM = multilevel structural equation model.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table S7

Standardized Estimates for the Six Cross-Level Mediation Models of Students' ***Intrinsic Value*** *Predicted by Teachers'* ***Teaching Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (New Teacher vs. Known Teacher)*

	Enthusiasm		Examples		Relevance	
	New teacher	Known teacher	New teacher	Known teacher	New teacher	Known teacher
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients						
Individual level						
T1 students' IV → T3 students' IV	.74 ***	.70 ***	.73 ***	.70 ***	.72 ***	.68 ***
	[.69, .78]	[.64, .77]	[.69, .78]	[.63, .77]	[.67, .76]	[.61, .75]
T1 students' IV → Mediator	.14 ***	.24 ***	.16 ***	.22 ***	.23 ***	.31 ***
	[.09, .20]	[.16, .32]	[.09, .23]	[.14, .30]	[.16, .30]	[.23, .38]
Mediator → T3 students' IV	.09 ***	.10 **	.09 **	.13 ***	.13 ***	.16 ***
	[.05, .14]	[.03, .16]	[.04, .14]	[.07, .20]	[.08, .18]	[.10, .23]
Class level						
T1 students' IV → T3 students' IV	-.15	.13	-.15	.19	-.13	.18
	[-.33, .04]	[-.09, .35]	[-.34, .05]	[-.05, .43]	[-.31, .06]	[-.09, .44]
T1 students' IV → Mediator	.05	.70 *	.27	.81 ***	.22	.73 ***
	[-.45, .56]	[.16, 1.23]	[-.36, .89]	[.36, 1.27]	[-.30, .74]	[.33, 1.12]
Mediator → T3 students' IV	.06	.10 †	.02	-.02	-.02	.00
	[-.09, .21]	[-.01, .21]	[-.10, .14]	[-.14, .11]	[-.15, .12]	[-.14, .15]
T1 teachers' TE → Mediator	.25 **	.21 *	.24 **	.12	.25 **	.14 *
	[.11, .39]	[.04, .39]	[.07, .40]	[-.03, .28]	[.10, .40]	[.02, .26]
T1 teachers' TE → T3 students' IV	-.01	.02	.01	.04	.01	.04
	[-.09, .07]	[-.02, .06]	[-.05, .06]	[-.01, .10]	[-.06, .07]	[-.01, .09]
Master's student condition → Mediator	-.32 †	-.16	-.04	.11	.07	.13
	[-.68, .03]	[-.56, .25]	[-.38, .30]	[-.37, .59]	[-.24, .38]	[-.17, .43]
Master's student condition → T3 students' IV	.05	-.19 *	.02	-.22 *	.01	-.22 *
	[-.10, .20]	[-.35, -.04]	[-.14, .18]	[-.41, -.03]	[-.15, .16]	[-.40, -.04]
Teacher condition → Mediator	-.04	-.12	.03	.28	.23	.24
	[-.40, .33]	[-.53, .29]	[-.33, .39]	[-.14, .70]	[-.08, .55]	[-.06, .55]
Teacher condition → T3 students' IV	-.09	-.03	-.09	-.07	-.11	-.08
	[-.22, .04]	[-.17, .11]	[-.23, .06]	[-.25, .11]	[-.24, .03]	[-.26, .10]

Table S7 *(continued)*

Covariances						
T1 teachers' TE WITH...						
T1 students' IV	-.01	-.01	-.02	-.01	-.02	-.01
	[-.09, .06]	[-.10, .09]	[-.09, .06]	[-.10, .09]	[-.09, .06]	[-.10, .08]
Master's student condition	-.02	.16 †	-.02	.16 †	-.02	.16 †
	[-.15, .12]	[-.01, .34]	[-.16, .12]	[-.02, .34]	[-.16, .11]	[-.02, .34]
Teacher condition	-.06	-.08	-.05	-.08	-.05	-.08
	[-.20, .08]	[-.24, .08]	[-.19, .08]	[-.24, .08]	[-.19, .08]	[-.24, .08]
T1 students' IV WITH...						
Master's student condition	.03 †	-.01	.03 †	-.01	.03 †	-.01
	[.00, .06]	[-.05, .03]	[.00, .06]	[-.05, .03]	[.00, .06]	[-.05, .03]
Teacher condition	-.03	.00	-.03	.00	-.03	.00
	[-.07, .01]	[-.04, .03]	[-.07, .01]	[-.04, .03]	[-.07, .01]	[-.04, .03]
Master's student condition WITH...						
Teacher condition	-.10 ***	-.14 ***	-.10 ***	-.14 ***	-.10 ***	-.14 ***
	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]
Indirect, total indirect, and total effects						
Cross-level indirect effect (a_2b_1)	.02 *	.02 †	.02 *	.02	.03 **	.02 *
	[.01, .04]	[.00, .04]	[.00, .04]	[-.01, .04]	[.01, .06]	[.00, .04]
Unique class-level indirect effect (a_2b_{cont})	.02	.02	.01	.00	-.01	.00
	[-.03, .06]	[-.01, .05]	[-.02, .03]	[-.02, .01]	[-.04, .03]	[-.02, .02]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.04	.04 †	.03	.01 †	.03	.02 *
	[-.01, .09]	[.00, .09]	[-.01, .06]	[.00, .03]	[-.01, .07]	[.00, .04]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.03	.07 *	.03	.06 †	.04	.06 †
	[-.04, .09]	[.00, .13]	[-.03, .09]	[.00, .12]	[-.02, .10]	[.00, .12]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; TE = teaching enthusiasm. Differences in the total indirect and total effects between new vs known were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S8

Standardized Estimates for the Six Cross-Level Mediation Models for Students' ***Intrinsic Value*** *Predicted by Teachers'* ***Math Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (New Teacher vs. Known Teacher)*

	Enthusiasm		Examples		Relevance	
	New teacher	Known teacher	New teacher	Known teacher	New teacher	Known teacher
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients						
Individual level						
T1 students' IV → T3 students' IV	.74 *** [.69, .78]	.70 *** [.64, .77]	.73 *** [.69, .78]	.70 *** [.63, .77]	.72 *** [.67, .76]	.68 *** [.61, .75]
T1 students' IV → Mediator	.14 *** [.09, .20]	.24 *** [.16, .32]	.16 *** [.09, .23]	.22 *** [.14, .30]	.23 *** [.16, .30]	.31 *** [.23, .38]
Mediator → T3 students' IV	.09 *** [.05, .14]	.10 ** [.03, .16]	.09 ** [.04, .14]	.13 *** [.07, .20]	.13 *** [.08, .18]	.16 *** [.10, .23]
Class level						
T1 students' IV → T3 students' IV	-.15 [-.33, .04]	.12 [-.12, .35]	-.16 [-.35, .03]	.17 [-.10, .43]	-.13 [-.32, .05]	.15 [-.14, .44]
T1 students' IV → Mediator	.00 [-.53, .53]	.71 ** [.19, 1.22]	.21 [-.38, .80]	.82 ** [.34, 1.30]	.15 [-.35, .65]	.72 ** [.28, 1.16]
Mediator → T3 students' IV	.05 [-.07, .18]	.12 † [.00, .24]	.03 [-.09, .14]	.01 [-.10, .12]	-.01 [-.14, .11]	.04 [-.12, .19]
T1 teachers' ME → Mediator	.02 [-.13, .16]	.05 [-.14, .23]	-.01 [-.16, .14]	.05 [-.14, .23]	.01 [-.13, .16]	.01 [-.13, .15]
T1 teachers' ME → T3 students' IV	.01 [-.03, .06]	-.02 [-.07, .02]	.02 [-.03, .06]	-.02 [-.07, .03]	.01 [-.03, .06]	-.02 [-.07, .03]
Master's student condition → Mediator	-.38 † [-.76, .00]	-.01 [-.47, .46]	-.10 [-.46, .27]	.20 [-.24, .63]	.01 [-.31, .34]	.22 [-.09, .53]
Master's student condition → T3 students' IV	.06 [-.09, .20]	-.17 * [-.33, -.02]	.02 [-.13, .17]	-.19 * [-.37, -.01]	.01 [-.14, .16]	-.20 * [-.38, -.03]
Teacher condition → Mediator	-.13 [-.51, .25]	-.10 [-.56, .37]	-.06 [-.45, .33]	.29 [-.13, .71]	.15 [-.21, .51]	.25 [-.05, .55]
Teacher condition → T3 students' IV	-.08 [-.21, .05]	-.03 [-.17, .11]	-.09 [-.22, .05]	-.07 [-.26, .11]	-.11 † [-.23, .02]	-.08 [-.27, .11]

Table S8 *(continued)*

			Covariances			
T1 teachers' ME WITH...						
T1 students' IV	.02	-.01	.02	-.01	.02	-.01
	[-.06, .10]	[-.09, .08]	[-.06, .10]	[-.09, .08]	[-.06, .10]	[-.09, .08]
Master's student condition	-.03	.00	-.03	.00	-.03	.00
	[-.16, .10]	[-.17, .17]	[-.16, .10]	[-.17, .17]	[-.16, .10]	[-.17, .17]
Teacher condition	-.06	-.01	-.06	-.01	-.06	-.01
	[-.19, .08]	[-.17, .15]	[-.19, .08]	[-.17, .15]	[-.19, .08]	[-.17, .15]
T1 students' IV WITH...						
Master's student condition	.03 †	-.01	.03 †	-.01	.03 †	-.01
	[.00, .06]	[-.05, .03]	[.00, .06]	[-.05, .03]	[.00, .06]	[-.05, .03]
Teacher condition	-.03	.00	-.03	.00	-.03	.00
	[-.07, .01]	[-.04, .03]	[-.07, .01]	[-.04, .03]	[-.07, .01]	[-.04, .03]
Master's student condition WITH...						
Teacher condition	-.10 ***	-.14 ***	-.10 ***	-.14 ***	-.10 ***	-.14 ***
	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]
			Indirect, total indirect, and total effects			
Cross-level indirect effect (a_2b_1)	.00	.00	.00	.01	.00	.00
	[-.01, .01]	[-.01, .02]	[-.01, .01]	[-.02, .03]	[-.02, .02]	[-.02, .03]
Unique class-level indirect effect (a_2b_{cont})	.00	.01	.00	.00	.00	.00
	[-.01, .01]	[-.02, .03]	[.00, .00]	[-.01, .01]	[.00, .00]	[-.01, .01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.00	.01	.00	.01	.00	.00
	[-.02, .02]	[-.03, .05]	[-.02, .02]	[-.02, .03]	[-.02, .02]	[-.03, .03]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.01	-.01	.01	-.01	.01	-.02
	[-.03, .06]	[-.07, .05]	[-.03, .06]	[-.07, .05]	[-.03, .06]	[-.08, .04]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; ME = math enthusiasm. Differences in the total indirect and total effects between new vs known were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S9

*Standardized Estimates for the Six Cross-Level Mediation Models for Students’ **Intrinsic Value** Predicted by Teachers’ **Utility Value** for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (New Teacher vs. Known Teacher)*

	Enthusiasm		Examples		Relevance	
	New teacher	Known teacher	New teacher	Known teacher	New teacher	Known teacher
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients						
Individual level						
T1 students’ IV → T3 students’ IV	.74 *** [.69, .78]	.70 *** [.64, .77]	.73 *** [.69, .78]	.70 *** [.63, .77]	.72 *** [.67, .76]	.68 *** [.61, .75]
T1 students’ IV → Mediator	.14 *** [.09, .20]	.24 *** [.16, .32]	.16 *** [.09, .23]	.22 *** [.14, .30]	.23 *** [.16, .30]	.31 *** [.23, .38]
Mediator → T3 students’ IV	.09 *** [.05, .14]	.10 ** [.03, .16]	.09 ** [.04, .14]	.13 *** [.07, .20]	.13 *** [.08, .18]	.16 *** [.10, .23]
Class level						
T1 students’ IV → T3 students’ IV	-.16 [-.35, .03]	.11 [-.11, .33]	-.17 [-.37, .03]	.17 [-.08, .43]	-.15 [-.35, .05]	.15 [-.13, .43]
T1 students’ IV → Mediator	.03 [-.53, .58]	.70 * [.15, 1.26]	.26 [-.32, .83]	.77 ** [.29, 1.24]	.21 [-.27, .70]	.69 ** [.26, 1.13]
Mediator → T3 students’ IV	.06 [-.07, .18]	.12 * [.01, .23]	.04 [-.08, .15]	.00 [-.11, .11]	.01 [-.12, .13]	.03 [-.11, .18]
T1 teachers’ UV → Mediator	.06 [-.13, .26]	-.01 [-.16, .15]	.12 [-.04, .28]	.16 † [.00, .31]	.17 * [.02, .32]	.09 [-.02, .20]
T1 teachers’ UV → T3 students’ IV	-.03 [-.10, .04]	.03 [-.01, .07]	-.04 [-.11, .04]	.01 [-.04, .05]	-.04 [-.11, .03]	.01 [-.03, .05]
Master’s student condition → Mediator	-.37 * [-.72, -.01]	.00 [-.59, .59]	-.06 [-.41, .29]	.03 [-.43, .50]	.06 [-.25, .36]	.13 [-.19, .45]
Master’s student condition → T3 students’ IV	.04 [-.10, .18]	-.20 * [-.35, -.04]	.01 [-.14, .15]	-.19 † [-.39, .00]	-.01 [-.16, .13]	-.21 * [-.39, -.02]
Teacher condition → Mediator	-.10 [-.51, .31]	-.10 [-.60, .41]	.00 [-.40, .39]	.14 [-.28, .57]	.22 [-.14, .59]	.17 [-.14, .47]
Teacher condition → T3 students’ IV	-.11 [-.24, .03]	-.04 [-.20, .11]	-.11 [-.26, .04]	-.08 [-.27, .12]	-.14 * [-.27, .00]	-.09 [-.29, .11]

Table S9 *(continued)*

Covariances						
T1 teachers' UV WITH...						
T1 students' IV	-.02	.01	-.02	.01	-.02	.01
	[-.08, .04]	[-.11, .13]	[-.08, .04]	[-.11, .13]	[-.08, .04]	[-.11, .13]
Master's student condition	-.02	.13	-.02	.13	-.02	.13
	[-.12, .09]	[-.06, .31]	[-.12, .09]	[-.06, .31]	[-.12, .09]	[-.06, .31]
Teacher condition	-.07	.05	-.07	.05	-.07	.05
	[-.20, .05]	[-.10, .21]	[-.20, .05]	[-.10, .21]	[-.20, .05]	[-.10, .21]
T1 students' IV WITH...						
Master's student condition	.03 †	-.01	.03 †	-.01	.03 †	-.01
	[.00, .06]	[-.05, .03]	[.00, .06]	[-.05, .03]	[.00, .06]	[-.05, .03]
Teacher condition	-.03	.00	-.03	.00	-.03	.00
	[-.07, .01]	[-.04, .03]	[-.07, .01]	[-.04, .03]	[-.07, .01]	[-.04, .03]
Master's student condition WITH...						
Teacher condition	-.10 ***	-.14 ***	-.10 ***	-.14 ***	-.10 ***	-.14 ***
	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]
Indirect, total indirect, and total effects						
Cross-level indirect effect (a_2b_1)	.01	.00	.01	.02	.02 *	.01
	[-.01, .02]	[-.02, .01]	[.00, .03]	[-.01, .05]	[.00, .04]	[-.01, .03]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	.00	.00	.00	.00
	[-.01, .02]	[-.02, .02]	[-.01, .02]	[-.02, .02]	[-.02, .02]	[-.01, .02]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.01	.00	.01	.02 †	.02 †	.02
	[-.02, .04]	[-.03, .03]	[-.01, .04]	[.00, .05]	[.00, .05]	[-.01, .04]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	-.03	.03	-.02	.03	-.02	.03
	[-.10, .05]	[-.02, .08]	[-.10, .05]	[-.02, .08]	[-.09, .05]	[-.02, .08]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; UV = utility value. Differences in the total indirect and total effects between new vs known were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S10

Standardized Estimates for the Six Cross-Level Mediation Models for Students’ ***Utility Value*** *Predicted by Teachers’* ***Teaching Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (New Teacher vs. Known Teacher)*

	Enthusiasm		Examples		Relevance	
	New teacher	Known teacher	New teacher	Known teacher	New teacher	Known teacher
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients						
Individual level						
T1 students’ UV → T3 students’ UV	.59 *** [.55, .64]	.56 *** [.48, .64]	.59 *** [.54, .64]	.54 *** [.46, .62]	.55 *** [.49, .60]	.50 *** [.43, .57]
T1 students’ UV → Mediator	.18 *** [.11, .26]	.19 *** [.10, .28]	.22 *** [.15, .29]	.26 *** [.18, .35]	.30 *** [.23, .37]	.35 *** [.28, .43]
Mediator → T3 students’ UV	.14 ** [.06, .23]	.13 ** [.04, .21]	.15 *** [.08, .21]	.18 *** [.10, .26]	.25 *** [.17, .32]	.27 *** [.20, .34]
Class level						
T1 students’ UV → T3 students’ UV	.05 [-.17, .26]	-.02 [-.20, .16]	.04 [-.17, .25]	-.06 [-.29, .17]	.06 [-.14, .27]	-.05 [-.25, .15]
T1 students’ UV → Mediator	.49 [-.20, 1.18]	.45 * [.03, .87]	.54 [-.15, 1.22]	.58 * [.06, 1.09]	.54 † [-.06, 1.14]	.49 * [.10, .87]
Mediator → T3 students’ UV	-.08 [-.25, .08]	.06 [-.06, .18]	-.05 [-.19, .08]	.09 [-.06, .23]	-.11 [-.26, .05]	.08 [-.10, .25]
T1 teachers’ TE → Mediator	.23 ** [.09, .37]	.17 † [-.03, .36]	.22 * [.05, .39]	.06 [-.09, .21]	.23 ** [.08, .39]	.09 [-.04, .21]
T1 teachers’ TE → T3 students’ UV	-.02 [-.10, .06]	.03 [-.04, .10]	-.03 [-.09, .04]	.04 [-.02, .10]	-.04 [-.10, .03]	.03 [-.03, .08]
Master’s student condition → Mediator	-.32 † [-.66, .01]	-.20 [-.60, .20]	-.02 [-.32, .29]	.07 [-.39, .53]	.09 [-.19, .36]	.09 [-.22, .40]
Master’s student condition → T3 students’ UV	.13 [-.03, .28]	.11 † [-.01, .23]	.12 [-.04, .27]	.06 [-.06, .19]	.10 [-.06, .26]	.06 [-.06, .17]
Teacher condition → Mediator	.00 [-.36, .37]	-.23 [-.65, .18]	.06 [-.29, .41]	.15 [-.25, .55]	.27 † [-.04, .57]	.12 [-.17, .42]
Teacher condition → T3 students’ UV	.06 [-.07, .19]	.12 † [-.01, .25]	.07 [-.06, .19]	.05 [-.07, .17]	.05 [-.09, .18]	.05 [-.07, .17]

Table S10 *(continued)*

Covariances						
T1 teachers' TE WITH...						
T1 students' UV	.03	.11 *	.03	.11 *	.03	.11 †
	[-.02, .09]	[.00, .22]	[-.02, .09]	[.00, .22]	[-.02, .09]	[.00, .22]
Master's student condition	-.02	.17 †	-.02	.17 †	-.02	.17 †
	[-.15, .12]	[-.01, .34]	[-.15, .12]	[-.01, .35]	[-.15, .12]	[-.01, .34]
Teacher condition	-.06	-.07	-.06	-.07	-.06	-.07
	[-.20, .08]	[-.23, .09]	[-.20, .08]	[-.23, .09]	[-.19, .08]	[-.23, .09]
T1 students' UV WITH...						
Master's student condition	.01	-.01	.01	-.01	.01	-.01
	[-.02, .04]	[-.07, .05]	[-.02, .04]	[-.07, .05]	[-.02, .04]	[-.07, .05]
Teacher condition	-.02	.03	-.02	.03	-.02	.03
	[-.06, .01]	[-.02, .08]	[-.06, .01]	[-.02, .08]	[-.06, .01]	[-.02, .08]
Master's student condition WITH...						
Teacher condition	-.10 ***	-.14 ***	-.10 ***	-.14 ***	-.10 ***	-.14 ***
	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]
Indirect, total indirect, and total effects						
Cross-level indirect effect (a_2b_1)	.03 **	-.14 ***	.03 *	-.14 ***	.06 **	-.14 ***
	[.01, .06]	[-.20, -.08]	[.00, .06]	[-.20, -.08]	[.02, .10]	[-.20, -.08]
Unique class-level indirect effect (a_2b_{cont})	-.02	.02 †	-.01	.01	-.03	.02
	[-.06, .02]	[.00, .05]	[-.04, .02]	[-.02, .04]	[-.07, .02]	[-.01, .06]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.01	.01	.02	.01	.03 †	.01
	[-.02, .05]	[-.01, .03]	[-.01, .05]	[-.01, .02]	[.00, .07]	[-.01, .02]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	-.01	.03	-.01	.02	.00	.03
	[-.07, .06]	[-.01, .07]	[-.07, .06]	[-.02, .05]	[-.07, .06]	[-.02, .08]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value; TE = teaching enthusiasm. Differences in the total indirect and total effects between new vs known were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S11

Standardized Estimates for the Six Cross-Level Mediation Models for Students' ***Utility Value*** *Predicted by Teachers'* ***Math Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (New Teacher vs. Known Teacher)*

	Enthusiasm		Examples		Relevance	
	New teacher	Known teacher	New teacher	Known teacher	New teacher	Known teacher
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients						
Individual level						
T1 students' UV → T3 students' UV	.59 *** [.55, .64]	.56 *** [.48, .64]	.59 *** [.54, .64]	.54 *** [.46, .62]	.55 *** [.49, .60]	.50 *** [.43, .57]
T1 students' UV → Mediator	.18 *** [.11, .26]	.19 *** [.10, .28]	.22 *** [.15, .29]	.26 *** [.18, .35]	.30 *** [.23, .37]	.35 *** [.28, .43]
Mediator → T3 students' UV	.14 ** [.06, .23]	.13 ** [.04, .21]	.15 *** [.08, .21]	.18 *** [.10, .26]	.25 *** [.17, .32]	.27 *** [.20, .34]
Class level						
T1 students' UV → T3 students' UV	.05 [-.18, .28]	-.01 [-.18, .18]	.04 [-.17, .26]	-.03 [-.26, .19]	.07 [-.14, .28]	-.05 [-.25, .15]
T1 students' UV → Mediator	.60 [-.13, 1.34]	.61 ** [.21, 1.02]	.64 † [-.06, 1.34]	.64 * [.15, 1.12]	.65 * [.00, 1.30]	.58 ** [.24, .93]
Mediator → T3 students' UV	-.11 [-.25, .04]	.07 [-.04, .19]	-.08 [-.20, .04]	.10 [-.04, .24]	-.16 * [-.29, -.02]	.10 [-.07, .28]
T1 teachers' ME → Mediator	.02 [-.10, .14]	.01 [-.17, .18]	.00 [-.13, .13]	.01 [-.17, .18]	.02 [-.11, .15]	-.02 [-.17, .12]
T1 teachers' ME → T3 students' UV	.07 ** [.02, .11]	.02 [-.04, .07]	.07 ** [.02, .11]	.02 [-.05, .09]	.07 ** [.02, .11]	.03 [-.04, .09]
Master's student condition → Mediator	-.38 * [-.72, -.04]	-.08 [-.51, .36]	-.08 [-.40, .25]	.12 [-.28, .52]	.03 [-.24, .30]	.15 [-.13, .44]
Master's student condition → T3 students' UV	.16 * [.02, .30]	.14 * [.02, .26]	.15 * [.02, .29]	.09 [-.03, .22]	.15 * [.01, .29]	.08 [-.04, .19]
Teacher condition → Mediator	-.07 [-.43, .30]	-.23 [-.68, .22]	-.01 [-.38, .36]	.15 [-.24, .54]	.20 [-.14, .54]	.12 [-.16, .40]
Teacher condition → T3 students' UV	.09 [-.05, .23]	.13 † [.00, .26]	.10 [-.03, .23]	.05 [-.08, .18]	.09 [-.04, .22]	.05 [-.07, .17]

Table S11 *(continued)*

Covariances						
T1 teachers' ME WITH...						
T1 students' UV	.00	.05	.00	.05	.00	.05
	[-.07, .07]	[-.08, .17]	[-.07, .07]	[-.08, .17]	[-.07, .07]	[-.08, .17]
Master's student condition	-.03	.00	-.03	.00	-.03	.00
	[-.16, .10]	[-.17, .17]	[-.16, .10]	[-.17, .17]	[-.16, .10]	[-.17, .17]
Teacher condition	-.06	-.01	-.06	-.01	-.06	-.01
	[-.19, .08]	[-.17, .15]	[-.19, .08]	[-.17, .15]	[-.19, .08]	[-.17, .15]
T1 students' UV WITH...						
Master's student condition	.01	-.01	.01	-.01	.01	-.01
	[-.02, .04]	[-.07, .05]	[-.02, .04]	[-.07, .05]	[-.02, .04]	[-.07, .05]
Teacher condition	-.02	.03	-.02	.03	-.02	.03
	[-.06, .01]	[-.02, .08]	[-.06, .01]	[-.02, .08]	[-.06, .01]	[-.02, .08]
Master's student condition WITH...						
Teacher condition	-.10 ***	-.14 ***	-.10 ***	-.14 ***	-.10 ***	-.14 ***
	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]
Indirect, total indirect, and total effects						
Cross-level indirect effect (a_2b_1)	.00	.00	.00	.00	.01	-.01
	[-.01, .02]	[-.02, .02]	[-.02, .02]	[-.03, .03]	[-.03, .04]	[-.05, .03]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	.00	.00	.00	.00
	[-.02, .01]	[-.01, .01]	[-.01, .01]	[-.02, .02]	[-.02, .02]	[-.02, .01]
Total indirect effect ($a_2b_1 + a_2b_{\text{cont}}$)	.00	.00	.00	.00	.00	-.01
	[.00, .01]	[-.03, .04]	[-.01, .01]	[-.05, .05]	[-.01, .01]	[-.06, .05]
Total effect ($c' + a_2b_1 + a_2b_{\text{cont}}$)	.07 **	.02	.07 **	.02	.07 **	.02
	[.02, .12]	[-.05, .09]	[.02, .11]	[-.05, .09]	[.02, .11]	[-.05, .09]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value; ME = math enthusiasm. Differences in the total indirect and total effects between new vs known were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S12

*Standardized Estimates for the Six Cross-Level Mediation Models for Students' **Utility Value** Predicted by Teachers' **Utility Value** for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (New Teacher vs. Known Teacher)*

	Enthusiasm		Examples		Relevance	
	New teacher	Known teacher	New teacher	Known teacher	New teacher	Known teacher
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients						
Individual level						
T1 students' UV → T3 students' UV	.59 *** [.55, .64]	.56 *** [.48, .64]	.59 *** [.54, .64]	.54 *** [.46, .62]	.55 *** [.49, .60]	.50 *** [.43, .57]
T1 students' UV → Mediator	.18 *** [.11, .26]	.19 *** [.10, .28]	.22 *** [.15, .29]	.27 *** [.18, .35]	.30 *** [.23, .37]	.35 *** [.28, .43]
Mediator → T3 students' UV	.14 ** [.06, .23]	.13 ** [.04, .21]	.15 *** [.08, .21]	.18 *** [.10, .26]	.25 *** [.17, .32]	.27 *** [.20, .34]
Class level						
T1 students' UV → T3 students' UV	.01 [-.25, .27]	-.03 [-.22, .15]	.01 [-.23, .24]	-.03 [-.26, .21]	.04 [-.19, .27]	-.05 [-.26, .17]
T1 students' UV → Mediator	.59 [-.13, 1.30]	.65 ** [.26, 1.05]	.58 [-.18, 1.34]	.54 * [.11, .97]	.54 [-.14, 1.22]	.53 ** [.18, .87]
Mediator → T3 students' UV	-.10 [-.25, .04]	.08 [-.04, .20]	-.08 [-.20, .04]	.09 [-.05, .23]	-.15 * [-.29, -.02]	.09 [-.09, .26]
T1 teachers' UV → Mediator	.02 [-.14, .18]	-.04 [-.19, .10]	.06 [-.11, .24]	.13 [-.03, .28]	.12 [-.04, .27]	.06 [-.05, .17]
T1 teachers' UV → T3 students' UV	.05 [-.03, .13]	.04 [-.01, .10]	.04 [-.04, .12]	.01 [-.05, .06]	.04 [-.04, .12]	.02 [-.04, .07]
Master's student condition → Mediator	-.38 * [-.72, -.05]	-.03 [-.57, .50]	-.06 [-.38, .27]	-.01 [-.45, .43]	.06 [-.22, .34]	.09 [-.22, .41]
Master's student condition → T3 students' UV	.15 † [-.02, .32]	.10 [-.02, .23]	.14 † [-.02, .31]	.09 [-.03, .21]	.13 [-.04, .30]	.07 [-.05, .18]
Teacher condition → Mediator	-.07 [-.46, .32]	-.20 [-.68, .28]	.01 [-.37, .39]	.05 [-.34, .43]	.23 [-.11, .58]	.08 [-.22, .37]
Teacher condition → T3 students' UV	.09 [-.03, .21]	.10 [-.03, .23]	.09 [-.03, .21]	.05 [-.08, .18]	.08 [-.04, .20]	.04 [-.08, .16]

Table S12 *(continued)*

Covariances						
T1 teachers' UV WITH...						
T1 students' UV	.06 *	.10	.06 *	.10	.06 *	.10
	[.01, .12]	[-.03, .23]	[.01, .12]	[-.03, .23]	[.01, .12]	[-.03, .23]
Master's student condition	-.02	.13	-.02	.13	-.02	.13
	[-.12, .09]	[-.06, .31]	[-.12, .09]	[-.06, .31]	[-.12, .09]	[-.06, .31]
Teacher condition	-.07	.05	-.07	.05	-.07	.05
	[-.20, .05]	[-.10, .21]	[-.20, .05]	[-.10, .21]	[-.20, .05]	[-.10, .21]
T1 students' UV WITH...						
Master's student condition	.01	-.01	.01	-.01	.01	-.01
	[-.02, .04]	[-.07, .05]	[-.02, .04]	[-.07, .05]	[-.02, .04]	[-.07, .05]
Teacher condition	-.02	.03	-.02	.03	-.02	.03
	[-.06, .01]	[-.02, .08]	[-.06, .01]	[-.02, .08]	[-.06, .01]	[-.02, .08]
Master's student condition WITH...						
Teacher condition	-.10 ***	-.14 ***	-.10 ***	-.14 ***	-.10 ***	-.14 ***
	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]	[-.14, -.05]	[-.20, -.08]
Indirect, total indirect, and total effects						
Cross-level indirect effect (a_2b_1)	.00	-.01	.01	.02	.03	.02
	[-.02, .03]	[-.02, .01]	[-.02, .04]	[-.01, .05]	[-.01, .07]	[-.02, .05]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	-.01	.01	-.02	.01
	[-.02, .02]	[-.02, .01]	[-.02, .01]	[-.01, .03]	[-.05, .02]	[-.01, .02]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.00	-.01	.00	.03 †	.01	.02
	[-.01, .01]	[-.04, .02]	[-.01, .02]	[-.01, .07]	[-.01, .03]	[-.02, .06]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.05	.03	.05	.04	.05	.04
	[-.03, .13]	[-.03, .10]	[-.03, .13]	[-.02, .10]	[-.03, .13]	[-.02, .10]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value. Differences in the total indirect and total effects between new vs known were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S13

Standardized Estimates and 95% Confidence Intervals for the Path Coefficients, Covariances, Indirect Effects, Total Indirect Effects, and Total Effects in the 12 Cross-Level Mediation Models for Students' ***Intrinsic Value*** *for Different Predictors and Mediators (for the Subsample of Classes for Which There Was* ***no Change in Teachers*** *During the Study (N_S = 1,635))*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
	Path coefficients								
Individual level									
T1 students' IV → T3 students' IV	.73***	.73***	.71***	.73***	.73***	.71***	.73***	.73***	.71***
	[.69,.77]	[.69,.76]	[.67,.74]	[.69,.77]	[.69,.76]	[.67,.74]	[.69,.77]	[.69,.76]	[.67,.74]
T1 students' IV → Mediator	.19***	.18***	.27***	.19***	.18***	.27***	.19***	.18***	.27***
	[.14,.24]	[.13,.23]	[.21,.32]	[.14,.24]	[.13,.23]	[.21,.32]	[.14,.24]	[.13,.23]	[.21,.32]
Mediator → T3 students' IV	.10***	.11***	.15***	.10***	.11***	.15***	.10***	.11***	.15***
	[.06,.13]	[.07,.15]	[.11,.19]	[.06,.13]	[.07,.15]	[.11,.19]	[.06,.13]	[.07,.15]	[.11,.19]
Class level									
T1 students' IV → T3 students' IV	-.04	-.02	.01	-.03	-.03	-.01	-.03	-.03	-.01
	[-.23,.16]	[-.22,.18]	[-.20,.21]	[-.22,.15]	[-.23,.17]	[-.20,.19]	[-.22,.15]	[-.23,.17]	[-.21,.19]
T1 students' IV → Mediator	.35†	.49*	.42**	.26	.41*	.33*	.26	.42*	.34*
	[-.01,.71]	[.11,.87]	[.10,.73]	[-.09,.61]	[.05,.77]	[.03,.63]	[-.09,.61]	[.07,.78]	[.04,.64]
Mediator → T3 students' IV	.07	.00	-.03	.07	.01	-.01	.07	.02	-.01
	[-.03,.18]	[-.10,.10]	[-.14,.08]	[-.02,.17]	[-.08,.11]	[-.12,.09]	[-.03,.17]	[-.08,.12]	[-.12,.10]
T1 teacher values → Mediator	.23***	.18***	.19***	.02	.00	-.01	.05	.15**	.13**
	[.13,.33]	[.09,.28]	[.11,.28]	[-.10,.14]	[-.11,.11]	[-.11,.09]	[-.06,.15]	[.05,.25]	[.05,.22]
T1 teacher values → T3 students' IV	.00	.02	.02	-.01	-.01	-.01	.00	-.01	-.01
	[-.05,.04]	[-.02,.05]	[-.02,.05]	[-.05,.02]	[-.04,.03]	[-.05,.03]	[-.04,.04]	[-.05,.03]	[-.05,.03]
Master's student condition → Mediator	-.26*	-.02	.07	-.23	.00	.08	-.24	-.01	.08
	[-.52,-.01]	[-.28,.25]	[-.14,.27]	[-.52,.05]	[-.27,.28]	[-.14,.31]	[-.54,.05]	[-.27,.25]	[-.14,.29]
Master's student condition → T3 students' IV	-.05	-.09	-.09	-.06	-.09	-.10†	-.05	-.09	-.09
	[-.16,.06]	[-.20,.03]	[-.21,.02]	[-.16,.05]	[-.20,.03]	[-.21,.02]	[-.16,.06]	[-.20,.03]	[-.21,.02]
Teacher condition → Mediator	.05	.23†	.34**	.00	.18	.28*	-.01	.19	.29*
	[-.23,.33]	[-.04,.50]	[.11,.56]	[-.30,.29]	[-.11,.47]	[.04,.53]	[-.30,.29]	[-.08,.46]	[.06,.53]
Teacher condition → T3 students' IV	-.05	-.06	-.08	-.06	-.07	-.09	-.05	-.07	-.09
	[-.16,.05]	[-.17,.05]	[-.19,.04]	[-.16,.05]	[-.18,.04]	[-.20,.03]	[-.16,.05]	[-.18,.04]	[-.20,.03]

Table S13 *(continued)*

				Covariances					
T1 teacher values WITH...									
T1 students' IV	-.02	-.03	-.03	-.01	-.01	-.01	.00	.00	.00
	[-.08,.04]	[-.09,.04]	[-.09,.03]	[-.06,.05]	[-.06,.05]	[-.06,.05]	[-.07,.07]	[-.07,.07]	[-.07,.07]
Master's student condition	.05	.05	.05	-.04	-.04	-.04	.02	.02	.02
	[-.06,.16]	[-.06,.16]	[-.07,.16]	[-.15,.07]	[-.15,.07]	[-.15,.07]	[-.08,.13]	[-.08,.13]	[-.08,.13]
Teacher condition	-.06	-.06	-.06	-.03	-.03	-.03	-.02	-.02	-.02
	[-.17,.05]	[-.17,.05]	[-.17,.05]	[-.13,.07]	[-.13,.07]	[-.13,.07]	[-.12,.09]	[-.12,.09]	[-.12,.09]
T1 students' IV WITH...									
Master's student condition	.01	.01	.01	.01	.01	.01	.01	.01	.01
	[-.02,.04]	[-.02,.04]	[-.02,.04]	[-.02,.04]	[-.02,.04]	[-.02,.04]	[-.02,.04]	[-.02,.04]	[-.02,.04]
Teacher condition	-.01	-.01	-.01	-.01	-.01	-.01	-.01	-.01	-.01
	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]
Master's student condition WITH...									
Teacher condition	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***
	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]
				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.02**	.02**	.03***	.00	.00	.00	.00	.02*	.02**
	[.01,.04]	[.01,.03]	[.01,.05]	[-.01,.01]	[-.01,.01]	[-.02,.01]	[-.01,.02]	[.00,.03]	[.01,.03]
Unique class-level indirect effect (a_2b_{cont})	.02	.00	-.01	.00	.00	.00	.00	.00	.00
	[-.01,.04]	[-.02,.02]	[-.03,.02]	[-.01,.01]	[.00,.00]	[.00,.00]	[-.01,.01]	[-.01,.02]	[-.02,.01]
Total indirect effect ($a_2b_1 + a_2b_{\text{cont}}$)	.04*	.02†	.02†	.00	.00	.00	.01	.02†	.02*
	[.01,.07]	[.00,.04]	[.00,.05]	[-.02,.02]	[-.01,.01]	[-.02,.01]	[-.01,.03]	[.00,.04]	[.00,.04]
Total effect ($c' + a_2b_1 + a_2b_{\text{cont}}$)	.04†	.04†	.04*	-.01	-.01	-.01	.01	.01	.01
	[.00,.07]	[.00,.07]	[.00,.08]	[-.05,.03]	[-.05,.03]	[-.05,.03]	[-.03,.05]	[-.03,.05]	[-.03,.05]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; T1 teacher values = values, i.e., teaching enthusiasm, math enthusiasm, and math utility value.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S14

*Standardized Estimates and 95% Confidence Intervals for the Path Coefficients, Covariances, Indirect Effects, Total Indirect Effects, and Total Effects in the 12 Cross-Level Mediation Models for Students' **Utility Value** for Different Predictors and Mediators (for the Subsample of Classes for Which There Was **no Change in Teachers** During the Study (N_S = 1,635))*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
	Path coefficients								
Individual level									
T1 students' UV → T3 students' IV	.57***	.56***	.52***	.57***	.56***	.52***	.57***	.56***	.52***
	[.53,.62]	[.52,.61]	[.47,.57]	[.53,.62]	[.52,.61]	[.47,.57]	[.53,.62]	[.52,.61]	[.47,.57]
T1 students' UV → Mediator	.19***	.24***	.32***	.19***	.24***	.32***	.19***	.24***	.32***
	[.13,.25]	[.18,.30]	[.27,.38]	[.13,.25]	[.18,.30]	[.27,.38]	[.13,.25]	[.18,.30]	[.27,.38]
Mediator → T3 students' UV	.14***	.16***	.26***	.14***	.16***	.26***	.14***	.16***	.26***
	[.08,.20]	[.10,.21]	[.20,.31]	[.08,.20]	[.10,.21]	[.20,.31]	[.08,.20]	[.10,.21]	[.20,.31]
Class level									
T1 students' UV → T3 students' UV	.06	.05	.07	.05	.03	.05	.01	.02	.04
	[-.09,.21]	[-.11,.21]	[-.08,.22]	[-.10,.20]	[-.12,.19]	[-.09,.20]	[-.16,.17]	[-.15,.19]	[-.12,.19]
T1 students' UV → Mediator	.41*	.52*	.45*	.56**	.63**	.57**	.57**	.50*	.46**
	[.04,.79]	[.10,.93]	[.11,.79]	[.18,.94]	[.22,1.03]	[.23,.91]	[.21,.93]	[.09,.92]	[.12,.81]
Mediator → T3 students' UV	-.01	.00	-.04	-.02	.00	-.05	-.01	-.01	-.07
	[-.11,.10]	[-.10,.10]	[-.17,.08]	[-.11,.08]	[-.10,.10]	[-.17,.06]	[-.11,.09]	[-.12,.09]	[-.19,.05]
T1 teacher values → Mediator	.20***	.14**	.16**	.00	-.02	-.02	-.01	.10†	.09†
	[.09,.31]	[.04,.24]	[.06,.25]	[-.10,.11]	[-.12,.09]	[-.12,.07]	[-.10,.09]	[-.01,.21]	[.00,.17]
T1 teacher values → T3 students' UV	-.01	-.01	-.02	.04*	.05*	.05*	.05†	.03	.03
	[-.06,.05]	[-.05,.04]	[-.06,.03]	[.01,.08]	[.01,.08]	[.01,.09]	[.00,.10]	[-.01,.08]	[-.01,.08]
Master's student condition → Mediator	-.26*	-.01	.07	-.24†	.00	.08	-.24†	.00	.08
	[-.51,-.01]	[-.26,.24]	[-.13,.27]	[-.51,.04]	[-.26,.26]	[-.12,.29]	[-.52,.05]	[-.25,.25]	[-.12,.29]
Master's student condition → T3 students' UV	.11*	.09†	.08	.13*	.11*	.10†	.12*	.09†	.08
	[.01,.22]	[-.02,.20]	[-.03,.19]	[.03,.23]	[.00,.21]	[-.01,.20]	[.01,.22]	[-.01,.20]	[-.03,.19]
Teacher condition → Mediator	.01	.18	.29*	-.04	.14	.25*	-.04	.15	.26*
	[-.26,.29]	[-.08,.44]	[.07,.52]	[-.33,.26]	[-.14,.42]	[.01,.49]	[-.33,.26]	[-.12,.42]	[.02,.50]
Teacher condition → T3 students' UV	.05	.04	.01	.07	.05	.03	.06	.05	.03
	[-.05,.15]	[-.06,.14]	[-.10,.12]	[-.03,.16]	[-.05,.15]	[-.07,.14]	[-.03,.16]	[-.05,.15]	[-.07,.13]

Table S14 *(continued)*

				Covariances					
T1 teacher values WITH...									
T1 students' UV	.06*	.06*	.06*	.03	.03	.03	.10**	.10**	.10**
	[.00,.12]	[.00,.12]	[.00,.12]	[-.04,.09]	[-.04,.09]	[-.04,.09]	[.03,.17]	[.03,.17]	[.03,.17]
Master's student condition	.05	.05	.05	-.04	-.04	-.04	.02	.02	.02
	[-.06,.17]	[-.06,.17]	[-.06,.16]	[-.15,.07]	[-.15,.07]	[-.15,.07]	[-.08,.13]	[-.08,.13]	[-.08,.13]
Teacher condition	-.06	-.06	-.06	-.03	-.03	-.03	-.02	-.02	-.02
	[-.17,.05]	[-.17,.05]	[-.17,.05]	[-.13,.07]	[-.13,.07]	[-.13,.07]	[-.12,.09]	[-.12,.09]	[-.12,.09]
T1 students' UV WITH...									
Master's student condition	.00	.00	.00	.00	.00	.00	.00	.00	.00
	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]
Teacher condition	.01	.01	.01	.01	.01	.01	.01	.01	.01
	[-.02,.03]	[-.02,.03]	[-.02,.03]	[-.02,.03]	[-.02,.03]	[-.02,.03]	[-.02,.03]	[-.02,.03]	[-.02,.03]
Master's student condition WITH...									
Teacher condition	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***	-.11***
	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]
				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.03**	.02*	.04**	.00	.00	-.01	.00	.02†	.02†
	[.01,.04]	[.00,.04]	[.01,.07]	[-.01,.02]	[-.02,.01]	[-.03,.02]	[-.01,.01]	[.00,.04]	[.00,.05]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	-.01	.00	.00	.00	.00	.00	-.01
	[-.02,.02]	[-.02,.02]	[-.03,.01]	[.00,.00]	[.00,.00]	[.00,.01]	[.00,.00]	[-.01,.01]	[-.02,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.03*	.02*	.03*	.00	.00	-.01	.00	.02	.02†
	[.00,.05]	[.00,.04]	[.01,.06]	[-.01,.01]	[-.02,.01]	[-.03,.02]	[-.01,.01]	[.00,.03]	[.00,.03]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.02	.02	.02	.04*	.04*	.04*	.05†	.05*	.05*
	[-.03,.07]	[-.03,.07]	[-.03,.07]	[.00,.08]	[.00,.08]	[.00,.08]	[.00,.09]	[.00,.10]	[.00,.10]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value; T1 teacher values = values, i.e., teaching enthusiasm, math enthusiasm, and math utility value.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S15

*Standardized Estimates and 95% Confidence Intervals for the Path Coefficients, Covariances, Indirect Effects, Total Indirect Effects, and Total Effects in the 12 Cross-Level Mediation Models for Students' **Intrinsic Value** for Different Predictors and Mediators (with **Mediators Assessed at T1** Instead of T2)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
				Path coefficients					
Individual level									
T1 students' IV → T3 students' IV	.73***	.73***	.73***	.73***	.73***	.73***	.73***	.73***	.73***
	[.69,.77]	[.69,.77]	[.69,.76]	[.69,.77]	[.69,.77]	[.69,.76]	[.69,.77]	[.69,.77]	[.69,.76]
T1 students' IV → Mediator	.27***	.20***	.29***	.27***	.20***	.29***	.27***	.20***	.29***
	[.22,.31]	[.15,.25]	[.24,.33]	[.22,.31]	[.15,.25]	[.24,.33]	[.22,.31]	[.15,.25]	[.24,.33]
Mediator → T3 students' IV	.03†	.05*	.05**	.03†	.05*	.05**	.03†	.05*	.05**
	[.00,.06]	[.01,.09]	[.01,.08]	[.00,.06]	[.01,.09]	[.01,.08]	[.00,.06]	[.01,.09]	[.01,.08]
Class level									
T1 students' IV → T3 students' IV	.00	.04	.04	-.02	.02	.02	-.02	.02	.02
	[-.19,.18]	[-.15,.23]	[-.16,.23]	[-.20,.17]	[-.17,.21]	[-.18,.21]	[-.20,.17]	[-.17,.21]	[-.18,.21]
T1 students' IV → Mediator	.59**	.42*	.40**	.52**	.38*	.35*	.53**	.38*	.36*
	[.21,.98]	[.06,.78]	[.13,.66]	[.14,.90]	[.02,.73]	[.07,.63]	[.15,.90]	[.03,.72]	[.09,.63]
Mediator → T3 students' IV	.07	.00	.02	.09	.02	.04	.09	.02	.05
	[-.04,.19]	[-.13,.12]	[-.12,.15]	[-.02,.19]	[-.10,.14]	[-.09,.18]	[-.02,.19]	[-.10,.14]	[-.09,.18]
T1 teacher values → Mediator	.23***	.14**	.15**	.02	-.05	-.04	.06	.02	.06
	[.12,.34]	[.05,.24]	[.06,.24]	[-.08,.13]	[-.14,.03]	[-.13,.04]	[-.05,.16]	[-.07,.11]	[-.02,.14]
T1 teacher values → T3 students' IV	.01	.03	.03	-.01	.00	.00	.00	.00	.00
	[-.03,.06]	[-.01,.07]	[-.01,.06]	[-.04,.03]	[-.04,.04]	[-.04,.04]	[-.04,.04]	[-.04,.04]	[-.04,.04]
Master's student condition → Mediator	-.16	-.02	-.03	-.12	-.02	-.02	-.13	-.01	-.01
	[-.40,.08]	[-.22,.17]	[-.18,.13]	[-.39,.15]	[-.24,.21]	[-.19,.16]	[-.41,.14]	[-.23,.22]	[-.18,.15]
Master's student condition → T3 students' IV	-.08	-.09	-.09	-.08	-.09	-.09	-.08	-.09	-.09
	[-.20,.04]	[-.21,.02]	[-.20,.02]	[-.19,.04]	[-.20,.03]	[-.20,.03]	[-.19,.04]	[-.21,.03]	[-.20,.03]
Teacher condition → Mediator	.04	-.05	.04	-.01	-.11	-.02	-.02	-.09	.00
	[-.21,.29]	[-.28,.17]	[-.17,.24]	[-.28,.26]	[-.32,.10]	[-.21,.18]	[-.29,.25]	[-.30,.12]	[-.20,.20]
Teacher condition → T3 students' IV	-.06	-.05	-.06	-.07	-.06	-.06	-.07	-.06	-.06
	[-.17,.05]	[-.17,.07]	[-.17,.06]	[-.18,.04]	[-.17,.05]	[-.18,.05]	[-.18,.04]	[-.17,.06]	[-.18,.05]

Table S15 *(continued)*

					Covariances				
T1 teacher values WITH...									
T1 students' IV	-.02	-.02	-.02	.01	.01	.01	-.01	-.01	-.01
	[-.07,.04]	[-.07,.04]	[-.07,.04]	[-.05,.06]	[-.05,.06]	[-.05,.06]	[-.07,.06]	[-.07,.06]	[-.07,.06]
Master's student condition	.06	.06	.06	-.02	-.02	-.02	.03	.03	.03
	[-.05,.16]	[-.05,.16]	[-.05,.16]	[-.12,.09]	[-.12,.09]	[-.12,.09]	[-.07,.12]	[-.07,.12]	[-.07,.12]
Teacher condition	-.07	-.07	-.07	-.04	-.04	-.04	-.01	-.01	-.01
	[-.17,.04]	[-.17,.04]	[-.17,.04]	[-.14,.06]	[-.14,.06]	[-.14,.06]	[-.11,.09]	[-.11,.09]	[-.11,.09]
T1 students' IV WITH...									
Master's student condition	.01	.01	.01	.01	.01	.01	.01	.01	.01
	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]	[-.01,.04]
Teacher condition	-.02	-.02	-.02	-.02	-.02	-.02	-.02	-.02	-.02
	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]	[-.04,.01]
Master's student condition WITH...									
Teacher condition	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***
	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]
					Indirect, total indirect, and total effects				
Cross-level indirect effect (a_2b_1)	.01	.01†	.01†	.00	.00	.00	.00	.00	.00
	[.00,.02]	[.00,.01]	[.00,.01]	[.00,.00]	[-.01,.00]	[-.01,.00]	[.00,.01]	[.00,.01]	[.00,.01]
Unique class-level indirect effect (a_2b_{cont})	.02	.00	.00	.00	.00	.00	.01	.00	.00
	[-.01,.05]	[-.02,.02]	[-.02,.02]	[-.01,.01]	[-.01,.01]	[-.01,.01]	[-.01,.02]	[.00,.00]	[-.01,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.02	.01	.01	.00	.00	.00	.01	.00	.01
	[-.01,.05]	[-.01,.02]	[-.01,.03]	[-.01,.01]	[-.01,.01]	[-.01,.01]	[-.01,.02]	[-.01,.01]	[-.01,.02]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.04†	.04†	.04†	.00	.00	.00	.00	.00	.00
	[.00,.07]	[.00,.07]	[.00,.08]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.05]	[-.04,.04]	[-.04,.04]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; T1 teacher values = values, i.e., teaching enthusiasm, math enthusiasm, and math utility value.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S16

Standardized Estimates and 95% Confidence Intervals for the Path Coefficients, Covariances, Indirect Effects, Total Indirect Effects, and Total Effects in the 12 Cross-Level Mediation Models for Students' ***Utility Value*** *for Different Predictors and Mediators (with* ***Mediators Assessed at T1*** *Instead of T2)*

	Teachers' teaching enthusiasm			Teachers' math enthusiasm			Teachers' math utility value		
	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance	Enthusiasm	Examples	Relevance
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
					Path coefficients				
Individual level									
T1 students' UV → T3 students' IV	.58***	.59***	.56***	.58***	.59***	.56***	.58***	.59***	.56***
	[.54,.63]	[.54,.63]	[.51,.61]	[.54,.63]	[.54,.63]	[.51,.61]	[.54,.63]	[.54,.63]	[.51,.61]
T1 students' UV → Mediator	.24***	.22***	.39***	.24***	.22***	.39***	.24***	.22***	.39***
	[.19,.30]	[.18,.27]	[.35,.44]	[.19,.30]	[.18,.27]	[.35,.44]	[.19,.30]	[.18,.27]	[.35,.44]
Mediator → T3 students' UV	.07**	.06*	.10***	.07**	.06*	.10***	.07**	.06*	.10***
	[.03,.11]	[.01,.11]	[.05,.15]	[.03,.11]	[.01,.11]	[.05,.15]	[.03,.11]	[.01,.11]	[.05,.15]
Class level									
T1 students' UV → T3 students' UV	.06	.10	.08	.05	.09	.06	.02	.06	.04
	[-.10,.21]	[-.07,.25]	[-.09,.24]	[-.10,.20]	[-.06,.24]	[-.10,.22]	[-.14,.18]	[-.10,.22]	[-.12,.21]
T1 students' UV → Mediator	.40*	.08	.36*	.54**	.19	.45**	.53**	.17	.42**
	[.08,.72]	[-.24,.40]	[.06,.65]	[.19,.88]	[-.13,.51]	[.16,.75]	[.20,.87]	[-.17,.52]	[.10,.74]
Mediator → T3 students' UV	.05	.01	.02	.04	.03	.04	.05	.01	.02
	[-.05,.15]	[-.12,.14]	[-.11,.16]	[-.06,.14]	[-.10,.16]	[-.08,.17]	[-.05,.14]	[-.11,.14]	[-.11,.15]
T1 teacher values → Mediator	.20**	.13*	.12*	.02	-.06	-.05	.01	.00	.02
	[.08,.31]	[.03,.24]	[.03,.22]	[-.08,.11]	[-.15,.03]	[-.13,.03]	[-.10,.11]	[-.10,.10]	[-.06,.10]
T1 teacher values → T3 students' UV	-.01	.01	.01	.04*	.05**	.05**	.04†	.04†	.04†
	[-.05,.04]	[-.04,.06]	[-.04,.05]	[.01,.08]	[.02,.09]	[.02,.09]	[.00,.09]	[.00,.09]	[-.01,.09]
Master's student condition → Mediator	-.14	-.02	-.01	-.10	-.01	.00	-.11	.01	.01
	[-.38,.10]	[-.22,.19]	[-.17,.14]	[-.37,.16]	[-.23,.22]	[-.16,.16]	[-.37,.16]	[-.22,.23]	[-.16,.17]
Master's student condition → T3 students' UV	.11*	.10†	.10†	.12*	.11*	.11*	.11*	.10†	.10†
	[.00,.22]	[-.01,.21]	[-.01,.21]	[.02,.23]	[.01,.22]	[.01,.22]	[.00,.22]	[-.01,.21]	[-.01,.21]
Teacher condition → Mediator	.00	-.09	.01	-.04	-.13	-.04	-.05	-.12	-.02
	[-.25,.24]	[-.30,.13]	[-.20,.21]	[-.31,.23]	[-.35,.08]	[-.23,.16]	[-.32,.22]	[-.33,.10]	[-.22,.18]
Teacher condition → T3 students' UV	.07	.08†	.08	.08†	.09*	.09†	.08†	.08†	.08†
	[-.03,.16]	[-.01,.17]	[-.02,.17]	[-.01,.17]	[.00,.18]	[.00,.18]	[-.01,.16]	[-.01,.17]	[-.01,.17]

Table S16 *(continued)*

				Covariances					
T1 teacher values WITH...									
T1 students' UV	.06*	.06*	.06*	.02	.02	.02	.08*	.08*	.08*
	[.01,.12]	[.01,.11]	[.01,.12]	[-.05,.08]	[-.05,.08]	[-.05,.08]	[.02,.15]	[.02,.15]	[.02,.15]
Master's student condition	.06	.06	.06	-.02	-.02	-.02	.03	.03	.03
	[-.05,.17]	[-.04,.17]	[-.05,.17]	[-.12,.09]	[-.12,.09]	[-.12,.09]	[-.07,.12]	[-.07,.12]	[-.07,.12]
Teacher condition	-.07	-.07	-.07	-.04	-.04	-.04	-.01	-.01	-.01
	[-.17,.04]	[-.17,.03]	[-.17,.04]	[-.14,.06]	[-.14,.06]	[-.14,.06]	[-.11,.09]	[-.11,.09]	[-.11,.09]
T1 students' UV WITH...									
Master's student condition	.00	.00	.00	.00	.00	.00	.00	.00	.00
	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]	[-.04,.03]
Teacher condition	.00	.00	.00	.00	.00	.00	.00	.00	.00
	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]	[-.03,.03]
Master's student condition WITH...									
Teacher condition	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***	-.12***
	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]	[-.15,-.08]
				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.01*	.01	.01†	.00	.00	-.01	.00	.00	.00
	[.00,.03]	[.00,.02]	[.00,.02]	[-.01,.01]	[-.01,.00]	[-.01,.00]	[-.01,.01]	[-.01,.01]	[-.01,.01]
Unique class-level indirect effect (a_2b_{cont})	.01	.00	.00	.00	.00	.00	.00	.00	.00
	[-.01,.03]	[-.02,.02]	[-.01,.02]	[.00,.01]	[-.01,.01]	[-.01,.01]	[.00,.01]	[.00,.00]	[.00,.00]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.02†	.01	.01	.00	-.01	-.01	.00	.00	.00
	[.00,.05]	[-.01,.03]	[-.01,.04]	[-.01,.01]	[-.02,.01]	[-.02,.01]	[-.01,.01]	[-.01,.01]	[-.01,.01]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.02	.02	.02	.05*	.05*	.05*	.04†	.04†	.04†
	[-.03,.07]	[-.03,.07]	[-.03,.07]	[.01,.09]	[.01,.09]	[.01,.08]	[.00,.09]	[.00,.09]	[.00,.09]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value; T1 teacher values = values, i.e., teaching enthusiasm, math enthusiasm, and math utility value.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S17

Standardized Estimates for the Six Cross-Level Mediation Models for Students' ***Intrinsic Value*** *Predicted by Teachers'* ***Teaching Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (Teacher Condition vs. Master's Student Condition vs. Control Condition)*

	Teachers' teaching enthusiasm								
	Enthusiasm			Examples			Relevance		
	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' IV → T3 students' IV	.68***	.71***	.79	.68***	.70***	.79	.66***	.69***	.77
	[.60,.76]	[.66,.76]	[-.22,.22]	[.60,.76]	[.66,.75]	[-.20,.20]	[.59,.74]	[.63,.74]	[-.19,.20]
T1 students' IV → Mediator	.27***	.19***	.10**	.19***	.18***	.17***	.27***	.28***	.25***
	[.19,.34]	[.11,.28]	[.04,.16]	[.09,.29]	[.09,.26]	[.09,.26]	[.17,.36]	[.19,.37]	[.17,.34]
Mediator → T3 students' IV	.06†	.12***	.10*	.08**	.14***	.08†	.12***	.16***	.14***
	[.00,.12]	[.06,.18]	[.02,.17]	[.02,.14]	[.09,.20]	[-.01,.18]	[.05,.18]	[.10,.22]	[.07,.21]
Class level									
T1 students' IV → T3 students' IV	.03	.34*	-.21*	-.05	.38**	-.28**	.02	.38**	-.26*
	[-.29,.35]	[.06,.62]	[-.39,-.04]	[-.35,.26]	[.11,.66]	[-.48,-.08]	[-.30,.34]	[.10,.66]	[-.47,-.05]
T1 students' IV → Mediator	.65	.70*	-.22	.91*	.39	.27	.67†	.50*	.19
	[-.13,1.42]	[.09,1.31]	[-.69,.24]	[.09,1.72]	[-.11,.89]	[-.32,.86]	[-.08,1.41]	[.02,.99]	[-.27,.65]
Mediator → T3 students' IV	.08	-.05	.19*	.11	-.11†	.02	.06	-.11	-.03
	[-.06,.22]	[-.19,.08]	[.01,.37]	[-.04,.25]	[-.23,.01]	[-.15,.19]	[-.07,.19]	[-.25,.02]	[-.28,.23]
T1 teachers' TE → Mediator	.19†	.23**	.28***	.17†	.20**	.20*	.23*	.20**	.17*
	[-.02,.41]	[.06,.40]	[.15,.41]	[-.01,.34]	[.05,.35]	[.04,.36]	[.05,.40]	[.08,.32]	[.03,.30]
T1 teachers' TE → T3 students' IV	-.03	.05	-.05	-.03	.06†	.01	-.04	.06	.01
	[-.09,.03]	[-.01,.12]	[-.12,.01]	[-.10,.03]	[-.01,.13]	[-.04,.07]	[-.10,.03]	[-.01,.13]	[-.04,.07]
Covariances									
T1 teachers' TE WITH...									
T1 students' IV	-.03	.00	-.03	-.03	.00	-.03	-.04	.00	-.03
	[-.13,.07]	[-.08,.08]	[-.14,.09]	[-.14,.07]	[-.08,.08]	[-.15,.08]	[-.14,.07]	[-.08,.08]	[-.15,.08]

Table S17 *(continued)*

				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.01	.03*	.03†	.01	.03*	.02	.03†	.03**	.02*
	[-.01,.03]	[.00,.05]	[.00,.06]	[-.01,.03]	[.00,.06]	[-.01,.04]	[.00,.06]	[.01,.05]	[.00,.04]
Unique class-level indirect effect (a_2b_{cont})	.02	-.01	.05†	.02	-.02	.00	.01	-.02	-.01
	[-.02,.05]	[-.04,.02]	[.00,.11]	[-.01,.05]	[-.06,.01]	[-.03,.04]	[-.02,.04]	[-.05,.01]	[-.05,.04]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.03	**.02**$_a$	.08*	.03	.01	.02	.04†	.01	.02
	[-.01,.07]	[-.02,.06]	[.02,.14]	[-.01,.07]	[-.02,.03]	[-.03,.07]	[.00,.09]	[-.02,.04]	[-.03,.07]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.00	.07*	.03	.00	.07†	.03	.00	.07*	.03
	[-.07,.07]	[.00,.14]	[-.04,.09]	[-.07,.06]	[.00,.13]	[-.03,.09]	[-.07,.07]	[.00,.13]	[-.03,.09]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; TE = teaching enthusiasm. Differences in the total indirect and total effects between the three conditions were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S18

Standardized Estimates for the Six Cross-Level Mediation Models for Students' ***Intrinsic Value*** *Predicted by Teachers'* ***Math Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (Teacher Condition vs. Master's Student Condition vs. Control Condition)*

	Teachers' math enthusiasm								
	Enthusiasm			Examples			Relevance		
	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' IV → T3 students' IV	.68***	.71***	.79	.68***	.70***	.79	.66***	.69***	.77
	[.60,.76]	[.66,.76]	[-.22,.22]	[.60,.76]	[.66,.75]	[-.20,.20]	[.59,.74]	[.63,.74]	[-.19,.20]
T1 students' IV → Mediator	.27***	.19***	.10**	.19***	.17***	.17***	.27***	.28***	.25***
	[.19,.34]	[.10,.28]	[.04,.16]	[.09,.29]	[.09,.26]	[.09,.26]	[.17,.36]	[.19,.37]	[.17,.34]
Mediator → T3 students' IV	.06†	.12***	.10*	.08**	.14***	.08†	.12***	.16***	.14***
	[-.01,.12]	[.06,.17]	[.02,.17]	[.02,.13]	[.09,.20]	[-.01,.18]	[.05,.18]	[.10,.22]	[.07,.21]
Class level									
T1 students' IV → T3 students' IV	.04	.31*	-.21*	-.03	.36*	-.29**	.04	.35*	-.27*
	[-.30,.37]	[.02,.60]	[-.38,-.04]	[-.36,.31]	[.08,.64]	[-.49,-.09]	[-.31,.39]	[.06,.64]	[-.47,-.06]
T1 students' IV → Mediator	.50	.68*	-.30	.78†	.37	.19	.51	.51†	.12
	[-.33,1.33]	[.08,1.28]	[-.75,.14]	[-.03,1.60]	[-.19,.94]	[-.34,.73]	[-.25,1.26]	[-.04,1.06]	[-.30,.55]
Mediator → T3 students' IV	.06	-.01	.13	.08	-.06	.03	.02	-.05	-.01
	[-.07,.20]	[-.16,.13]	[-.05,.31]	[-.06,.22]	[-.18,.07]	[-.13,.18]	[-.11,.15]	[-.19,.08]	[-.26,.23]
T1 teachers' ME → Mediator	-.06	.02	.10†	-.06	.02	.09	-.04	-.01	.07
	[-.28,.16]	[-.20,.24]	[-.01,.20]	[-.22,.11]	[-.18,.22]	[-.09,.27]	[-.23,.15]	[-.19,.17]	[-.07,.20]
T1 teachers' ME → T3 students' IV	-.03	.00	-.01	-.03	.01	.00	-.04	.01	.00
	[-.08,.02]	[-.07,.07]	[-.07,.05]	[-.08,.02]	[-.06,.08]	[-.06,.06]	[-.08,.01]	[-.06,.08]	[-.06,.06]
Covariances									
T1 teachers' ME WITH...									
T1 students' IV	-.04	.04	.01	-.04	.04	.01	-.04	.04	.01
	[-.11,.04]	[-.04,.11]	[-.14,.15]	[-.11,.04]	[-.04,.11]	[-.14,.15]	[-.11,.04]	[-.04,.11]	[-.14,.15]

Table S18 *(continued)*

				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.00	.00	.01	.00	.00	.01	-.01	.00	.01
	[-.02,.01]	[-.02,.03]	[-.01,.02]	[-.02,.01]	[-.03,.03]	[-.01,.03]	[-.03,.02]	[-.03,.03]	[-.01,.03]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	.01	.00	.00	.00	.00	.00	.00
	[-.02,.01]	[.00,.00]	[-.01,.03]	[-.02,.01]	[-.01,.01]	[-.01,.02]	[-.01,.01]	[-.01,.01]	[-.02,.02]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	-.01	.00	.02	-.01	.00	.01	-.01	.00	.01
	[-.04,.02]	[-.02,.03]	[.00,.05]	[-.04,.02]	[-.02,.02]	[-.02,.04]	[-.03,.02]	[-.02,.02]	[-.01,.03]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	-.04	.01	.01	-.04	.01	.01	-.04	.01	.01
	[-.09,.01]	[-.07,.08]	[-.05,.07]	[-.09,.01]	[-.07,.09]	[-.05,.07]	[-.09,.01]	[-.07,.08]	[-.05,.07]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; ME = math enthusiasm. Differences in the total indirect and total effects between the three conditions were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S19

*Standardized Estimates for the Six Cross-Level Mediation Models for Students' **Intrinsic Value** Predicted by Teachers' **Math Utility Value** for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (Teacher Condition vs. Master's Student Condition vs. Control Condition)*

	Teachers' math utility value								
	Enthusiasm			Examples			Relevance		
	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' IV → T3 students' IV	.68***	.71***	.79	.68***	.70***	.79	.66***	.69***	.77
	[.60,.76]	[.66,.76]	[-.22,.22]	[.60,.76]	[.66,.75]	[-.20,.20]	[.59,.74]	[.63,.74]	[-.19,.20]
T1 students' IV → Mediator	.27***	.19***	.10**	.19***	.17***	.17***	.27***	.28***	.25***
	[.19,.34]	[.10,.28]	[.04,.16]	[.09,.29]	[.09,.26]	[.09,.26]	[.17,.36]	[.19,.37]	[.17,.34]
Mediator → T3 students' IV	.06†	.12***	.10*	.08**	.14***	.08†	.12***	.16***	.14***
	[.00,.12]	[.06,.17]	[.02,.17]	[.02,.13]	[.09,.20]	[-.01,.18]	[.05,.18]	[.10,.22]	[.07,.21]
Class level									
T1 students' IV → T3 students' IV	.07	.31*	-.21*	.00	.36**	-.29**	.07	.35*	-.27*
	[-.25,.39]	[.03,.59]	[-.39,-.03]	[-.32,.32]	[.10,.63]	[-.50,-.08]	[-.27,.41]	[.07,.62]	[-.47,-.06]
T1 students' IV → Mediator	.51	.71*	-.31	.83*	.41	.16	.56	.52*	.10
	[-.36,1.37]	[.15,1.28]	[-.73,.12]	[.02,1.63]	[-.10,.91]	[-.37,.68]	[-.19,1.31]	[.06,.99]	[-.33,.53]
Mediator → T3 students' IV	.07	-.01	.13	.08	-.06	.06	.02	-.05	.02
	[-.06,.19]	[-.15,.13]	[-.04,.30]	[-.06,.22]	[-.17,.06]	[-.11,.23]	[-.10,.15]	[-.19,.10]	[-.25,.28]
T1 teachers' UV → Mediator	-.05	.21	.03	.02	.20†	.20**	.05	.22*	.13*
	[-.29,.19]	[-.06,.47]	[-.08,.14]	[-.17,.21]	[-.02,.41]	[.07,.34]	[-.14,.23]	[.04,.39]	[.02,.23]
T1 teachers' UV → T3 students' IV	.03	-.01	-.02	.01	-.01	-.04	.01	-.01	-.03
	[-.04,.10]	[-.09,.08]	[-.07,.03]	[-.05,.08]	[-.09,.07]	[-.12,.05]	[-.05,.08]	[-.10,.07]	[-.10,.05]
Covariances									
T1 teachers' UV WITH...									
T1 students' IV	-.04	-.01	.02	-.04	-.01	.02	-.04	-.01	.02
	[-.11,.03]	[-.07,.06]	[-.15,.19]	[-.11,.03]	[-.07,.06]	[-.15,.19]	[-.11,.03]	[-.07,.06]	[-.15,.19]

Table S19 *(continued)*

	Indirect, total indirect, and total effects								
Cross-level indirect effect (a_2b_1)	.00	.02	.00	.00	.03†	.02	.01	.04*	.02*
	[-.02,.01]	[-.01,.05]	[-.01,.01]	[-.01,.02]	[-.01,.06]	[.00,.04]	[-.02,.03]	[.00,.07]	[.00,.03]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	.00	.00	-.01	.01	.00	-.01	.00
	[-.02,.01]	[-.03,.03]	[-.01,.02]	[-.01,.02]	[-.03,.01]	[-.02,.05]	[-.01,.01]	[-.04,.02]	[-.03,.03]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	-.01	.02	.01	.00	.02	.03	.01	.03	.02
	[-.04,.02]	[-.02,.07]	[-.02,.03]	[-.03,.03]	[-.02,.05]	[-.01,.07]	[-.02,.03]	[-.02,.07]	[-.01,.05]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.02	.01	-.01	.02	.01	-.01	.02	.01	-.01
	[-.05,.09]	[-.08,.11]	[-.08,.05]	[-.06,.09]	[-.08,.10]	[-.07,.06]	[-.06,.09]	[-.08,.10]	[-.07,.05]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; IV = intrinsic value; UV = utility value. Differences in the total indirect and total effects between the three conditions were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S20

*Standardized Estimates for the Six Cross-Level Mediation Models for Students' **Utility Value** Predicted by Teachers' **Teaching Enthusiasm** for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (Teacher Condition vs. Master's Student Condition vs. Control Condition)*

	Teachers' teaching enthusiasm								
	Enthusiasm			Examples			Relevance		
	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' UV → T3 students' UV	.59***	.55***	.60	.58***	.54***	.59	.54***	.50***	.54
	[.51,.67]	[.48,.62]	[-.23,.21]	[.49,.66]	[.47,.61]	[-.20,.19]	[.47,.62]	[.42,.58]	[-.20,.18]
T1 students' UV → Mediator	.26***	.20***	.10**	.32***	.20***	.18**	.34***	.33***	.30***
	[.17,.35]	[.09,.31]	[.03,.17]	[.23,.41]	[.11,.30]	[.08,.29]	[.23,.44]	[.25,.40]	[.20,.40]
Mediator → T3 students' UV	.15**	.17***	.08	.15***	.16**	.15***	.26***	.24***	.25***
	[.05,.25]	[.08,.27]	[-.02,.18]	[.07,.24]	[.07,.26]	[.07,.24]	[.18,.35]	[.13,.35]	[.16,.34]
Class level									
T1 students' UV → T3 students' UV	-.06	.22*	-.05	-.12	.30***	-.06	-.10	.26***	.01
	[-.37,.24]	[.04,.41]	[-.23,.14]	[-.40,.15]	[.15,.44]	[-.29,.17]	[-.37,.16]	[.13,.40]	[-.21,.22]
T1 students' UV → Mediator	.72*	.75**	-.40	.61	.27	.78*	.52	.49†	.42†
	[.06,1.38]	[.25,1.26]	[-1.05,.26]	[-.13,1.35]	[-.26,.81]	[.04,1.52]	[-.16,1.19]	[-.01,.99]	[-.05,.90]
Mediator → T3 students' UV	-.11	.01	-.05	-.03	.09	-.10	-.11	.04	-.23†
	[-.28,.05]	[-.14,.16]	[-.30,.20]	[-.22,.15]	[-.05,.24]	[-.26,.06]	[-.31,.09]	[-.14,.21]	[-.49,.04]
T1 teachers' TE → Mediator	.16	.16*	.32***	.12	.18*	.12	.20*	.15*	.12†
	[-.06,.37]	[.00,.32]	[.18,.47]	[-.08,.32]	[.02,.33]	[-.05,.29]	[.01,.39]	[.03,.28]	[-.02,.26]
T1 teachers' TE → T3 students' UV	.06	-.07†	.05	.05	-.09*	.04	.04	-.09*	.04†
	[-.03,.15]	[-.14,.00]	[-.04,.13]	[-.04,.14]	[-.17,-.02]	[-.01,.09]	[-.06,.13]	[-.16,-.02]	[-.01,.09]
Covariances									
T1 teachers' TE WITH...									
T1 students' UV	.00	.09*	.10†	.00	.09*	.09†	.00	.09*	.09†
	[-.10,.09]	[.01,.17]	[-.01,.21]	[-.10,.09]	[.01,.17]	[-.01,.20]	[-.10,.09]	[.01,.17]	[-.01,.20]

Table S20 *(continued)*

				Indirect, total indirect, and total effects					
Cross-level indirect effect (a_2b_1)	.02	.03*	.02	.02	.03†	.02	.05†	.04*	.03†
	[-.01,.06]	[.00,.05]	[-.01,.06]	[-.01,.05]	[.00,.06]	[-.01,.05]	[.00,.11]	[.01,.07]	[.00,.06]
Unique class-level indirect effect (a_2b_{cont})	-.02	.00	-.02	.00	.02	-.01	-.02	.01	-.03
	[-.05,.02]	[-.02,.03]	[-.09,.06]	[-.03,.02]	[-.01,.05]	[-.04,.01]	[-.08,.03]	[-.02,.03]	[-.06,.01]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.01	.03†	.01	.01	.05†	.01	.03	.04*	.00
	[-.02,.03]	[-.01,.07]	[-.06,.08]	[-.01,.04]	[.00,.09]	[-.02,.03]	[-.01,.07]	[.00,.08]	[-.03,.03]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.07	**-.04**$_a$	**.05***$_a$	.07	**-.05**$_b$	**.05**$^\dagger_b$	.07	**-.05**$_c$	**.05**$^\dagger_c$
	[-.02,.16]	[-.11,.03]	[.00,.10]	[-.03,.16]	[-.12,.02]	[.00,.10]	[-.02,.16]	[-.12,.02]	[-.01,.10]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value; TE = teaching enthusiasm. Differences in the total indirect and total effects between the three conditions were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S21

Standardized Estimates for the Six Cross-Level Mediation Models for Students' ***Utility Value*** *Predicted by Teachers'* ***Math Enthusiasm*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (Teacher Condition vs. Master's Student Condition vs. Control Condition)*

	Teachers' math enthusiasm								
	Enthusiasm			Examples			Relevance		
	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' UV → T3 students' UV	.59***	.55***	.60	.58***	.54***	.59	.54***	.50***	.54
	[.51,.67]	[.48,.62]	[-.23,.21]	[.49,.66]	[.47,.61]	[-.20,.19]	[.47,.62]	[.42,.58]	[-.20,.18]
T1 students' UV → Mediator	.26***	.20***	.10**	.32***	.20***	.18**	.34***	.32***	.30***
	[.17,.35]	[.09,.31]	[.03,.17]	[.23,.41]	[.11,.30]	[.08,.29]	[.23,.44]	[.25,.40]	[.20,.40]
Mediator → T3 students' UV	.15**	.18***	.08	.16***	.16**	.15**	.26***	.24***	.25***
	[.05,.25]	[.08,.27]	[-.02,.18]	[.07,.24]	[.07,.26]	[.07,.24]	[.18,.35]	[.13,.35]	[.16,.34]
Class level									
T1 students' UV → T3 students' UV	-.07	.18	-.07	-.13	.23*	-.11	-.11	.22*	-.04
	[-.40,.27]	[-.07,.44]	[-.23,.09]	[-.42,.17]	[.04,.43]	[-.33,.11]	[-.39,.17]	[.01,.42]	[-.25,.17]
T1 students' UV → Mediator	.69†	.89**	-.13	.57	.43	.91**	.50	.63*	.54*
	[-.06,1.44]	[.39,1.40]	[-.81,.54]	[-.31,1.45]	[-.11,.97]	[.25,1.57]	[-.37,1.36]	[.14,1.13]	[.07,1.00]
Mediator → T3 students' UV	-.08	-.03	-.02	-.01	.03	-.09	-.08	-.03	-.21
	[-.27,.10]	[-.19,.13]	[-.21,.17]	[-.18,.17]	[-.14,.19]	[-.24,.07]	[-.24,.08]	[-.20,.14]	[-.48,.06]
T1 teachers' ME → Mediator	-.03	.03	.11†	-.05	.03	.00	-.02	.00	.02
	[-.22,.16]	[-.17,.22]	[.00,.21]	[-.23,.14]	[-.17,.23]	[-.13,.14]	[-.21,.17]	[-.18,.18]	[-.10,.14]
T1 teachers' ME → T3 students' UV	.01	.05	.07**	.01	.05†	.07**	.01	.06†	.07**
	[-.05,.07]	[-.02,.12]	[.02,.11]	[-.04,.07]	[-.01,.12]	[.03,.11]	[-.05,.06]	[-.01,.13]	[.03,.11]
Covariances									
T1 teachers' ME WITH...									
T1 students' UV	-.07	.02	.10†	-.07	.02	.10†	-.07	.02	.10†
	[-.15,.02]	[-.11,.15]	[-.02,.22]	[-.15,.02]	[-.11,.15]	[-.02,.22]	[-.15,.02]	[-.11,.15]	[-.02,.22]

Table S21 *(continued)*

	Indirect, total indirect, and total effects								
Cross-level indirect effect (a_2b_1)	.00	.01	.01	-.01	.00	.00	-.01	.00	.00
	[-.03,.02]	[-.03,.04]	[-.01,.02]	[-.03,.02]	[-.03,.04]	[-.02,.02]	[-.06,.04]	[-.04,.04]	[-.03,.03]
Unique class-level indirect effect (a_2b_{cont})	.00	.00	.00	.00	.00	.00	.00	.00	.00
	[-.01,.02]	[-.01,.01]	[-.02,.02]	[-.01,.01]	[-.01,.01]	[-.01,.01]	[-.01,.02]	[-.01,.01]	[-.03,.02]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	.00	.00	.01	-.01	.01	.00	.00	.00	.00
	[-.02,.01]	[-.02,.03]	[-.01,.02]	[-.04,.02]	[-.03,.04]	[-.01,.01]	[-.04,.03]	[-.04,.04]	[-.01,.01]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.01	.06	.07**	.01	.06	.07**	.00	.06	.07***
	[-.05,.07]	[-.02,.14]	[.03,.11]	[-.06,.07]	[-.02,.14]	[.03,.11]	[-.06,.06]	[-.02,.14]	[.03,.11]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value; ME = math enthusiasm. Differences in the total indirect and total effects between the three conditions were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table S22

Standardized Estimates for the Six Cross-Level Mediation Models for Students' ***Utility Value*** *Predicted by Teachers'* ***Math Utility Value*** *for the Three Mediators (Student-Perceived Teacher Enthusiasm, Use of Everyday Life Examples, and Relevance Support) Separated by Group (Teacher Condition vs. Master's Student Condition vs. Control Condition)*

	Teachers' math utility value								
	Enthusiasm			Examples			Relevance		
	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition	Teacher condition	Master's student condition	Control condition
	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]	β [CI]
Path coefficients									
Individual level									
T1 students' UV → T3 students' UV	.59*** [.51,.67]	.55*** [.48,.62]	.60 [-.23,.21]	.58*** [.49,.66]	.54*** [.47,.61]	.59 [-.20,.19]	.54*** [.47,.62]	.50*** [.42,.58]	.54 [-.20,.18]
T1 students' UV → Mediator	.26*** [.17,.35]	.20*** [.09,.31]	.10** [.03,.16]	.32*** [.23,.41]	.21*** [.11,.30]	.18** [.08,.29]	.34*** [.23,.44]	.33*** [.25,.40]	.30*** [.20,.40]
Mediator → T3 students' UV	.15** [.05,.25]	.18*** [.08,.27]	.08 [-.02,.18]	.16*** [.07,.24]	.16** [.07,.26]	.15** [.07,.24]	.26*** [.18,.35]	.24*** [.13,.35]	.25*** [.17,.34]
Class level									
T1 students' UV → T3 students' UV	-.11 [-.45,.24]	.19† [-.03,.41]	-.19† [-.40,.01]	-.15 [-.45,.15]	.25** [.08,.42]	-.21 [-.46,.05]	-.13 [-.42,.16]	.23** [.06,.40]	-.16 [-.40,.09]
T1 students' UV → Mediator	.72† [-.06,1.50]	.83*** [.39,1.27]	-.10 [-.83,.64]	.61 [-.22,1.44]	.35 [-.07,.78]	.62 [-.20,1.44]	.52 [-.30,1.33]	.55** [.15,.94]	.37 [-.11,.84]
Mediator → T3 students' UV	-.07 [-.25,.11]	-.02 [-.18,.13]	-.02 [-.21,.17]	-.01 [-.18,.17]	.04 [-.11,.19]	-.11 [-.28,.05]	-.08 [-.25,.08]	-.02 [-.18,.14]	-.24 [-.52,.05]
T1 teachers' UV → Mediator	-.08 [-.28,.12]	.14 [-.09,.37]	.04 [-.05,.13]	-.03 [-.21,.16]	.17 [-.05,.38]	.12 [-.04,.28]	.02 [-.16,.19]	.17* [.01,.34]	.08 [-.02,.18]
T1 teachers' UV → T3 students' UV	.05 [-.03,.14]	.00 [-.12,.12]	.09** [.04,.14]	.05 [-.03,.12]	-.02 [-.12,.09]	.09*** [.04,.13]	.04 [-.03,.12]	-.02 [-.13,.10]	.09*** [.05,.14]
Covariances									
T1 teachers' UV WITH...									
T1 students' UV	.01 [-.08,.10]	.05 [-.05,.15]	.20** [.07,.33]	.01 [-.08,.10]	.05 [-.05,.15]	.20** [.07,.33]	.01 [-.08,.10]	.05 [-.05,.15]	.20** [.07,.33]

Table S22 *(continued)*

	Indirect, total indirect, and total effects								
Cross-level indirect effect (a_2b_1)	-.01	.02	.00	.00	.03	.02	.00	.04[†]	.02
	[-.04,.02]	[-.02,.06]	[-.01,.01]	[-.03,.02]	[-.01,.07]	[-.01,.05]	[-.04,.05]	[-.01,.09]	[-.01,.05]
Unique class-level indirect effect (a_2b_{cont})	.01	.00	.00	.00	.01	-.01	.00	.00	-.02
	[-.01,.03]	[-.03,.02]	[-.01,.01]	[-.01,.01]	[-.02,.03]	[-.04,.02]	[-.02,.01]	[-.03,.03]	[-.05,.02]
Total indirect effect ($a_2b_1 + a_2b_{cont}$)	-.01	.02	.00	.00	.03	.01	.00	.04*	.00
	[-.02,.01]	[-.01,.05]	[.00,.01]	[-.03,.02]	[-.01,.08]	[-.02,.03]	[-.03,.03]	[.00,.07]	[-.02,.02]
Total effect ($c' + a_2b_1 + a_2b_{cont}$)	.05	.02	.09***	.04	.02	.09***	.04	.02	.10***
	[-.04,.14]	[-.11,.14]	[.04,.14]	[-.04,.13]	[-.11,.14]	[.04,.14]	[-.04,.13]	[-.10,.15]	[.05,.14]

Note. Enthusiasm = student-perceived teacher enthusiasm; Examples = student-perceived use of everyday life examples; Relevance = student-perceived relevance support; CI = 95% confidence interval; UV = utility value. Differences in the total indirect and total effects between the three conditions were tested in terms of significance; coefficients that share a subscript differ significantly by $p < .05$.

[†] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

5

STUDY 3: Gleiche Wirkung in jedem Klassenzimmer? Moderationseffekte durch motivationale Unterrichtspraktiken am Beispiel einer Nützlichkeitsintervention im Mathematikunterricht und damit einhergehende Herausforderungen

Dies ist ein Vorabdruck des folgenden Beitrages:

Parrisius, C., Gaspard, H., Flunger, B., Trautwein, U., & Nagengast, B., Gleiche Wirkung in jedem Klassenzimmer? Moderationseffekte durch motivationale Unterrichtspraktiken am Beispiel einer Nützlichkeitsintervention im Mathematikunterricht und damit einhergehende Herausforderungen [Same effect in every classroom? Treatment by moderator effects of a relevance intervention as a function of motivational teaching practices, and methodological challenges], zur Veröffentlichung angenommen in Edition ZfE – Motivation in unterrichtlichen Lehr-Lernkontexten, herausgegeben von R. Lazarides und D. Raufelder, 2020, Springer Vieweg, vervielfältigt mit Genehmigung von Springer Nature. Die final authentifizierte Version wird online verfügbar sein.

Zusammenfassung

In den vergangenen Jahren wurden zahlreiche Motivationsinterventionen entwickelt und auf ihre Wirksamkeit in der Förderung der Schülerinnen- und Schülermotivation überprüft. Dabei ist eine offene Frage, ob eine Motivationsintervention in Abhängigkeit motivationaler Unterrichtspraktiken im Regelunterricht in jeder Klasse gleichermaßen wirksam ist. Diese Frage bleibt aufgrund mangelnder Power jedoch oftmals unbeantwortet. Anhand einer exemplarischen, auf Klassenebene randomisierten kontrollierten Interventionsstudie mit 82 neunten Klassen (n = 1916) wurde daher untersucht, (1) welche kleinstmöglichen Moderationseffekte unter gegebenen Parametern mit wünschenswerter Power aufgedeckt werden können und (2) wie viele Klassen für vergleichbare Studien zur Untersuchung von Moderationsfragestellungen mit adäquater Power rekrutiert werden müssten. Zudem wurde untersucht, (3) ob die Effekte der Intervention auf die Wertüberzeugungen und Leistung in Mathematik durch motivationale Unterrichtspraktiken im Regelunterricht moderiert wurden. Die Poweranalysen wiesen auf die Einschränkungen der Studie zur Untersuchung solcher Moderationseffekte hin. Es zeigten sich vereinzelte signifikante Moderationseffekte durch motivationale Unterrichtspraktiken. Diese Ergebnisse und deren Bedeutung für die Planung vergleichbarer Interventionsstudien zur Untersuchung von Moderationseffekten auf Klassenebene werden hinsichtlich der Power und der benötigten Klassenanzahl diskutiert.

Schlüsselwörter: Cluster-Randomized Trial · Intervention · Moderationseffekte · Motivation · Power

Abstract

Numerous motivation interventions have been developed and tested for their impact on students' motivation. However, it is an open question whether motivation interventions are equally effective in every classroom as a function of motivational teaching practices during regular instruction. This question often remains unanswered due to insufficient power. Based on data from an exemplary cluster-randomized controlled trial with 82 ninth-grade classes (*n* = 1916), we examined (1) the minimal detectable moderation effect size under given sample parameters with adequate power and (2) which sample size would be necessary for examining moderation effects with adequate power in comparable studies. Additionally, (3) we investigated whether intervention effects on students' math value beliefs and performance were moderated by motivational teaching practices. The power analyses pointed to the limitations of the study to investigate such moderation effects. There were few significant moderation effects through motivational practices during regular instruction. We discuss these results and their significance for designing a comparable cluster-randomized controlled trial in terms of power and the minimum number of classes required.

Keywords: cluster-randomized trial · intervention · moderation effects · motivation · power

Einleitung

Die schulische Motivation von Schülerinnen und Schülern ist ein zentraler Prädiktor für erfolgreiche Lernprozesse (Linnenbrink und Pintrich, 2002). Besorgniserregend ist jedoch, dass die Motivation von Schülerinnen und Schülern im Laufe der Sekundarstufe im Mittel immer weiter absinkt (für einen Überblick siehe Scherrer und Preckel, 2019), insbesondere im Fach Mathematik (z.B. Watt, 2004). In der Vergangenheit konnten erfolgreich verschiedene Interventionen als Ansätze zur Förderung der Motivation im Schulkontext getestet werden, in denen Schülerinnen und Schülern beispielsweise Verknüpfungen des Unterrichtsinhalts mit ihrem eigenen Leben aufgezeigt wurden (Nützlichkeitsinterventionen, bspw. Hulleman und Harackiewicz, 2009; für einen Überblick siehe Lazowski und Hulleman, 2016). Fraglich und für die Praxis relevant ist jedoch, ob solche Interventionen in jedem Kontext gleichermaßen wirksam sind. So ist es beispielsweise denkbar, dass Schülerinnen und Schüler empfänglicher für eine Intervention sind, wenn der in der Intervention vermittelte Inhalt durch einen motivationsförderlichen Unterricht verstärkt wird (bspw. durch eine Lehrkraft, die häufig Verknüpfungen zur Lebenswelt der Schülerinnen und Schüler herstellt; siehe auch Walton und Yeager, in Druck). Ebenso ist es denkbar, dass Motivationsinterventionen nur dann wirksam sind, wenn Schülerinnen und Schüler im Regelunterricht eine wenig motivationsförderliche Gestaltung durch die Lehrkraft erfahren und somit ein besonders hoher Bedarf an Motivationsförderung besteht (Rosenzweig und Wigfield, 2016).

Zum Einfluss solcher Kontextmerkmale wie der motivationalen Gestaltung des Regelunterrichts auf die Wirksamkeit einer Motivationsintervention liegen jedoch bislang kaum Forschungsergebnisse vor. Wie wir am Beispiel einer Studie zur Überprüfung einer Nützlichkeitsintervention (MoMa; Gaspard et al., 2015a; Brisson et al., 2017) beleuchten, liegt dies unter anderem an den methodischen Herausforderungen, die mit der Untersuchung von Moderationseffekten durch solche Kontextmerkmale einhergehen (siehe auch Spybrook et al., 2016). Trotz ihrer hohen methodischen Qualität (u.a. a priori Power-Analyse zur Untersuchung von Haupteffekten) stößt auch diese exemplarische, auf Klassenebene randomisierte kontrollierte Feldstudie (*cluster-randomized trial*; CRT) an die Grenzen ihrer Aussagefähigkeit in Bezug auf Moderationseffekte. Beispielhaft für vergleichbare CRTs, in denen also ganze Klassen anstelle von einzelnen Schülerinnen oder Schülern einer der Bedingungen zufällig zugeordnet werden, ermittelten wir mittels post-hoc durchgeführter Poweranalysen, ab welcher Effektstärke Moderationseffekte mit den vorliegenden Stichprobenparametern aufgedeckt werden können und welche Stichprobengröße notwendig gewesen wäre, um tatsächlich zu erwartende

Effektgrößen als signifikant anzuzeigen. Potenzielle Moderationseffekte wurden anschließend mittels Mehrebenenanalysen untersucht. Dabei wurden differenzielle Effekte der MoMa-Intervention auf die Wertüberzeugungen sowie Leistung von Schülerinnen und Schülern der neunten Jahrgangsstufe in Abhängigkeit verschiedener motivationaler Unterrichtspraktiken (Alltagsbezug, Lernunterstützung sowie und enthusiastisches Verhalten) in den Blick genommen.

Schulische Motivation von Schülerinnen und Schülern

Die schulische Motivation von Schülerinnen und Schülern umfasst ihre Überzeugungen sowie Werte und Ziele, die zur Wahl einer Aktivität und der Ausdauer in der Verfolgung der Aktivität beitragen (Wentzel und Wigfield, 2009). Genauer sagen laut der Erwartungs-Wert Theorie von Eccles und Kollegen (1983) die Erfolgserwartung („Kann ich es?") und Wertüberzeugungen („Was bringt es mir?") das Lernverhalten, die Leistung sowie akademische Entscheidungen von Schülerinnen und Schülern vorher. Die Wertüberzeugungen bezüglich eines Fachs lassen sich in die wahrgenommene Nützlichkeit, den intrinsischen Wert, die Wichtigkeit und die wahrgenommenen Kosten unterteilen (Eccles, 2005). Die Nützlichkeit gilt dabei im Vergleich zu den restlichen Wertüberzeugungen als am leichtesten von außen beeinflussbar, da sie im Vergleich zu anderen Wertkomponenten weniger in individuellen Interessen bzw. der eigenen Identität verankert ist (Harackiewicz et al., 2014). Für die Herausbildung der Wertüberzeugungen von Schülerinnen und Schülern spielt unter anderem das Verhalten der Lehrkraft eine entscheidende Rolle (Eccles, 2007). Entsprechend stehen motivationale Unterrichtspraktiken der Lehrkraft in positivem Zusammenhang mit den Wertüberzeugungen ihrer Schülerinnen und Schüler. Wertüberzeugungen können beispielweise durch Lehrkräfte gefördert werden, indem diese die Relevanz der Inhalte hervorheben (z.B. Rakoczy et al., 2008; Schreier et al., 2014; Schmidt et al., 2019). Auch ein lernunterstützendes Verhalten von Lehrkräften steht in positivem Zusammenhang mit Wertüberzeugungen von Schülerinnen und Schülern (z.B. Wentzel et al., 2010; Dietrich et al., 2015; Lazarides et al., 2019). Je enthusiastischer eine Lehrkraft zudem im Unterricht wahrgenommen wird, desto mehr empfinden Schülerinnen und Schüler selbst Freude im Unterricht (z.B. Lazarides et al., 2019; siehe auch Keller et al., 2016, für einen Überblick) und berichten zudem positivere Wichtigkeits- und Nützlichkeitswahrnehmungen sowie geringere subjektive Kosten (z.B. Lazarides et al., 2018).

Motivationsinterventionen

Neben dem Unterrichtskontext als Einflussfaktor für die Motivation von Schülerinnen und Schülern sind in den letzten Jahren zahlreiche Motivationsinterventionen als gezielte, in der Regel einmalige und häufig von außen implementierte Maßnahmen zur Förderung der Motivation und der Leistung entwickelt worden (Lazowski und Hulleman, 2016). Beispielsweise zeigten Interventionen, die die Schülerinnen und Schüler zu Verknüpfungen zwischen dem Unterrichtsinhalt und ihrem Leben anregten, positive Effekte auf ihr Interesse und ihre Leistung (Hulleman und Harackiewicz, 2009; für einen Überblick siehe auch Harackiewicz et al., 2014). Solche Nützlichkeitsinterventionen sind dabei oftmals nicht (nur) im Mittel wirksam in der Förderung verschiedener Motivationskomponenten und der Leistung (bspw. Gaspard et al., 2015a; Brisson et al., 2017), sondern erweisen sich insbesondere als wirksam für bestimmte Risikogruppen (bspw. für Schülerinnen und Schüler mit geringen Erfolgserwartungen, Hulleman und Harackiewicz, 2009; oder für Mädchen in Mathematik und Naturwissenschaften, Gaspard et al., 2015a).

Auch die MoMa-Intervention, eine Intervention zur Motivationsförderung im Mathematikunterricht, zielt auf die Förderung der Wertüberzeugungen von Schülerinnen und Schülern der neunten Jahrgangsstufe ab, indem ihnen die Relevanz der Mathematik für verschiedene Bereiche des jetzigen und späteren Lebens mittels einer 90-minütigen Unterrichtseinheit aufgezeigt wird. Die MoMa-Intervention war nicht nur im Mittel wirksam in der Förderung des intrinsischen Werts, Wichtigkeit, Ergebnissen im Leistungstest, Anstrengungsbereitschaft und Erfolgserwartungen (Gaspard et al., 2015a; Brisson et al., 2017), sondern es profitierten Mädchen stärker als Jungen (Gaspard et al., 2015a) sowie diejenigen Schülerinnen und Schüler, deren Eltern ein geringes Mathematikinteresse berichteten (Häfner et al., 2017).

Kontextspezifische differenzielle Effekte von Motivationsinterventionen

Differenzielle Effekte von Motivationsinterventionen wurden in der Vergangenheit vermehrt bezüglich individueller Merkmale von Schülerinnen und Schülern untersucht, die typischerweise mit einer geringeren Motivation in Zusammenhang stehen (bspw. geringeres Vorwissen, geringere Erfolgserwartungen oder geringere motivationale Ressourcen; für einen Überblick siehe bspw. Rosenzweig und Wigfield, 2016). Es ist jedoch ebenso vorstellbar, dass eine unterschiedliche Wirksamkeit einer Intervention für ganze Klassen vorliegt. Schülerinnen und Schüler erleben unterschiedlich motivationale Lernumgebungen in ihrem Schulalltag. Diese Unterschiedlichkeit in den motivationalen Unterrichtspraktiken im Regelunterricht kann nicht nur in direktem Zusammenhang mit der Motivation (z.B. Dietrich et al., 2015; Lazarides et al., 2019; Schmidt et al., 2019) und dem Engagement (z.B. Reeve et al., 2004; Wentzel, 2009; Frenzel et al., 2010; Zhang, 2013) der Schülerinnen und Schüler stehen, sondern gleichermaßen den Erfolg einer Nützlichkeitsintervention befördern (*Potenzialperspektive*) oder beeinträchtigen (*defizitäre Perspektive*). Walton und Yeager (in Druck) argumentieren, dass eine Intervention nur dann wirksam sein kann, wenn sie auf einen unterstützenden Kontext trifft, da nur ein kongruenter Kontext die Akzeptanz, Übernahme und Fortdauer der Interventionsbotschaft durch die Schülerinnen und Schüler ermögliche. Ebenso ist denkbar, dass eine Intervention nur in einem wenig motivationsförderlichen Kontext ihre gesamte Wirkkraft entfalten kann, da ein höherer Bedarf einer solchen Intervention vorliegt (Rosenzweig und Wigfield, 2016).

Einige Studien weisen bereits darauf hin, dass sowohl formale als auch informale Kontextressourcen den Erfolg von Interventionen beeinflussen können (bspw. in Abhängigkeit der Leistungen und Einstellungen der Mitschülerinnen und -schüler; Yeager et al., 2019; Walton und Brady, 2020). Darüber hinaus ist jedoch die Frage weitestgehend unbeantwortet, ob der Erfolg einer Nützlichkeitsintervention vom motivationalen Unterrichtskontext, in dem eine Intervention implementiert wird und der eigenständig bereits ähnliche Effekte wie die Intervention aufweist, abhängt. Für die Weiterentwicklung und potenzielle flächendeckende Implementation von Motivationsinterventionen ist es wichtig, solche Kontextmerkmale und ihre Auswirkungen auf eine erfolgreiche Implementation zu untersuchen (Yeager et al., 2019). Allerdings ist dies bei weitem keine gängige Praxis – vielmehr findet sich unseres Wissens nach keine Untersuchung, die motivationale Unterrichtspraktiken der Lehrkraft als Moderatoren berücksichtigt.

Methodische Herausforderungen bei der Aufdeckung von Moderationseffekten

Dass Moderationseffekte in Abhängigkeit von Kontextmerkmalen so selten in den Blick genommen werden, lässt sich unter anderem auf methodische Herausforderungen bei der Untersuchung von Moderationseffekten zurückführen. Bei der Aufdeckung von tatsächlich vorhandenen oder „wahren" Effekten der Intervention in einem CRT spielt insbesondere die Teststärke (oder auch gängiger der englische Begriff *Power*) einer Studie eine entscheidende Rolle (Snijders, 2005). Ist die Power zur Aufdeckung von Moderationseffekten zu gering, werden wahre Moderationseffekte mit erhöhter Wahrscheinlichkeit als nicht signifikant angezeigt und folglich übersehen (β-Fehler). Zugleich überschätzen statistisch signifikante Moderationseffekte in der Stichprobe den wahren Moderationseffekt deutlich (Gelman und Carlin, 2014).

Um eine adäquate Power (bspw. 0,80; siehe z.B. Muthén und Muthén, 2002) zur Aufdeckung von Interventionseffekten zu erreichen, ist insbesondere die Rekrutierung einer angemessenen Anzahl an Klassen entscheidend (Raudenbush und Liu, 2000). Bei identischer Stichprobengröße und unter der Annahme vergleichbar hoher Regressionskoeffizienten für Haupt- und Moderationseffekte ist die Power zur Aufdeckung eines Moderationseffekts jedoch um ein Vielfaches kleiner als jene zur Aufdeckung eines Haupteffekts (Spybrook et al., 2016). Um dieselbe Power zur Untersuchung von Moderationseffekten zu erreichen, ist teilweise eine vielfach größere Stichprobe nötig.

CRTs werden neben der Untersuchung von Haupteffekten einer Intervention oftmals auch für die Untersuchung von Moderationseffekten genutzt – auch wenn dies regelmäßig nicht vorab geplant und die Studie entsprechend angelegt wurde. Folglich ist zum einen interessant, wie informativ Moderationsanalysen mit gegebenen Datenkonstellationen überhaupt sein können (d.h. welche Effektgrößen aufgedeckt werden könnten). Zeitgleich ist es aber auch wichtig zu wissen, in welcher Größenordnung zukünftige CRTs angelegt sein müssten, um eine adäquate Power zur Untersuchung von Moderationseffekten zu erzielen. Mittels der Untersuchung eines exemplarischen CRTs (MoMa) liefert dieser Beitrag daher Einblicke in die kleinstmögliche Effektgröße, die mit einer vergleichbaren Interventionsstudie mit adäquater Power aufgedeckt werden kann, und in die Anzahl der Klassen, die zur Beantwortung von zukünftigen Moderationsfragestellungen unter ähnlichen Bedingungen rekrutiert werden müsste.

Ziele der vorliegenden Studie

Nützlichkeitsinterventionen können die Leistung und die Motivation von Schülerinnen und Schülern fördern (Lazowski und Hulleman, 2016). Unklar ist bislang jedoch weitestgehend, inwiefern der Unterrichtskontext (bspw. motivationale Unterrichtspraktiken im Regelunterricht) die Wirksamkeit einer Nützlichkeitsintervention beeinflussen kann. Mittels einer beispielhaften Nützlichkeitsinterventionsstudie (der MoMa-Studie) wollen wir daher der Frage nachgehen, inwiefern die alltagsbezogene, lernunterstützende und enthusiastische Gestaltung des Regelunterrichts durch die Lehrkraft den Erfolg der MoMa-Intervention beeinflusst. Die MoMa-Studie wird hierbei stellvertretend als Beispiel einer auf Klassenebene randomisierten kontrollierten Feldstudie untersucht. Sie wurde auf Grundlage einer vorab für die Haupteffekte durchgeführten Poweranalyse geplant (mit einer Power von 0,73, um Haupteffekte von 0,20 aufzudecken; Gaspard et al., 2015a). Nichtsdestotrotz stößt auch die MoMa-Studie in Bezug auf Moderationseffekte an die Grenzen ihrer statistischen Aussagekraft.

In diesem Artikel möchten wir daher die folgenden Fragen beantworten: (1) Welches sind die kleinstmöglichen Moderationseffekte, die mit einer auf Klassenebene randomisierten kontrollierten Feldstudie (wie bspw. der MoMa-Studie) aufgedeckt werden können? (2) Welche Stichprobengröße wäre für Studien zur Aufdeckung typischerweise erwartbarer Moderationseffekte mit akzeptabler Power notwendig? (3) Finden sich differenzielle Effekte der MoMa-Intervention auf die Wertüberzeugungen und Leistung in Abhängigkeit verschiedener motivationaler Unterrichtspraktiken (Alltagsbezug, Lernunterstützung und enthusiastisches Verhalten)?

Methode

Eine Zustimmung zur Durchführung dieser Studie wurde vorab durch die Ethikkommission der Wirtschafts- und Sozialwissenschaftlichen Fakultät der Universität Tübingen erteilt.

Stichprobe und Prozedere

Zur Untersuchung der Forschungsfragen wurden Reanalysen der MoMa-Studie aus dem Schuljahr 2012/13 (Gaspard et al., 2015a; Brisson et al., 2017) durchgeführt. An dieser Studie nahmen 1978 Schülerinnen und Schüler der neunten Jahrgangsstufe aus 82 Klassen von 25 baden-württembergischen Gymnasien nach aktivem Elterneinverständnis teil. Da 62 Schülerinnen und Schüler am Tag der Intervention abwesend waren, wurden sie konsistent zu vorherigen Untersuchungen (Gaspard et al., 2015a; Brisson et al., 2017) ausgeschlossen. Die Analysen basieren folglich auf einer Stichprobe von 1916 Schülerinnen und Schülern (53,5% weiblich; Alter zu Beginn der Studie $M = 14.7$ Jahre, $SD = 0.6$ Jahre). Die Mathematiklehrkräfte und ihre Klassen wurden randomisiert der *Textbedingung* (30 Klassen), der *Zitatebedingung* (25 Klassen) oder der Wartekontrollbedingung (27 Klassen) zugewiesen.

Die 90-minütige Intervention wurde durch fünf Doktorandinnen implementiert. Die Schülerinnen und Schüler wurden zu Beginn des Schuljahres (Oktober 2012; Prätest), durchschnittlich 6 Wochen (Posttest), als auch durchschnittlich 5 Monate nach der Intervention (Follow-Up) zu ihren Wertüberzeugungen sowie zum Prätest zu ihrer Wahrnehmung motivationaler Unterrichtspraktiken im Regelunterricht befragt und absolvierten zum Follow-Up einen normierten Leistungstest.

Nützlichkeitsintervention

Die MoMa-Intervention war in den Mathematikunterricht eingebettet und sollte den Nutzen der Mathematik aufzeigen (Gaspard et al., 2015a; Brisson et al., 2017). Zunächst verfolgten die Schülerinnen und Schüler eine zweiteilige psychoedukative Präsentation. Im ersten Teil wurden ihnen Forschungsergebnisse zur Bedeutung von Anstrengungsbereitschaft und Selbstkonzept für die Leistung in Mathematik sowie zu den Effekten unterschiedlicher Vergleichsprozesse im Klassenzimmer vorgestellt. Der zweite Teil enthielt Beispiele zur Relevanz der Mathematik für verschiedene Studiengänge und Ausbildungen, Berufsmöglichkeiten sowie Freizeitaktivitäten. Die Präsentation unterschied sich nicht zwischen den beiden Interventionsbedingungen.

In der zweiten Hälfte der 90-minütigen Intervention bearbeiteten die Schülerinnen und Schüler eigenständig einen Arbeitsauftrag, der sich je nach Bedingung unterschied. In der Textbedingung erhielten die Schülerinnen und Schüler die Aufgabe, Argumente für den persönlichen Nutzen von Mathematik zu sammeln und schriftlich zu erläutern. Schülerinnen und Schüler der Zitatebedingung erhielten sechs verschriftlichte Interviewzitate junger Erwachsener über den Nutzen von Mathematik, die sie in Bezug auf ihre persönliche Relevanz bewerten sollten. Schülerinnen und Schüler der Wartekontrollbedingung erhielten nach Abschluss der Datenerhebungen die erfolgreichere der beiden Interventionen (d.h. das Bewerten von Zitaten; für mehr Informationen siehe Gaspard et al., 2015a; Brisson et al., 2017).

Instrumente

Die Wertüberzeugungen und motivationalen Unterrichtspraktiken wurden anhand einer vierstufigen Ratingskala (von 1 „*stimmt gar nicht*" bis 4 „*stimmt genau*") eingeschätzt. Beispielitems, Reliabilitäten sowie Korrelationen zwischen den Skalen finden sich in Tab. 1 und 2.

Wertüberzeugungen

Die Wertüberzeugungen der Schülerinnen und Schüler wurden basierend auf der EWT (Eccles et al., 1983) in Bezug auf die Dimensionen *Nützlichkeit* (12 Items), *intrinsischer Wert* (4 Items), *Wichtigkeit* (10 Items) und *Kosten* (11 Items) zu allen drei Testzeitpunkten erfasst. Konfirmatorische Faktorenanalysen bestätigten die Trennbarkeit dieser Dimensionen (Gaspard et al., 2015b).

Mathematik-Leistung

Als Prätest-Messung für die Leistung der Schülerinnen und Schüler dienten die Ergebnisse der landesweiten Lernstandserhebungen in Baden-Württemberg zu Beginn von Klassenstufe 9. Sie umfassten 38 Aufgaben zu den Themenbereichen Algebra, Geometrie sowie Wahrscheinlichkeitsrechnung, wobei die Leistung in Prozent korrekt gelöster Aufgaben angegeben wurde. Zum Follow-Up wurde die Leistung der Schülerinnen und Schüler mittels eines 3-minütigen normierten Speed-Tests gemessen, der 50 Aufgaben zum Umgang mit typischen mathematischen Operationen umfasste (maximal erreichbare Punktzahl = 50; Schmidt et al., 2013).

Tabelle 1

Beispielitems und Reliabilitäten der verwendeten Skalen zu allen Messzeitpunkten

Variable	Beispielitem	α_{T1}	α_{T2}	α_{T3}
Nützlichkeit	Ich werde die Mathematik in meinem Leben noch oft benötigen.	0,84	0,86	0,87
Intrinsischer Wert	Mathematik macht mir Spaß.	0,94	0,93	0,92
Wichtigkeit	Mathematik ist mir persönlich sehr wichtig.	0,91	0,92	0,92
Kosten	Um in Mathematik gut zu sein, müsste ich viel Freizeit opfern.	0,93	0,94	0,94

Anmerkung. Eine vollständige Liste der Items kann in Gaspard et al. (2015b) eingesehen werden.

Tabelle 2

Interkorrelationen der Wertüberzeugungen über alle Messzeitpunkte

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Nützlichkeit T1	—											
(2) Nützlichkeit T2	0,69	—										
(3) Nützlichkeit T3	0,62	0,69	—									
(4) Intrins. Wert T1	0,54	0,41	0,38	—								
(5) Intrins. Wert T2	0,46	0,51	0,42	0,79	—							
(6) Intrins. Wert T3	0,42	0,42	0,51	0,74	0,79	—						
(7) Wichtigkeit T1	0,68	0,54	0,46	0,64	0,54	0,49	—					
(8) Wichtigkeit T2	0,56	0,67	0,53	0,52	0,60	0,52	0,76	—				
(9) Wichtigkeit T3	0,50	0,54	0,66	0,47	0,50	0,59	0,68	0,76	—			
(10) Kosten T1	-0,31	-0,24	-0,24	-0,68	-0,56	-0,55	-0,41	-0,34	-0,33	—		
(11) Kosten T2	-0,30	-0,26	-0,27	-0,61	-0,61	-0,58	-0,38	-0,39	-0,36	0,78	—	
(12) Kosten T3	-0,27	-0,24	-0,24	-0,56	-0,54	-0,59	-0,35	-0,34	-0,36	0,73	0,82	—

Anmerkung. Alle Korrelationen sind signifikant mit $p < 0{,}001$.

Motivationale Unterrichtspraktiken

Zur Erfassung motivationaler Unterrichtspraktiken der Lehrkraft im Regelunterricht zum Prätest berichteten die Schülerinnen und Schüler den wahrgenommenen *Alltagsbezug* (3 Items; bspw. Baumert et al., 2009) sowie die wahrgenommene *Lernunterstützung* durch die Lehrkraft (7 Items; Lazarides et al., 2019; siehe auch Baumert et al., 2009). Darüber hinaus berichteten sie ihre Wahrnehmung des *enthusiastischen Verhaltens* der Lehrkraft im Mathematikunterricht (3 Items; Baumert et al., 2009).

Statistisches Vorgehen

Poweranalysen

In einem ersten Schritt interessierte uns die (1) minimal aufdeckbare Effektgröße im Vergleich zum Haupteffekt (*minimum detectable effect size difference*, MDESD) eines CRTs wie der MoMa-Studie und die (2) minimal erforderliche Stichprobengröße (*minimum required sample size*, MRSS), um eine adäquate Power zu erreichen. Hierfür führten wir pro interessierendem Parameter (MDESD, MRSS), Outcome (Nützlichkeit, Wichtigkeit, intrinsischer Wert, Kosten, Leistung) und Messzeitpunkt (Posttest, Follow-Up) je eine Poweranalyse mit dem R-Package PowerUpR v1.0.3 (Bulus et al., 2019) durch. Da in einer Poweranalyse jeweils nur eine Interventionsbedingung im Verhältnis zur Kontrollbedingung berücksichtigt werden kann, wurden diese Analysen zusätzlich getrennt für Text- und Zitatebedingung durchgeführt. Dabei lagen den Analysen eine angenommene Power von 0,80 und für die MRSS ein zu erwartender Moderationseffekt von 0,10 (bzw. 0,15) zugrunde. Die zu erwartenden Effektgrößen lehnen sich zum einen an Werte von Spybrook und Kollegen an (2016) und wurden zum anderen an die gefundenen Haupteffekte (zwischen 0,12 und 0,30; Gaspard et al., 2015a; Brisson et al., 2017) angelehnt unter Berücksichtigung, dass Moderationseffekte typischerweise geringer als Haupteffekte ausfallen (Aguinis et al., 2005).

Die für die Bestimmung der MDESD und MRSS relevanten Strichprobenparameter – Intraklassenkorrelation (ICC) der interessierenden Outcome-Variablen, Anteil der erklärten Varianz durch den Prätestwert auf Individualebene (R_1^2) und Klassenebene (R_2^2), das Verhältnis von Schülerinnen und Schülern der Interventionsbedingung zur Wartekontrollbedingung (P), durchschnittliche Anzahl der Schülerinnen und Schüler pro Klasse (n) und Anzahl der Klassen pro Bedingung (J) – wurden post-hoc aus den Daten der MoMa-Studie ermittelt. Die ICC sowie R_1^2 und R_2^2 wurden dabei analog zum Vorgehen nach Dong und Kollegen (2016) separat pro

Outcome und Testzeitpunkt ermittelt (siehe Tab. 3). Die Substichproben bestehend aus Schülerinnen und Schülern der Textbedingung/der Zitatebedingung je inklusive der Wartekontrollbedingung wiesen ein Verhältnis von $P_{Text} = 0{,}53/P_{Zitate} = 0{,}48$ auf. Es wurde jeweils g* = 1 weitere Kovariate auf Klassenebene berücksichtigt (der Prätestwert), in einer Klasse waren durchschnittlich $n_{Text} = 24/n_{Zitate} = 23$ Schülerinnen und Schüler und die Substichproben umfassten $J_{Text} = 57/J_{Zitate} = 52$ Klassen.

Tabelle 3

Stichprobenparameter je nach Interventionsbedingung (jeweils inkl. Wartekontrollbedingung) als Grundlage für die Durchführung der Poweranalysen

	Nützlichkeit		Intrins. Wert		Wichtigkeit		Kosten		Leist.
	T2	T3	T2	T3	T2	T3	T2	T3	T3
Textbedingung									
ICC	0,08	0,09	0,08	0,07	0,05	0,07	0,05	0,06	0,03
R_1^2	0,43	0,35	0,61	0,53	0,56	0,43	0,59	0,50	0,27
R_2^2	0,76	0,83	0,77	0,76	0,63	0,58	0,73	0,65	0,34
Zitatebedingung									
ICC	0,06	0,04	0,04	0,04	0,03	0,03	0,03	0,04	0,02
R_1^2	0,50	0,40	0,63	0,54	0,58	0,51	0,60	0,55	0,24
R_2^2	0,63	0,67	0,50	0,54	0,55	0,73	0,39	0,30	0,04

Anmerkung. Nützlichk. = Nützlichkeit; Wichtigk. = Wichtigkeit; Intrins. W. = Intrinsischer Wert; T2 = Posttest; T3 = Follow-Up.
ICC = Intraklassenkorrelationskoeffizient; R_1^2 = Anteil der erklärten Varianz auf Individualebene durch Prätestwert; R_2^2 = Anteil der erklärten Varianz auf Klassenebene durch Prätestwert.

Moderationsanalysen

Zur Beantwortung der Frage nach differenziellen Effekten der MoMa-Intervention in Abhängigkeit verschiedener motivationaler Unterrichtspraktiken führten wir Mehrebenenregressionsanalysen in Mplus 7.31 (Muthén und Muthén, 1998-2015) durch. Dabei orientierten sich die Modelle an Gaspard et al. (2015a) und Brisson et al. (2017) und wurden zur Beantwortung der dritten Fragestellung um den Moderator und die Interaktionsterme ergänzt.

Konkret wurden pro abhängige Variable (d.h. Wertüberzeugungen und Leistung) und Moderator zum Posttest und zum Follow-Up separate Modelle spezifiziert. Alle Modelle enthielten auf Individual- sowie Klassenebene die korrespondierende Prätest-Variable des Outcomes sowie eine Moderatorvariable (d.h. Alltagsbezug, Lernunterstützung, enthusiastisches Verhalten) als Prädiktoren. Diese Variablen wurden auf der Individualebene am Klassenmittel zentriert (Enders und Tofighi, 2007) und auf Klassenebene manifest aggregiert (Marsh et al., 2009). Das jeweils interessierende Outcome wurde auf Klassenebene zudem auf zwei Dummy-

Variablen, die die Zugehörigkeit zur jeweiligen Interventions- im Vergleich zur Kontrollgruppe anzeigten, regrediert. Darüber hinaus wurden zwei manifeste multiplikative Terme zwischen diesen Dummy-Variablen und dem entsprechenden Moderator auf Klassenebene als weitere Prädiktoren in das Modell aufgenommen. Mittels der Benjamini-Hochberg-Prozedur wurde eine Korrektur der *p*-Werte der Interaktionsterme vorgenommen (Benjamini und Hochberg, 1995).

Umgang mit fehlenden Werten

Fehlende Werte (zwischen 5,9% und 12,0%) wurden wie in vorherigen Überprüfungen der MoMa-Intervention (Gaspard et al., 2015a; Brisson et al., 2017) durch das Full Information Maximum Likelihood-Verfahren in Mplus berücksichtigt (Graham, 2009). Um die hierfür nötige Missing at Random-Annahme plausibler zu machen, wurden verschiedene zum Prätest erhobene Hilfsvariablen verwendet, indem Korrelationen dieser Variablen mit allen unabhängigen Variablen und mit den Fehlertermen der Outcome-Variablen sowie innerhalb der Hilfsvariablen spezifiziert wurden (s.g. Saturated Correlates Modell; siehe Collins et al., 2001; Graham, 2003). Diese Hilfsvariablen umfassten zu vorherigen Untersuchungen identische Variablen, d.h. das Geschlecht sowie mehrere Leistungsmaße (die durch die Schulen berichteten Mathematik-Endjahresnoten aus Klassenstufe 8 sowie – sofern nicht im Fokus der Analyse selbst – Ergebnisse der Lernstandserhebung aus Klassenstufe 9 und das Ergebnis eines nonverbalen kognitiven Fähigkeitstests; Heller und Perleth, 2000).

Ergebnisse

Poweranalysen

Zunächst interessierten uns die (1) MDESD bei einer Power von 0,80 und die (2) MRSS zur Aufdeckung eines Moderationseffekts von 0,10 (bzw. 0,15) bei einer Power von 0,80. Hierfür wurden 54 Poweranalysen durchgeführt, deren Ergebnisse in Tab. 4 berichtet werden.

MDESD

Für eine exemplarische, auf Klassenebene randomisierte kontrollierte Feldstudie wie die MoMa-Studie fand sich für je eine Interventionsbedingung (im Vergleich zu Wartekontrollbedingung) zu beiden Testzeitpunkten eine MDESD zwischen 0,14 und 0,19 (*Mdn* = 0,16). Darunter liegende (womöglich wahre) Moderationseffekte können nicht mit ausreichend hoher Wahrscheinlichkeit als signifikant angezeigt werden.

Tabelle 4

Minimale aufdeckbare Effektgrößendifferenz (MDESD) mit 95%-Konfidenzintervall, sowie minimal erforderliche Stichprobengröße (MRSS) zur Aufdeckung von zu erwartenden Moderationseffekten (δ_{Mod} = 0,10 bzw. δ_{Mod} = 0,15) bei adäquater Power (= 0,80) je nach Interventionsbedingung

	Nützlichkeit	Intrins. Wert	Wichtigkeit	Kosten	Leistung
			MDESD		
Textbedingung					
Posttest	0,16	0,15	0,15	0,14	-
	[0,05; 0,27]	[0,04; 0,25]	[0,05; 0,26]	[0,04; 0,23]	-
Follow-Up	0,16	0,15	0,18	0,16	0,18
	[0,05; 0,27]	[0,04; 0,25]	[0,05; 0,31]	[0,05; 0,27]	[0,05; 0,30]
Zitatebedingung					
Posttest	0,17	0,16	0,15	0,16	-
	[0,05; 0,29]	[0,05; 0,27]	[0,04; 0,25]	[0,05; 0,27]	-
Follow-Up	0,16	0,16	0,14	0,18	0,19
	[0,05; 0,28]	[0,05; 0,28]	[0,04; 0,24]	[0,05; 0,31]	[0,06; 0,32]
			MRSS		
δ_{Mod} = 0,10					
Textbedingung					
Posttest	136	112	120	101	-
Follow-Up	133	117	169	135	162
Zitatebedingung					
Posttest	141	118	105	118	-
Follow-Up	127	125	97	154	169
δ_{Mod} = 0,15					
Textbedingung					
Posttest	64	54	57	49	-
Follow-Up	63	56	79	64	76
Zitatebedingung					
Posttest	66	56	51	56	-
Follow-Up	60	59	47	72	79

Anmerkung. MDESD = minimale aufdeckbare Effektgrößendifferenz; MRSS = minimal erforderlicher Stichprobenumfang auf Klassenebene; δ_{Mod} = angenommener, zu erwartender Moderationseffekt. Die für die Durchführung der Poweranalysen relevanten Stichprobenparameter wurden post-hoc aus den Daten der MoMa-Studie ermittelt mit P_{Text} = 0,53/P_{Zitate} = 0,48), g* = 1 und n_{Text} = 24/n_{Zitate} = 23.
- = nicht zutreffend, da Leistung nur zum Follow-Up erhoben wurde.

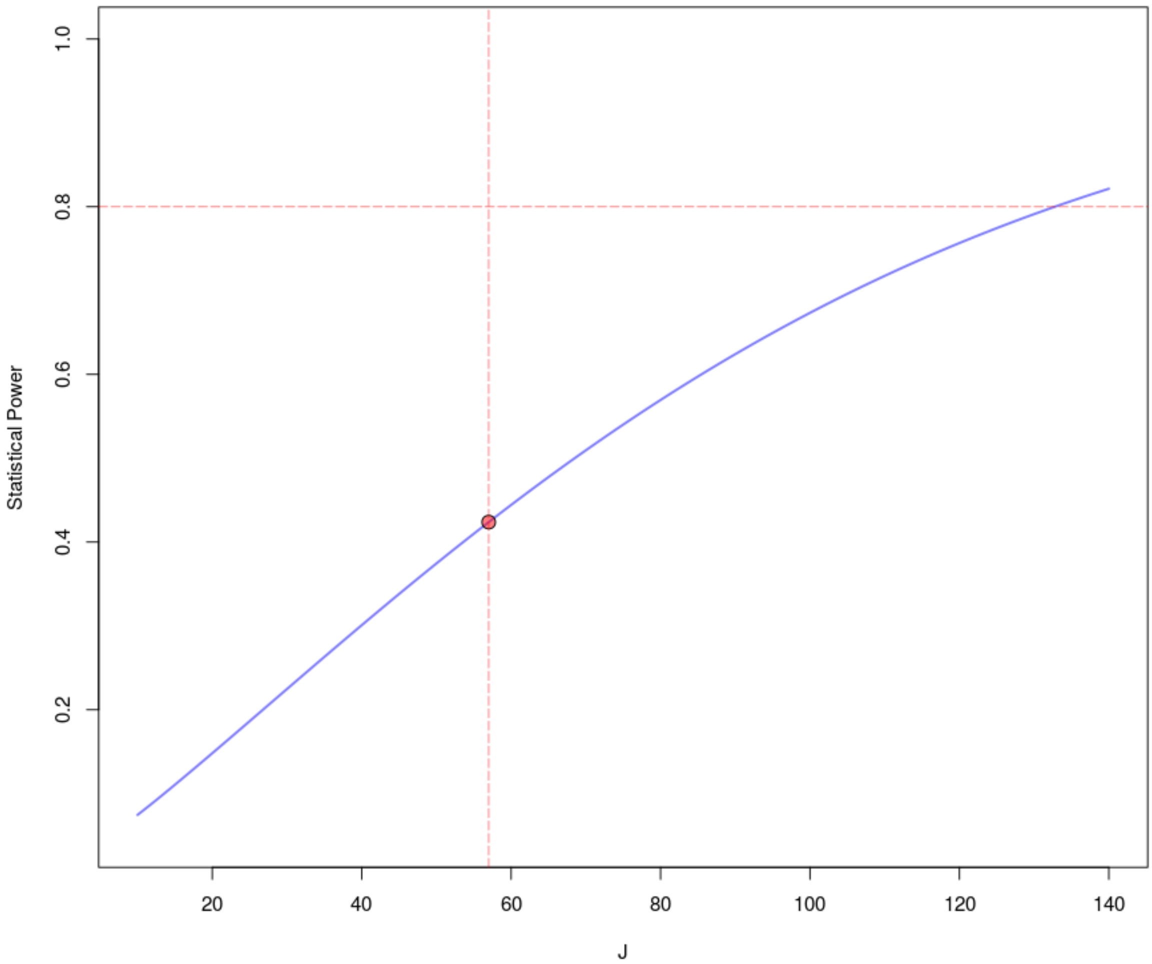
MRSS

Zur Aufdeckung eines Moderationseffekts von 0,10 müssten für je zwei Bedingungen zwischen 97 und 169 Klassen (*Mdn* = 126) rekrutiert werden, um eine adäquate Power von 0,80 zu erreichen. Für die MoMa-Studie würde dies bei gleichmäßiger Verteilung auf die drei Bedingungen eine Gesamtstichprobe von etwa 189 Klassen bedeuten. Zur Aufdeckung eines Moderationseffekts von 0,15 müsste eine Gesamtstichprobe von etwa 89 Klassen rekrutiert werden.

Exemplarisch für Moderationseffekte der Textbedingung auf die Nützlichkeitswahrnehmung der Schülerinnen und Schüler zum Follow-Up kann in Abb. 1 das Verhältnis von Anzahl der Klassen zu Power betrachtet werden.

Abbildung 1

Power-Kurve für einen Moderationseffekt von δ_{Mod} = 0,10 der Textbedingung mit einem Klassenlevel-Moderator auf die Nützlichkeitswahrnehmung der Schülerinnen und Schüler zum Follow-Up in Abhängigkeit der Klassenanzahl J



Moderationsanalysen

Die Ergebnisse der Mehrebenenregressionsanalysen finden sich in Tab. 5 bis 7. Signifikante Ergebnisse sind darüber hinaus zur leichteren Interpretierbarkeit der Richtung in Abb. 2 visualisiert.

Haupteffekte der Moderatoren

Die Haupteffekte der Moderatoren geben den durchschnittlichen Effekt auf die entsprechenden Outcomes in der Wartekontrollbedingung an. Wie die Ergebnisse zeigen, hatte der wahrgenommene Alltagsbezug im Regelunterricht einen positiven Effekt auf die Wahrnehmung der Nützlichkeit und Wichtigkeit auf Individualebene zum Posttest sowie auf die Nützlichkeit auf Individual- und Klassenebene zum Follow-Up. Darüber hinaus erzielten Klassen, die einen höheren Alltagsbezug wahrnahmen, eine signifikant niedrigere Leistung unter zeitgleicher Kontrolle der Leistung zum Prätest. Auch für die wahrgenommene Lernunterstützung fand sich ein positiver Effekt auf die Nützlichkeit und die Wichtigkeit auf Individual- und Klassenebene (Wichtigkeit nur Posttest). Darüber hinaus verringerte eine hohe wahrgenommene Lernunterstützung die subjektiven Kosten auf Individualebene zum Posttest und zum Follow-Up und hatte eine negative Auswirkung auf die Leistung auf Klassenebene. Klassen, die das Verhalten ihrer Lehrkraft als enthusiastischer wahrnahmen, berichteten zudem eine höhere Nützlichkeitswahrnehmung und zeigten geringere Leistungen im Vergleich zum Prätest.

Moderationseffekte

Zusätzlich fanden sich in den beiden Interventionsbedingungen Interaktionseffekte zwischen $-0{,}38 \leq \beta \leq 0{,}12$ auf die Wertüberzeugungen der Schülerinnen und Schüler. Von diesen insgesamt 48 Moderationskoeffizienten wurden jedoch lediglich zehn (nach Korrektur der p-Werte sogar nur noch ein Koeffizient) als statistisch signifikant angezeigt: Es fanden sich keine signifikanten Interaktionen der Interventionsbedingungen mit dem wahrgenommenen Alltagsbezug. Im Gegensatz zum Alltagsbezug fanden sich in einigen Fällen jedoch signifikante Moderationseffekte mit der Lernunterstützung. Je höher die wahrgenommene Lernunterstützung der Lehrkraft durch die Klasse war, desto geringer war der Effekte beider Interventionsbedingungen auf die Nützlichkeitswahrnehmung (zum Posttest nur in der Zitatebedingung). Zugleich war die Intervention also auch umso wirksamer bzgl. der Nützlichkeitswahrnehmung, wenn die Lehrkraft als *wenig* lernunterstützend wahrgenommen wurde (insbesondere in der Zitatebedingung). Bezüglich der subjektiven Kosten verstärkte sich der Effekt beider Bedingungen zum Follow-Up, d.h. die Schülerinnen und Schüler berichteten weniger hohe Kosten, wenn die Lernunterstützung als höher wahrgenommen wurde. Ebenso wie bei der wahrgenommenen Lernunterstützung fanden sich auch bezüglich des wahrgenommenen enthusiastischen Verhaltens signifikante Moderationseffekte auf verschiedene Wertüberzeugungen der Schülerinnen und Schüler. Für Klassen, die das Verhalten der Lehrkraft als enthusiastischer wahrnahmen, war der Effekt der Zitatebedingung zum Follow-Up auf die Nützlichkeitswahrnehmung geringer. Zugleich fand sich sowohl zum Posttest als auch zum Follow-Up ein stärkerer negativer Effekt auf die Kosten (d.h. Schülerinnen und Schüler berichteten weniger hohe subjektive Kosten; zum Posttest nur in der Textbedingung). Zudem fand sich in der Textbedingung ein stärkerer positiver Effekt auf den intrinsischen Wert zum Posttest für Klassen, die das Verhalten der Lehrkraft als enthusiastischer wahrnahmen.

Bezüglich der Leistung fanden sich ausschließlich positive Moderationseffekte der beiden Interventionsbedingungen mit den drei Moderatoren ($0,04 \leq \beta \leq 0,19$). In einem von sechs Fällen (nach Korrektur der *p*-Werte sogar in keinem) wurden diese statistisch signifikant. Für Schülerinnen und Schüler, die das Verhalten der Lehrkraft im Vergleich zum Klassenmittel als enthusiastischer wahrnahmen, fand sich ein größerer Effekt der Textbedingung auf ihre Leistungen.

Diskussion

In den letzten Jahren wurden vermehrt Interventionen entwickelt, um die Motivation von Schülerinnen und Schülern zu fördern, und auf ihre Wirksamkeit getestet (für einen Überblick siehe Lazowski und Hulleman, 2016). Dabei ist eine offene Frage, ob die Wirksamkeit einer Intervention auch durch den motivationalen Unterrichtskontext, in den die Intervention eingebettet ist, beeinflusst sein kann. In Einklang mit vorheriger Forschung fanden wir Zusammenhänge motivationaler Unterrichtspraktiken (Alltagsbezug im Mathematikunterricht, Lernunterstützung durch die Lehrkraft sowie enthusiastisches Verhalten der Lehrkraft) mit den Wertüberzeugungen der Schülerinnen und Schüler (z.B. Frenzel et al., 2010; Kunter et al., 2013; Schmidt et al., 2019). Der vorliegenden Untersuchung lag jedoch die Frage zugrunde, ob der Erfolg einer gezielten, von außen an eine Klasse herangetragenen Motivationsintervention von solchen vielversprechenden Unterrichtspraktiken zur Förderung der Schülerinnen- und Schülermotivation abhängt.

Problematisch bei der Untersuchung solcher Moderationseffekte in Abhängigkeit des Kontextes sind Anforderungen an die Stichprobengröße. Wie unsere Ergebnisse zeigten, ist die Power der MoMa-Studie – einem großen CRT mit Schülerinnen und Schülern der neunten

Jahrgangsstufe – lediglich ausreichend, Moderationseffekte auf die Wertüberzeugungen und die Leistung der Schülerinnen und Schüler ab einer Effektgröße von etwa 0,16 mit einer Teststärke von 0,80 aufzudecken. Die Wahrscheinlichkeit, einen tatsächlich vorhandenen, aber kleineren Moderationseffekt als statistisch signifikant anzuzeigen, ist folglich gering. Für mit der MoMa-Studie vergleichbare randomisierte kontrollierte Feldstudien impliziert dies, dass unter üblichen bis idealen Bedingungen (d.h. Planung der Studie bereits auf Basis einer a priori Poweranalyse zur Aufdeckung von relativ geringen Haupteffekten) lediglich verhältnismäßig große wahre Moderationseffekte mit einer akzeptablen Power aufgedeckt werden können. Oftmals fallen Moderationseffekte in der Praxis jedoch vermutlich kleiner aus, was ihre Aufdeckung unter vergleichbaren Bedingungen deutlich erschwert. Für die Planung einer auf Klassenebene randomisierten kontrollierten Feldstudie mit vergleichbaren Parametern wie die der MoMa-Studie wären zur Aufdeckung eines vermutlich realistischeren Moderationseffekts von 0,10 (bzw. 0,15, was aber wohl eher als obere Grenze für erwartbare Moderationseffekte anzunehmen ist) mindestens 189 (bzw. 89 Klassen) statt tatsächlichen 82 Klassen notwendig.

Bei der Untersuchung von Interventionseffekten der MoMa-Intervention auf die Nützlichkeit, intrinsischen Wert, Wichtigkeit, Kosten und Leistungen in Abhängigkeit des durch die Schülerinnen und Schüler wahrgenommenen Alltagsbezugs, Lernunterstützung und enthusiastischen Verhaltens der Lehrkraft fanden sich folgerichtig nur wenige, eher unsystematische Moderationseffekte, die mit Vorsicht interpretiert werden müssen. Insgesamt wurden elf der insgesamt 54 getesteten Interaktionsterme (20,37 %) und nach Korrektur der *p*-Werte nach Benjamini und Hochberg (1995) sogar nur noch ein Term (1,85 %) als statistisch signifikant angezeigt. Darunter fanden sich in Abhängigkeit der wahrgenommenen Lernunterstützung und des enthusiastischen Verhaltens geringere Interventionseffekte auf die Nützlichkeitswahrnehmung und zum Teil stärkere Effekte auf die subjektiven Kosten und Leistung. Neben den gefunden signifikanten Moderationseffekten könnten weitere wahre Effekte vorliegen, diese aufgrund ihrer Größe jedoch nicht als statistisch signifikant angezeigt werden. Zugleich ist die Höhe der als signifikant angezeigten Moderationseffekte nicht unbedingt interpretierbar, da diese bei zu geringer Power oftmals tatsächliche Effekte überschätzen (Gelman und Carlin, 2014). Die folgenden Schlussfolgerungen sind daher unter Berücksichtigung der beschriebenen Einschränkungen zu interpretieren und einzuordnen.

Tabelle 5

*Interventionseffekte in Abhängigkeit des durch die Schülerinnen und Schüler wahrgenommenen **Alltagsbezugs** zum Posttest und zum Follow-Up*

	Nützlichkeit				Intrinsischer Wert				Wichtigkeit				Kosten				Leistung			
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Posttest																				
Individualebene [a]																				
Wert zu T1	0,65	0,000		(0,02)	0,78	0,000		(0,02)	0,75	0,000		(0,02)	0,77	0,000		(0,02)				
Alltagsbezug	0,05	0,044		(0,02)	0,03	0,145		(0,02)	0,04	0,030		(0,02)	-0,02	0,202		(0,02)				
Klassenebene																				
Wert zu T1	0,73	0,000		(0,07)	0,77	0,000		(0,07)	0,72	0,000		(0,08)	0,82	0,000		(0,07)				
Alltagsbezug	0,12	0,062		(0,07)	0,07	0,323		(0,07)	0,01	0,815		(0,06)	-0,04	0,512		(0,06)				
Textbedingung [b]	0,16	0,004		(0,06)	0,01	0,912		(0,05)	0,00	0,937		(0,05)	-0,02	0,627		(0,05)				
Zitatebedingung [b]	0,30	0,000		(0,06)	0,09	0,108		(0,05)	0,12	0,029		(0,05)	-0,09	0,113		(0,06)				
Textb. × Alltagsbezug	-0,04	0,627	0,941	(0,09)	0,09	0,271	0,665	(0,08)	0,07	0,484	0,933	(0,09)	-0,04	0,534	0,901	(0,07)				
Zitateb. × Alltagsbezug	-0,04	0,678	0,915	(0,10)	-0,08	0,325	0,585	(0,08)	0,09	0,421	0,632	(0,11)	0,05	0,604	0,858	(0,09)				
	ΔR^2				ΔR^2				ΔR^2				ΔR^2				ΔR^2			
Individualebene																				
Alltagsbezug [c]	0,00				0,01				0,00				0,00							
Klassenebene																				
Alltagsbezug [c]	0,01				0,01				0,01				0,01							
Interaktionen [c]	0,00				0,01				0,00				0,00							
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Follow-Up																				
Individualebene [a]																				
Wert zu T1	0,58	0,000		(0,03)	0,72	0,000		(0,02)	0,67	0,000		(0,02)	0,72	0,000		(0,02)	0,55	0,000		(0,03)
Alltagsbezug	0,07	0,006		(0,03)	0,03	0,146		(0,02)	0,03	0,140		(0,02)	0,00	0,766		(0,02)	0,05	0,100		(0,03)

Tabelle 5 *(Fortführung)*

	Nützlichkeit				Intrinsischer Wert				Wichtigkeit				Kosten				Leistung			
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Klassenebene																				
Wert zu T1	0,73	0,000		(0,08)	0,76	0,000		(0,08)	0,75	0,000		(0,09)	0,87	0,000		(0,09)	0,33	0,000		(0,07)
Alltagsbezug	0,14	0,024		(0,06)	0,04	0,586		(0,08)	0,04	0,561		(0,07)	-0,01	0,933		(0,09)	-0,14	0,048		(0,07)
Textbedingung [b]	0,17	0,002		(0,06)	0,05	0,370		(0,05)	0,07	0,222		(0,06)	-0,01	0,809		(0,06)	0,05	0,406		(0,06)
Zitatebedingung [b]	0,26	0,000		(0,06)	0,15	0,011		(0,06)	0,14	0,007		(0,05)	-0,06	0,271		(0,06)	0,19	0,003		(0,06)
Textb. × Alltagsbezug	-0,09	0,323	0,727	(0,09)	0,02	0,788	0,887	(0,09)	0,04	0,758	0,975	(0,12)	-0,06	0,564	0,896	(0,10)	0,06	0,514	0,925	(0,09)
Zitateb. × Alltagsbezug	-0,13	0,209	0,470	(0,10)	-0,09	0,340	0,574	(0,10)	-0,01	0,944	0,980	(0,09)	0,04	0,723	0,813	(0,12)	0,04	0,714	0,876	(0,10)
	ΔR^2				ΔR^2				ΔR^2				ΔR^2				ΔR^2			
Individualebene																				
Alltagsbezug [c]	0,01				0,00				0,00				0,00				0,00			
Klassenebene																				
Alltagsbezug [c]	0,01				0,00				0,01				0,00				0,06			
Interaktionen [c]	0,01				0,01				0,00				0,00				0,00			

Anmerkung. T1 = Prätest; Par. = jeweiliger Parameter, d.h. entweder standardisierte Regressionskoeffizienten oder ΔR^2; *p* = *p*-Wert; *p* kor. = *p*-Wert korrigiert nach Benjamini-Hochberg; *SE* = Standardfehler. Als Hilfsvariablen wurden die Mathematiknote am Ende der Klassenstufe 8, das Ergebnis der Vergleichsarbeiten aus Klassenstufe 9 sowie das Geschlecht berücksichtigt. Interaktionen mit $p < 0{,}05$ wurden jeweils fett gedruckt.

[a] Skalen wurden am Klassenmittel zentriert. Effekte auf Klassenebene lassen sich daher als Kompositionseffekte verstehen.

[b] Effekte der Text- und der Zitatebedingung sind im Vergleich zur Wartekontrollbedingung zu verstehen. Beispielsweise bedeutet ein Effekt von 0,16 in der Textbedingung, dass der geschätzte Wert eines Schüler/einer Schülerin in der Textbedingung im Mittel um 0,16 *SD* höher ist als in der Wartekontrollbedingung zum gleichen Zeitpunkt.

[c] Die Ebenen-spezifischen Anteile zusätzlich erklärter Varianz durch die Hinzunahme der angegebenen Variablen (d.h. Alltagsbezug bzw. Interaktionen; $\Delta R_w^{2(f1)}$ und $\Delta R_b^{2(f2)}$) wurden nach Rights et al. (2019) bestimmt. Hierzu wurden neben den berichteten Modellen zwei weitere Modelle spezifiziert: Ein Modell, das nur den Prätestwert auf Individual- und Klassenebene sowie die zwei Interventionsbedingungen auf Klassenebene enthält; sowie ein weiteres Modell, das zusätzlich den Moderator (enthusiastisches Verhalten) auf Individual- und Klassenebene enthält.

Tabelle 6

*Interventionseffekte in Abhängigkeit der durch die Schülerinnen und Schüler wahrgenommenen **Lernunterstützung** durch die Lehrkraft zum Posttest und zum Follow-Up*

	Nützlichkeit				Intrinsischer Wert				Wichtigkeit				Kosten				Leistung			
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Posttest																				
Individualebene [a]																				
Wert zu T1	0,66	0,000		(0,02)	0,78	0,000		(0,02)	0,75	0,000		(0,02)	0,77	0,000		(0,02)				
Lernunterstützung	0,05	0,042		(0,02)	-0,01	0,474		(0,02)	0,04	0,033		(0,02)	-0,04	0,043		(0,02)				
Klassenebene																				
Wert zu T1	0,75	0,000		(0,06)	0,76	0,000		(0,07)	0,70	0,000		(0,08)	0,78	0,000		(0,07)				
Lernunterstützung	0,25	0,007		(0,09)	0,06	0,411		(0,08)	0,14	0,021		(0,06)	-0,01	0,820		(0,06)				
Textbedingung [b]	0,13	0,017		(0,05)	-0,01	0,795		(0,05)	-0,02	0,728		(0,05)	-0,02	0,714		(0,05)				
Zitatebedingung [b]	0,28	0,000		(0,06)	0,08	0,163		(0,06)	0,12	0,023		(0,05)	-0,08	0,139		(0,06)				
Textb. × Lernunterstützung	-0,14	0,198	0,668	(0,11)	0,11	0,232	0,696	(0,09)	-0,01	0,877	0,877	(0,08)	-0,08	0,241	0,651	(0,07)				
Zitateb. × Lernunterstützung	**-0,28**	**0,009**	0,081	(0,11)	-0,03	0,715	0,839	(0,09)	-0,15	0,075	0,253	(0,08)	-0,09	0,225	0,467	(0,07)				
	ΔR^2				ΔR^2				ΔR^2				ΔR^2				ΔR^2			
Individualebene																				
Lernunterstützung [c]	0,00				0,00				0,00				0,00							
Klassenebene																				
Lernunterstützung [c]	0,01				0,01				0,01				0,03							
Interaktionen [c]	0,03				0,01				0,03				0,01							
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Follow-Up																				
Individualebene [a]																				
Wert zu T1	0,58	0,000		(0,02)	0,73	0,000		(0,02)	0,66	0,000		(0,02)	0,71	0,000		(0,02)	0,55	0,000		(0,03)
Lernunterstützung	0,06	0,007		(0,02)	0,00	0,970		(0,02)	0,04	0,113		(0,02)	-0,06	0,006		(0,02)	0,02	0,412		(0,03)

Tabelle 6 *(Fortführung)*

	Nützlichkeit				Intrinsischer Wert				Wichtigkeit				Kosten				Leistung			
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Klassenebene																				
Wert zu T1	0,77	0,000		(0,07)	0,73	0,000		(0,08)	0,73	0,000		(0,08)	0,82	0,000		(0,09)	0,31	0,000		(0,07)
Lernunterstützung	0,28	0,000		(0,07)	0,06	0,288		(0,06)	0,16	0,101		(0,10)	0,12	0,149		(0,09)	-0,19	0,011		(0,07)
Textbedingung [b]	0,14	0,004		(0,05)	0,04	0,479		(0,05)	0,05	0,364		(0,06)	-0,03	0,646		(0,06)	0,08	0,183		(0,06)
Zitatebedingung [b]	0,24	0,000		(0,05)	0,14	0,021		(0,06)	0,14	0,008		(0,05)	-0,08	0,200		(0,06)	0,20	0,002		(0,06)
Textb. × Lernunterstützung	**-0,18**	**0,044**	0,238	(0,09)	0,04	0,627	0,891	(0,08)	-0,04	0,773	0,907	(0,13)	**-0,22**	**0,031**	0,419	(0,10)	0,17	0,096	0,370	(0,10)
Zitateb. × Lernunterstützung	**-0,38**	**0,000**	**0,000**	(0,09)	-0,03	0,699	0,899	(0,08)	-0,17	0,122	0,299	(0,11)	**-0,22**	**0,027**	0,182	(0,10)	0,15	0,077	0,231	(0,09)
	ΔR^2				ΔR^2				ΔR^2				ΔR^2				ΔR^2			
Individualebene																				
Lernunterstützung [c]	0,00				0,00				0,00				0,00				0,00			
Klassenebene																				
Lernunterstützung [c]	0,00				0,01				0,01				0,00				0,02			
Interaktionen [c]	0,06				0,00				0,01				0,03				0,02			

Anmerkung. T1 = Prätest; Par. = jeweiliger Parameter, d.h. entweder standardisierte Regressionskoeffizienten oder ΔR^2; *p* = *p*-Wert; *p* kor. = *p*-Wert korrigiert nach Benjamini-Hochberg; *SE* = Standardfehler. Als Hilfsvariablen wurden die Mathematiknote am Ende der Klassenstufe 8, das Ergebnis der Vergleichsarbeiten aus Klassenstufe 9 sowie das Geschlecht berücksichtigt. Interaktionen mit *p* < 0,05 wurden jeweils fett gedruckt.

[a] Skalen wurden am Klassenmittel zentriert. Effekte auf Klassenebene lassen sich daher als Kompositionseffekte verstehen.

[b] Effekte der Text- und der Zitatebedingung sind im Vergleich zur Wartekontrollbedingung zu verstehen. Beispielsweise bedeutet ein Effekt von 0,13 in der Textbedingung, dass der geschätzte Wert eines Schüler/einer Schülerin in der Textbedingung im Mittel um 0,13 *SD* höher ist als in der Wartekontrollbedingung zum gleichen Zeitpunkt.

[c] Die Ebenen-spezifischen Anteile zusätzlich erklärter Varianz durch die Hinzunahme der angegebenen Variablen (d.h. Lernunterstützung bzw. Interaktionen; $\Delta R_w^{2(f1)}$ und $\Delta R_b^{2(f2)}$) wurden nach Rights et al. (2019) bestimmt. Hierzu wurden neben den berichteten Modellen zwei weitere Modelle spezifiziert: Ein Modell, das nur den Prätestwert auf Individual- und Klassenebene sowie die zwei Interventionsbedingungen auf Klassenebene enthält; sowie ein weiteres Modell, das zusätzlich den Moderator (enthusiastisches Verhalten) auf Individual- und Klassenebene enthält.

Tabelle 7

*Interventionseffekte in Abhängigkeit des durch die Schülerinnen und Schüler wahrgenommenen **enthusiastischen Verhaltens der Lehrkraft** zum Post-test und zum Follow-Up*

	Nützlichkeit				Intrinsischer Wert				Wichtigkeit				Kosten				Leistung			
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Posttest																				
Individualebene [a]																				
Wert zu T1	0,66	0,000		(0,02)	0,78	0,000		(0,02)	0,75	0,000		(0,02)	0,77	0,000		(0,02)				
Enthusiastisches Verhalten	0,01	0,615		(0,02)	0,02	0,413		(0,02)	0,02	0,373		(0,02)	-0,02	0,179		(0,02)				
Klassenebene																				
Wert zu T1	0,72	0,000		(0,07)	0,73	0,000		(0,07)	0,67	0,000		(0,08)	0,77	0,000		(0,07)				
Enthusiastisches Verhalten	0,16	0,047		(0,08)	0,06	0,305		(0,06)	0,09	0,088		(0,06)	0,03	0,573		(0,06)				
Textbedingung [b]	0,14	0,010		(0,05)	-0,01	0,864		(0,05)	-0,01	0,823		(0,05)	-0,02	0,599		(0,04)				
Zitatebedingung [b]	0,29	0,000		(0,06)	0,08	0,122		(0,05)	0,12	0,016		(0,05)	-0,09	0,115		(0,06)				
Textb. × Enth. Verhalten	-0,03	0,768	0,943	(0,09)	**0,12**	**0,049**	0,221	(0,06)	0,07	0,368	0,764	(0,07)	**-0,13**	**0,032**	0,288	(0,06)				
Zitateb. × Enth. Verhalten	-0,16	0,089	0,240	(0,09)	-0,01	0,822	0,888	(0,07)	-0,08	0,242	0,467	(0,07)	-0,13	0,065	0,251	(0,07)				
	ΔR^2				ΔR^2				ΔR^2				ΔR^2				ΔR^2			
Individualebene																				
Enthusiastisches Verhalten [c]	0,00				0,00				0,00				0,00							
Klassenebene																				
Enthusiastisches Verhalten [c]	0,02				0,02				0,04				0,03							
Interaktionen [c]	0,02				0,02				0,01				0,02							
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Follow-Up																				
Individualebene [a]																				
Wert zu T1	0,60	0,000		(0,02)	0,73	0,000		(0,02)	0,67	0,000		(0,02)	0,72	0,000		(0,02)	0,55	0,000		(0,03)
Enthusiasmus	-0,02	0,467		(0,02)	0,01	0,633		(0,03)	0,00	0,931		(0,02)	-0,03	0,129		(0,02)	0,02	0,634		(0,03)

Tabelle 7 *(Fortführung)*

	Nützlichkeit				Intrinsischer Wert				Wichtigkeit				Kosten				Leistung			
	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)	Par.	*p*	*p* kor.	(SE)
Klassenebene																				
Wert zu T1	0,73	0,000		(0,08)	0,71	0,000		(0,08)	0,69	0,000		(0,09)	0,84	0,000		(0,09)	0,34	0,000		(0,06)
Enthusiastisches Verhalten	0,18	0,014		(0,07)	0,07	0,182		(0,06)	0,12	0,154		(0,08)	0,09	0,166		(0,06)	-0,24	0,000		(0,06)
Textbedingung [b]	0,15	0,003		(0,05)	0,04	0,436		(0,05)	0,06	0,309		(0,06)	-0,02	0,700		(0,06)	0,08	0,146		(0,06)
Zitatebedingung [b]	0,26	0,000		(0,05)	0,13	0,017		(0,06)	0,14	0,007		(0,05)	-0,07	0,235		(0,06)	0,21	0,000		(0,06)
Textb. × Enthusiasmus	-0,04	0,698	0,942	(0,09)	0,01	0,850	0,918	(0,07)	0,02	0,862	0,895	(0,10)	**-0,15**	**0,037**	0,250	(0,07)	**0,19**	**0,027**	0,729	(0,09)
Zitateb. × Enthusiasmus	**-0,27**	**0,005**	0,068	(0,10)	0,00	0,972	0,972	(0,08)	-0,09	0,384	0,610	(0,10)	**-0,15**	**0,049**	0,265	(0,08)	0,16	0,060	0,270	(0,09)
	ΔR^2				ΔR^2				ΔR^2				ΔR^2				ΔR^2			
Individualebene																				
Enthusiastisches Verhalten [c]	0,00				0,00				0,00				0,00				0,00			
Klassenebene																				
Enthusiastisches Verhalten [c]	0,02				0,02				0,03				0,00				0,08			
Interaktionen [c]	0,05				0,00				0,01				0,01				0,05			

Anmerkung. T1 = Prätest; Par. = jeweiliger Parameter, d.h. entweder standardisierte Regressionskoeffizienten oder ΔR^2; *p* = *p*-Wert; *p* kor. = *p*-Wert korrigiert nach Benjamini-Hochberg; *SE* = Standardfehler. Als Hilfsvariablen wurden die Mathematiknote am Ende der Klassenstufe 8, das Ergebnis der Vergleichsarbeiten aus Klassenstufe 9 sowie das Geschlecht berücksichtigt. Interaktionen mit $p < 0{,}05$ wurden jeweils fett gedruckt.

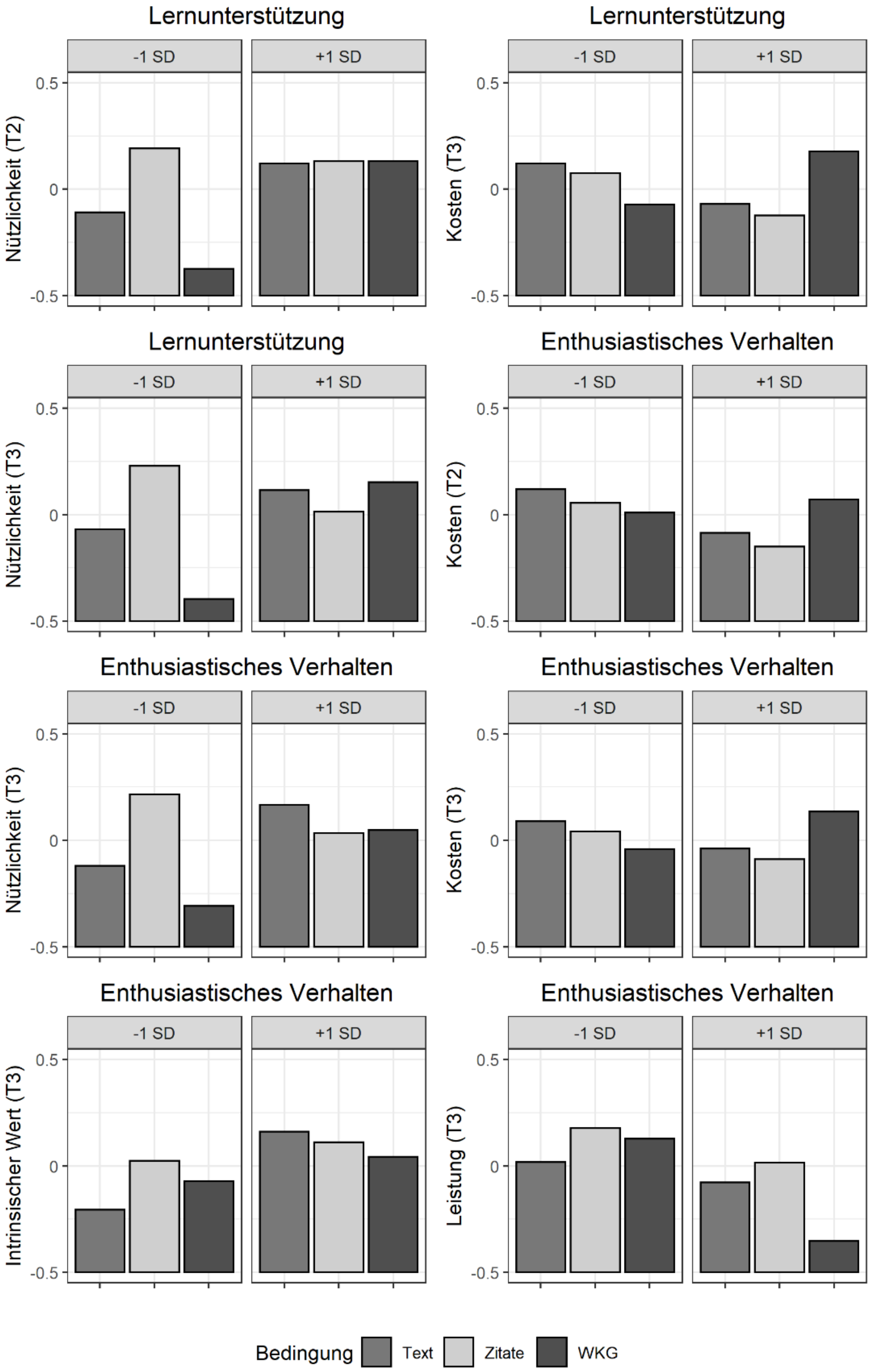
[a] Skalen wurden am Klassenmittel zentriert. Effekte auf Klassenebene lassen sich daher als Kompositionseffekte verstehen.

[b] Effekte der Text- und der Zitatebedingung sind im Vergleich zur Wartekontrollbedingung zu verstehen. Beispielsweise bedeutet ein Effekt von 0,14 in der Textbedingung, dass der geschätzte Wert eines Schüler/einer Schülerin in der Textbedingung im Mittel um 0,14 *SD* höher ist als in der Wartekontrollbedingung zum gleichen Zeitpunkt.

[c] Die Ebenen-spezifischen Anteile zusätzlich erklärter Varianz durch die Hinzunahme der angegebenen Variablen (d.h. enthusiastisches Verhalten bzw. Interaktionen; $\Delta R_w^{2(f1)}$ und $\Delta R_b^{2(f2)}$) wurden nach Rights et al. (2019) bestimmt. Hierzu wurden neben den berichteten Modellen zwei weitere Modelle spezifiziert: Ein Modell, das nur den Prätestwert auf Individual- und Klassenebene sowie die zwei Interventionsbedingungen auf Klassenebene enthält; sowie ein weiteres Modell, das zusätzlich den Moderator (enthusiastisches Verhalten) auf Individual- und Klassenebene enthält.

Abbildung 2

Darstellung adjustierter Mittelwerte aus den 8 (von 27 getesteten) Modellen, in denen Interaktionen der Interventionsbedingungen mit den motivationalen Unterrichtspraktiken als signifikant angezeigt wurden



Anmerkung. Die adjustierten Mittelwerte sind getrennt für Klassen mit einer unterdurchschnittlichen (-1 *SD*) bzw. überdurchschnittlichen (+1 *SD*) Ausprägung motivationaler Unterrichtspraktiken dargestellt.

Es scheint, als mache es bezüglich der Nützlichkeitswahrnehmung von Schülerinnen und Schülern, deren Lehrkräfte motivationale Unterrichtspraktiken wie die Lernunterstützung oder ein enthusiastisches Auftreten im Unterricht verwenden, keine großen Unterschiede, ob sie die MoMa-Intervention erhielten oder nicht. Ihre Nützlichkeitswahrnehmung entwickelte sich im Laufe des Schuljahres ähnlich zu den Mitschülerinnen und –schülern, die keine Intervention erhielten (siehe auch linke Hälfte von Abb. 2). Je geringer diese motivationalen Ressourcen jedoch waren, desto relevanter erschien der Erhalt der MoMa-Intervention, da ihre Auswirkung auf die Nützlichkeitswahrnehmung stieg. In der Tendenz schien dies auch für die Wichtigkeit und den intrinsischen Wert zuzutreffen, ohne dass sich hierfür signifikante Hinweise finden.

Diese Befunde deuten auf einen Einfluss des motivationalen Kontexts hin, der sich eher aus einer defizitären Perspektive erklären ließe (Rosenzweig und Wigfield, 2016). Lehrkräfte können ihre Schülerinnen und Schüler durch Lernunterstützung und mit enthusiastischem Verhalten für ein Fach motivieren (z.B. Dietrich et al., 2015; Frenzel et al., 2018). Werden Schülerinnen und Schüler hingegen im Regelunterricht nicht hinreichend dabei unterstützt, Freude an und Motivation für Mathematik zu entdecken und aufrechtzuerhalten, kann eine zielgerichtete Intervention ein Schlüsselmoment sein, das die Motivation der Schülerinnen und Schüler umso stärker beeinflusst.

Bezüglich der subjektiven Kosten und der Leistung der Schülerinnen und Schüler fanden wir entgegengesetzte Hinweise zur Wirkweise der motivationalen Unterrichtspraktiken, die somit eher auf eine Potenzialperspektive hindeuteten (siehe auch rechte Hälfte von Abb. 2; siehe außerdem Walton und Yeager, in Druck). Je positiver der wahrgenommene motivationale Unterrichtskontext (d.h. Lernunterstützung und enthusiastisches Verhalten) durch die Lehrkraft im Regelunterricht, desto stärker führte die MoMa-Intervention scheinbar zu niedrigeren Kosten und besseren Leistungen (insbesondere in der Textbedingung).

Entgegen unserer Erwartungen fanden sich keine differenziellen Effekte der MoMa-Intervention in Abhängigkeit des Alltagsbezugs im Regelunterricht. Dies könnte zum einen auf die fehlende Power zurückführbar sein. Zum anderen könnte es sein, dass eine so stark kognitiv beurteilte Kontextvariable wie der Alltagsbezug (entgegen der Lernunterstützung und dem enthusiastischen Verhalten; Frenzel et al., 2010), der darüber hinaus mit der individuellen Nützlichkeitswahrnehmung konfundiert sein könnte, tatsächlich zu keiner unterschiedlichen Wirksamkeit der MoMa-Intervention führt.

Stärken, Grenzen und zukünftige Forschung

Die Untersuchung von kontextuellen differenziellen Effekten einer Motivationsintervention ist bislang keine gängige Praxis, auch wenn sie aufschlussreiche Hinweise über die Heterogenität von Interventionseffekten und die mögliche flächendeckende Wirksamkeit von Interventionen liefern würden. Bislang geraten zwar vereinzelt kontextuelle Merkmale in den Fokus von Untersuchungen wie bspw. die Einstellungen der Mitschülerinnen und Mitschüler (Yeager et al., 2019), die aktuelle Studie ist jedoch die erste uns bekannte, die motivationale Unterrichtspraktiken der Lehrkraft im Regelunterricht als mögliche Moderatoren der Wirksamkeit einer Motivationsintervention im Klassenkontext untersucht. Dabei wurden potenzielle Moderatoren betrachtet, die aus der bisherigen Forschung abgeleitet als vielversprechende Einflussfaktoren auf die Motivation von Schülerinnen und Schüler zu bewerten sind.

Unklar ist dabei jedoch, welche Effektgrößen bei der Betrachtung von Moderationseffekten zu erwarten sind. Die Stichprobenparameter, die für die Durchführung einer Poweranalyse notwendig sind, wurden für diese Untersuchung direkt aus der MoMa-Studie ermittelt. Im optimalen Fall einer a priori durchgeführten Poweranalyse müssen entsprechende Parameter (bspw. ICC der interessierenden Outcome-Variable) jedoch aus vorheriger Forschung abgeleitet werden – hierfür sind realistische Richtlinien (*empirical benchmarks*; Hill et al., 2008), die auf Analysen mit möglichst ähnlichen Studien beruhen, notwendig. Bezüglich der Bewertung realistischer Effektgrößen ist zudem zu berücksichtigen, ob diese auch als substantiell einzuordnen sind – hierfür ist die Orientierung an der Höhe möglicher Effekte auf die Motivation von Schülerinnen und Schülern innerhalb eines Schuljahres als „maximal erreichbare Effektgröße" denkbar (Yeager et al., 2019; siehe auch Hanushek, 2011; Funder und Ozer, 2019). Erste Anhaltspunkte hierfür liefern zwar beispielsweise Brunner und Kollegen (2018), die Design-Parameter von repräsentativen PISA-Daten bezüglich Leistung, Affekt und Motivation sowie Lernstrategien von 15-jährigen Schülerinnen und Schülern aus 81 Ländern präsentieren, aber weitere richtungsweisende Untersuchungen insbesondere im deutschsprachigen Raum sind wünschenswert.

Wie die Poweranalysen der vorliegenden Untersuchung zudem zeigten, ist die MoMa-Studie mit zu wenigen Klassen ausgestattet, um kleine Moderationseffekte mit ausreichend großer Wahrscheinlichkeit aufdecken zu können. Es ist also unklar, ob die gefundenen Moderationseffekte bereits alle wahren Effekte abdecken und ob signifikante Moderationseffekte die wahren Effekte überschätzen. Eine Replikation der MoMa-Studie mit adäquater Stichprobengröße auf Klassenebene zur Aufdeckung kleiner Moderationseffekte wäre folglich notwendig (aber siehe bspw. Stallasch et al., 2020).

Forschungspraktische Implikationen

Auch wenn die Suche nach bedeutsamen Moderatoren von großem inhaltlichem Interesse ist, stößt sie jedoch forschungspraktisch und ökonomisch oftmals an ihre Grenzen (Moerbeek, 2006). Unsere Ergebnisse zeigen deutlich, dass das Testen von Moderationseffekten im Rahmen einer Interventionsstudie, die nicht für diesen Zweck geplant wurde, mit großen Schwierigkeiten verbunden sein kann und signifikante Moderationseffekte daher mit Vorsicht interpretiert werden müssen. Stattdessen könnte also die entscheidende Schlussfolgerung für zukünftige Interventionsstudien die Notwendigkeit sein, direkt bei der Planung mögliche Moderationsfragestellungen zu berücksichtigen und die Rekrutierung entsprechend auszulegen. Für die Interventionsforschung wird aktuell stark diskutiert, unter welchen Bedingungen Interventionen im Klassenkontext erfolgreich sind (bspw. Yeager et al., 2019). Umso mehr besteht also der Bedarf nach genügend groß angelegten Studien, die Antworten auf die Interaktion mit individuellen und ebenso kontextuellen Faktoren liefern können. Diese Untersuchung konnte erste Hinweise darauf liefern, dass eine Nützlichkeitsintervention wie die MoMa-Intervention in motivational-defizitären Unterrichtskontexten, in denen also typischerweise ein höherer Förderbedarf besteht, besonders wirksam die Nützlichkeitswahrnehmung von Schülerinnen und Schülern fördern kann. Weiterführende Forschung in diese Richtung erachten wir als besonders vielversprechend.

Die Rekrutierung von adäquaten Stichproben, die eine auf Klassenebene randomisierte kontrollierte Feldstudie mit ausreichender Power zur Aufdeckung von Moderationseffekten ausstatten, geht jedoch mit immensem finanziellen und zeitlichen Aufwand einher. Es erscheint folglich eher unrealistisch, in Zukunft immer größere Stichproben zu rekrutieren, deren Größe auch die Aufdeckung von geringfügigen Moderationseffekten zulässt. Fraglich ist somit, ob die Untersuchung solcher Moderationseffekte die hohen Kosten, die damit einhergingen, rechtfertigt. Joyce und Cartwright (2019) fordern daher anstelle der Durchführung großangelegter Evaluationsstudien, deren Ergebnisse Rückschlüsse auf eine Population ermöglichen, die Evaluation von Interventionen jeweils unter *gegebenen* Umständen in *gegebenen* Subpopulationen – ohne den Anspruch der Verallgemeinerbarkeit. Entsprechend wäre es nicht erstrebenswert, immer größere Studien zu planen, die die Untersuchung von Moderatoren erlauben, sondern vielmehr gezielte Untersuchungen von Interventionen in bestimmten Kontexten, wobei die Interventionen den Spezifika des Kontexts vorab angepasst werden sollten.

Praktische Implikationen

Praktische Implikationen lassen sich aus dieser Untersuchung aufgrund der geringen Power zur Aufdeckung von differenziellen Effekten nur mit Vorsicht ziehen. Nichtsdestotrotz lässt sich aufgrund der Ergebnisse zumindest schlussfolgern, dass Merkmale auf Klassenebene durchaus Einfluss auf die Wirksamkeit einer Motivationsintervention haben können. Nicht in jedem Klassenzimmer ist eine solche Intervention immer gleichermaßen wirksam. Eine Motivationsintervention, die sich in einem gewissen Kontext, in einer bestimmten Klasse oder bei einer bestimmten Lehrkraft als erfolgreich herausgestellt hat, kann keine Wirkung oder – im Extremfall – sogar eine negative Wirkung in einem anderen Kontext, einer anderen Klasse oder bei einer anderen Lehrkraft aufweisen. Dies sollte vor dem Einsatz einer sich als im Mittel wirksam erwiesenen Intervention berücksichtigt werden. Die MoMa-Intervention zeigte sich im unterdurchschnittlichen, durchschnittlichen, oder überdurchschnittlichen motivationalen Unterrichtskontext als weitestgehend förderlich oder im schlimmsten Fall als nicht schädlich. Somit kann der Einsatz der MoMa-Intervention unter Berücksichtigung der untersuchten Konstrukte insgesamt als positiv bewertet werden.

Fazit

Die Frage „Für wen und unter welchen Umständen ist eine Intervention wirksam?“ (Spybrook et al., 2016, S. 606) bleibt oftmals unbeantwortet. Ein Grund sind methodische Herausforderungen bei der Aufdeckung solcher Moderationseffekte. Anhand einer exemplarischen, auf Klassenebene randomisierten kontrollierten Feldstudie, der MoMa-Studie, konnten wir zeigen, dass zur Aufdeckung von erwartungsgemäß geringeren Moderationseffekten eine vielfach größere Anzahl an Klassen notwendig ist als zur Aufdeckung von Haupteffekten einer Intervention. Diese Studie liefert außerdem erste Hinweise darauf, dass Motivationsinterventionen im Klassenkontext in Abhängigkeit von motivationalen Unterrichtspraktiken unterschiedlich wirksam sein können. Weitere Studien mit ausreichender Power wären jedoch notwendig, um diese ersten Hinweise zu bekräftigen.

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6
General Discussion

School is probably one of the most important contexts outside the family environment in which students have the chance to let their achievement motivation unfold to its full potential (Wentzel & Miele, 2016). However, given that students' motivation across most subjects tends to follow a steady decline during secondary education, which is particularly pronounced in the domain of math (e.g., Gaspard et al., 2017; Jacobs et al., 2002; Watt, 2004), it is important to investigate and provide students with conditions under which they can motivate themselves in the educational context. The present dissertation investigated the unfolding of students' motivation in the educational setting and focused in particular on teachers' motivational teaching behaviors during instruction for creating such conditions (e.g., Kunter et al., 2008; Reeve & Jang, 2006; Stroet et al., 2013; Wentzel, 2009). Additionally, the current dissertation was especially aimed at improving the understanding of how motivational teaching behaviors come into effect during math class. In this light, I raised three key substantive questions for current and future research at the intersection of research on motivational science and teaching quality. These three key substantive questions were (a) *How consistent are motivational teaching behaviors?*, (b) *What are the antecedents of motivational teaching behaviors?*, and (c) *What are other external sources that target students' motivation and tend to accompany motivational teaching behaviors in the educational setting?*

I addressed these questions by conducting three empirical studies from a motivation-theory-led perspective. These investigations revealed the following main findings: (a) Study 1 targeted specifically the consistency *over time* and indicated that students' expectancies and values as well as in their perceptions of motivational teaching behaviors fluctuated substantially from lesson to lesson. Additionally, by and large, both time-consistent and occasion-specific components of motivational teaching behaviors predicted students' situational expectancies and values, whereas particularly the time-consistent aspects predicted students' importance and intrinsic value. (b) Study 2 targeted teachers' values as antecedents of their motivational teaching behaviors. Findings from Study 2 revealed that teachers' values predicted how students perceived their teachers' motivational teaching behaviors during instruction. Additionally, teachers' values operated as predictors of students' own values, whereas this link was to some extent explained by the mechanism of value transmission from teachers to their students through motivational teaching behaviors. And (c) Study 3 targeted a relevance intervention as other external source accompanying motivational teaching behaviors in the natural classroom setting. Study 3 demonstrated that, with respect to students' positive values (utility value and intrinsic value), a short relevance intervention during math class compensated to a certain extent for a lack of motivational teaching behaviors during regular class. Furthermore, it boosted the predictive power of motivational teaching behaviors for students' costs and their achievement. However, these findings can only be interpreted with caution because this investigation also pointed to the restricted statistical power of the present and, thus, similar intervention studies.

In the following, I discuss these findings with respect to the three guiding questions that I posed to the intersection of motivational science and teaching quality. First, I discuss the general findings across the three empirical studies (6.1), followed by a discussion of lessons learned from the investigation of the consistency of motivational teaching behaviors (6.1.1), a discussion of a more comprehensive perspective on antecedents of motivational teaching behaviors (6.1.2), and a discussion of relevance interventions as a potential magic bullet for research on motivation and teaching quality (6.1.3). Subsequently, I highlight the strengths and limitations of the current dissertation (6.2) and conclude with implications for future research (6.3.1) as well as for educational policy and practice (6.3.2).

6.1 Discussion of General Findings

Student motivation is a central construct in educational research and is sometimes even viewed as being “at the core of human psychology” (Dweck, 2017, p. 689). Consequently, motivation represents a key concern with respect to questions about how and why students learn, thrive, and succeed academically while others struggle (Pintrich, 2003). Drawing on a social-cognitive perspective, the natural classroom setting and particularly the instructional strategies used by teachers are often considered important for student motivation to unfold, and, thus, characteristics of this setting have gradually been coming to the fore of motivational science in the past few decades (e.g., Eccles, 1993; Reeve & Jang, 2006; Roeser et al., 2000). Largely independent from motivational science, research on teaching and teaching quality has emerged over the last few decades. Influenced by work by Brophy and Good (e.g., 1986; Good et al., 1975), teaching quality dimensions have obtained a prominent position in research on teaching (e.g., Klieme & Rakoczy, 2008; Pianta & Hamre, 2009; Praetorius et al., 2018). More holistic frameworks on learning such as the offer-take-up model by Göbel and Helmke (2010) or the offer-use-model by Helmke (2012) embed teaching quality as a characteristic of the lesson (the “offer”) in a comprehensive set of factors including the broader context, the teacher and their characteristics and competences, students’ personal background and their achievement potential including their motivational potential to delineate effects on learning outcomes (the “take-up”). Yet motivational science and research on teaching quality have seldom been married explicitly, and well-established frameworks for explaining their interrelatedness and underlying processes are widely missing.

The current dissertation adopted an integrative approach to investigate the role of teaching behaviors for the emergence of students’ motivation in the natural classroom setting. In this dissertation, I integrated multiple indicators of motivational teaching behaviors such as autonomy support (Assor, 2012; Reeve, 2006; Ryan & Deci, 2020), enthusiastic teaching (Keller et al., 2016; Kunter et al., 2008, 2011), or the provision of meaningful rationales (Assor et al., 2002; Reeve et al., 2002; Vansteenkiste et al., 2018) into the core dimensions of teaching quality (e.g., Hamre & Pianta, 2010; Klieme & Rakoczy, 2008; Pianta & Hamre, 2009; Praetorius et al., 2018). Thus, instead of merely relying on different constructs from two worlds (student motivation and teaching quality dimensions), I undertook the attempt to integrate established antecedents of student motivation that are contingent on the teacher into the framework of teaching quality or—to turn it the other way—to conceptualize established teaching quality dimensions from a motivational-science perspective.

Consistently across all the empirical studies in this dissertation, motivational teaching behaviors that explicitly targeted the relevance of the subject matter (e.g., the provision of meaningful rationales, use of everyday life examples, relevance support, and the practical focus of the math lesson) were prospectively associated with students' utility value/importance at the individual and class levels (even when controlling for students' prior utility value/importance). Also with respect to the other motivation dimensions such as students' expectancies, intrinsic value, and in part even their subjective cost, the findings from the three empirical studies pointed to a particularly profound link between motivational teaching behaviors and students' motivation, though less systematic than for students' utility value/importance.

Overall, motivational teaching behaviors turned out to be a remarkably relevant feature of the natural classroom setting that can explain systematic variation in students' motivation for math (e.g., explaining up to an additional 33% of the variance in Study 1 over and above individual and dispositional characteristics). However, within the scope of this dissertation, I also indicated that work at the intersection of motivational science and teaching quality is still in its infancy. Much has already been learned about the interrelatedness of motivational teaching behaviors and student motivation, yet it is about time to develop a systematization of and guide for future efforts at the intersection of motivational science and research on teaching and teaching quality. As a first attempt, I raised three key substantive questions addressing current and future work, and I subsequently began to answer these questions. When the current results are pooled with other empirical evidence, all of the accumulated results may have the potential to draw a comprehensive picture of the current status of and future directions for this intersection.

6.1.1 Lessons Learned from Findings on the Consistency of Motivational Teaching Behaviors over Time

The first question I aimed to answer was *How consistent are motivational teaching behaviors?* Previous research targeting this question has shown that students seem to perceive their teachers' behaviors in different ways that tend to depend on students' background characteristics (e.g., gender), the whole group of students (e.g., the teacher simply gets along better with students from one class compared with another), the subject they are teaching, and the grade level (e.g., the teacher can better adapt to the needs of older than of younger students, which is reflected in the quality of their teaching). The current dissertation adds to these findings by examining the consistency of teaching behaviors *over time* within the same groups of students, the same class compositions, the same subjects, and the same teacher-classroom matches.

Study 1 showed that students' individual perceptions of their teachers' autonomy-supportive teaching behaviors varied substantially between lessons and deviated from their classmates' perceptions within lessons. This mirrors previous findings on the situative and idiosyncratic nature of students' perceptions of teaching (e.g., Patall et al., 2016; Patall, Steingut, et al., 2018; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008; Wagner et al., 2016) and is indicative of several implications. First, teachers might indeed vary substantially in their level of autonomy support from lesson to lesson, which is why students' situation-specific perceptions of their teachers' autonomy-supportive teaching behaviors fluctuate around their typical level of perceptions. Second, the students' individual level of need support might also vary from lesson to lesson, which is why they perceive their teachers' (potentially even) persistent autonomy-supportive teaching behaviors as differently autonomy supportive as a function of their needs. Putting both possible explanations together, teachers might also constantly adapt their autonomy-supportive teaching behaviors to their students' changing needs (i.e., both teachers' behaviors and their students' needs constantly shift), which sometimes works more or less well (resulting in varying perceptions of autonomy support). Broadening the focus to include students' needs for their teachers to exhibit motivational teaching behaviors in future research might shed more light on these findings.

Additionally, Study 1 provided evidence that students' *shared* perceptions of such teaching behaviors also vary with the lesson. Due to the situational measures used in this study, this result expands upon previous findings on the situation-specificity of shared teaching appraisals, which has thus far relied on trait-like measures (e.g., Wagner et al., 2016). Derived from this finding, the motivational climate in a classroom seems to be systematically impacted by common situational influence factors (e.g., teachers' behaviors). Thus, Study 1 substantiated assumptions regarding reasons for situation-specific fluctuations in students' individual perceptions of autonomy-supportive teaching behaviors: Given that the shared perceptions of students within the classroom tend to shift in sync from lesson to lesson as well (i.e., deviate collectively from the typical shared level), this is highly indicative that the teacher's behaviors in fact vary from lesson to lesson (see also Moeller et al., 2020).

Ultimately, fluctuations in students' individual and shared perceptions were systematically reflected in fluctuations of their individual and shared motivation during the same math lesson, particularly in their importance and intrinsic value. These findings replicate and expand upon previous research (e.g., Patall, Steingut, et al., 2018; Tsai, Kunter, Lüdtke, Trautwein, et al., 2008) as they are indicative of an "attuning" process between teachers and individual students (see Nolen, 2020) and additionally between teachers and whole classes. Consequently, investigating the consistency of motivational teaching behaviors from a temporal perspective not only enabled insights into the nature of such behaviors (and thus contributed to answering the question of *How consistent are motivational teaching behaviors?*). It also facilitated an inside view into how motivational teaching behaviors might work and pointed toward both a long-lasting effect on and an immediate reflection in students' motivation. By diving further into the question of the consistency of motivational teaching behaviors, future research could develop a gradually expanding understanding of such processual aspects.

Notwithstanding the predictive validity of fluctuations in students' perceptions of their teachers' motivational teaching behaviors, however, differences in the perceptions between students in the same class and differences in perceptions between classes were ultimately more predictive of enduring differences in students' motivation. Thus, when interested in longer lasting interrelations between motivational teaching behaviors and student motivation, it seems reasonable to focus methodologically (e.g., in terms of measures) and analytically (e.g., in terms of statistical approaches) on these relatively stable features of motivational teaching behaviors and student motivation in the remaining empirical studies in this dissertation.

6.1.2 A More Comprehensive Perspective on Antecedents of Teachers' Motivational Teaching Behaviors During Class

Second, I addressed the question *What are the antecedents of motivational teaching behaviors?* According to Kunter and colleagues (2013), previous discussions about teacher-dependent antecedents of teaching quality in general have followed two opposing lines of argumentation. First, previous discussions revolved around the Bright Person Hypothesis (e.g., Kennedy et al., 2008), which proposes that teachers whose teaching is high in quality are those teachers who "are bright, well-educated people who are smart enough and thoughtful enough to figure out the nuances of teaching in the process of doing it" (Kennedy et al., 2008, p. 1250; for a discussion of this hypothesis from the perspective of teacher intelligence, see Bardach & Klassen, 2020). Second, previous discussions have revolved around the Knowledgeable Teacher Hypothesis (Anderson et al., 1995; Shulman, 1987), which proposes that effective teaching is determined by the teacher's professional knowledge (including content knowledge, pedagogical content knowledge, and general pedagogical knowledge; e.g., Shulman, 1986).

However, with their focus on either rather fixed characteristics of the person or exclusively on knowledge that is detached from the person, both approaches have been criticized in the past (e.g., Aloe & Becker, 2009; Goodman et al., 2008; Grönqvist & Vlachos, 2008; Kunter, Klusmann, et al., 2013). To overcome these considerable aptitude-focused and knowledge-focused explanations of high teaching quality, more recently, Kunter, Klusmann, and colleagues (2013; see also Baumert & Kunter, 2013; Kunter, Kleickmann, et al., 2013) proposed the concept of professional competence, from which the focus of this dissertation on teacher motivation as dimension of their professional competence originated.

Study 2 showed that teachers' teaching enthusiasm and their math utility value were strong predictors of their motivational teaching behaviors. When teachers were enthusiastic about professional activities and perceived math as useful in general for people's lives, their students perceived them as teaching more enthusiastically and as more intensively highlighting the relevance of math. Ultimately, not only were teachers' teaching enthusiasm and math utility value reflected in corresponding perceptible behaviors during class, but they also predicted students' own intrinsic and utility values. Consequently, Study 2 provided insights into potential value transmission effects from teachers to their students during math class, thus expanding on research on emotional contagion and value induction mechanisms (Frenzel et al., 2009, 2018; Hsee et al., 1990; Pekrun, 2000, 2006). However, most importantly for the focus of the current dissertation, the findings from Study 2 substantiated the understanding of motivational antecedents of teachers' behaviors during class. In this light, the findings from Study 2 emphasized the significance of teachers' teaching enthusiasm for their motivational teaching behaviors as found in previous studies (e.g., Kunter, Klusmann, et al., 2013; Praetorius et al., 2017) and added initial evidence for the significance of their beliefs about the usefulness of math. With the overarching goal to support students in their motivation, such findings provide valuable starting points on where to potentially intervene. Other than aiming to change students' belief systems about themselves and the value of math, it might prove reasonable to intervene in their educational context. As Study 2 revealed, it is not only directly observable teacher behaviors in class that have to be considered as part of this context but also teachers' own values, which could ultimately represent auspicious staring points for long-terms changes (for an analogous argument, see Praetorius et al., 2017).

Apart from the direct predictive value of students' perceptions of their teachers' behaviors during class, teachers' values should be considered from a more comprehensive perspective on antecedents of their motivational teaching behaviors for two reasons. First, teachers' enthusiasm as an indicator of their motivation has previously been found to be positively related to their job and life satisfaction and negatively related to burnout (e.g., Kunter et al., 2011). Supporting and expanding this finding to apply it to other aspects of teacher motivation, a wide range of studies has found that teachers' more autonomous forms of motivation are negatively related to indicators of burnout (e.g., Eyal & Roth, 2011; Fernet et al., 2008, 2012; Van den Berghe et al., 2014). Taking such consequences of (low) teacher motivation into account can broaden the understanding of the effects on motivational teaching behaviors (and, subsequently, on student motivation). Second, additionally to teachers' motivation operating as one of several factors that accumulatively impact teachers' behaviors during instruction, their motivation might also compensate for the lack of other critical antecedents of high-quality teaching—and consequently, teacher motivation might take on an even more important role. For instance, students' interest was found to compensate for a lack of conscientiousness in predicting their effort in multiple studies (e.g., Rieger et al., 2020; Song et al., 2019; Trautwein et al., 2015, 2019). Given that, among other characteristics, teachers' personality traits were also found to predict their teaching quality as rated by their students up to 10 years later (Roloff et al., 2020; for a recent meta-analysis on the relation between teacher personality and teacher effectiveness, see also L. E. Kim et al., 2019) and given the predictive validity of teachers' motivation (Study 2), it appears to be a next logical step to transfer and investigate such mechanisms regarding students' academic effort to teachers' effort for engaging in professional activities (and thus, their quality of teaching).

Taken together, a more comprehensive perspective on teachers' motivation as an antecedent of several relevant factors affecting their professional activities should be taken into account in future research. Additionally, a more comprehensive perspective that considers teachers' motivation as one of many factors encompassing relevant antecedents of their motivational teaching behaviors could stimulate future research located at the intersection of motivational science and teaching quality.

6.1.3 Relevance Interventions: A Magic Bullet for Research on Motivation and Teaching Quality?

As the third and final question, I asked *What are other external sources that target students' motivation and tend to accompany motivational teaching behaviors in the educational setting?* When targeting the unique role motivational teaching behaviors play in determining students' motivation in the natural classroom setting, it is indispensable to also consider surrounding factors that might interact with teachers' efforts to support their students' motivation. In recent decades, relevance interventions have been found to be particularly appealing for affecting students' average motivation in school (for overviews, see Harackiewicz et al., 2014; Lazowski & Hulleman, 2016; Priniski et al., 2018).

However, motivation intervention studies in general and relevance interventions studies in particular have oftentimes also found heterogeneous effects (e.g., Gaspard, Dicke, Flunger, Brisson, et al., 2015; Hulleman & Harackiewicz, 2009), which can indicate that an intervention did not work in the same way for everybody or in every context (e.g., Weiss et al., 2014). In educational intervention studies, heterogeneity has mostly been investigated from the perspective of students' individual characteristics (also called aptitude × treatment effects, Cronbach, 1975). For instance, many studies have identified differential effects that depend on students' prior knowledge or achievement (e.g., Hulleman et al., 2010), initial motivation (e.g., Durik & Harackiewicz, 2007), gender (e.g., Gaspard, Dicke, Flunger, Brisson, et al., 2015), or even family characteristics (e.g., Häfner et al., 2017). Such heterogeneous effects are not reflected by average results from intervention studies and can become apparent by conducting, for instance, moderation analyses or more or less strict replication studies that show potentially different effects (e.g., Harackiewicz et al., 2012; and Piesch et al., 2019; or Hulleman & Harackiewicz, 2009; and Rosenzweig, Hulleman, et al., 2019; see also J. S. Kim, 2019). In addition to individual characteristics as reasons for heterogeneity, the question of implementation fidelity (i.e., the quality and accuracy of implementation as intended during the actual intervention) has obtained increasing attention in recent years because it can determine the extent to which an intervention was successfully implemented in each classroom and might thereby explain heterogeneity in intervention effects (e.g., Hulleman & Cordray, 2009).

Consequently, even though relevance interventions often appear to be a promising lever for boosting students' motivation due to their often minimally invasive character and relatively high effects (Lazowski & Hulleman, 2016), several arguments speak against the exclusive trust in relevance interventions for working against students' decreasing motivation during the phase of adolescence, and against the unconditional reliance on relevance intervention studies as magical bullets in motivational science and research on teaching quality. First, notwithstanding their minimally invasive character, the implementation of relevance interventions requires time and financial resources (e.g., Foster et al., 2007; Moerbeek, 2006) and can thus always be only *one* instrument in a set of tools to support student motivation (though potentially more cost-effective than, e.g., school reforms or other approaches, see Borman et al., 2003; Yeh, 2010).

Second, the natural setting in which learning and the ontogeny of motivation first and foremost take place—the natural, everyday classroom setting—can never be blocked out when implementing interventions. Artificial, externally imposed interventions are thus never stand-alone interventions or are detached from the educational context—“they rather operate within the context of existing structures to make them more effective” (Yeager & Walton, 2011, p. 274). This means that relevance interventions that have been found to be effective for boosting students’ motivation in one setting might work differently in another setting (J. S. Kim, 2019) because an intervention always has to be treated as *one* experience out of the many experiences that students have throughout the school day, week, or year.

The findings from Study 3 substantiated this particular view on relevance interventions. Though the MoMa intervention, which was the focus of Study 3, was found to be successful on average in supporting students’ expectancies and values (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015), the extent to which this applied to each class varied as a function of the motivational climate students’ math teachers were able to create during regular math class. Taking up the “seed” and “soil” discussion (Walton & Yeager, 2020, see also Section 1.3.3), the findings from Study 3 supported Walton and Yeager’s assumption that the success of an intervention might indeed depend on the “soil” the intervention was implemented in. To turn it the other way, motivational teaching behaviors during regular class might be boosted by an externally imposed relevance intervention (in terms of students’ utility and intrinsic values as in the MoMa 1 study), and a lack of motivational teaching behaviors might be compensated for by a relevance intervention with respect to students’ subjective costs (i.e., perceiving less cost) and achievement.

However, one of the main findings of Study 3 was also that the power of cluster-randomized controlled trials such as the MoMa 1 study might not be sufficient for investigating interaction effects and, consequently, the probability of overlooking actual interaction effects is increased, and statistically significant effects are often overestimated (Gelman & Carlin, 2014). This is a typical finding for (cluster-)randomized trials similar to MoMa 1 (Spybrook et al., 2020). Unfortunately, this extends previous research that summarized that randomized controlled field trials are often uninformative (Lortie-Forgues & Inglis, 2019). Lortie-Forgues and Inglis traced this finding back to three possible explanations: First, the literature that these interventions were based on might be unreliable (i.e., based on this literature, effects can actually not be expected); second, the intervention studies were potentially not well enough designed or implemented (i.e., actually existing effects are not detectable due to the realized design); and third, statistical power is often too low to detect intervention effects (particularly with respect to Level 2 units). Even when an intervention was theoretically well-thought through and designed (i.e., an effect can theoretically be expected and is detectable design-wise; thus, the first two explanations are not applicable any more), simply raising the sample sizes to ensure sufficient statistical power (as suggested by Sims, 2020) might not be an adequate solution for this issue due to feasibility and financial reasons (Lortie-Forgues & Inglis, 2020).

Still, relevance interventions and randomized controlled field trials that accompany such interventions are certainly reasonable and valuable for realizing and investigating average treatment effects on students' motivation (when well designed and powered). However, motivational science has to face the question of whether intervention research has reached a tipping point; a tipping point at which ever increasing theoretical advances with demands on the statistical power and the capability for empirical implications can no longer be met due to, among other issues, unattainable requirements for sample sizes, even though future statistical and methodological developments might prove me wrong. Additionally, motivational science has to deal with the question of whether interventions that are aimed at changing the individual student (i.e., aiming to adapt their motivation to the system) is the appropriate goal, or whether systemic changes such as training teachers to adapt their motivational teaching behaviors more specifically to their students' needs (e.g., Aelterman et al., 2014) or creating permanent learning environments that are specifically designed to meet students' individual needs might be more desirable (for an analogous argument, see Graham, 2020; Nolen, 2020).

6.2 Strengths and Limitations

Contemporary Educational Psychology recently published a special issue on “Prominent motivation theories: The past, present, and future” edited by Allan Wigfield and Alison Koenka (2020). In her introduction to this special issue, Koenka (2020) noted that there are several “underexplored and timely issues regarding motivation theory” (p. 1). More precisely, Koenka stated that research that investigates the dynamic and contextual nature of motivation, motivational processes, and intervention effects could contribute to key advances in the field of motivation. The current dissertation targeted these relevant issues by attempting to capture the contextual and situative nature of motivational constructs (Study 1), to explore processes connected to motivational constructs (Study 2), and to explore treatment by moderator effects (Study 3). All these accomplishments were achieved with a particular focus on the natural classroom setting and thus overcame the limited external validity of laboratory studies (Hulleman & Cordray, 2009; Mitchell, 2012). Additionally, by conducting the three empirical studies, the current dissertation was able to replicate and extend previous research findings (see Frenzel et al., 2018, for value transmission effects; and Tsai, Kunter, Lüdtke, Trautwein, et al., 2008, for the situative nature of motivation), and to illuminate current discussions regarding the question of “seed” and “soil” (Walton & Yeager, 2020). Nevertheless, when interpreting the findings of the present dissertation, several limitations have to be kept in mind.

First, for these undertakings, the current dissertation made use of two strong data sets that stand out due to their longitudinal designs, large sample sizes (at both the individual and class levels), and an experimental design that was adequately suited to address treatment by moderator effects. At the same time, a particular strength of Study 3—that the data stemmed from a cluster-randomized field trial—can be considered a downside of Studies 1 and 2, which relied on similar data. Cluster-randomized controlled field studies are considered the gold standard for investigating treatment effects in educational research and beyond (e.g., D. M. Murray et al., 2004). Even though intervention effects were not the focus of Studies 1 and 2, these studies still relied on intervention data. However, potential intervention effects were taken into account by controlling for the intervention conditions. Furthermore, thoroughly conducted robustness checks in both studies did not indicate any impact of the intervention with respect to the investigated associations. Yet overly generalizing the study results might not be warranted, and future research might want to substantiate the findings of this dissertation with other data.

Second, the two samples underlying the three empirical studies are largely comparable because they comprise ninth-grade students in academic-track schools in the German state of Baden-Württemberg who were asked to appraise their motivation and the instructional behaviors of their teachers during math class. It can therefore be assumed that the results are comparable as well. However, in Germany, classes usually comprise the same set of students across all subjects; thus, students' experiences are predominantly affected by varying teachers (usually one teacher per subject) while the composition of the class is held more or less constant over the term of not only 1 school year but oftentimes even multiple years during secondary education. Students' intraindividual references while appraising their own attitudes and the teachers' behaviors may thus be more aligned in German classrooms than in classrooms from other school systems because students might—comparable to the phenomenon of "grading on the curve" (e.g., C. Campbell, 2012; Kajitani et al., 2020)—implicitly "appraise on the curve." The typically low ICCs for students' motivation and social-cognitive constructs in general (e.g., Brunner et al., 2018; Gaspard, Dicke, Flunger, Brisson, et al., 2015) could be an indicator of this phenomenon, and it would be interesting to see whether and how this affects the associations between teaching behavior perceptions and student motivation in future research.

Third, though the focus of the empirical studies was intentionally on ninth-grade math classrooms (because the decrease in motivation is on average most pronounced in math and during mid-adolescence; e.g., Gaspard et al., 2017), this constitutes a limitation to the generalizability of the findings. Furthermore, the data stem from academic-track students only, and results cannot be generalized to students from other tracks. However, in past years, more than 40% of the students in Germany have transitioned to such academic-track schools after primary education (Autorengruppe Bildungsberichterstattung, 2020). Particularly in the state of Baden-Württemberg (where all of the data from the two MoMa studies were collected), this transition is not contingent upon the school's recommendation to choose an "adequate" track for the respective student. Consequently, the previously assumed strong links between socioeconomic background and students' chance to attend an academic-track school as a result of these recommendations (Maaz et al., 2008) might be less pronounced, and students might be relatively heterogeneous in terms of their academic performance and socioeconomic background.

Finally, following the implicit aim of the current dissertation (exploring students' subjective experiences in their educational environment and subsequent associations with their motivation), the three empirical studies drew on student self-reports of their motivation and of their perceptions of the educational context as well. In combination with these self-reports, the application of state-of-the-art statistical methods that were explicitly tailored to the respective research questions and not only acknowledged but made use of the hierarchical data structures facilitated the simultaneous investigation of intraindividual and interindividual associations at the individual level, as well as associations at the individual and class levels. Nevertheless, when interpreting the findings of the present dissertation, it has to be kept in mind that students' appraisals of their teachers' behaviors during class only reflect their idiosyncratic perceptions and are not comparable to theoretically objective measures of the quality of teaching (see Clausen, 2002; and Kunter & Baumert, 2006, for discussions).

6.3 General Implications and Future Directions

The findings of the current dissertation allow for several implications for future research as well as for educational policy and practice. In the following, I present theoretical implications for future research with respect to the consolidation of enrichments of SEVT and with respect to the future of the intersection of motivational science and teaching quality. Subsequently, I outline implications for educational policy and practice with a particular focus on teachers' professional development and implications for implementing and scaling educational interventions.

6.3.1 Implications for Future Research

Consolidating the Enrichment of SEVT

The present dissertation was fundamentally based on SEVT (Eccles et al., 1983; Eccles & Wigfield, 2020). However, throughout the dissertation, I explicitly made use of other motivation theories (i.e., self-determination theory; Deci & Ryan, 1985; control-value theory; Pekrun, 2000; and interest theories; Krapp et al., 1992) with the goals of reinforcing and conceptually substantiating what has already been faintly laid out in SEVT (e.g., the role of the teacher and the concept of value transmission) and enriching SEVT by adding other concepts (e.g., stability). The three empirical studies made a strong case that the educational context in general and motivational teaching behaviors in particular, as well as the concept of consistency over time and the mechanisms by which value is transmitted from teachers to their students could all be used to enrich the understanding of students' expectancies and values in the natural classroom. Thus these studies make important contributions to the expansion of SEVT. Eccles and Wigfield (2020) recently encouraged such relevant work that is grounded in SEVT, as it continues to refine SEVT and the theoretical understanding of students' motivation.

In light of such refinements of SEVT, the task for future research is twofold. First, ongoing efforts to enrich SEVT with newly developed or adapted concepts are key for future theoretical developments in motivational science. Learning from other theories or even disciplines (Smaldino, 2020) can help to achieve such developments. Hence, future research should continuously synthesize knowledge from different perspectives on motivation and aim at enriching and broadening preconceived concepts. Especially work on mechanisms and processes involving students' expectancies and values are valuable and represent substantial extensions to the current state of SEVT (Eccles & Wigfield, 2020). Other methodological paths might prove necessary for achieving such goals, for instance, by embracing mixed-method approaches even more (McCrudden et al., 2019). Second, current and future research has the responsibility to consolidate reasonable and well-supported extensions to SEVT. Analogous to Eccles and colleagues' parent socialization model (Eccles, 1993; see also Simpkins et al., 2015), it might be about time to develop a theoretical model that encompasses the unfolding of students' motivation in the educational context and is based on the rich empirical evidence that has been compiled during past decades.

The Future of the Intersection of Motivational Science and Teaching Quality

Going hand in hand with the call for a model that represents motivational formation processes in the educational environment, the findings from the current dissertation imply that it is about time to more strongly and more systematically integrate motivational concepts into research on teaching quality and vice versa. Targeting student motivation as an outcome of high-quality teaching facilitated new insights into the features and the operating mode of motivational teaching behaviors. In the following, I derive several starting points for such an integration from the theoretical considerations and findings of the current dissertation, starting at a relatively abstract level and becoming gradually more concrete.

First, the literature review on student motivation and teaching quality made evident that motivational science and research on teaching quality coexist with only minor overlap, even though they often enough consider similar concepts and constructs. For instance, both research in motivational science and research on teaching quality focused on supportive teaching behaviors such as autonomy support (in motivational science; e.g., Reeve & Jang, 2006) and emotional or learning support (as dimension of teaching quality; e.g., Hamre & Pianta, 2010; Klieme & Rakoczy, 2008) as beneficial factors for student outcomes. Even though teaching quality researchers often even explicitly refer to self-determination theory when introducing the dimension of learning support (e.g., Hamre & Pianta, 2010; Klieme & Rakoczy, 2008; Praetorius et al., 2018), the different terminology of these research strands bear the risk of jangle fallacies. Such jangle fallacies have already been approached in motivational science with respect to different motivational concepts (e.g., H. R. Lee et al., 2020; Marsh et al., 2019) and should become a matter of concern for concepts shared between motivational science and teaching quality.

Second, this dissertation carved out the strong relation between motivational teaching behaviors and students' motivation. Nolen (2020) recently emphasized that it might be reasonable to even more strongly conceptualize the context as something that *includes* the individual, which consequently suggests bidirectional forces. Considering teachers' motivational teaching behaviors as a response to students' motivation should thus add to future research at the intersection of motivational science and research on teaching quality (e.g., Frenzel et al., 2018; Patall, Steingut, et al., 2018).

Third, in all of the three empirical studies, students' perceptions of their teachers' motivational teaching behaviors during class were on average important predictors of their motivation. However, it remained unclear whether differences in students' perceptions of motivational teaching behaviors were due to, for instance, students' deviations from each other in their needs for external support of their motivation or due to teachers attuning their behaviors (with different levels of success) to the needs of their students. The consideration of motivation as an outcome of motivational teaching behaviors thus indicated a differential functionality of teaching practices, and the aforementioned issue particularly puts the spotlight for future research on questions about idiosyncratic perceptions and dyadic relations between teachers and students (e.g., Göllner et al., 2018) as well as adaptive teaching strategies (e.g., Corno, 2008).

Fourth, a naïve interpretation of the findings from the empirical studies might seem to indicate "the more motivational teaching behaviors the better." However, findings on the authenticity of teaching behaviors (e.g., Frenzel et al., 2009; Keller et al., 2018; Taxer & Frenzel, 2018) call this naïve interpretation into question and stress the need to consider teachers' underlying motivation as well and to achieve a well-balanced alignment of teacher motivation and their behaviors. In particular, the findings on (the lack of) direct links between teacher motivation and student motivation in Study 2 might result from a lack of authenticity in some classrooms. The focus of future research might have to shift even further to the question of whether the alignment of teacher motivation, motivational teaching behaviors, *and* student motivation is likewise desirable or necessary. Either way, the consideration of motivation as an outcome of motivational teaching practices made explicit that the intensity of teaching behaviors might not be linearly linked to desirable outcomes but that other factors have an additional regulatory impact.

Finally, a particular strength of SEVT compared with other motivation theories is its focus on the value dimension of *cost* (Eccles, 2005; Eccles et al., 1983), which in some respect also reflects the positive value that one assigns to other subjects (e.g., negative values for one subject that play into the evaluation of another subject). Thus, with this conceptualization of cost, dimensional comparison effects are deeply embedded in SEVT, though initially not explicitly stated (but see, e.g., Möller & Marsh, 2013; Wigfield et al., 2020). The consideration of cost in Studies 1 and 3 revealed different mechanisms involving this value belief compared with others because the patterns of results for cost were often different from the other values. This could be a first indication of hidden dimensional comparison processes (i.e., the value of other subjects might have played into the processes under investigation in the respective studies, leading to other results regarding the subjective cost of engaging in math activities than regarding the remaining values). In light of the dimensional comparison processes also found for the appraisal of teaching quality in other studies (Arens & Möller, 2016; Dietrich et al., 2015; Jaekel et al., 2020), a comprehensive investigation of joint dimensional comparison effects in future research appears much needed to expand on current and past research findings.

6.3.2 Implications for Educational Policy and Practice

Notwithstanding the consistent need for more research to substantiate the findings of the current dissertation, there are still some implications that can be drawn for educational policy and practice. It became apparent from this dissertation that high-quality teaching that facilitates conditions under which students can motivate themselves are key for the quality of students' motivation. Consequently, attaining and consolidating the consistent use of motivational teaching behaviors should be a high-priority goal of educational policy and practice. In this light, the *Organisation for Economic Co-operation and Development* (OECD) stressed that "teachers must become lifelong learners and inquisitive professionals" (OECD, 2018, p. 31). Findings that in-service teachers' professional development (e.g., through workshops) is—apart from preservice training (including clinical training)—a specific quality of high-performing countries are in accordance with this claim (OECD, 2018). Professional development can be implemented successfully to support teachers in their teaching (e.g., Gore et al., 2017), though several features of such training programs and their implementation can impact their effect on teacher outcomes (e.g., Kowalski et al., 2020).

The current dissertation illuminated the idea that students' motivation interacts differently with their perceptions of the educational context created through teachers' behaviors during class. This was not only the case for individual students but also for the shared perceptions of the students from the same class. Hence, professional development trainings should focus on evolving competences in teachers that allow them to recognize and adapt to individual and shared needs of their students and to continuously adjust to changing conditions in the classroom.

Furthermore, in addition to teachers' motivational teaching behaviors in class, their own motivation can be critical for creating conditions under which students can motivate themselves. Shifting the focus in teachers' pre- and in-service training to such individual characteristics is an important task for educational policy and practice. Though teachers' well-being and stress factors are often acknowledged and considered relevant topics in teacher education, their motivation must become equally central with respect to both their well-being and their professional competence.

Finally, educational policy makers and practitioners might want to consider relevance interventions as additional boosters or compensators of (lacking) motivational teaching behaviors in math classrooms. For this purpose, thoroughly identifying classes with a particular need of such a boost or compensation appears a relevant precondition for this endeavor to protect against potential backfiring of such support attempts. However, apart from considering relevance interventions as boosters or compensators of the regular motivational climate in class created through motivational teaching behaviors, the current dissertation also made clear that even when educational interventions are well-developed and have been successfully tested in the past, they are usually not directly ready for scaling up. Factors such as varying educational contexts call for sound and extensive research on conditions under which interventions can be successful or might backfire. Nevertheless, educational interventions are often implemented "way ahead of how ready the science is" (D. S. Yeager in Denworth, 2019; see also Binning & Browman, 2020). Findings such as those from Study 3 (in terms of both the statistical power and the results of the interaction analyses) urge educational policy and practice for patience and deliberateness when it comes to the extensive implementation of intervention programs.

6.4 Conclusion

In summary, to fully understand and eventually to support students' motivation in the educational context, a perspective including teachers' behaviors during instruction is needed. This dissertation adapted such a perspective and highlighted the relevance of motivational teaching behaviors for students' motivation by focusing on their features, antecedents, and other factors that tend to accompany motivational teaching behaviors in the natural classroom setting. This dissertation utilized complementary aspects and concepts arising from several strands of research. Such a joint consideration is essential to furthering research on the unfolding of students' motivation in the natural classroom setting and enables novel implications for educational policy and practice.

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