Students' Motivation and Positive Emotions: Longitudinal Analyses of Influencing Factors and Effectiveness of a Multicomponent Intervention in Mathematics in Grades 7 and 8

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Abstract

Motivation plays a crucial role in successful learning processes, academic achievement, and lifelong learning. However, existing research has revealed unfavorable developments of motivational constructs as well as positive emotions over the school years—especially after the transition to secondary education and in the subject of mathematics. Given the relevance for learning and future careers and the unfavorable trajectories, fostering students' motivation and positive emotions in mathematics is of importance. Accordingly, the purpose of this dissertation was to gain a deeper understanding of the development and promotion of students' motivation and emotions in mathematics in lower secondary education. The three studies of this dissertation provide an in-depth analysis of the development and interplay of different motivational and emotional factors. Moreover, the effectiveness of a multicomponent intervention to promote motivation and positive emotions was evaluated. Within the intervention project "Maintaining and Fostering Students' Positive Learning Emotions and Learning Motivation in Maths Instruction During Early Adolescence (EMo-Math)," data from 348 students in the lowest-ability tier in mathematics in the Swiss canton of Bern were collected during Grades 7 and 8. Studies I and II investigated the interplay of basic psychological needs and self-determined forms of motivational regulation as well as control and value appraisals and different emotions. The results provided empirical support that these motivational and emotional factors are related to the self-determined forms of motivational regulation and different emotions and thus are suitable factors for promoting motivation and positive emotions. Furthermore, the two studies investigated the development of the constructs and revealed that intraindividual changes occurred in motivational and emotional factors as well as self-determined forms of motivation and emotions. In addition, the results of Study II also suggested between-person differences existed regarding changes, and Study III provided information on the stability of motivation profiles within the sample and the intraindividual changes between the motivation profiles. Regarding the effectiveness of the intervention, Studies I and II revealed no significant effect of the intervention. However, the results of Study III suggest an interaction existed between students' motivation and the intervention (i.e., aptitude-treatment interaction) that resulted in differential effects of the intervention among students. The intervention seemed to be effective for some students, whereas it was counterproductive for other students. Overall, the research findings highlighted the complexity of student motivation and emotions and the challenges associated with their promotion. Finally, implications for theory, future research, and educational practice are discussed.

Zusammenfassung

Motivation spielt eine entscheidende Rolle für erfolgreiche Lernprozesse, schulische Leistungen und lebenslanges Lernen. Die bisherige Forschung hat jedoch gezeigt, dass sich motivationale Konstrukte und positive Emotionen über die Schulzeit ungünstig entwickeln – insbesondere nach dem Übertritt in die Sekundarstufe und im Fach Mathematik. Aufgrund der Relevanz für das Lernen und das spätere Berufsleben kommt der Förderung der Motivation und der positiven Emotionen von Sekundarschülerinnen und -schülern im Fach Mathematik eine entscheidende Bedeutung zu. Entsprechend war das Ziel der vorliegenden Dissertation, ein tieferes Verständnis für die Entwicklung und Förderung der Motivation und der Emotionen von Sekundarschülerinnen und -schülern im Fach Mathematik zu gewinnen. Die drei Studien dieser Dissertation liefern eine vertiefte Analyse über die Entwicklungen und das Zusammenspiel verschiedener motivationaler und emotionaler Faktoren. Darüber hinaus wurde die Wirksamkeit einer Multikomponenten-Intervention zur Förderung der selbstbestimmten Motivation und positiver Emotionen untersucht. Im Rahmen des Interventionsprojekts «Maintaining and Fostering Students' Positive Learning Emotions and Learning Motivation in Maths Instruction During Early Adolescence» (EMo-Math) wurden die Daten von 348 Sekundarschülerinnen und -schülern des niedrigsten Leistungsniveaus (Realschule) im Fach Mathematik im Kanton Bern während der 7. und 8. Klasse erhoben. Die Studien I und II untersuchten das Zusammenspiel der psychologischen Grundbedürfnisse und der selbstbestimmten Motivation sowie der Kontroll- und Wert-Appraisals und unterschiedlichen Emotionen. Die Ergebnisse belegen empirisch, dass diese motivationalen beziehungsweise emotionalen Faktoren mit den selbstbestimmten Formen von Motivation beziehungsweise Emotionen zusammenhängen und sie somit geeignete Faktoren zur Förderung von selbstbestimmter Motivation und positiven Emotionen darstellen. Darüber hinaus untersuchten die beiden Studien die Entwicklung der Konstrukte im Zeitverlauf und zeigten, dass intraindividuelle Veränderungen bei den motivationalen und emotionalen Faktoren sowie bei den selbstbestimmten Formen der Motivation und den Emotionen auftreten. Weiter deuten die Ergebnisse der Studie II darauf hin, dass es auch zwischen den Schülerinnen und Schülern Unterschiede in den Veränderungen gibt. Studie III gab Aufschluss über die Stabilität der Motivationsprofile innerhalb der Stichprobe und über die intraindividuellen Veränderungen zwischen den Motivationsprofilen. Hinsichtlich der Wirksamkeit der Intervention ergaben die Studien I und II keine signifikanten Effekte der Intervention. Die Ergebnisse der Studie III deuten jedoch darauf hin, dass es eine Wechselwirkung zwischen der Motivation der Schülerinnen und Schüler und der Intervention gibt (d.h. eine Aptitude-Treatment Interaktion), die zu unterschiedlichen Effekten bei den Schülerinnen und Schülern führte. Demnach scheint die

Intervention für einige Schülerinnen und Schüler wirksam zu sein, während sie für andere Schülerinnen und Schüler kontraproduktiv sein könnte. Insgesamt verdeutlichen die Forschungsergebnisse die Komplexität der Konstrukte *Motivation* und *Emotion* sowie die Herausforderungen, die mit ihrer Förderung einhergehen. Abschliessend werden Implikationen für die Theorie, die künftige Forschung und die pädagogische Praxis diskutiert.

List of Publications

1. Held-Augustin, T., Hagenauer, G., & Hascher, T. (in press). Zusammenhänge zwischen der Erfüllung der psychologischen Grundbedürfnisse und der selbstbestimmten Lernmotivation im Mathematikunterricht der Sekundarstufe I [Relations between the satisfaction of basic psychological needs and self-determined learning motivation in mathematics in lower secondary education]. In R. Lazarides & D. Raufelder (Hrsg.), *Edition Zeitschrift für Erziehungswissenschaft: Bd. 10. Motivation in unterrichtlichen fachbezogenen Lehr-Lernkontexten* (S. 151–180). Springer.

2. Held, T., & Hascher, T. (under revision). Testing effects of promoting antecedents of mathematics achievement emotions: A change-change model. *Learning and Individual Differences.*

3. Held, T., & Hascher, T. (under review). Stability and change of low-achieving secondary school students' motivation profiles for mathematics: Effects of an intervention. *Journal of School Psychology.*

The versions of the publications included here might not exactly replicate the final published versions. They are not a copy of the record. All rights for the original versions are with the respective publishers. The three studies are presented in an order that corresponds to their fit regarding content and not according to the chronological order of the submissions/acceptances of the papers. Study I is presented in the language of the original publication (German).

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Table of Contents

1 Introduction

Motivation is an important prerequisite for academic learning processes and achievement and thus also for lifelong learning and active participation in society. However, several researchers have identified a general decline in students' motivation (e.g., Gillet et al., 2012; Gnambs & Hanfstingl, 2016; Scherrer & Preckel, 2019) as well as important motivational factors, such as positive emotions over time (Bieg et al., 2019; Hagenauer & Hascher, 2010; Meyer & Schlesier, 2021), especially after the transition to secondary education (Gottfried et al., 2013; Vierhaus et al., 2016). Although these negative trends have be observed in various subjects, the subject of mathematics seems to be particularly affected by this adverse development (Gottfried et al., 2001; Raccanello et al., 2013). Given the relevance of motivation for academic success and future life, researchers have developed several interventions to foster learning motivation in general (Lazowski & Hulleman, 2016) as well as in mathematics (Rosenzweig & Wigfield, 2016).

Several theoretical approaches have been applied to investigating students' motivation and how to promote adaptive behaviors, emotional well-being, and learning. However, most interventions rely on a single theoretical framework. Moreover, motivation is a complex phenomenon that resists simple reductionism (Ryan, 2012). Thus, the present dissertation addressed this complexity by applying a multicomponent intervention: Based on different theoretical approaches, various motivation-enhancing factors were addressed to achieve broad promotion. Therefore, the present dissertation aimed to contribute to the understanding of the development and promotion of motivational and emotional factors in mathematics and evaluate the effectiveness of the multicomponent intervention in lower secondary education. Three key topics were focused on: a) the interplay between motivational factors and self-determined motivation as well as emotional factors and emotions; b) the development of these aspects across time; c) the effectiveness of the multicomponent intervention over 2 school years for secondary school students in the lowest-ability tier in mathematics.

Such an investigation is of undoubted significance for theory, research, and practice. For theory, the dissertation highlights the complexity of the phenomenon of student motivation and provides an in-depth analysis of students' motivation and emotion and related constructs. For research, the dissertation contributes to the field by examining the long-term effects of a multicomponent intervention and providing additional insights into the interindividual nature of motivation and emotion and their promotion. Likewise, this research is valuable for practice, as it discusses the potential to promote motivation and positive emotions in school and learning.

The dissertation consists of four parts: In the first part, the theoretical background for the three empirical studies is presented in Chapters 2 and 3 to situate these studies in the broader research context. At the beginning of Chapter 2, the concept of motivation is overviewed by considering different theoretical approaches and outlining possible factors that promote students' motivation and the effects of motivation on students' learning. In addition, the most important research findings on the trajectories of students' motivation are presented. Moreover, Chapter 2 is devoted to the concept of emotion, the most important research findings regarding the effects of emotions on learning, and the development of students' emotions. Finally, Chapter 2 concludes with the interplay of emotions and motivation in the context of the different motivation theories. Based on the theoretical considerations of motivation and emotion, Chapter 3 focuses on motivational interventions by highlighting the conceptual characteristics of motivational interventions and the effectiveness of motivational interventions. Finally, Chapter 3 concludes with a spotlight on aptitude-treatment interaction research. In the second part of this dissertation, the derivation of the research questions is presented in Chapter 4 and the methodological underpinnings of the project on which the studies are based are introduced in Chapter 5. Subsequently, in Chapter 6, an overview of the studies of the present dissertation is provided. The third part presents the three empirical studies conducted as part of this dissertation: The first study presents a cross-lagged study of students' self-determined forms of motivational regulation and students' perceived basic psychological needs (Chapter 7). The second study investigates the interplay of control and value appraisals and different emotions and whether these appraisals are affected by the intervention (Chapter 8). The third study explores differential effects of the motivational intervention on students' motivation based on students' aptitude (Chapter 9). Finally, the fourth part provides a summary and general discussion of the findings as well as strengths and limitations of the dissertation. Chapter 10 concludes with a discussion of implications for theory development, future research, and educational practice.

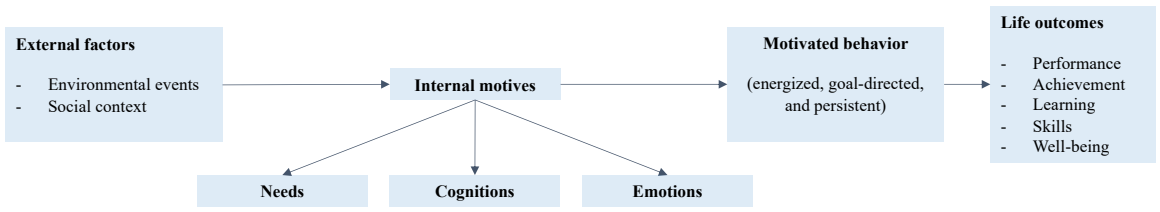
2 The Inseparables: Motivation and Emotion

Etymologically, the word motivation originates from the Latin verb *movere* and means "to move." Although researchers agree on the word's origin, individual definitions within motivation research vary according to their theoretical perspective (e.g., neurological, cognitive), level of description, and underlying causal model (Dai & Sternberg, 2004; Murphy & Alexander, 2000; Ryan, 2012; Schunk et al., 2014; Strombach et al., 2016). In general, research on motivation attempts to answer the why questions of behavior and try to identify the hidden causes (e.g., "Why did they start a specific behavior?" and "Why is the behavior maintained or changed over time?"; Heckhausen, 2018; Reeve, 2018). More precisely, motivation research seeks to understand the internal process that provides a behavior with its *vigor, direction*, and *persistence* (Bergin et al., 1993, p. 437; Murphy & Alexander, 2000; Reeve, 2018; Schunk et al., 2014), which imply that behavior is relatively strong and resilient, directed toward a goal or outcome, and sustained over time and across various situations (Reeve, 2018).

A general term for this internal process that drives motivated behavior is an *internal motive* (cf. Figure 1). Internal motives, as the proximal and direct causes, can be distinguished in *needs*, *cognitions*, and *emotions*. Needs are the conditions that are crucial for sustaining life and promoting well-being. These conditions include biological needs (e.g., water) as well as psychological needs (e.g., competence). Cognitions comprise mental events, such as thoughts, beliefs, goals, and self-concepts, and refer to a person's thought process. Emotions are complex reactions to events consisting of the four aspects of feeling, arousal, purpose, and expression, which influence the person's behavior (Reeve, 2018).

Figure 1

Framework on the Interplay of Motivation and Emotion (adapted from Reeve, 2018, p. 13)



In addition, external factors such as environmental events (e.g., external stimuli, including praise or punishment) and the social context (e.g., classroom climate) influence internal motives. These antecedent conditions affect an individual's needs, cognitions, and emotions and result in energized and goal-directed behavior (Reeve, 2018). For example, positive

feedback (antecedent condition) promotes perceived competence (need), self-concept and expectations (cognitions), and enjoyment (emotion), which lead to persistent, goal-directed behavior.

In the context of school, the crucial fact is that motivation is reciprocally related to learning and achievement across time—in other words, motivation influences learning and achievement and what students learn and achieve, in turn, influences their motivation. Therefore, "motivation for learning promotes learning and sustains itself for future learning" (Schunk et al., 2014, p. 6). Based on this longitudinal relationship, motivation is highly relevant to a person's professional and social development.

In the following sections, student motivation is examined from a variety of perspectives while introducing frequently used motivational theories and embedding them within the larger framework of motivational research. In addition, motivation-enhancing factors and their effects on students are highlighted and the trajectories of student motivation over time are considered. Further, the role of emotions is addressed by explaining their development and effects on learning as well as the trajectories of different emotions across time. Finally, the role of emotions in different motivation theories is addressed and discussed.

2.1 Student Motivation

The intellectual origin of current motivation research in education is rooted in the work of the ancient Greek philosophers Socrates, Plato, and Aristoteles (Reeve, 2018; Schunk et al., 2014). Since then, the concept of motivation has changed and evolved, individual concepts have been challenged and replaced, and other concepts have been refined (for a historical overview of motivation research cf. Heckhausen, 2018; Reeve, 2018). In the 21st century, student motivation is being examined from different perspectives and with various theories to answer specific questions within the motivational process, each contributing a different piece to the puzzle of motivation (Reeve, 2018; Ryan, 2012).

Due to the conceptual overlaps of the theories, motivation researchers (e.g., Dweck, 2017) have sometimes discussed the need to synthesize these theories—although few have attempted to realize this (Anderman, 2020; Lazowski & Hulleman, 2016). Whether an overarching meta-theory on this complex phenomenon of motivation will be developed remains unclear; hence, the advantages of the numerous mini-theories are highlighted. In particular, these mini-theories enable research studies to be precisely designed and specific research questions to be investigated (Anderman, 2020). Also, the understanding that behavior is dynamic and complex and is energized and influenced by a variety of interacting influences, supports the use of various

mini-theories, each attempting to understand only a particular motivational phenomenon, rather than trying to explain the process of student motivation as a whole (Reeve, 2018; Ryan, 2012; Schunk et al., 2014).

Thus, a selection of four theories—namely attribution theory, expectancy-value theory (EVT), goal orientation theory, and self-determination theory (SDT)—that have made a significant contribution to research in recent years and have often been applied empirically in educational contexts (Cook & Artino, 2016; Koenka, 2020) is described in the following. Although each of the theories can be used to examine academic motivation, they differ in their underlying research questions (cf. Table 1), examine different constructs, and make different contributions to educational practice. Despite these differences, they share some common characteristics: These theories all employ a social-cognitive approach to understanding academic motivation and integrate beliefs, values, and goals along with the antecedents and consequences of the motivational process (Eccles & Wigfield, 2002; Koenka, 2020).

In line with their individual foci, the four theories are described separately in the following chapters. The theories are listed alphabetically because each has a different explanatory power and relevance for specific motivational phenomena and none takes precedence over the others (Koenka, 2020; Ryan, 2012).

Table 1

Theories and Possible Research Questions (adapted from Anderman, 2020, p. 3)

Theory	Questions that could be answered
Attribution theory (Weiner, 1985)	Why did a student succeed at a specific task? Why not?
Expectancy-value theory (Eccles et al., 1983)	Is engaging in a specific task useful, interesting, and worth a student's time?
Goal orientation theory (Ames, 1992; Dweck, 1986; Maehr, 1984; Nicholls, 1984)	Why is a student doing this task? To attain mastery or demonstrate competence?
Self-determination theory (Deci & Ryan, 1985)	Is a student engaging in a specific task for its own sake (intrinsic motivation) or to attain an outcome that is separate from the task (extrinsic motivation)?

2.1.1 Attribution Theory

Attribution theory (Weiner, 1985; for a historical review of attribution research see Weiner, 2008) pursues the why questions of behavior by seeking a causal explanation (attribution) for an event or outcome (e.g., "Why did I fail the exam?"). Attribution theory focuses on cognitions and emotions activated once a behavior is ceased and assumes that individual causal attribution of success or failure determines subsequent effort (Graham & Williams, 2009; Weiner, 2010). Thus, attribution theory encompasses both the causes, related antecedents and dimensions as well as the cognitive, affective, and behavioral consequences of causal attributions[1] (Graham, 2020; Graham & Williams, 2009).

According to attribution theory, motivated behavior begins with an outcome that is interpreted as either a success or failure (cf. Figure 2). This interpretation leads to an initial emotional reaction (outcome-dependent emotion, e.g., happiness or sadness). Next, considering attributional antecedents (e.g., teacher feedback [Rattan et al., 2012] or school climate [Schacter & Juvonen, 2015]), a causal explanation (causal ascription) is sought to determine why this outcome occurred (Graham & Taylor, 2016; Graham & Williams, 2009). In the educational context, success or failure is often attributed to aptitude, ability, effort, task characteristics, other people (e.g., teacher), or luck (Graham & Williams, 2009; Weiner, 2010). These causal ascriptions can be characterized based on three dimensions: *locus* (is the cause internal or external to the individual), *stability* (is the cause constant or likely to change?), and *controllability* (is a cause volitionally controllable?; Graham & Williams, 2009; Weiner, 2010). For example, effort is typically perceived as internal, unstable, and controllable, whereas innate skill is internal, stable, and uncontrollable. Each of these dimensions has a specific influence on different aspects of behavior and is linked to a set of psychological, emotional, and behavioral consequences (Graham & Williams, 2009).

The locus dimension is associated with self-esteem and esteem-related emotions (e.g., pride or shame). Attributing success to internal attributions (e.g., effort) rather than external attributions (e.g., luck) leads to greater self-esteem and pride (Banks & Woolfson, 2008; Oades-Sese et al., 2014). In contrast, failures should be attributed to external rather than internal causes for the maintenance of self-esteem.

The stability dimension influences expectations for success: Stable causes lead to the belief that the future will not be different from the past, whereas unstable causes lead to the hope

[1]Although Weiner's attribution theory distinguishes between the consequences of attributions made by individuals about their own outcomes (intrapersonal theory of motivation) and the consequences of attributions made about outcomes of others (interpersonal theory of motivation; Graham & William, 2009), the focus of the following description is only on the intrapersonal theory of motivation.

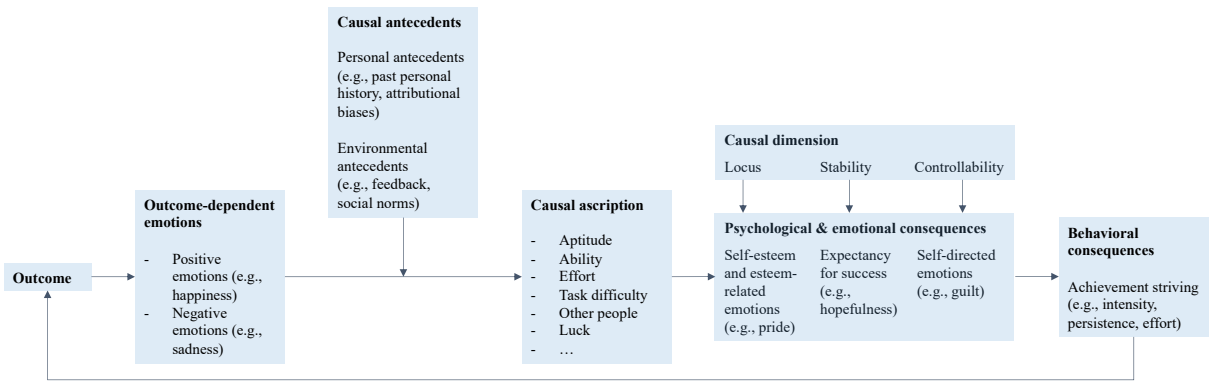
that the future might change (Weiner, 1985, 2010). For example, if a student attributes success to a stable cause (e.g., innate skill), they are more likely to assume the same outcome (i.e., success) in future situations than if the success is attributed to an unstable cause (e.g., effort).

Finally, the controllability dimension is related to self-directed emotions. When failure is attributed to controllable causes, it leads to feelings of guilt. In contrast, if failure is attributed to uncontrollable causes, this leads to shame, helplessness, and dejection (Graham, 2020; Graham & Williams, 2009).

In sum, these psychological and emotional consequences of the three dimensions in turn influence behavior (e.g., intensity and persistence of behavior), as expectancy and emotions are considered key mediators of achievement-related behavior. "Thus, increased school motivation and decreased school dropouts can be affected by alteration of perceived causality" (Weiner, 2010, p. 562).

Figure 2

Conceptual Representation of Weiner's Attribution Theory of Intrapersonal Motivation (adapted from Graham & Williams, 2009, p. 13)



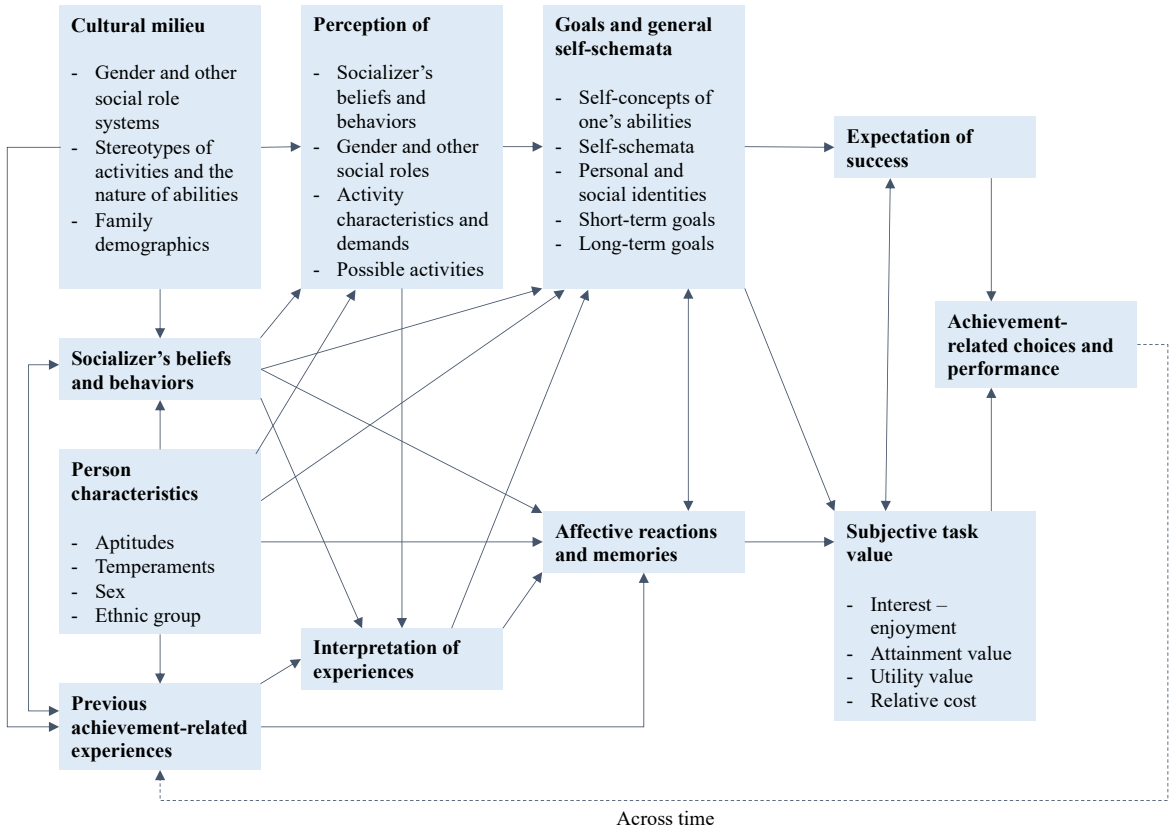
2.1.2 Expectancy-Value Theory

EVT (Eccles et al., 1983; Wigfield & Eccles, 2000) attempts to answer the why question by identifying motivated behavior as the product of *expectancy of success* and perceived *value* of the task (cf. Figure 3). Expectations of success refer to children's beliefs about how well they will perform on an upcoming task (Eccles & Wigfield, 2002; Wigfield et al., 2009). Task value comprises four components: *attainment value*, *intrinsic value*, *utility value*, and *cost* (Eccles et al., 1983). Attainment value is defined as the personal importance of performing well in the task, while intrinsic value refers to the enjoyment experienced in performing the task. Utility value is defined by how well a task aligns with current and future goals. Thus, a task may have positive value because it enables important future goals, even if the person is not interested in

the task itself. Finally, cost includes the negative aspects of task performance, such as the required effort, other opportunities that are lost as a result of task engagement, and emotional cost (e.g., anxiety; Eccles & Wigfield, 2002; Wigfield et al., 2016). Notably, how expectancies of success and subjective task value predict performance and choice are widely supported by empirical studies (cf. Eccles & Wigfield, 2020; Wigfield & Eccles, 2020).

Figure 3

Expectancy-Value Model of Achievement Choices (Eccles & Wigfield, 2020, p. 2)



Expectations of success and subjective task value are influenced by social-cognitive variables, such as perceptions of competence and task difficulty, individual goals, and self-schema. These, in turn, are influenced by perceptions of other people's attitudes and expectations and one's interpretations of the results of past performance, the cultural milieu, and the behaviors and beliefs of socializers (e.g., teachers, or parents; Wigfield et al., 2016). Thus, the model consists of constructs at different levels and different time frames (e.g., cultural milieu as a long-term macro-level construct vs. expectation of success as a moment-to-moment decision at a micro-cognitive level; Eccles & Wigfield, 2020, p. 2). Overall, the EVT highlights the complexity of individual development of success expectations and subjective task values influenced

by the social context and how these relate to students' future performance, choice, and engagement (Eccles & Wigfield, 2020; Schunk et al., 2014; Wigfield et al., 2016).

2.1.3 Goal Orientation Theory

Goal orientation theory, also referred to as achievement goal theory, was developed through the contributions of Ames (1992), Dweck (1986), Maehr (1984), and Nicholls (1984) and pursues the why question by specifying the kinds of goals that direct achievement-related behavior (Maehr & Zusho, 2009, p. 77; Schunk et al., 2014; Urdan & Maehr, 1995). In this context, the goal does not refer to what a person wants to achieve (e.g., "My goal is to get an A on the next mathematics test.") but seeks to understand why a person wants to achieve this goal (e.g., "Why would a student want to get an A?"). Thus, achievement goals are "superordinate classes of goals" (Urdan & Maehr, 1995, p. 215) and refer to an integrated pattern of beliefs, attributions, and affect that direct students toward specific achievement behaviors (Ames, 1992). Consequently, depending on the reason for a student's goal, success may be defined differently, and these definitions of success influence how a student performs on a task. Thus, it is assumed that there is more than one way to be motivated and that different types of motivation may lead to different qualities of learning (Urdan & Kaplan, 2020). For example, a student may want to get an A on the test because they want to learn and understand the topic. Thus, they define success as learning, understanding, and developing a new skill and, therefore, will be more likely to engage in the task and will be more resilient in case of setbacks. In contrast, another student may want to get an A to demonstrate to others (e.g., teachers, classmates) that they are smarter than the others. Therefore, they define success as performing better than others and appearing intelligent and are likely to take shortcuts (e.g., cheating), avoid challenging tasks, and give up in case of setbacks (Maehr & Zusho, 2009; Urdan & Kaplan, 2020).

Based on these definitions of success, two types of achievement goal orientation can be defined: mastery and performance. Mastery goal orientation (also referred to as learning or task goal orientation) focuses on the purpose of developing competencies and skills through learning. In contrast, performance goal orientation (also referred to as ego or ability goal orientation) focuses on the purpose of demonstrating one's competence (Ames, 1992; Kaplan & Maehr, 2007; Urdan & Kaplan, 2020). However, the kind of goal orientation a student pursues is not an encapsulated component of the self but is, as mentioned above, an incorporated conception. It depends on factors such as the perception of the self, how they have responded affectively and behaviorally in previous similar situations, and identity, which is influenced by the cultural and social environment (Maehr & Zusho, 2009; Urdan & Kaplan, 2020).

However, researchers have criticized this dichotomous achievement-goal construct for lacking the energizing component and have highlighted the need to incorporate a distinction between approach and avoidance motivation. Based on the prevalence of positive and negative outcomes with performance goals (Elliot & Harackiewicz, 1996), a trichotomous framework of achievement goals comprising *mastery*, *performance-approach*, and *performance-avoidance* orientation was proposed (Elliot, 1999; Elliot & Church, 1997; Elliot & Harackiewicz, 1996). In the performance-approach orientation, individuals are motivated to demonstrate their competence and superiority, whereas, in the performance-avoidance orientation, individuals are motivated to avoid failure and looking incompetent (Elliot, 1999; Elliot & Harackiewicz, 1996; Schunk et al., 2014). In short, the two performance orientations differ in terms of the valence of competence.

In the 2x2 model, this valence distinction was later also applied to the mastery orientation (Elliot & McGregor, 2001; Midgley et al., 1998; Pintrich, 2000) with a focus on achieving success (*mastery-approach orientation*, e.g., further developing competence) versus a focus on avoiding failure (*mastery-avoidance orientation*, e.g., not stagnating in development competence). The trichotomous and the 2x2 models are subsumed by the *multiple goals perspective*, which generally assumes that the impact of performance goals is not entirely negative; moreover, neither model assumes that mastery and performance goal orientations represent two ends of a continuum. Thus, the goals are relatively independent of one another and it is possible to pursue both simultaneously (Maehr & Zusho, 2009; Senko, 2016). In contrast, theorists of the dichotomous model assume the two goals are opposing orientations that are largely incompatible and thus require an equal amount of effort (Senko, 2016).

Although confirmatory factor analysis validated the four-goal structure over the two- and three-goal structure (e.g., Elliot & Murayama, 2008; Zusho et al., 2007), the four-goal structure has been the least empirically tested and has not been widely embraced (King & McInerney, 2014; Maehr & Zusho, 2009; Senko, 2016). In sum, no model can be determined to be favored. However, the 2x2 model is the most controversial, and the mastery-avoidance goal construct is the least accepted, which is why the majority of researchers prefer the trichotomous model (Maehr & Zusho, 2009). Overall, goal orientation theory assumes different orientations influence a person's behavior and are, therefore, subject to different cognitive, affective, and behavioral consequences.

2.1.4 Self-Determination Theory

SDT (Deci & Ryan, 1985; Ryan & Deci, 2002) is a broad framework that seeks to understand the why question by identifying biological, social, and cultural factors that facilitate or undermine motivated behavior (e.g., "Why do students study for a mathematics test?"). Due to the comprehensive framing and broad scientific and practical contributions (Ryan & Deci, 2017, 2019), and because the following empirical articles are related to SDT as outcome variables, it is described more comprehensively than the previous theories.

In contrast to other motivation theories (e.g., EVT) that use a unitary concept of motivation, SDT distinguishes between different forms of motivation based on their locus of causality (cf. continuum of self-determination). SDT, as an organismic theory, assumes an inherent propensity for psychological growth and integration in humans, and thus that "individuals have natural, innate, and constructive tendencies to develop an ever more elaborated and unified sense of self" (Ryan & Deci, 2002, p. 5). In addition to this organismic perspective, SDT also suggests a dialectic view, assuming a permanent interactive relationship between the integration process and influences of the social environment (e.g., social-cultural factors) that promote or hinder this integrative tendency (Ryan & Deci, 2002, 2016).

SDT as a macro theory of human behavior and development has evolved over the decades and consists today of six mini-theories (listed in the order of their conceptualization): *cognitive evaluation theory*, *organismic integration theory*, *causality orientations theory*, *basic psychological needs theory*, *goal contents theory*, and the most-recent *relationships motivation theory* (Ryan & Deci, 2002, 2017). All mini-theories share the organismic and dialectic assumption, and each mini-theory represents a piece of the SDT framework.

Cognitive Evaluation Theory

Cognitive evaluation theory (CET) focuses on how the social environment impacts intrinsic motivation, which refers to a class of actions performed based on inherent satisfaction and pleasurable feelings. Thus, it is the prototype of self-determined behavior, which is willingly and volitionally done, and no external pressures or incentives are required (Deci & Ryan, 2009; Ryan & Deci, 2000a). Given the association of intrinsic motivation with greater conceptual understanding (Grolnick & Ryan, 1987), academic achievement (Taylor et al., 2014), lifelong learning (Parisi et al., 2019), and well-being (Vansteenkiste et al., 2007), it is considered desirable and worthy of being promoted. However, intrinsic motivation is an evolved and inherent human tendency and, therefore, cannot be caused by social-contextual factors—although such factors can either enhance or diminish intrinsic motivation.

Research within CET focuses on social-cultural factors (e.g., reward, punishment) that promote, maintain, or undermine intrinsic motivation (Ryan & Deci, 2017). Early studies (e.g., Deci, 1971, 1972) on the effect of rewards revealed that expected tangible rewards (e.g., money) decrease intrinsic motivation, whereas verbal rewards (e.g., positive feedback) tend to promote intrinsic motivation (Deci et al., 1999). This undermining effect of tangible rewards has also been confirmed from a neuropsychological perspective (Ma et al., 2014; Murayama et al., 2010; c.f. Murayama, 2019). Further research also revealed an undermining effect of punishment (Deci & Cascio, 1972), evaluation (Grolnick & Ryan, 1987), surveillance (Plant & Ryan, 1985), and imposed deadlines on work (Amabile et al., 1976).

Although choice (Patall et al., 2010) and positive feedback (De Muynck et al., 2017) have been documented to promote intrinsic motivation, it should be considered that such events are embedded in interpersonal relationships and social contexts (cf. Ryan & Deci, 2017). The interpretation of, for example, feedback is also influenced by the goals and relationships of the person providing it. Therefore, interpersonal styles, attitudes, and intentions may affect the functional meaning of an event. In addition, intrinsic motivation is affected by one's intrapersonal context (e.g., values, attitudes, interest). These interpersonal and intrapersonal processes cause that not all individuals respond in the same way and differ in their intrinsic motivation (Deci & Ryan, 2008; Ryan & Deci, 2017).

In sum, intrinsic motivation is considered an important predictor of academic success. However, not everything is fun and interesting in school, which often leads to behaviors that are not intrinsically, but extrinsically, motivated. These activities are not likely to be performed if there is no extrinsic reason (Ryan & Deci, 2002). The next mini-theory is, therefore, dedicated to extrinsic motivation.

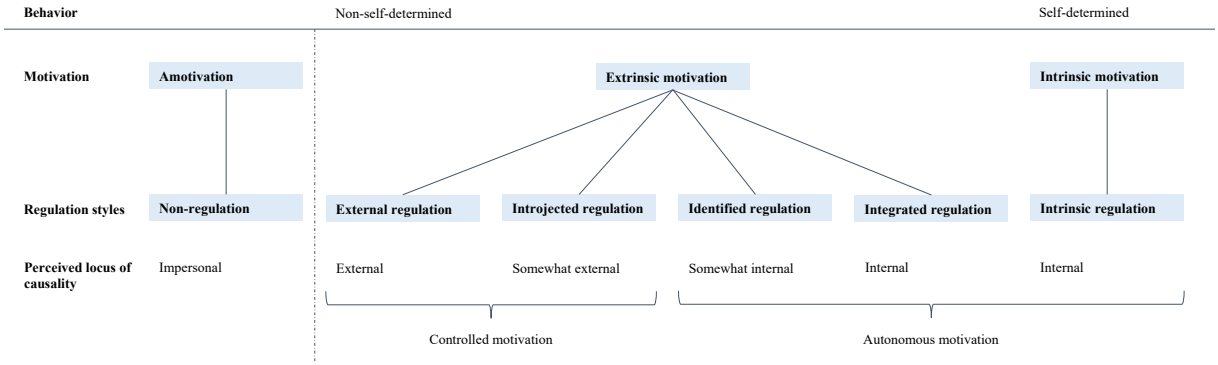
Organismic Integration Theory

SDT does not conceptualize extrinsic motivation as contradictory to intrinsic motivation, nor as one-dimensional; rather, it differentiates between types of extrinsic motivation (Ryan & Deci, 2017). Organismic integration theory (OIT) focuses on these various forms of extrinsic motivation and describes the factors in a social and interpersonal context that facilitate or undermine the integrative tendency of humans. OIT assumes that individuals tend to internalize external prompts from relevant reference groups that encourage, promote, or even compel them to engage in an activity for which they are not intrinsically motivated (Ryan & Deci, 2002, 2017). Internalization is the internal psychological "process of taking values, beliefs, or behavioral regulations from external sources and transforming them into" the self and represents a

natural process of growth (Ryan & Deci, 2017, p. 180). Internalization is thereby not viewed from a dichotomous but a continuum perspective: Depending on the quality of endorsement or acceptance of external values, a stronger or weaker degree of internalization results (Deci & Ryan, 2008; Ryan & Deci, 2017). OIT assumes four regulation types of extrinsic motivation exist that differ in the degree to which values are internalized into a person's self: *external regulation*, *introjected regulation*, *identified regulation*, and *integrated regulation* (cf. Figure 4).

Figure 4

The Organismic Integration Theory Taxonomy of Regulatory Styles (adopted from Ryan & Deci, 2000b, p. 72)



External regulation includes behavior that is motivated by and dependent on external rewards or punishments. The behavior is only demonstrated when an external consequence is expected and leads to a lack of maintenance of the behavior as soon as the exception is removed (Ryan & Deci, 2002, 2017). An example of external regulation is when a student learns material for a mathematics test because they will receive money for a good grade. The student learns as long as they get the money, but if the parents stop paying, the student no longer has a reason to achieve and may stop learning at all. Such behavior is not internalized, has an external perceived locus of causality, and is considered controlled (Ryan & Deci, 2017).

Introjected regulation is the least effective form of internalization when an external value is considered, but internalization is only partially accomplished (Ryan & Deci, 2002, 2017). The behavior is demonstrated because of an inner controlling force because one "should" or "must" do something and is associated with feelings like guilt or pride. A student, for example, learns material for a mathematics test because otherwise they feel guilty (Deci & Ryan, 2008; Ryan & Deci, 2017). Introjected regulation is an intrapersonal form of regulation because it does not depend directly on external factors but on evaluative processes within the individual. It is thus a form of control over oneself and, therefore, has the advantage of being somewhat

more consistent than external regulation, although it has still an external perceived locus of causality (Ryan & Deci, 2017).

In identified regulation, the behavior is subject to an internal endorsement of the formerly external values, so that it is considered personally important (Ryan & Deci, 2002, 2017). Compared to introjected regulation, identified regulation is characterized by experiencing greater autonomy and more internal perceived locus of causality (Deci & Ryan, 2008; Ryan & Deci, 2017). An example of identified regulation is when a student learns material for a mathematics test because they need good grades in mathematics for a potential future job. Based on the identified importance of an action, the behavior is more stable, persistent, and associated with more positive emotions (Ryan & Deci, 2017, 2019).

Integrated regulation represents the most self-determined form of extrinsic motivation, in which individuals have fully integrated external values into the self through self-reflection and reciprocal assimilation (Ryan & Deci, 2002, 2017). When this is achieved, a fuller endorsement of the behavior or value and an absence of conflict with other enduring identifications will be experienced (Deci & Ryan, 2008; Ryan & Deci, 2017). Integrated regulation and intrinsic motivation have some similarities, such as flexibility and volitional engagement, but they differ in that intrinsically motivated behavior is performed because it is interesting and enjoyable, whereas behavior based on integrated regulation is performed because it is personally important, valuable, and meaningful to the person (Deci & Ryan, 2008; Ryan & Deci, 2002). Because they retain their instrumental orientation, formerly extrinsically motivated behaviors are typically not transformed into intrinsically motivated ones (Deci & Ryan, 2012; Ryan & Deci, 2020).

Thus, in contrast to intrinsic motivation, extrinsic motivation is a heterogeneous category containing four regulation forms that are located on a continuum and vary systematically in the degree of self-determination and internalization (cf. Figure 4). Based on this continuum, OIT regards external and introjected regulation as forms of *controlled motivation*, whereas identified, integrated, and intrinsic regulations are forms of *autonomous motivation* (Ryan & Deci, 2002). Each type reflects an individual's intention to act but may lead to different quality outcomes (Deci & Ryan, 2008).

Both intrinsic and extrinsic motivation entail the intention to behave. In contrast, *amotivation* reflects the lack of intention to act and results from not valuing a behavior or outcome and, therefore, lies outside the continuum (Ryan & Deci, 2017, 2020). The continuum perspective of external, introjected, identified, and intrinsic regulation is confirmed by a quasi-simplex pattern in that the types of regulation adjacent on the continuum are more highly correlated than

those more distant (Howard et al., 2018; Ryan & Connell, 1989; Ryan & Deci, 2017). Integrated regulation is usually not considered because it cannot be clearly distinguished from identified regulation by self-report (Ryan & Deci, 2017).

Overall, OIT thus assumes social context influences extrinsic motivation. Depending on the internalization strength of external prompts, different styles of regulation can be distinguished, which in turn predict functional quality (e.g., performance or persistence) and well-being (Ryan & Deci, 2002, 2017).

Causality Orientations Theory

CET and OIT focus on the social-contextual influences on intrinsic motivation and internalization of extrinsic motivation, whereas causality orientations theory (COT), the third mini-theory of SDT, focuses on individual differences in motivational styles. Causality orientations describe individual tendencies in how motivationally relevant information is perceived and organized, which are associated with specific antecedents and consequences (Ryan & Deci, 2017). Three main orientations are proposed in COT, all of which are present to some degree in every person: *autonomous*, *controlled*, and *impersonal orientations* (Deci & Ryan, 1985, 2002; Ryan & Deci, 2017).

Autonomy orientation is characterized by behavioral regulation based on interests and self-determined values (Ryan & Deci, 2002). Individuals with a tendency toward an autonomy orientation tend to interpret the environment as supportive of their autonomy, use identified and integrated styles of regulation, and reveal a higher level of intrinsic motivation (Weinstein et al., 2011; cf. Ryan & Deci, 2017, 2019). Controlled orientation is characterized by orienting to external controls and directives on how to behave and losing sight of one's values or interests. Individuals with a tendency toward a controlled orientation tend to interpret their environments as pressurizing and coercive, use introjected and external styles of regulation, and reveal a lower level of intrinsic motivation (cf. Deci & Ryan, 2012; Ryan & Deci, 2017). Finally, impersonal orientation is characterized by nonintentional behavior and interpreting the environment as an obstacle to achieving desired outcomes and is, therefore, related to amotivation (Soenens et al., 2005; cf. Deci & Ryan, 2012; Ryan & Deci, 2019). Thus, each orientation predicts various behaviors and outcomes (e.g., strong autonomy orientation positively correlates with self-esteem [Deci & Ryan, 1985], prosocial behavior [Gagné, 2003], and psychological well-being [Legault et al., 2017; cf. Ryan & Deci, 2017]).

As mentioned, COT assumes that all orientations are present in an individual but differ in their relative strength, so that each individual engages with the world in some degree

autonomy-oriented, some degree control-oriented, and some degree impersonal-oriented (Deci & Ryan, 2012; Ryan & Deci, 2002, 2017). Thus, orientations are "sets or attitudes that are more or less persuasive and salient" that, on the one hand, can be seen as a kind of average across different domains and situations and, on the other hand, may be influenced by prompts from the environment to make one orientation more salient (Ryan & Deci, 2017, p. 234). Consequently, COT helps to explain why individuals behave differently even when they are in the same social context (Deci & Ryan, 2012; Ryan & Deci, 2017).

Basic Psychological Needs Theory

The fourth mini-theory, basic psychological needs theory (BPNT), plays a crucial role in SDT because the other mini-theories are implicitly or explicitly related to it. BPNT focuses on the effect of basic psychological need satisfaction on motivation, behavior, and well-being. It is assumed that the satisfaction of three basic psychological needs is essential for optimal development and well-being: *needs for autonomy*, *competence*, and *relatedness* (Deci & Ryan, 2012; Ryan & Deci, 2002, 2017). Autonomy refers to "the need of individuals to experience self-endorsement and ownership of their action" (Ryan & Deci, 2017, p. 86). Competence refers to feeling effective in interactions with the social environment and experiencing opportunities to exercise and expand capacities. Thus, it is not a skill or capability but a felt sense of confidence and effectiveness in action (Ryan & Deci, 2002, p. 7; 2017). Relatedness refers to feeling connected to others and having a sense of belonging; this includes caring for others on the one hand and experiencing care on the other (Ryan & Deci, 2002, 2017).

BPNT hypothesizes that greater satisfaction of these basic psychological needs promotes intrinsic motivation, internalization of extrinsic motivation, as well as more autonomous causality orientations. Therefore, the satisfaction of these basic psychological needs is postulated as a necessary condition for growth, whereas frustration is associated with greater ill-being (cf. Deci & Ryan, 2012; Ryan & Deci, 2002, 2017, 2019). These assumptions have been tested and confirmed by numerous studies across different cultures, ages, and contexts (e.g., Chen et al., 2015; Ng et al., 2012; Van den Broeck et al., 2016; Yu et al., 2018). In sum, the three basic psychological needs can be seen as proximal predictors of autonomous motivation and are highly correlated (Lombas & Esteban, 2018; Skinner et al., 2017).

Goal Contents Theory

Goal contents theory (GCT), as the fifth mini-theory, focuses on different life goals and aspirations that shape individuals' attitudes and behavior. A basic distinction is made between

intrinsic and *extrinsic life goals*. Intrinsic life goals comprise goals that are directly related to the pursuit of what is inherently valuable (e.g., relationships or personal growth), whereas extrinsic life goals are focused on instrumental outcomes (e.g., money or fame; Ryan & Deci, 2017, p. 275).

Numerous studies across different cultural contexts (e.g., Martos & Kopp, 2012; Schmuck et al., 2000) and age groups (e.g., Mackenzie et al., 2018) revealed that intrinsic life goals are positively related to greater school success (Fryer et al., 2014) and well-being (Hope et al., 2019), whereas extrinsic life goals are positively related to depression and anxiety (cf. Ryan & Deci, 2017). These relationships between intrinsic and extrinsic life goals and well-being are thereby mediated by the satisfaction of the three basic psychological needs (Hope et al., 2019; Mackenzie et al., 2018).

Relationships Motivation Theory

Finally, the sixth mini-theory, the relationships motivation theory (RMT), focuses on the importance and qualities of relationships and their consequences for motivation and well-being. RMT assumes that relatedness—as one of the basic psychological needs—is essential for high-quality relationships and well-being in general (Ryan & Deci, 2019). Moreover, in contrast to other theories, RMT does not conceptualize relatedness to others as the opposite or antithesis of autonomy (Markus & Kitayama, 2003; cf. Vansteenkiste et al., 2020). Within SDT, autonomy is defined as willingness, empowerment, and volition and not as independence or individualism (Vansteenkiste et al., 2020). Thus, in a high-quality relationship, autonomy is equally important because individuals need to feel volitional within and about a relationship to assume a high-quality relationship (Ryan & Deci, 2019). Therefore, RMT suggests that high-quality relationships entail mutuality of autonomy (Deci et al., 2006) and illustrates why autonomous actions enhance feelings of relatedness for both individuals while cooperating or helping even if no reciprocal benefits are expected (Martela & Ryan, 2016; Weinstein & Ryan, 2010).

High-quality relationships and relatedness are inherent human propensities (Baumeister & Leary, 1995; Harlow, 1958) that are crucial for (motivational) development and well-being (cf. Clark & Mills, 2011). Thus, RMT highlights that relating to others is not merely an instrumental value for internalization or security but that belonging is valued for its own sake (Ryan & Deci, 2017, 2019). We learned that high-quality relationships have yielded benefits to us and, therefore, we are intrinsically motivated to be related to others. Supporting this behavioral relatedness propensity satisfies directly our basic psychological needs (Ryan & Hawley, 2016; cf. Vansteenkiste et al., 2020).

In sum, SDT has steadily evolved to understand human endeavors, and each of the six mini-theories contributes a piece to this puzzle of human behavior and development. SDT, therefore, addresses what individuals need to experience themselves as integrated, encompassing variables that are meaningful, measurable, and changeable (Ryan & Deci, 2019). Based on this broad understanding and the underlying variables, SDT provides a sound framework for a comprehensive understanding of student motivation.

2.1.5 Effects and Promoting Factors of Motivation

The four above-mentioned theories are all widely used in educational settings, and the major assumptions regarding their effects on learning and achievement have already been mentioned in the description of the theories. Thus, based on the enormous body of research on student motivation, the following section on effects and promoting factors is limited to research within SDT in line with this dissertation's outcome variables.

According to SDT, autonomous and controlled forms of motivation are distinguished, and these forms have different effects on learning behavior. Regarding autonomous motivation, numerous studies across different age groups have highlighted the relevance of intrinsic regulation, as it is related to more cognitive engagement (Walker et al., 2006), conceptual understanding (Vansteenkiste et al., 2008), lower school dropout rates (Vallerand & Bissonnette, 1992), and higher academic achievement (Froiland & Worrell, 2016; Taylor et al., 2014). Similar positive effects are also achieved by identified regulation, as it predicts greater school value and deeper learning approaches (Yamauchi & Tanaka, 1998), higher academic achievement (Guay, Ratelle, et al., 2010), and effort (Waaler et al., 2013).

Regarding the controlled forms of motivation, existing research revealed that introjected regulation is positively associated with more anxiety, poorer coping with failure (Ryan & Connell, 1989), short-term persistence (Pelletier et al., 2001), procrastination (Mouratidis et al., 2018), and negatively related to academic achievement (Taylor et al., 2014; Wijsman et al., 2018). External regulation is positively associated with procrastination (Mouratidis et al., 2018) and negatively related to interest, value (Ryan & Connell, 1989), academic achievement (Taylor et al., 2014), and school satisfaction (Li et al., 2018). However, the results of the controlled forms of regulation, especially in terms of achievement, are inconclusive. For example, other studies found no or a positive relation to achievement (Buzdar et al., 2017; Jeno et al., 2018; Lemos & Veríssimo, 2014). These mixed results might be explained by the fact that controlled motivation also stimulates students and thus predicts more effort but it may not be high-quality effort (e.g., use of deep-learning strategies) that improves performance (Malmberg & Martin,

2019). Finally, amotivation is associated with greater boredom, poorer concentration (Vallerand et al., 1993), more stress (Baker, 2004), higher school dropout rates (Vallerand & Bissonnette, 1992), and poorer academic achievement (Taylor et al., 2014).

The advantages of autonomous motivation highlight the relevance of internalization. Students can be autonomously motivated to learn something that they do not find inherently interesting and for which they are not intrinsically motivated but see the value. Thus, the development of a personal value for school and its related activities is an important factor for academic success (Ryan & Deci, 2017). As mentioned in Section 2.1.4 (BPNT), the fulfillment of three basic psychological needs (autonomy, competence, and relatedness) is essential for internalization. The satisfaction of these needs leads to the internalization of external values and, therefore, to a more autonomous form of motivation and greater well-being (Ryan & Deci, 2017, 2019). The positive effect of autonomy-supportive contexts on internalization (e.g., by an autonomy-supportive teaching style) and autonomous motivation has been confirmed by numerous research studies across different age groups and cultural contexts (e.g., Hardre & Reeve, 2003; Jang et al., 2010). Contexts that satisfy the need for competence (e.g., with positive feedback) has also been revealed to promote internalization (Jeno et al., 2019; Mouratidis et al., 2008) as well as contexts fulfilling relatedness (Streb et al., 2015; Xiang et al., 2017). Further, many studies revealed that satisfying all three basic needs together promotes internalization and autonomous motivation, whereas suppressing the basic needs is detrimental (e.g., Chen et al., 2015; Lazarides et al., 2016; Niemiec & Ryan, 2009; Skinner et al., 2017). Overall, basic psychological needs offer explanations for the social-contextual influences on internalization and provide a basis for a priori predictions about their effects (Deci & Ryan, 2016).

So far, only the effects of the different regulation forms and how these forms might be influenced have been described. However, given the length of time students spend in the educational system, the average development of these forms of regulation over time is also relevant when investigating motivation.

2.1.6 Trajectories of Motivation

Previous research from multiple contexts has repeatedly revealed that students' autonomous motivation tends to decline across school years (e.g., Gillet et al., 2012; Gnambs & Hanfstingl, 2016; Lepper et al., 2005; Otis et al., 2005; Scherrer & Preckel, 2019). Regarding controlled forms of motivational regulation, existing research also revealed a downward trend, although this trend is less severe than in the case of autonomous motivation (Gillet et al., 2012; Gnambs & Hanfstingl, 2016; Otis et al., 2005). These results are general trends—but because motivation

is domain-specific, this decline may vary between subjects (Guay, Chanal et al., 2010). However, existing research revealed that this negative trend occurs in most subjects and that it is particularly pronounced in mathematics compared to other subjects, such as languages (Gottfried et al., 2001; Gottfried et al., 2007).

To explain this decline, some researchers (e.g., Gottfried et al., 2001) focused on aspects of the school setting and curriculum that tend to diminish autonomous motivation: In infancy and early childhood, learning is primarily intrinsically motivated and follows spontaneous interest (Carlton & Winsler, 1998). However, when children enter school, the focus of learning shifts, and they are forced to manage their learning in a formal, teacher-directed environment. Usually, a teacher instructs an age-homogeneous group of children in preselected material, which mostly does not correspond to the interests and abilities of all children but follows a prescribed curriculum. The contents are thus externally imposed and sometimes not packed in a way that is intrinsically motivating or relevant to students' daily lives (Ryan & Deci, 2017). In addition, strong performance pressure prevails in a formal educational institution (e.g., in Switzerland; Güntzer, 2017). Thus, the decline in autonomous motivation might be a result of the emerging pressure and decontextualization of learning.

The stage-environment fit theory (SEFT; Eccles & Midgley, 1989; Eccles et al., 1993) provides another prominent explanation for this motivational decline. In line with SDT, it is assumed that the social context, and especially the satisfaction of the three basic psychological needs, has an impact on students' motivation. SEFT suggests that negative development occurs because of a mismatch between students' needs and what their social environment offers (Eccles, 2004; Eccles et al., 1993). Individuals' emotional, cognitive, and social needs and personal goals are thought to change with aging: For example, adolescents have an increased need for autonomy, intellectually challenging environments, and relatedness (especially to peers). In contrast, with advancing school years, the learning environment becomes more performance-oriented, fewer opportunities exist to participate in decisions about one's learning, and student friendship networks are disrupted due to transitions (Eccles & Roeser, 2012; Midgley et al., 1995; Wigfield & Wagner, 2005). Taken together, the increase in basic needs and the decrease in opportunities for satisfaction lead to a widening gap and results in motivational decline (Eccles, 2004; Eccles & Roeser, 2012). Thus, from the perspective of SEFT, the satisfaction of basic psychological needs plays an essential role in the development of student motivation and a good fit between students' needs, and the opportunities provided by the social environment (at home and school) is required but often not fulfilled.

However, because motivation is not an independent construct and an individual develops as a totality, the influence of the social context is not limited to motivation. A negative development in intrinsic motivation also affects well-being and is associated with less positive and more negative emotions (Ryan & Deci, 2017). So far, emotions have only been addressed implicitly, which does not do justice to their relevance in the context of motivation. Therefore, the following section focuses on the connection between emotions and motivation and how emotions are embedded in motivation research.

2.2 Student Emotions

As indicated at the beginning of the chapter (cf. Figure 1), a link exists between the constructs of motivation and emotion. Emotions, together with needs and cognitions, are the proximal cause of motivated behavior and, therefore, a subset of motivation that serves a distinct motivational function (Lerner et al., 2015; Ryan et al., 1990; Zeelenberg et al., 2008). This motivational function is also visible in the general definition of emotions provided by Kleinginna and Kleinginna (1981, p. 355):

> Emotion is a complex set of interactions among subjective and objective factors, mediated by neural/hormonal systems, which can (a) give rise to affective experiences such as feelings of arousal, pleasure/displeasure; (b) generate cognitive processes such as emotionally relevant perceptual effects, appraisals, labeling processes; (c) activate widespread physiological adjustments to the arousing conditions; and (d) lead to behavior that is often, but not always, expressive, goal-directed, and adaptive.

Emotions are complex and multifaceted phenomena consisting of affective, cognitive, physiological, motivational, and expressive components (Shuman & Scherer, 2014). For example, anxiety before an exam may consist of nervous feelings (affective), worries about not passing the exam (cognitive), increased heart rate (physiological), impulses to escape the exam situation (motivation), and trembling (expressive; Pekrun & Linnenbrink-Garcia, 2014). In educational settings, the focus is often on so-called *achievement emotions*. These are those emotions that are experienced in direct relation to achievement activities (e.g., learning activities) and achievement outcomes (Pekrun, 2000, 2006; Pekrun & Perry, 2014). Achievement emotions can be taxonomized according to the criteria of *object focus*, *valence,* and *activation* (cf. Table 2). The criterion object focus distinguishes between activity and outcome emotions, valence is used to differentiate between positive and negative emotions, and activation is used to differentiate between activating and deactivating emotions (Pekrun & Perry, 2014). In everyday life,

students face a variety of different achievement emotions. How these different emotions arise and by which factors they are influenced is explained by the control-value theory (CVT).

Table 2

Three-Dimensional Taxonomy of Achievement Emotions (Pekrun & Perry, 2014, p. 121)

Valence		**Positive**		**Negative**	
Activation		**Activating**	**Deactivating**	**Activating**	**Deactivating**
Object focus	**Activity**	Enjoyment	Relaxation	Anger	Boredom
	Outcome[1]	Hope	Relief	Anxiety	Hopelessness

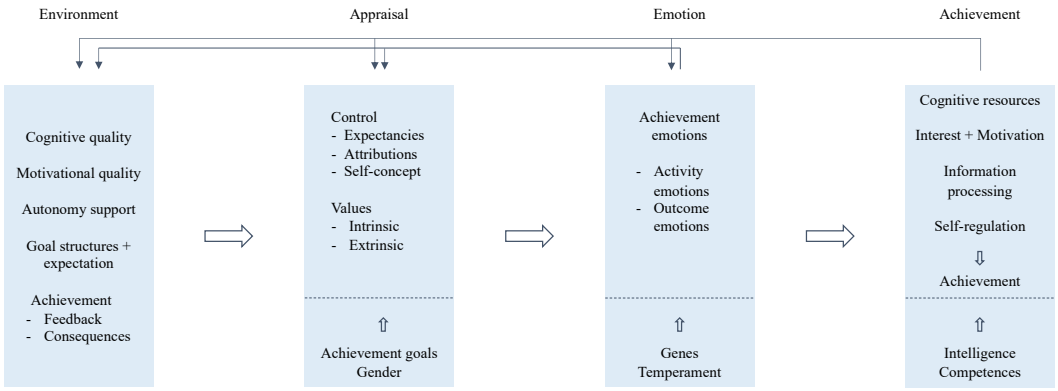
Note. [1]Outcome emotions can further be distinguished between prospective and retrospective outcome emotions.

2.2.1 Control-Value Theory of Achievement Emotions

The CVT of achievement emotions (Pekrun, 2006) assumes that appraisals are the antecedents of emotions (for an overview of appraisal research, see Scherer et al., 2001). Appraisals are a cognitive process of evaluating and interpreting the event in relation to oneself and depend on goals, needs, values, beliefs, and personal relationships (Beckmann & Heckhausen, 2018; Reeve, 2018). As people's goals, values, etc. differ, appraisals may also differ between persons and cause different emotions in the same situation (cf. Figure 5). Therefore, it is assumed that appraisals mediate situational factors and lead to emotions (Pekrun, 2006). Regarding achievement emotion, CVT (Pekrun, 2000, 2006) assumes that mainly the two appraisal groups of perceived control and perceived value are relevant.

Figure 5

Basic Proposition of the Control-Value Theory of Achievement Emotions (Pekrun & Perry, 2014, p. 123)



Perceived control refers to subjective control over activities and outcomes (controllability) or future-oriented expectations about the relationship between causes and their future

effects (i.e., causal expectations: “If I put in the effort, then I will do well on my next mathematics exam.” vs. “I am just not good at mathematics, so I can’t pass the exam.”). Perceived control also comprises current perceptions of control (e.g., “This is exactly what I studied.” vs. “I don’t understand what the teacher is asking.”) and retrospective attributions for past performance (e.g., “I was just lucky last time.” vs. “I learned a lot last time.”). In sum, perceived control refers to constructs such as self-efficacy, self-concept, and attributions (cf. Frenzel & Stephens, 2013; Pekrun & Perry, 2014, p. 20).

Perceived value refers, on the one hand, to the personal importance and meaningfulness (goal relevance) of an activity or outcome. On the other hand, value appraisal refers to the perceived perception (positive or negative) of an activity or outcome (Frenzel & Stephens, 2013, p. 20; Pekrun & Perry, 2014). For example, the same grade in a mathematics test may be interpreted positively by student A (“Yes, I got a D! I didn’t fail!”) and negatively by student B (“Oh, no! I got only a D!”).

The combination of control and value leads to a specific emotion with distinctive patterns of control and value leading to different emotions (Pekrun, 2006; Pekrun & Perry, 2014). For example, if a student’s control appraisal of learning mathematics is high (e.g., triggered by high self-efficacy) and they have a positive value appraisal of the learning activity, the student will enjoy learning, whereas another student with low control appraisals and negative intrinsic value of the activity will experience frustration (cf. Table 3).

In sum, control and value appraisals are assumed to be the proximal antecedents of emotions (cf. Figure 5). Existing research has widely confirmed the connection between perceived control and value and different emotions in different age groups and contexts (e.g., Dettmers et al., 2011; Pekrun et al., 2011; Putwain et al., 2018; Putwain et al., 2021). Thus, the promotion of positive emotions can be achieved through the deliberate alteration of control and value appraisals.

However, control and value appraisals are not independent factors but are influenced by the social environment. This includes parents, teachers, peers, and the media, which shape the students’ social environments and thus are distal factors on students’ appraisals (Frenzel & Stephens, 2013; Pekrun, 2000, 2006). For example, teachers may influence students’ control appraisals by designing lessons and tests so that students experience a higher level of control over the activity and outcome. Parents may influence students’ value appraisals by attaching great value to school, a specific subject, or learning.

So far, the proximal and distal causes of emotions have been described, but for motivation research, the focus is on the effects of emotions on behavior. Therefore, how different emotions affect school-related behavior is outlined in the following section.

Table 3

Combination of Control and Value Appraisals and their Corresponding Emotions (Pekrun, 2006, p. 320)

	Appraisals		
Object Focus	Value	Control	Emotion
Activity	Positive	High	Enjoyment
	Negative	High	Anger
	Positive/ Negative	Low	Frustration
	None	High / Low	Boredom
Outcome (prospective)	Positive	High	Anticipatory joy
		Medium	Hope
		Low	Hopelessness
	Negative	High	Anticipatory relief
		Medium	Anxiety
		Low	Hopelessness
Outcome (retrospective)	Positive	Irrelevant	Joy
		Self	Pride
		Others	Gratitude
	Negative	Irrelevant	Sadness
		Self	Shame
		Others	Anger

2.2.2 Effects of Emotions

Emotions are core elements of well-being and have far-reaching consequences for our daily life. Regarding achievement emotions, the CVT assumes that achievement emotions influence cognitive, regulatory, and motivational processes and these mediate learning, achievement, and well-being (Pekrun, 2006; Pekrun et al., 2002). In terms of cognitive resources, research revealed that negative emotions diminish cognitive resources by focusing attention away from

the task, which in turn undermine performance (Frenzel & Stephens, 2013; Pekrun, 2006). Existing research has largely confirmed this assumption for the emotions of anxiety (Zeidner, 1998, 2014), anger (Camacho-Morles et al., 2019), and boredom (Tze et al., 2016). In contrast, positive emotions help one to concentrate on the learning activity, which in turn leads to better performance (cf. Ainley & Hidi, 2014; Buff et al., 2011).

Further, achievement emotions affect the use of learning strategies: Negative emotions, such as boredom, are negatively associated with effective learning strategies (e.g., elaboration), whereas positive emotions are positively associated with effective learning strategies (Muis et al., 2015; Ranellucci et al., 2015). Regarding less effective learning strategies (e.g., rehearsal), existing research is inconsistent about their association with negative and positive emotions (Muis et al., 2015; Pekrun et al., 2010). Achievement emotions also affect how much students self-regulate their learning. Negative emotions, such as anxiety, are associated with a lower ability to regulate and monitor learning processes (Morosanova & Fomina, 2017; Yang et al., 2019), whereas positive emotions are associated with a higher level of self-regulation (Ranellucci et al., 2015; Villavicencio & Bernardo, 2013).

Regarding motivation, positive emotions, such as enjoyment and hope, promote intrinsic and extrinsic motivation by stimulating one to strive for achievement goals (Kim & Hodges, 2012; Kulakow & Raufelder, 2020). In contrast, negative emotions, such as anxiety and anger, negatively predict autonomous motivation (Sutter-Brandenberger et al., 2018). In addition, positive emotions, such as enjoyment and pride, are positively associated with mastery- and performance-approach orientations (Ranellucci et al., 2015), whereas negative emotions, such as anger and anxiety, are negatively associated with these orientations (Pekrun et al., 2009).

In sum, empirical evidence across subjects and cultural contexts indicates that positive emotions (e.g., enjoyment) moderated by cognitive, regulatory, and motivational processes positively influence student learning and achievement, whereas negative emotions (e.g., anger) have a negative effect (Camacho-Morles et al., 2021). However, the effects of emotional development should not be viewed unidirectionally because emotions and outcomes influence appraisals as well as one's perceptions of the environment (cf. Figure 5; Pekrun & Perry, 2014). Thus, it is a dynamic process that changes over time. This leads to the question of how students' emotions develop over time, which is discussed in the next section.

2.2.3 Trajectories of Emotions

Several longitudinal studies have examined the development of students' emotions (e.g., Hagenauer & Hascher, 2010; Meyer & Schlesier, 2021; Vierhaus et al., 2016). Regarding positive

emotions, such as enjoyment, existing research across different subjects indicates a decline from kindergarten to fifth grade (Helmke, 1993), between Grades 6 and 7 (Hagenauer & Hascher, 2010), and during secondary education (Bieg et al., 2019; Meyer & Schlesier, 2021). However, few longitudinal studies cover the entire academic careers of students (Vierhaus et al., 2016). Other positive emotions, such as pride or hope, are less investigated; however, existing results indicate a decline over time for these emotions as well (Pekrun et al., 2007; Raccanello et al., 2013). In contrast, negative emotions (e.g., anger, anxiety, boredom) tend to increase during primary school (Lichtenfeld et al., 2012; Raccanello et al., 2019) and secondary education (Meyer & Schlesier, 2021; Raccanello et al., 2013; Vierhaus et al., 2016).

However, the findings above only indicate general trends of achievement emotions. Indeed, because emotions are subject-specific (Goetz et al., 2007), differences exist between subjects in the number of different emotions based on the cultural context. For example, in Italy, primary to secondary school students showed higher levels of enjoyment and pride and lower levels of guilt, boredom, and hopelessness for mathematics than for their first language (i.e., Italian; Raccanello et al., 2013; Raccanello et al., 2019). In contrast, Goetz et al. (2013) revealed that secondary school students (Grades 8 and 11) in Germany showed significantly lower levels of enjoyment for mathematics than for their first language (i.e., German) and no difference in pride. Further, the German students showed higher levels of anxiety and helplessness in mathematics than in their first language and no significant difference in anger and boredom between the subjects. Despite these differences in the level of emotions between subjects, the subject-specific trajectories corresponded to the trajectories of the general emotions (i.e., decline in enjoyment and pride and increase in boredom and anger; Raccanello et al., 2013).

Based on the relationship between positive and negative emotions and motivation and achievement, the overall development of emotions is unfavorable. As in the case of motivation development, SEFT (Eccles & Midgley, 1989) provides a possible explanation. Because of the mismatch between student needs and environmental opportunities, positive emotions decrease and negative emotions increase. As a pronounced change was found after the transition to secondary education (Vierhaus et al., 2016), this supports the explanation of the mismatch between the secondary school environment and students' needs. Thus, it can be assumed that secondary schools might have a poorer fit for students' needs than elementary schools. Moreover, this change could also be age-related to some extent and thus due to students' developmental changes (Bru et al., 2010).

2.3 Role of Emotions in Motivation Theories

Although emotion research exists as an independent area of research with theoretical assumptions, it can also be seen as a proximal cause with a motivational function and is consequently part of motivation research. How and to what extent achievement emotions are integrated into the four presented motivation theories will be outlined in the following paragraphs.

In attribution theory, a clear connection exists with emotions. In the temporal sequence, emotions play a crucial role in several steps (cf. Figure 2): The interpretation of success or failure is accompanied by corresponding emotions, such as happiness or sadness, which are labeled as *outcome-dependent/attribution independent emotions* (Graham & Taylor, 2014, p. 97). Following these emotions, an analysis of causes may be conducted to determine why the success or failure occurred. Based on this causal attribution and the associated causal dimension (locus, stability, controllability), emotional consequences are triggered (e.g., anxiety, pride; cf. Graham & Taylor, 2016; Weiner, 2010). In sum, attribution theory assumes a thinking-feeling-action sequence in which causal thoughts guide emotions and emotions guide behavior (Graham & Taylor, 2014; Weiner, 2010).

In contrast to attribution theory, in which emotions take a mediating role for motivated behavior, emotions are less focused in EVT and thus have an implicit role. Emotions appear in EVT as a subset of affective reactions and memories that influence the subjective value of a task (Brush, 1985). Moreover, they are also implicitly involved in intrinsic value, as this is defined as the enjoyment achieved by the task, and in cost, as this also includes emotional costs (e.g., anxiety) incurred by a task. Furthermore, research suggests that students' expectancies and values may have emotional consequences and revealed different associations between expectancies, values, and emotions, such as shame or anxiety (Pekrun, 1992; Turner & Schallert, 2001; cf. Henning et al., 2012).

Goal orientation theory also reveals a clear inclusion of emotions, as it assumes that goal orientations are composed of beliefs, attributions, and affects[2] that direct students toward a particular behavior (Ames, 1992). From a longitudinal perspective, affect directs goal orientation, which predicts different emotions, as the content (mastery/performance) and direction of the goal (approach/avoidance) determine the resulting emotion (Linnenbrink & Pintrich, 2002; Linnenbrink-Garcia & Barger, 2014). For example, a mastery-approach orientation is associated with positive, activating emotions, such as enjoyment (Schweder, 2020), whereas performance-avoidance is mostly linked to negative, activating emotions, such as anxiety (Cron et al., 2005).

[2]Affect is used as an overarching term encompassing moods and emotions (Linnenbrink & Pintrich, 2002).

Finally, in SDT, emotions again play a more implicit role, with the relevance of these emotions hinted at in several mini-theories. In CET, a connection between emotions and motivation exists in the definition of intrinsic motivation, which cannot be distinctively separated from enjoyment (cf. definition of intrinsic motivation as behavior performed because of inherent satisfaction and pleasurable feelings; Ryan & Deci, 2002). In OIT, links to emotions exist particularly regarding the outcomes of the different forms of extrinsic motivation. Previous research indicates that autonomous motivation is positively associated with positive emotions (Carbonneau et al., 2012; Isen & Reeve, 2005; Vandercammen et al., 2014;) and negatively associated with negative emotions (Sutter-Brandenberger et al., 2018; Vandercammen et al., 2014). Further, evidence indicates controlled motivation is positively associated with negative emotions (Hortop et al., 2013; Walls & Little, 2005). Similar patterns emerge between emotions and causality orientations according to COT. Autonomy orientation is positively associated with positive emotions and negatively associated with negative emotions (Farmer & Sundberg, 1986; Neighbors & Knee, 2003), whereas controlled orientation and impersonal orientation are positively associated with negative emotions (Knee et al., 2001; Young et al., 2016). Also, the satisfaction of the basic needs (BPNT) is positively associated with positive emotions (Holzer et al., 2021) and negatively with negative emotions (Black & Deci, 2000; cf. Stanley et al., 2021). Also, according to GCT, intrinsic life goals are positively associated with positive emotions and negatively associated with negative emotions (Gunnell et al., 2014; Sheldon et al., 2004), whereas extrinsic life goals are negatively associated with positive emotions (Dittmar et al., 2014; Kasser & Ryan, 1996). Finally, in RMT, positive emotions are again expected outcomes of close relationships, whereas ostracism leads to negative emotions (Gagné et al., 2003; Legate et al., 2013; Williams, 2009). Overall, emotions are included in research within SDT primarily as outcomes. This fact that SDT does not formally consider emotions as relevant variables in the motivation-generating process, however, contradicts the large body of research indicating that emotions are important in the occurrence of motivation (cf. Isen & Reeve, 2005; Meyer & Turner, 2006; Reeve, 2018). As Isen and Reeve (2005, p. 321) stated, positive emotions "may play a more central role in understanding the intrinsic motivational process than is currently recognized by SDT". This may also be true for extrinsic motivational processes.

In sum, emotions play a major role in some motivation theories (e.g., attribution theory), whereas they play a more implicit role in others (e.g., SDT). However, regardless of the integration of the two constructs, sufficient empirical evidence credits both—motivation and emotion—for successful learning behavior. Motivational and emotional processes occur in response to environmental events and cause behavior and outcomes (cf. Figure 1). Thus, motivation and

emotion are variables that intervene between causes (antecedents) and outcomes and explain these cause and effect relations (Reeve, 2018, p. 16). Therefore, these intervening variables are crucial for successful learning processes. The next chapter builds on this premise and focuses on how motivation and positive emotions can be promoted by an intervention.

3 Interventions Targeting Student Motivation

Motivational intervention research is interested in developing interventions to promote students' motivation, learning, and performance and examining whether and to what extent change has been achieved as a result of the intervention (Lazowski & Hulleman, 2016). The unfavorable but systematic development of motivation and emotions in schools in combination with the high relevance for learning success highlights the need for interventions targeting these variables. Despite the need for (more) motivational interventions (Wentzel & Wigfield, 2007), intervention research in education has declined since 1995 (Hsieh et al., 2005; Lazowski & Hulleman, 2016; Robinson et al., 2007; Ryan & Deci, 2019). This trend toward nonexperimental designs (e.g., correlational studies) persists, although several motivation interventions have provided promising results (e.g., De Naeghel et al., 2016; Gaspard et al., 2015; Harackiewicz et al., 2016).

To achieve intended results, several important conceptual characteristics must be addressed when designing a motivational intervention. These characteristics are discussed in the following section. Next, the effectiveness and mechanisms of different motivational interventions based on the outlined motivation theories are described in detail. Finally, aptitude-treatment interactions research and its related challenges are summarized.

3.1 Conceptual Characteristics of Motivational Interventions

Motivational interventions can widely vary in their design and implementation. The selection of *target group(s)*, *target variable(s)*, and the chosen *method* are the most important aspects that must be discussed when designing motivational interventions (Hascher et al., 2019). Different target groups can be specified for motivation promotion: For example, interventions can be targeted to students (Bernacki et al., 2016), teachers (Assor et al., 2018), or families (Froiland, 2010). In addition, interventions can be applied to special at-risk groups, such as low-achieving students (Hulleman et al., 2017), girls in science, technology, engineering, and math (STEM) subjects (Walton et al., 2015), or students with a migration background (Harackiewicz et al., 2016). Based on the identified problem or characteristics of the target group, it is important to determine what change (target variables) and under which theoretical framework the change should be achieved (Hascher et al., 2019).

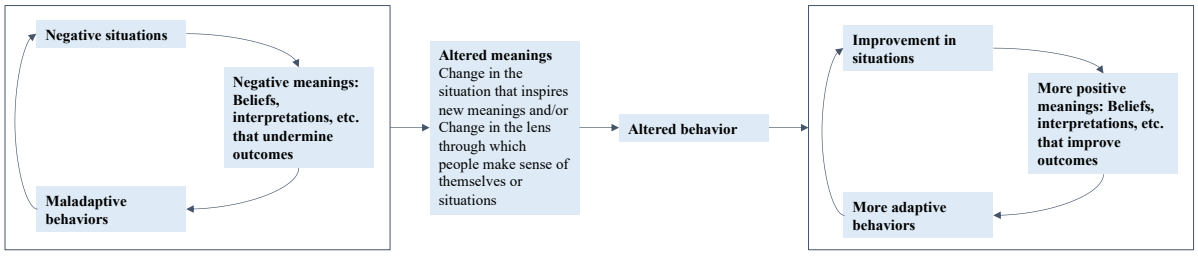
In accordance with target group(s), target variable(s) and theoretical framework, the method is selected to perform the intervention. Methodically, interventions may differ in terms of duration and intensity, delivery approach (direct vs. indirect), focus (subject-specific vs.

general), and setting (within the curriculum vs. as a supplemental program; Hascher et al., 2019; Hascher & Schmitz, 2010; Landmann et al., 2010). In addition, interventions can differ in terms of how they work: Interventions can target academic skills (e.g., planning skills; Crook & Evans, 2014), structural conditions (e.g., school reforms; McCaslin, 2006), or social-psychological processes to promote motivation (cf. Dittmann & Stephens, 2017).

Interventions targeting individual skills promote student motivation by fostering academic competencies, whereas interventions targeting structural conditions alter the learning environment to improve the fit between students' needs and the environment. While the mechanism of interventions that target individual skills and structural conditions is usually easy to understand, interventions targeting the social-psychological process are sometimes referred to as "magical" or "miraculous" (Yeager & Walton, 2011, p. 267). Because instead of teaching academic content or dramatically changing the educational setting, these interventions target thoughts, feelings, and beliefs in and about school and learning (Garcia & Cohen, 2013; Yeager & Walton, 2011, p. 268). Thus, *social-psychological interventions* (also referred to as wise interventions, story editing interventions, or targeted interventions; cf. Harackiewicz & Priniski, 2018; Yeager & Walton, 2011) focus "on the meanings and inferences people draw about themselves, other people, and/or a situation they are in and use precise, theory- and research-based techniques to alter these meanings" (Walton & Wilson, 2018, p. 618). Consequently, social-psychological interventions aim to direct individuals to more positive ways of understanding themselves and their circumstances (i.e., meaning-making) to improve their trajectories (cf. Figure 6; Walton, 2014; Walton & Wilson, 2018).

Figure 6

Mechanisms of Change: Recursive Change in Person and Situation (Walton & Wilson, 2018, p. 621)



Existing research has used four different techniques to change students' meaning-making: direct labeling, prompting new meanings, increasing commitment through action, and active reflection exercise (Walton & Wilson, 2018, p. 624). As the name implies, direct labeling involves providing the target group with a positive label so they are motivated to behave

according to the label (Hall et al., 2007; cf. Walton & Wilson, 2018). In the prompting new meanings approach, the target group receives a new inference about themselves, others, or a situation to revise their thinking. This can be accomplished, for example, by changing the situation, providing new information, or asking leading questions that require new meanings (Blackwell et al., 2007; cf. Cohen et al., 2017; Walton & Wilson, 2018). Increasing commitment through action mostly uses the technique *saying is believing* to change meaning-making. The target group receives a new idea or information that they have to explain or pass on to another person. By actively engaging with the idea, the target group is encouraged to internalize it (Yeager et al., 2016; cf. Cohen et al., 2017; Walton & Wilson, 2018). Finally, in the active reflection exercise approach, the target group is supported in reinterpreting their experiences through, for example, writing activities with structured prompts (Ramirez & Beilock, 2011; cf. Walton & Wilson, 2018).

For social-psychological interventions to be successful, they must meet three key requirements: First, they must precisely address a specific psychological process based on a clear theoretical assumption (i.e., the intervention must be tailored). Therefore, it is important to understand the subjective experience of students in school because an inaccurate understanding of a problem may lead to distorted interventions and misleading results (Cohen et al., 2017; Walton & Wilson, 2018; Yeager & Walton, 2011). Second, the interventions must consider that subjective meanings belong to a complex system. Simply manipulating psychological processes to improve learning is not enough if the learning context (individual and structural factors) does not provide opportunities for learning (Cohen et al., 2017; Garcia & Cohen, 2013; Walton & Wilson, 2018). Third, the interventions must target recursive processes to flourish and achieve lasting changes. By using recursive dynamics, a self-enhancing tendency may develop over time, leading to an upward cycle of, for example, motivation and the accumulation of effects over time (cf. Figure 6; Walton, 2014; Walton & Wilson, 2018; Yeager & Walton, 2011). Therefore, a social-psychological intervention is not a remedy in itself but a trigger for a process that can be repeatedly stimulated by the context (Cohen et al., 2017, p. 669).

In line with the theory that motivated behavior is based on the interaction between the person and the situation and the most simple and cost-efficient intervention, most motivational interventions target this social-psychological process (cf. Lazowski & Hulleman, 2016). Thus, in the next section, the effectiveness and mechanisms of different social-psychological interventions within the presented motivation theories will be reviewed.

3.2 Effectiveness and Mechanism of Motivational Interventions

In their meta-analysis of 92 motivational interventions in education, Lazowski and Hulleman (2016) revealed interventions targeting motivation were generally effective and no significant difference existed in effect size based on the underlying motivation theory, age of students (elementary to post-secondary students), or type of dependent variable. Rosenzweig and Wigfield (2016) reported a similar result for 52 motivation interventions in STEM fields and supported the conclusion that motivation intervention can improve student motivation, achievement, and engagement (cf. Karabenick & Urdan, 2014; Wentzel & Wigfield, 2007). Both meta-analyses included interventions related to the presented motivational theories (i.e., attribution theory, EVT, goal orientation theory, SDT, and CVT), supporting their effectiveness and relevance to academic motivational processes. In the following, some of the recent intervention studies are briefly highlighted to provide additional information on the effectiveness of the interventions and intended mechanism (cf. summary of target groups, target variable(s), and method in Appendix A).

Attribution Theory

Based on attribution theory, attribution retraining (AR) studies (Dryden et al., 2021; Hamm et al., 2020; Perry et al., 2014) seek to change students' maladaptive attributions upon failure (e.g., from low ability or a lack of effort). Changing maladaptive attributions to factors that can be controlled or that improve over time subsequently promotes persistence, motivation, task engagement, goal stiving, and performance (Graham, 2020; Perry & Hamm, 2017; Walton & Wilson, 2018).

In one study, Hamm et al. (2020) showed that STEM students who received AR after several months had greater control attributions compared with the control group. Although no treatment effects were found on intrinsic motivation after several months, increased persistence to graduation over 8 years was seen, which indicates a decreased likelihood of dropout. In the intervention setting, Hamm et al. (2020) asked students to reflect on their past academic failures. Adaptive attributions were then indirectly prompted by sharing stories (via video presentation) that older students had experienced and overcome. The video showed an interaction of two students who discussed their academic failure/setbacks. They explained how they improved their subsequent performance after realizing that their initial failures were largely due to controllable causes (e.g., insufficient effort). Finally, students completed a test to apply the information learned in the video and participated in a group discussion to reflect on their attributions of previous failures (cf. Hamm et al., 2020).

Intervention targets maladaptive beliefs by providing students with alternative beliefs. In this regard, students must learn that challenges, setbacks, and failures are normal experiences and that challenges can be overcome with effort (i.e., students can control their academic outcomes; Harackiewicz & Priniski, 2018). The intervention thus may change the negative beliefs (i.e., failures as one's shortcomings) about one's abilities and potential. This may alter the person's behavior (e.g., more effort), which can lead to better outcomes and motivation, so this belief becomes self-confirming (Walton & Wilson, 2018).

Expectancy-Value Theory

A growing number of EVT-based interventions were successfully carried out over the last decade (cf. Wigfield & Eccles, 2020). The main goal of these interventions was to enhance students' utility value and thereby promote students' persistence, motivation, and achievement (Canning et al., 2018; Hecht, Harackiewicz, et al., 2019; Rozek et al., 2017). A few other interventions within this framework focused on reducing students' perceived cost (Rosenzweig et al., 2020), whereas no intervention has focused on enhancing attainment value (Harackiewicz & Priniski, 2018; Wigfield & Eccles, 2020).

As an example of a utility-value intervention, Canning et al. (2018) showed that biology students who were writing utility assignments achieved higher grades in the course, were more likely to enroll in the continuing biology courses, and were less likely to drop out of their biology program, compared to students in the control group. In the intervention setting, students were asked three times to write a 1–2 page essay or letter to a family member or close friend about the last 5-week unit of the course. Students were given the prompt: "Why is the course material useful for me or the person addressed in the letter?" (p. 842). Students were instructed to write about why this learning content is relevant to their life and to give personal examples. In contrast, students in the control group should organize the material in a meaningful way and summarize the material in their own words (cf. Canning et al., 2018).

By implementing a utility-value intervention, students can establish concrete connections between what they are learning and what is important to them. This prompting with leading questions may change beliefs about personal experiences that lack meaning, promoting perceptions of value and engagement with the course content (cf. prompting new meanings; Harackiewicz & Priniski, 2018; Walton & Wilson, 2018). This altered behavior, in turn, can lead to better outcomes and motivation.

Goal Orientation Theory

To change goal orientation, two basic approaches can be distinguished (cf. Elliot & Hulleman, 2017): Interventions can either target the structural aspects of the learning and achievement context to create an environment that emphasizes mastery goals and depreciate performance goals (structure-focused; Barkoukis et al., 2008; Meece & Miller, 1999; O'Keefe et al., 2013) or they can directly target students' goal orientation adaption and seek to guide students toward mastery rather than performance goals (person-focused; Bernacki et al., 2016; Ranellucci et al., 2017; Smeding et al., 2013).

As an example of a person-focused intervention, Bernacki et al. (2016) showed that high school students who received a goal orientation intervention reported higher values in mastery goal orientation and greater situational interest for science after one semester than the control group. In the intervention, students were instructed to complete a science diary once or twice a week for 10 minutes. In this diary, students were asked to respond to self-assessment prompts and assess their mastery of recently covered science concepts (e.g., "Think of a concept that you feel like you kind of understand, but haven't mastered. What do you feel like you know for sure? What parts do you need to learn more about? How will you master these parts?"; Bernacki et al., 2016, p. 45). Students in the control group were prompted to summarize the content of the lesson (e.g., "Name the three most important ideas from today's class. Write a few sentences to help you remember each."; Bernacki et al., 2016, p. 46).

Through this intervention, students were encouraged to develop explicit intrapersonal criteria for what it means to master something. In addition, articulating the level of competence and creating plans for learning a concept that has not yet been mastered led students not only to adopt these goals but also to be more likely to pursue them (Bernacki et al., 2016). Thus, similar interventions may change beliefs about goals by prompting students to think about when, where, and how they can achieve their goals (cf. active reflection exercises). This may alter behavior (e.g., more effort), which can have a positive impact on students' beliefs and outcomes (Walton & Wilson, 2018).

Self-Determination Theory

Intervention studies based on SDT are also much less prevalent compared with the overwhelming amount of nonexperimental SDT research (Ryan & Deci, 2019). SDT interventions focus primarily on teachers and their use of instructional practices that satisfy students' basic psychological needs (i.e. autonomy support; cf. Su & Reeve, 2011). This instructional practice enables

students to perceive more choices and greater control while promoting their autonomous motivation (Assor et al., 2018; De Naeghel et al., 2016; Froiland, 2010; cf. Su & Reeve, 2011).

For example, De Naeghel et al. (2016) showed that fifth-grade students whose teacher participated in a workshop that aimed at providing knowledge and skills to implement an autonomy-supportive and structuring teaching style reported an increase in autonomous reading motivation 3 months later. In the intervention (ca. 4.5-hour workshop), teachers gained knowledge about the relevance of autonomy-supportive and structuring teaching style for autonomous motivation and achievement. Further, specific strategies to provide autonomy support and structure were exemplified, discussed, and reflected. Based on this knowledge, teachers prepared a reading activity for their class. After the workshop, teachers received a weekly electronic reminder to encourage them to implement an autonomy-supportive and structuring motivating teaching style (cf. De Naeghel et al., 2016).

The intervention targeted teachers' knowledge and skill about motivational teaching by prompting them with information. As a result, teachers' behavior changed toward teaching that promoted motivation (i.e., instruction that satisfies students' basic needs). According to SDT, this provides an improved situation for students (prompting by altering the situation), which can lead to more autonomous motivation and better outcomes (Hascher et al., 2019; Walton & Wilson, 2018).

Control-Value Theory

CVT suggests that "appraisals […] can be assumed to mediate the impact of situational factors and can be targeted by educational interventions intended to foster positive emotional development" (Pekrun, 2006, p. 317). CVT interventions aim to reduce negative emotions (e.g., Balmer et al., 2007; Ramirez & Beilock, 2011) and/or enhance positive emotions through actively changing control appraisals (Kim & Hodges, 2012; Raccanello & Hall, 2020). Also, AR (Hall et al., 2007) can be used as an example of an intervention that aims to promote positive emotions and reduce negative emotions by changing control appraisals, as emotions mediate the effects of AR on motivation and achievement (cf. close connection of attribution theory and emotions; Haynes et al., 2009). In addition, because the value component of CVT has significant overlaps with the value component of EVT (Pekrun & Perry, 2014), utility-value interventions may also be used to promote emotions. Consequently, emotions may also moderate the effects of utility interventions on motivation and achievement (Falco et al., 2010).

As an example of an intervention that explicitly targeted control appraisals to change emotions, Kim and Hodges (2012) showed that college students in a mathematics course who

participated in an intervention reported higher levels of enjoyment and pride as well as higher motivation 3 weeks later. However, regarding negative emotions, (i.e., anger, fear, shame, hopelessness, and boredom), no significant effect of the intervention was achieved. The intervention aimed to help students recognize that they have control over their attention, appraisal, and responses. Students were supported in being aware of the situation and their emotions and how to consciously appraise and provoke or suppress emotional responses (e.g., suppressing anger). The prompted strategies were thereby embedded in the story of a fictional former student who had emotional problems in this mathematics course, which was presented through a 6-minute video (Kim & Hodges, 2012).

Through the intervention, the beliefs of emotions are changed by prompting with information. In line with CVT, the belief that appraisals, emotions, and outcomes are controllable may lead to more positive emotions, which may change students' learning behavior and in turn can lead to positive outcomes (i.e., positive emotions, motivation, achievement; Walton & Wilson, 2018).

Conclusion on the Effectiveness of Motivation Interventions

In sum, previous intervention studies suggest that various theoretical approaches and targeted processes may contribute to the promotion of positive emotions, motivation, and achievement across subjects, age groups, and regions (Harackiewicz & Priniski, 2018; Walton, 2014; Walton & Wilson, 2018; Yeager & Walton, 2011). The presented interventions each targeted a single motivational construct or component; however, to be maximally effective, an intervention may need to address multiple facets and motivational constructs. So far, however, research on multicomponent interventions is sparse (Hascher et al., 2019; Hulleman & Barron, 2015). Moreover, nonsignificant or counteracting effects can also be found for these theories, questioning the encouraging results of single-component interventions (e.g., Craven et al., 1991; Ranellucci et al., 2017; cf. Benning et al., 2019).[3] Social-psychological interventions may not lead to the desired outcomes regarding emotion, motivation, engagement, and achievement in every case because they are still dependent on individual characteristics (e.g., skills and abilities). This dependence of the intervention on individual factors is focused on aptitude-treatment interaction research.

[3]Due to possible publication bias, more intervention studies confirming the hypothesized effects might exist than vice versa (Polanin et al., 2016). Therefore, the promising results should not be overestimated.

3.3 Aptitude-Treatment Interaction Research

Aptitude-treatment interaction (ATI) research examines how an intervention outcome depends on the match between students' aptitude and the treatment (e.g., an intervention program) they receive (Snow, 1991a; Yeh, 2012). It is assumed that the effect of a treatment is optimal when the treatment and the student's aptitudes match and they can realize the maximum payoff (Cronbach, 1957). In line with the origin concept, aptitude encompasses any measurable characteristics of a person, such as motivation, interest, or attitudes about self and school (for an overview of the term development see Snow, 1991b; Snow, 1992). Based on their aptitudes, students differ in their readiness to profit from an intervention (Snow, 1991a, 1991b, 1992). It is assumed that an interaction occurs when the intervention has an impact on some students with a specific aptitude and a different or no effect on other students (Cronbach & Snow, 1977; Haynes et al., 2009; Yeh, 2012). In sum, ATI research aims to find interactions between students' aptitudes and the intervention, create matching interventions for different student groups with similar aptitudes, and optimize learning (Yeh, 2012).

The recognition of the interaction between treatment and individuals was a conceptual revolution in intervention research, and ATI research quickly gained popularity (Blumenthal et al., 2014; Zhao, 2017). Unfortunately, the problem of interactions between aptitudes and treatments is extremely complex. This complexity led to many inconsistencies in the empirical evidence of the existence of ATI (Helmke, 1998; Snow, 1992; Zhao, 2017). In turn, these inconsistencies led many researchers to ignore or reject the ATI phenomenon (Zhao, 2017). Nevertheless, some ATI research has evaluated the impact of different interventions on students' outcomes (e.g., Chow & Wehby, 2019; Cronbach & Snow, 1977; Fuchs et al., 2019; Fuchs et al., 2014; Helmke & Weinert, 1997; Tobias, 1976). Based on the clear definition and its ease of investigation, ATI research often focused on prior achievement and intelligence as aptitudes and different teaching styles as treatments. Results revealed that the lower the level of prior achievement or intelligence, the more effective (i.e., leading to better achievement) teacher-centered instruction, whereas at higher levels of prior achievement or intelligence, a student-centered, open instruction style with a high level of autonomy is more appropriate (Fuchs et al., 2019; Helmke & Weinert, 1997; Tobias, 1976). However, aptitude is more than intelligence and achievement (cf. Snow, 1991b): A wide set of individual characteristics (e.g., personality or motivation) can mediate the effect of different treatments (e.g., teaching style or intervention; Fuchs & Fuchs, 2019; Zhao, 2017).

Only a few studies exist that have considered motivation and emotion as aptitudes. For example, Hancock (2001) revealed that students with high test anxiety in a high-evaluative

condition were less motivated than students with low test anxiety. However, all students in the low-evaluative condition were more motivated than the students in the high-evaluative condition. These results suggest an interaction between the aptitude "test anxiety" and the teaching style. In addition, Lapka et al. (2011) investigated the mediating role of motivation within an online intervention on self-regulated learning. They found psychology students with a competence-oriented profile and students with motivational deficits benefited from the intervention, whereas no effects were found for motivationally balanced students. Overall, research with individual characteristics as aptitudes is scarce and remains a direction for future research (Fuchs et al., 2019; Kalyuga, 2007; Preacher & Sterba, 2019; Wigfield & Koenka, 2020).

In sum, the fact that interventions are not equally effective for everyone is not a new issue but a lack of systematic research remains (Cronbach & Snow, 1969). Moreover, increasing heterogeneity in classrooms (e.g., for Switzerland: Wolter et al., 2018) underscores the importance of differentiated analyses of interventions because heterogeneity increases the likelihood of ATI (Haynes et al., 2009, p. 231; Souvignier, in press). Therefore, more research is needed to account for individuals' aptitudes and ensure appropriate intervention to maximize the payoff of an intervention.

4 The Present Research

Existing theories and recent research highlight the pivotal role of emotion and motivation concerning academic achievement and lifelong learning. However, a negative trend in all forms of motivational regulation exists, especially in autonomous motivation (i.e., intrinsic and identified regulation) and positive emotions. This unfavorable development is particularly noticeable in mathematics (Gottfried et al., 2001; Raccanello et al., 2013). Moreover, mathematics often elicits negative emotions, such as anxiety (Suárez-Pellicioni et al., 2016) or anger (Larkin & Jorgensen, 2016). This is problematic because mathematics is a main subject in Switzerland (along with German and the first foreign language) in which the fundamental requirements must be achieved (D-EDK, 2014). In addition, the subject of mathematics has a high instrumental relevance, so that a decline in motivation and an associated decline in mathematics achievement can have far-reaching consequences for future life. In Switzerland, for example, one's mathematics grade has been shown to be more important for apprenticeship application than the grade in German (Häberlin et al., 2005). Furthermore, mathematics provides useful skills (e.g., problem-solving, logical thinking) for adult life (Gravemeijer et al., 2017), and thus any decline in mathematics motivation is a serious problem and must be counteracted accordingly.

Based on the trajectories of motivation and positive emotions in general, as well as in mathematics, a critical phase occurs after the transition to secondary education. According to SEFT, an increasing gap exists between students' needs and the environment provided by the secondary school (Eccles & Roeser, 2012). In addition, the age-related changes during this period may have an additional influence on the negative developments of motivation and emotions (Bru et al., 2010). Overall, increased attention to motivation and emotions is required during this period.

Finally, given the close relationship between motivation and academic achievement, students in low-achieving tiers (i.e., students in the canton of Bern attending Realschule) are particularly at risk for a decline in motivation and positive emotions. Secondary school students in low-achieving tiers are negatively selected, typically experience a greater feeling of incompetence, and have lower expectations for achievement (Eccles et al., 1991; Eccles et al., 1993). Feeling incompetent leads to a decrease in motivation, positive emotions, and other aspects relevant to motivation (e.g., self-concept; Eccles et al., 1993). Moreover, because mathematics tasks become more complex in secondary school, the likelihood of feeling competent decreases. Therefore, fostering motivation and positive emotions toward mathematics is especially important for low-achieving students.

In summary, low-achieving students in secondary education in mathematics are particularly at risk for a decline in motivation and positive emotions. Based on the requirements of social-psychological interventions that the intervention must be well-targeted and timed to achieve the intended outcome and to produce sustainable gains for students (Cohen et al., 2017; Walton & Wilson, 2018; Yeager & Walton, 2011), this intersection of the above-noted risk factors might be an appropriate target group for an intervention to promote students' motivation and positive emotions. Accordingly, the present dissertation aimed to contribute to the development and promotion of motivation and positive emotions and evaluate the effectiveness of a multicomponent intervention in mathematics in the lowest-ability tier in lower secondary education. By using a quasi-experimental design, the present research addresses the call for more intervention research (Lazowski & Hulleman, 2016; Robinson et al., 2007). Moreover, an intervention that consists of multiple components may transcend previous intervention research by addressing multiple facets of student motivation and thus might maximize its effectiveness (Hulleman & Barron, 2015).

In detail, the dissertation focused on three key topics: the interplay between motivational factors and motivation as well as between emotional factors and emotions; the development of these aspects across time; and the effectiveness of the multicomponent intervention over 2 school years for low-achieving secondary school students in mathematics. Thus, the following research questions were addressed:

1. What is the relationship between motivational factors (i.e., basic psychological needs) and autonomous motivation in mathematics? (Study I)
2. What is the interplay between emotional factors (i.e., control and value appraisals) and emotions in mathematics? (Study II)
3. What are the developmental trends of students' motivation and emotions across time? (Studies I, II, and III)
4. Does the multicomponent intervention affect self-determined forms of motivational regulation and different emotions? (Studies I and II)
5. Are there differences in the effectiveness of the intervention between different subgroups based on their aptitudes (i.e., motivation profile)? (Study III)

5 Method

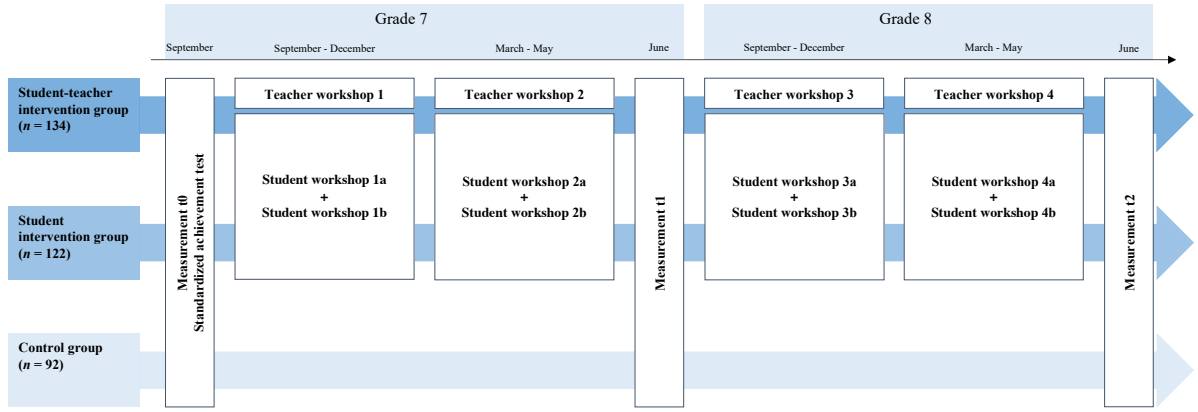
To address the research questions, the studies in this dissertation use data from three waves of the longitudinal intervention project "Maintaining and Fostering Students' Positive Learning Emotions and Learning Motivation in Maths Instruction During Early Adolescence (EMo-Math, 2015-2019)."[4] This intervention project was conducted to counteract students' negative motivational and emotional development during Grades 7 and 8 in the lowest-ability tier in mathematics.

5.1 Participants and Procedures

The sample for all three studies of this dissertation consists of students (N = 348) from 22 classes in the lowest-ability tier (Realschule) in secondary education in the German-speaking part of the canton of Bern. All students and teachers completed paper-and-pencil questionnaires three times over 2 school years: at the beginning of Grade 7, end of Grade 7, and end of Grade 8. In addition, students completed a standardized mathematics test at the beginning of Grade 7 (cf. Figure 7). Data collection took place during regular mathematics classes and was conducted by trained university staff members.

Figure 7

Study Design



Of the 348 students, 134 students (eight classes) participated in the *student-teacher intervention*, 122 students (eight classes) participated in the *student intervention*, and 92 students (six classes) were in the *control group*. In the student-teacher intervention setting, the students participated in eight workshops (four in Grade 7 and four in Grade 8), and the teachers

[4]The EMo-Math project was funded by the Swiss National Science Foundation (grant number 156710).

participated in four workshops (two in Grade 7 and two in Grade 8). Students in the student intervention setting attended the same eight workshops during Grades 7 and 8 as students in the student-teacher intervention. Students in the control group received no intervention. For details on the considerations of the intervention design, see Brandenberger (2017).

5.2 Intervention

The intervention has a multicomponent nature and incorporates different theoretical components of SDT, CVT, attribution theory, EVT, and goal orientation theory. The workshops lasted two to three lessons each and were conducted by trained project staff during regular mathematics lessons in the regular classroom setting. Each workshop followed a structured implementation plan and was realized with the identical materials developed and tested in advance to ensure the intervention protocol.

Overall, in each workshop, students' basic psychological needs were met to achieve motivation to participate in the workshops. For example, cooperative activities were used to increase social relatedness, competence was promoted by allowing tasks to be completed with varying levels of prior knowledge and ability, and autonomy was promoted through choices within the tasks. Each workshop addressed different objectives within the overall goal of promoting learning motivation and positive emotions. The contents of the workshops were sequential and related to students' daily lives. The workshops consisted of a mix of theoretical inputs, hands-on activities, group collaboration, video examples, and reflection on their learning and the importance of mathematics for their own lives and learning. According to social-psychological interventions, the multicomponent intervention aimed to achieve a change in students' beliefs about emotions, ability and potential, goals, qualities of the self and personal experiences, and contexts that lack meaning by prompting new meanings, increasing commitment through action (saying is believing), and active reflection exercises (cf. Walton & Wilson, 2018). Thus, according to the presented intervention studies in Chapter 3.2, the content of the workshops aimed at triggering different psychological processes, which were expected to influence the trajectories of students' experiences and motivational and emotional outcomes. The description of the workshops, types of targets, and techniques according to Walton and Wilson (2018) are shown in Table 4.

Table 4

Overview of the Intervention Content for Student Workshops

		Description	Contents[a]	Psychological targets[a,b]	Techniques[a,b]
Grade 7	September - December	**Workshop 1a: Motivation and emotion** Students get an awareness of the multiple experiences in school, with a special focus on mathematics; Students learn more about scholastic learning and rethink their motivation and emotions concerning learning mathematics.	- Theory: Introduction on motivation and emotion in school - Hands-on activities (e.g., case studies in which students self-generated strategies in emotional regulation) - Reflection (e.g., assessing one's motivation for learning mathematics; noticing one's own emotions before and during math lessons)	- Change beliefs about personal experiences (e.g., does mathematics have personal meaning to me?) - Change beliefs about emotions, states, and the valence (e.g., are negative past emotions, states, and experiences ongoing and undermining?)	- Active reflection exercise - Increasing commitment through action: saying is believing
		Workshop 1b: Participation, self-portrait, and learning goals Students reflect on subjective learning experiences in mathematics classes, determine positive attitudes toward mathematics, and rethink their learning goals in mathematics.	- Theory: Setting learning goals - Hands-on activities (e.g., case studies in which students identified opportunities to improve their participation in the classroom; creating a self-portrait [my motivation, my learning goal, my emotions, my potential for improvement]) - Reflection (e.g., setting learning goals [SMART]; identifying relevant factors for successful mathematics learning)	- Change beliefs about ability and potential (e.g., am I capable of learning or performing well?) - Change beliefs about goals (e.g., how will I accomplish my goals?) - Change beliefs about emotions, states, and the valence (e.g., are negative past emotions, states, and experiences ongoing and undermining?)	- Active reflection exercise - Increasing commitment through action: saying is believing - Promoting new meanings: leading questions
	March - May	**Workshop 2a: Learning strategies** Students enhance knowledge and improve their use of learning strategies in mathematics.	- Theory: Introduction on learning strategies - Hands-on activities (e.g., case studies on the different learning strategies; use of learning strategies in the class) - Reflection (e.g., own use of learning strategies; use of learning strategies to achieve own learning goals)	- Changing beliefs about personal experiences/contexts that lack meaning (e.g., does mathematics have personal meaning to me?) - Change beliefs about goals (e.g., how will I accomplish my goals?)	- Prompting new meanings: prompting with information/skills - Increasing commitment through action: saying is believing
		Workshop 2b: Self-regulation Students learn to use emotional and motivational self-regulation strategies in mathematics.	- Theory: Introduction on self-regulation (focus on planning) - Hands-on activities (e.g., create a plan for achieving one's goals in mathematics; role play on the topic of distraction while learning) - Reflection (e.g., tips against distractions during learning)	- Change beliefs about ability and potential (e.g., does struggling mean I can't do it?) - Change beliefs about goals (e.g., how will I accomplish my goals?) - Change in qualities of the self (e.g., can emotions change?)	- Active reflection exercise - Increasing commitment through action: saying is believing

Grade 8	September - December	**Workshop 3a: Positive attitudes / attribution** Students improve their causal attributions to learning and their value- and control-cognition in mathematics.	- Theory: Introduction on attribution - Hands-on activities (e.g., dealing with mistakes [appraisals]) - Reflection (e.g., a reappraisal of success/failure)	- Change beliefs about emotions, states, and the valence (e.g., are negative past emotions, states, and experiences ongoing and undermining?) - Changing beliefs about ability and potential (e.g., does struggling mean I can't do it?)	- Increasing commitment through action: saying is believing - Promoting new meanings: leading questions
		Workshop 3b: Attitudes and professional future Students understand the relevance of mathematics learning and can link this relevance to their own lives.	- Theory: Introduction on individual reference-norm orientation - Hands-on activities (e.g., relevance of mathematics for their professional future; mathematics task related to professional future) - Reflection (e.g., to compare oneself with others and with oneself; relevance of mathematics for oneself)	- Change beliefs about goals (e.g., what are my goals?) - Changing beliefs about personal experiences/contexts that lack meaning (e.g., does mathematics have personal meaning to me?)	- Promoting new meanings: leading questions - Increasing commitment through action: saying is believing
	March - May	**Workshop 4a: Cycle of learning** Repetition on learning strategies, emotional and motivational self-regulation strategies.	- Theory: Introduction on the cycle of learning - Hands-on activities (e.g., jigsaw on learning strategies, emotional and motivational self-regulation strategies) - Reflection (e.g., own use of strategies)	- Change beliefs about goals (e.g., how will I accomplish my goals?) - Change in qualities of the self (e.g., can emotions change?)	- Prompting new meanings: prompting with information - Increasing commitment through action:saying is believing
		Workshop 4b: Successfully into the professional future Repetition on value cognitions in math and emotional and motivation self-regulation strategies.	- Theory: Introduction on dealing with anxiety, stress, and pressure - Hands-on activities (e.g., individual tasks relating to one's professional future or career goal; tips to cope with anxiety, stress, and pressure) - Reflection (e.g., what are stress factors for me and why; personal coping strategies)	- Changing beliefs about personal experiences/contexts that lack meaning (e.g., does mathematics have personal meaning to me?) - Change beliefs about emotions, states, and the valence (e.g., are negative past emotions, states, and experiences ongoing and undermining?)	- Promoting new meanings: leading questions - Active reflection on positive aspects of self

Note: [a] This is not an exhaustive list but rather the most central contents, targets, and techniques; [b] According to Walton and Wilson's (2018) taxonomy.

Teacher workshops took place on Wednesday afternoons at the university and were conducted by trained staff members. The contents of the teacher workshops were aligned with the contents of the student workshops. The overall aim of the teacher workshops was to encourage teachers to reflect on their mathematics instruction and to support them in implementing more motivation-enhancing teaching. However, teacher workshops served only as a supplement since specific instructional changes were not the focus of the intervention project. Teacher workshops consisted of a mix of theory, hands-on activities, and reflection (cf. Table 5).

Table 5

Overview of the Intervention Content for Teacher Workshops

		Description	Contents[a]
Grade 7	December	**Workshop L1: Decline of motivation in math classes and how teachers can deal with it** Teachers improve their competencies concerning student needs.	- Theory: Introduction on student' motivation and emotion: self-determination theory, stage-environment fit theory, control-value theory - Hands-on activities (e.g., discussion about own practical experiences, discussion of opportunities to promote positive emotions and motivation) - Reflection (e.g., own strengths and opportunities for improvement)
	March	**Workshop L2: Teaching and learning: Students' participation in mathematics education** Teachers receive input on how to work with students to create a more productive learning environment.	- Theory: Introduction on offer-and-use model of instruction, dealing with mistakes - Hands-on activities (e.g., discussion about own practical experiences) - Reflection (e.g., own strengths and opportunities for improvement)
Grade 8	September	**Workshop L3: Shaping school positively** Teachers enrich their knowledge of high-quality teaching.	- Theory: Introduction on dealing with mistakes and basic psychological needs; self-determination theory, attribution theory - Hands-on activities (e.g., discussion about own practical experiences, case studies on different attributions) - Reflection (e.g., own handling of mistakes)
	April	**Workshop L4: It's the togetherness that counts** Teachers improve the quality of their teaching concerning students' needs.	- Theory: Repetition - Hands-on activities (e.g., discussion about own practical experiences, discussion how to give constructive feedback) - Reflection (e.g., teacher-student relationship, own strengths and opportunities for improvement regarding the quality of teaching)

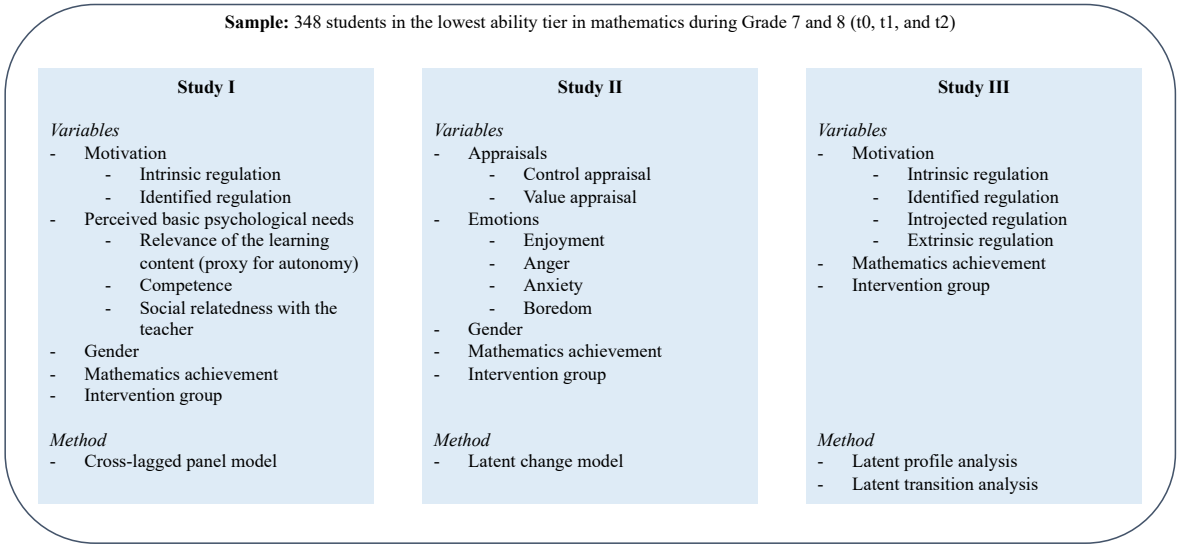
Note: [a] This is not an exhaustive list but rather the most central content.

6 Overview of the Studies of the Dissertation

This section provides an overview of the three individual research studies in the present dissertation (cf. Figure 8). The major goals, methods, and findings of each study as well as each study's contribution to the dissertation with cross-reference to the research questions are provided.

Figure 8

Overview of Study Variables and Methods



Study I – Relations Between the Satisfaction of Basic Psychological Needs and Self-Determined Learning Motivation in Mathematics in Lower Secondary Education

Aim: The first study aimed to investigate the relationship between basic psychological needs and self-determined forms of motivational regulation in mathematics. In particular, the study examined (a) whether students' perceived fulfillment of basic psychological needs for autonomy, competence, and relatedness influence their intrinsic and identified regulation, (b) whether students' intrinsic and identified regulation influence their perceived fulfillment of basic psychological needs, and (c) whether students' perceived fulfillment of basic psychological needs and their intrinsic and identified regulation influence each other reciprocally across Grades 7 and 8. Moreover, this study investigated the development of the constructs across 2 school years. Finally, intervention group membership was considered in the modeling to reveal the effects of the intervention on the constructs.

Method: Data were collected from 348 students in Grades 7 and 8 in the lowest-ability tier in mathematics from the Swiss canton of Bern. A cross-lagged panel design using the latent

variable approach was applied to investigate the direction of the relationship between the constructs as well as their temporal stability. Separate models were conducted for both forms of self-determined motivational regulation (i.e., intrinsic and identified regulation), paired with each of the three basic psychological needs (i.e., relevance of the learning content as a proxy of perceived autonomy, perceived competence, and social relatedness with the teacher).

Results: The findings of the study suggested that the constructs are interrelated, but no reliable longitudinal effects between the constructs were observed. It is noteworthy that the two forms of self-determined motivation may have different associations with students' perceived fulfillment of basic psychological needs. The specified constructs demonstrated moderate temporal stability (autoregressive coefficients), indicating that changes in individuals standing in the constructs across 2 school years occurred. Finally, no effects of the intervention were found.

Contribution to the dissertation: By demonstrating the relationship between students' perceived fulfillment of basic psychological needs and self-determined forms of motivational regulation, the results provided a better understanding of the interplay between the constructs (Research Question 1) and highlighted the temporal stability of students' self-determined forms of motivational regulation in mathematics (Research Question 3). Moreover, the present intervention revealed no impact on students' perceived fulfillment of basic psychological needs nor self-determined forms of motivational regulation (Research Question 4). This study thus contributes to the overall dissertation by identifying potential factors for promoting motivation in mathematics instruction in lower secondary education and providing evidence on the effectiveness of a multicomponent intervention.

Study II – Testing Effects of Promoting Antecedents of Mathematics Achievement Emotions: A Change-Change Model

Aim: The second study aimed to investigate whether the intervention had an impact on changes in students' perceived control and value appraisals and achievement emotions in mathematics in lower secondary education. In addition, the study examined the effects of changes in control and value appraisals on changes in different achievement emotions (i.e., enjoyment, anger, anxiety, and boredom). Furthermore, the study sought to gain information on between-person differences in changes in control and value appraisals as well as in different emotions in mathematics across time.

Method: The study used the same sample of 348 students in Grades 7 and 8 in the lowest-ability tier in mathematics from the Swiss canton of Bern. Separate latent change models were

applied to investigate the effectiveness of the intervention and the interplay and development of the constructs across time.

Results: Findings revealed no effect of the intervention on students' perceived control and value appraisals and emotions in mathematics. However, the change-change assumption for control and value appraisals and different emotions was confirmed. Intraindividual changes in control and value appraisals predicted intraindividual changes in emotions. In addition, the relatively high negative correlations between the constructs and the latent changes indicated that intraindividual changes differ between individuals as a function of the baseline level over 2 school years.

Contribution to the dissertation: By revealing the effects of change in appraisals on emotions and the nature of the between-person difference in changes, the second study shed light on how these constructs are interrelated (Research Question 2) and how they have developed intraindividually over time (Research Question 3). The effects of the present intervention revealed no impact on students' perceived control and value appraisals, as well as on the different achievement emotions at the intraindividual level (Research Question 4). Overall, this study contributes to the dissertation by providing evidence on the effectiveness of a multicomponent intervention and by identifying potential factors for the promotion of positive emotions and the reduction of negative emotions, and thus as a possible contribution to the promotion of motivation.

Study III – Stability and Change of Low-Achieving Secondary School Students' Motivation Profiles for Mathematics: Effects of an Intervention

Aim: The third study aimed to identify motivation profiles in mathematics within the specifically vulnerable student group of low-achieving students in Grades 7 and 8. Moreover, the study investigated the patterns of change in the motivation profiles over 2 school years. In particular, the study sought to gain information about differences between intervention and control groups regarding patterns of change over time. Therefore, the study aimed to analyze whether different motivation profiles respond differently to the intervention (i.e., ATIs).

Method: Data were collected from the same sample of 348 students in Grades 7 and 8 in the lowest-ability tier in mathematics from the Swiss canton of Bern. To identify motivation profiles, latent profile analyses were conducted for each measurement point. To investigate patterns of change, latent transition analyses were applied—once for the whole sample and once with the intervention as a grouping variable.

Results: Findings indicated three motivation profiles based on intrinsic, identified, introjected, and extrinsic regulation existed in the sample. Based on the manifestation of the four variables,

the profiles were named low-mixed, high-mixed, and self-determined motivation profiles. Results of the latent transition analysis suggested the majority of the students remained in the profile across 2 school years. However, in combination with the grouping variable, different effects of the intervention on different profiles appeared.

Contribution to the dissertation: By illustrating different motivation profiles in the group of low-achieving students in mathematics, the study demonstrated differences between students even in an at-risk group of low-achieving students regarding their motivation. Further, the development of these motivation profiles was investigated (Research Question 3). In addition, this study also indicated that the effectiveness of the intervention differed between students depending on their motivational aptitudes (Research Question 5). Thus, this study contributes to the overall dissertation by examining the development of motivation profiles and the effectiveness of the intervention in different subgroups, demonstrating their differences in effectiveness, and identifying potential side effects of promoting motivation.

Zusammenhänge zwischen der Erfüllung der psychologischen Grundbedürfnisse und der selbstbestimmten Lernmotivation im Mathematikunterricht der Sekundarstufe I

Held-Augustin, T., Hagenauer, G., & Hascher, T. (in press). Zusammenhänge zwischen der Erfüllung der psychologischen Grundbedürfnisse und der selbstbestimmten Lernmotivation im Mathematikunterricht der Sekundarstufe I [Relations between the satisfaction of basic psychological needs and self-determined learning motivation in mathematics in lower secondary education]. In R. Lazarides & D. Raufelder (Hrsg.), *Edition Zeitschrift für Erziehungswissenschaft: Bd. 10. Motivation in unterrichtlichen fachbezogenen Lehr-Lernkontexten* (S. 151–180). Springer.

Zusammenfassung

Die Lernmotivation gilt als einer der wichtigsten individuellen Prädiktoren für gelingende Lernprozesse und für schulischen Erfolg. Die Erfüllung der psychologischen Grundbedürfnisse nach Autonomie, Kompetenz und sozialer Eingebundenheit nimmt dabei eine zentrale Rolle für die qualitative Ausprägung der selbstbestimmten Motivation ein. Der vorliegende Text stellt die Beziehung zwischen zwei Formen der selbstbestimmten Motivation – intrinsische und identifizierte Motivation – und den psychologischen Grundbedürfnissen im Mathematikunterricht anhand einer Längsschnittstudie (drei Messzeitpunkte) mit 348 Schülerinnen und Schülern der Sekundarstufe I in den Mittelpunkt. Die Analysen von insgesamt sechs Cross-Lagged Panel Modellen ergeben keine reziproken Zusammenhänge, sondern ausschließlich autoregressive und vereinzelte unidirektionale Beziehungen, die jedoch in ihrer Stärke und Richtung zwischen den drei psychologischen Grundbedürfnissen (Relevanz der Inhalte als Proxy für Autonomie, Kompetenzerleben und soziale Eingebundenheit) variieren.

Schlüsselwörter: Motivation, Selbstbestimmungstheorie, Psychologische Grundbedürfnisse, reziproke Beziehungen

Abstract

Learning motivation is one of the most important psychological individual predictors for learning processes and school success. The fulfilment of the basic psychological needs for autonomy, competence and relatedness plays a crucial role for the quality of self-determined motivation. In this paper, we report on the relations between self-determined motivation –intrinsic and identified motivation – and basic needs in mathematics in lower secondary education on the basis of a longitudinal study (three waves) with 348 students. The analyses of six cross-lagged panel models do not reveal reciprocal relations but only autoregressive and a few unidirectional relations. These relations vary with regard to the direction and the effect size depending on the respective basic psychological need (relevance of the learning content as proxy of the perceived autonomy, perceived competence and social relatedness with the teacher).

Keywords: Basic Needs, Motivation, Reciprocal relations, Self-determination theory

7.1 Einleitung

Die Lernmotivation gilt als eines der wichtigsten psychologischen Konzepte für das Gelingen von Lernprozessen und für schulischen Erfolg (Gnambs und Hanfstingl 2015). Zahlreiche Forschungsergebnisse bestätigen den Zusammenhang von Lernmotivation mit Ausdauer, Lernen und Leistung (z. B. Vallerand et al. 1992; Taylor et al. 2014). Da sich jedoch in der frühen Jugend und vor allem nach der Transition in die Sekundarstufe ein bedeutungsvoller Rückgang der Lernmotivation feststellen lässt (z. B. Eccles et al. 1993; Wigfield et al. 2015), ist eine gezielte Förderung der Lernmotivation der Schülerinnen und Schüler von zentraler Bedeutung und führt zu der Frage, welche Bedingungen sich begünstigend auf die Lernmotivation auswirken und wie diese für erfolgreiche Lernprozesse genutzt werden können. Bisherige Befunde verweisen auf die Relevanz von Variablen aus dem sozialen Kontext (z. B. Martin et al. 2007) sowie auf die Rolle von individuellen Unterschieden als Ursachen und Moderatoren (z. B. Guay et al. 2010). Der Erfüllung der psychologischen Grundbedürfnisse kommt dabei eine zentrale Bedeutung für die Motivation zu (Deci und Ryan 1993). In der Regel wird davon ausgegangen, dass die Erfüllung der psychologischen Grundbedürfnisse die Motivation determiniert (Olafsen et al. 2018). Da ein erhöhtes Maß an selbstbestimmter Motivation aber zugleich auch mit einer verbesserten Wahrnehmung der Autonomie, einem erhöhten Kompetenzerleben sowie einer besseren sozialen Eingebundenheit zur Lehrperson einhergeht (vgl. z. B. Reeve et al. 2004), sollen in diesem Beitrag die Zusammenhänge zwischen den psychologischen Grundbedürfnissen und der selbstbestimmten Motivation im Mathematikunterricht in der 7. und 8. Klassenstufe genauer untersucht werden. Dies erfolgt anhand einer Längsschnittstudie in Bezug auf drei Fragen: a) Geht eine Veränderung in der Erfüllung der psychologischen Grundbedürfnisse mit einer Veränderung in der selbstbestimmten Motivation einher? b) Kommt es bei einer Veränderung der selbstbestimmten Motivation auch zu einer Veränderung in der Erfüllung der drei psychologischen Grundbedürfnisse? c) Stehen die Erfüllung der psychologischen Grundbedürfnisse und die selbstbestimmte Lernmotivation in einem reziproken Verhältnis?

Motivation ist domänenspezifisch zu betrachten. Im vorliegenden Beitrag wird das Fach Mathematik fokussiert, da es besonders von einem Motivationsabfall auf der Sekundarstufe betroffen ist (z. B. Gottfried et al. 2001; Gaspard et al. 2015). Zudem kommt dem Fach Mathematik ein hoher Stellenwert zu, da es für den schulischen Bildungserfolg zentral ist und beispielsweise zu den vier Fachbereichen im Schweizer Schulsystem zählt, in welchem nationale Grundkompetenzen erreicht werden müssen (D-EDK 2016). Weiter weist Mathematik eine hohe instrumentelle Relevanz auf, weshalb eine negative motivationale Entwicklung für den weiteren Lebensverlauf weitreichende Folgen haben kann (Haeberlin et al. 2004).

7.2 Erfüllung der psychologischen Grundbedürfnisse und Schülerinnen- und Schülermotivation

Unter Motivation wird «die aktivierende Ausrichtung des momentanen Lebensvollzugs auf einen positiv bewerteten Zielzustand» verstanden (Rheinberg 2008, S. 15). Die Selbstbestimmungstheorie der Motivation (Self-Determination Theory [SDT]) von Deci und Ryan (1993) geht von der Annahme aus, dass ein Mensch das angeborene Bedürfnis besitzt, die eigenen Fähigkeiten und Fertigkeiten aktiv zu erproben, neue Erfahrungen zu sammeln und ein kohärentes Selbst zu entwickeln. Der Mensch wird als ein aktiver Organismus gesehen, dessen Verhalten durch die Integration der Bedingungen des sozialen Kontextes und durch das emotionale Erleben geprägt ist (Deci und Ryan 1993). Lernkontexte können diese Integration unterstützen oder untergraben und somit zu unterschiedlichen qualitativen Ausprägungen der Motivation führen, etwa, wenn ehemals externale Werte und regulatorische Prozesse von einer Person übernommen und in einem weiterführenden Prozess in das Selbst assimiliert werden (Deci und Ryan 1993). Folglich wird aufgrund des Ausmaßes, zu welchem das extrinsisch motivierte Verhalten internalisiert und integriert ist, zwischen den fünf Regulationsformen externale, introjizierte, identifizierte, integrierte und intrinsische Regulation unterschieden (Deci und Ryan 2009). Die identifizierte, integrierte und intrinsische Regulation gelten dabei hinsichtlich der Motivationsförderung als die erwünschten Formen, da bei diesen die Handlungen als selbstbestimmt und sinnhaft erachtet sowie bessere Lernergebnisse erzielt werden (Deci und Ryan 2000). Die Lernkontexte ihrerseits bestimmen, inwiefern die drei psychologischen Grundbedürfnisse nach Autonomie, Kompetenz und sozialer Eingebundenheit erfüllt sind (Deci und Ryan 1993, 2000). Für die Gestaltung der Lernkontexte im schulischen Umfeld kommt der Lehrperson und ihrem Unterrichtshandeln eine herausragende Bedeutung zu (Lipowsky 2006), wodurch sich Lernkontexte und folglich auch die Erfüllung der psychologischen Grundbedürfnisse der Schülerinnen und Schüler zwischen Fächern deutlich unterscheiden können. Diese Kontextgebundenheit legt nahe, Motivation als domänenspezifisches Konstrukt zu analysieren.

Die theoretische Grundlage für das Autonomiebedürfnis bildet das Konzept *„need for personal causation“* von DeCharms (1968). Von Autonomie wird gesprochen, wenn sich die agierende Person als eigenständiges Handlungszentrum sieht, sodass die Handlung als internal verantwortet erlebt wird (Reeve et al. 2004; Deci und Ryan 2016). Dabei stimmen die persönlichen Wünsche und Ziele mit der Handlung überein, sodass das Handeln im Einklang mit dem Selbst ist (Deci 1998, S. 152). Im mathematikspezifischen Kontext konnten Hagger et al. (2015) beispielsweise aufzeigen, dass die von den Schülerinnen und Schülern wahrgenommene

Autonomieunterstützung durch die Lehrperson einen positiven Effekt auf die selbstbestimmte Motivation in Mathematik aufwies.

Skinner und Belmont (1993) betonen, dass die persönliche Relevanz einer Aufgabe einen zentralen Aspekt des Autonomieerlebens darstellt. Dadurch kann das Individuum den Wert einer Handlung in Bezug auf die eigenen Ziele erkennen, was der Handlung besondere Wichtigkeit verleiht und dazu führt, dass sich die Schülerinnen und Schüler freier in ihrem Handeln fühlen (Waldis 2012). Die positive Beziehung zwischen der Relevanz, dem Engagement und der selbstbestimmten Motivation wurde von Assor et al. (2002) bestätigt. Den Schülerinnen und Schülern Wahlmöglichkeiten in der Aufgabenbearbeitung anzubieten, kann Autonomie unterstützen, jedoch ist es von hoher Bedeutung, dass diese Aufgaben den Schülerinnen und Schülern auch sinnvoll erscheinen, damit sie Autonomie erleben. Daher stellen alle Bemühungen auf Seiten der Lehrperson, den Schülerinnen und Schülern die Relevanz von Inhalten zu verdeutlichen, zentrale Maßnahmen zur Autonomieförderung dar. Ebenso unterstreichen Rakoczy et al. (2008) die Bedeutsamkeit der Relevanz für die selbstbestimmte Motivation in Mathematik. Ihren Arbeiten zufolge trägt die subjektive Bedeutsamkeit der Lerninhalte zur Internalisierung von external an die Schülerinnen und Schüler herangetragenen Aufgabenstellungen und Zielsetzungen bei. Damit wird deutlich, dass Lehrpersonen durch ihre Unterrichts- und Aufgabengestaltung das wahrgenommene Autonomieerleben der Schülerinnen und Schüler beeinflussen (Guay et al. 2001).

Das Bedürfnis nach Kompetenz wird erfüllt, wenn eine Aufgabe aus eigener Kraft bewältigt und die eigenen Fähigkeiten weiterentwickelt werden können (Deci und Ryan 1993; Krapp et al. 2014). Dies erleben Schülerinnen und Schüler, wenn die Lehrperson ihren Unterricht dem Fähigkeitsniveau der Schülerinnen und Schüler anpasst und ihnen individuelles Feedback gibt (Mittag et al. 2009). Das Bedürfnis nach Kompetenz kann somit als das Bestreben nach Effektivität und Können gesehen werden, welches allerdings durch Misserfolg oder auch fehlende Herausforderungen vermindert wird. Es zeigt sich, dass die wahrgenommene Kompetenzunterstützung sowohl positiv mit der intrinsischen Motivation (Ntoumanis et al. 2009; Devloo et al. 2015; Goldman et al. 2017; van Egmond et al. 2017; Guo 2018) als auch mit der Anstrengung (Trautwein et al. 2009) korreliert. Eine wichtige Voraussetzung für das Kompetenzerleben ist somit die optimale Passung zwischen Anforderung und Kompetenzen. Zudem sind die inhaltsbezogene Hilfe und das Unterstützungsangebot von Seiten der Lehrperson ausschlaggebend (Skinner und Belmont 1993; Rakoczy 2008; Rakoczy et al. 2008). In Bezug auf das Fach Mathematik konnten beispielsweise Costache et al. (2019) das wahrgenommene Kompetenzerleben als Prädiktor für die intrinsische Motivation bestätigen.

Die soziale Eingebundenheit als drittes Grundbedürfnis umfasst das Gefühl, in seiner sozialen Umwelt anerkannt zu sein und basiert folglich auf positiven Sozialbeziehungen. Die Konzeption geht auf die Konzepte *„need for relatedness"* von Maslow (1943), *„need for love"* (Harlow 1958) und *„need for affiliation"* von McClelland (1985) zurück. Bei dem Bedürfnis nach sozialer Eingebundenheit steht nicht das Erreichen eines Ziels im Vordergrund, sondern das Erleben emotionaler Bindung (Waldis 2012). Das Bedürfnis umfasst zwei Hauptmerkmale: Interdependente, konfliktarme persönliche Kontakte sind essentiell für die individuelle Entwicklung. Deshalb ist es bedeutsam, dass Menschen erleben, dass eine interpersonale Beziehung stabil ist und über eine absehbare Zeit fortgesetzt wird (Stroet et al. 2013). Zahlreiche Studien bestätigten Zusammenhänge zwischen einer positiven Lehrer-Schüler-Beziehung (international auch als *Teacher Involvement* bezeichnet) und dem schulischen Engagement (Ryan et al. 1994; Rosenfeld et al. 2000; Tucker et al. 2002; Brewster und Bowen 2004; Martin et al. 2007; Daly et al. 2009; Murray 2009; Guo 2018) sowie die zentrale Rolle einer unterstützenden Lehrperson, zu der man sich verbunden fühlt, für die selbstbestimmte Motivation (Skinner und Belmont 1993; Deci und Ryan 2002; Minnaert et al. 2007; Opdenakker und Minnaert 2011; Goldman et al. 2017). Eine positive Beziehung zur Lehrperson ist insbesondere für leistungsschwächere Schülerinnen und Schüler von Relevanz und ihre Bedeutung bleibt auch mit zunehmendem Alter der Schülerinnen und Schüler bestehen (Hamre und Pianta 2006). Der positive Effekt der sozialen Eingebundenheit auf die intrinsische Motivation in Mathematik konnte beispielsweise von Rubach und Lazarides (2019) nachgewiesen werden.

Eine Mehrheit der bisherigen Untersuchungen versteht die Erfüllung der psychologischen Grundbedürfnisse als Prädiktor für die Motivation und die Leistung der Schülerinnen und Schüler. Es wird davon ausgegangen, dass eine Erfüllung der psychologischen Grundbedürfnisse unabhängig von der Schulstufe zu einer erhöhten selbstbestimmten Motivation bei den Schülerinnen und Schülern führt (Deci und Ryan 2016). Obwohl es durchaus auch Hinweise für die andere Wirkrichtung gibt, fehlen Studien, die sich zum Ziel setzen, reziproke Beziehungen zu modellieren (vgl. Košir und Tement 2014). Aufgrund der Tatsache, dass die motivationale Ausprägung von personen- und situationsbezogenen Einflüssen, den antizipierten Handlungsergebnissen und auch von den Folgen beeinflusst wird (Heckhausen und Heckhausen 2006), ist nicht von einem unidirektionalen Zusammenhang auszugehen. Vielmehr ist eine Wechselwirkung, analog zum *self-enhancement* und dem *skill development* Ansatz in Bezug auf das Selbstkonzept und die Leistung (z. B. Calsyn und Kenny 1977; Marsh 1990; Helmke und van Aken 1995) zu erwarten: Im self-enhancement Ansatz wird angenommen, dass ein positives Selbstkonzept die Leistung beeinflusst, während im skill development Ansatz davon ausgegangen wird, dass

positive Leistungsentwicklungen die selbstbezogenen Kognitionen sowie weitere motivationale Konstrukte günstig beeinflussen (Helmke und van Aken 1995; Köller et al. 2000; Köller et al. 2001). Der Zusammenhang zwischen motivationalen Merkmalen wie dem Interesse und dem Selbstkonzept und dem Kompetenz- und Autonomieerleben sowie sozialer Eingebundenheit wurde bereits bestätigt (z. B. Kunter 2005). Aufgrund des querschnittlichen Designs konnten bisher jedoch keine wechselseitigen Zusammenhänge geprüft werden. Die vorliegende Arbeit geht davon aus, dass durch selbstbestimmt motiviertes Handeln eine bessere Leistung erzielt wird, wodurch das wahrgenommene Kompetenzerleben steigt und wiederum die selbstbestimmte Motivation positiv beeinflusst wird. Die psychologischen Grundbedürfnisse hängen somit nicht nur von äußeren Bedingungen ab, sondern werden auch durch das Verhalten einer Person begünstigt. Diese Argumentation griffen ebenfalls Greguras und Diefendorff (2010) auf. Sie zeigten, dass das Verfolgen von selbstbestimmten Zielen positiv mit der Erfüllung der psychologischen Grundbedürfnisse verbunden ist.

7.3 Forschungsfragen und Hypothesen

Insgesamt zeigt sich, dass die Beziehungen zwischen den erlebten psychologischen Grundbedürfnissen und der selbstbestimmten Motivation noch nicht hinreichend erforscht wurden (Košir und Tement 2014). In der vorliegenden Studie wird deshalb einerseits untersucht, inwieweit das Ausmaß der Erfüllung der psychologischen Grundbedürfnisse mit Veränderungen in der selbstbestimmten Motivation im Jugendalter einhergeht. Andererseits wird analysiert, ob und inwieweit die Veränderung der selbstbestimmten Motivation im Mathematikunterricht mit der Veränderung in der Wahrnehmung der psychologischen Grundbedürfnisse zusammenhängt. Zudem wird der wechselseitige Zusammenhang von Bedürfniserfüllung und Motivation untersucht. Dabei wird ein positiver Zusammenhang erwartet.

7.4 Methode

7.4.1 Stichprobe und Design

Die vorliegende Untersuchung wurde anhand der Daten aus dem vom Schweizerischen Nationalfonds geförderten Projekt «Maintaining and fostering students‘ positive learning emotions and learning motivation in maths instruction during early adolescence (EMo-Math)» durchgeführt. Die Projektleitung informierte Kontaktpersonen an Schulen sowie Schulleitungen des Kantons Bern über das Interventionsprojekt. Interessierte Mathematiklehrpersonen konnten sich mit ihrer Klasse an der Studie anmelden. An der Untersuchung nahmen 22 Klassen mit insgesamt 452 Schülerinnen und Schülern (228, 50.9 % weiblich) aus 17 Sekundarschulen im

Kanton Bern teil. Alle Schülerinnen und Schüler besuchten Klassen für das niedrigste Anforderungsniveau. Die Schülerinnen und Schüler wurden im Zeitraum von zwei Schuljahren (7. und 8. Schulstufe; der Übergang in die Sekundarstufe erfolgt in der Schweiz nach Klassenstufe 6) zu drei Messzeitpunkten schriftlich befragt. Der 1. Zeitpunkt lag zu Beginn der 7. Klassenstufe und somit kurz nach dem Übertritt in die Sekundarstufe, der 2. Zeitpunkt war am Ende der 7. Klasse angesetzt und der 3. Zeitpunkt am Ende der 8. Klasse. Ein Wechsel der Klassenlehrperson zwischen der 7. und 8. Klasse fand bei vier Schulklassen statt und betraf 59 Schülerinnen und Schüler. Das Durchschnittsalter der Jugendlichen zu Studienbeginn betrug 12.75 Jahre (*SD* = 0.64). Die Datenerhebungen fanden während des regulären Mathematikunterrichts statt und wurden von geschulten Projektmitarbeiterinnen und -mitarbeitern durchgeführt.

7.4.2 Messinstrument

Die selbstbestimmte Motivation in Mathematik wurde über die beiden Motivationsstile der intrinsischen und identifizierten Regulation mit den Subskalen von Müller et al. (2007) gemessen, bei denen es sich um eine adaptierte Version des Academic Self-Regulation Questionnaire (SRQ-A) nach Ryan und Connell (1989) handelt. Die Skala zur *intrinsischen Motivation* umfasste vier Items (z. B. «Ich arbeite und lerne in Mathematik, weil ich neue Dinge lernen möchte.», $\alpha_{t0} = .84$, $\alpha_{t1} = .82$, $\alpha_{t2} = .85$). Die *identifizierte Motivation* wurde ebenfalls mit vier Items erhoben (z. B. «Ich arbeite und lerne in Mathematik, weil ich damit mehr Möglichkeiten bei der späteren Berufswahl habe.», $\alpha_{t0} = .82$, $\alpha_{t1} = .83$, $\alpha_{t2} = .83$). Beide Merkmale wurden mittels einer fünfstufigen Likertskala (1 = stimmt überhaupt nicht, 5 = stimmt völlig) erfasst.
Die erlebte Relevanz der Lerninhalte (als Proxy für das Autonomieerleben, der eine Identifikation mit den Inhalten widerspiegelt), das wahrgenommene Kompetenzerleben sowie die wahrgenommene soziale Eingebundenheit zur Lehrkraft wurden je mit Hilfe einer vierstufigen Likertskala (1 = trifft nicht zu, 4 = trifft zu) erhoben. Für die Erfassung der erlebten *Relevanz der Lerninhalte* wurde eine erweiterte Skala von Assor et al. (2002) eingesetzt (z. B. «Mein Mathematiklehrer / Meine Mathematiklehrerin erklärt, weshalb die Lerninhalte (Themen) in Mathematik wichtig sind.», 6 Items; $\alpha_{t0} = .74.$, $\alpha_{t1} = .84$, $\alpha_{t2} = .83$). Die Skala zum *wahrgenommenen Kompetenzerleben* stammt aus der Schülerinnen- und Schülerbefragung von PISA 2003 (Ramm et al. 2006) und umfasste drei Items (z. B. «Im Mathematikunterricht traut mir die Lehrkraft auch schwierige Aufgaben zu.», $\alpha_{t0} = .60$, $\alpha_{t1} = .67$, $\alpha_{t2} = .70$). Die *wahrgenommene soziale Eingebundenheit zur Lehrperson* wurde mit sieben Items (z. B. «Mein Mathematiklehrer / meine Mathematiklehrerin nimmt mich ernst.», $\alpha_{t0} = .68$, $\alpha_{t1} = .79$, $\alpha_{t3} = .83$) von Rakoczy et al. (2005) erhoben.

Die Mathematikleistung der Schülerinnen und Schüler wurde zu Beginn der 7. Klasse mittels eines standardisierten Leistungstests des HarmoS-Projekts[i] erfasst. Dabei wurde die durchschnittliche Standardpunktzahl in Anlehnung an HarmoS auf den Mittelwert von 500 Punkten skaliert (*SD* = 100). Der Stichprobenmittelwert zu t0 liegt bei 432 Punkten (*SD* = 60.47). Dies entspricht dem erwarteten Wert für diesen Schultyp im Kanton Bern (Bauer et al. 2014).

7.4.3 Datenauswertung

Fehlende Werte

Aufgrund von Fluktuationen zwischen Leistungsniveaus im Verlauf der 7. Klasse wurden nur Schülerinnen und Schüler in die Analyse einbezogen, die an den ersten beiden Messzeitpunkten (t0 und t1) teilgenommen hatten (*N* = 348). Für den Messzeitpunkt t2 (Ende 8. Klasse) lagen bis zu 24.7 % fehlende Werte in den verwendeten Variablen vor. Für die deskriptive Statistik wurden die fehlenden Werte der 8. Klasse (t2) in SPSS (Version 25) multipel imputiert. Für die Strukturgleichungsmodelle wurde die Full Information Maximum Likelihood Estimation (FIML) in *Mplus* Version 8.2 (Muthén und Muthén 1998-2018) verwendet.

Messinvarianz

Mittels Messinvarianzprüfung wird getestet, ob die Messeigenschaften der latenten Variablen über die Zeit stabil sind und die latenten Konstrukte folglich über die Messzeitpunkte verglichen werden können (Little 2013). Dadurch kann sichergestellt werden, dass keine Änderungen im Messmodell vorliegen (Newsom 2015). Die Testung der Messinvarianz für alle Variablen über die drei Messzeitpunkte erfolgte anhand des von Little (2013) empfohlenen sequentiellen Vorgehens, das mit der jeweils geringsten restriktiven Lösung beginnt. Im Modell ohne Einschränkungen (*konfigurale Invarianz*) werden die Modellspezifikationen zu allen drei Messzeitpunkten identisch modelliert, sodass alle Parameter frei geschätzt werden. Bei der zweiten Stufe (*metrische Invarianz*) werden die Faktorladungen über die drei Messzeitpunkte gleichgesetzt. Bei der *skalaren Invarianz* als dritter Schritt werden zusätzlich zur identischen Faktorladung auch die Intercepts gleichgesetzt. Damit Mittelwerte miteinander verglichen werden können, muss skalare Invarianz vorliegen; zur Bestimmung von Beziehungen zwischen Faktoren über die Zeit benötigt es zumindest metrische Invarianz. Um die Annahme der Invarianz beurteilen zu können, wurden die Veränderungen des Comparative Fit Index (CFI) und des Root Mean Square Error of Approximation (RMSEA) zwischen den geschachtelten Modellen verglichen. Als Grenzwerte wurden die Veränderung des ΔCFI < 0.01 und die Veränderung von

ΔRMSEA < 0.01-0.015 festgesetzt (Chen 2007). Innerhalb dieser Werte kann davon ausgegangen werden, dass das restriktivere Modell die Datenstruktur im Vergleich zum vorherigen Modell nicht signifikant schlechter widerspiegelt (Little 2013).

Latente Cross-Lagged Panel Modelle

Um wechselseitige Beziehungen zwischen der wahrgenommenen Erfüllung der psychologischen Grundbedürfnisse und der selbstbestimmten Motivation der Schülerinnen und Schüler über die zwei Schuljahre zu untersuchen, wurden latente Cross-Lagged Panel Modelle spezifiziert. Als Kovariaten wurden zu allen Messzeitpunkten das Geschlecht, die Mathematikleistung zu Beginn der Studie sowie die Gruppenzugehörigkeit (Interventionsgruppe ja/nein[ii]) einbezogen. In allen Modellen wurden latente Faktoren spezifiziert; Autokorrelationen zwischen den Residuen der Einzelitems über die drei Messzeitpunkte wurden zugelassen.

In den Modellen 1a und 1b erfolgte die Testung der reziproken Beziehung im Längsschnitt zwischen der wahrgenommenen Relevanz der Lerninhalte und der intrinsischen (1a) und identifizierten (1b) Motivation. In den Modellen 2a und 2b wurden die Beziehung zwischen dem wahrgenommenen Kompetenzerleben der Schülerinnen und Schüler und der intrinsischen (2a) und der identifizierten (2b) Motivation untersucht. Die beiden abschließenden Modelle erfassten die reziproke Beziehung zwischen der wahrgenommenen sozialen Eingebundenheit zur Lehrperson und der intrinsischen (3a) und identifizierten (3b) Motivation.

Die Modellpassung der einzelnen Cross-Lagged Panel Modelle wurde anhand der Fitindizes CFI, TLI und RMSEA überprüft. Als Grenzwerte für eine gute Passung werden RMSEA-Werte < .07 (Steiger 2007) und CFI- sowie TLI-Werte > 0.9 verwendet (Tabachnick und Fidell 1996).

Um die hierarchische Cluster-Struktur der vorliegenden Daten aufgrund der Klassenzugehörigkeit zu kontrollieren, wurde der *Mplus* Befehl «Type = Complex» verwendet, welcher die Abhängigkeit der Beobachtungen bei der Berechnung des Standardfehlers sowie des Chi-Quadrat-Tests berücksichtigt (Muthén und Muthén 1998-2018). Auf mehrebenenanalytische Modellierungen wurde verzichtet, da sich alle Hypothesen auf die Individualebene beziehen. Die Intra-Klassenkorrelation in Abhängigkeit der Klassenzugehörigkeit beträgt zwischen .085 und .366 (siehe Tab. 1).

Für die Überprüfung der Messinvarianz sowie für die Modellierung der Strukturgleichungsmodelle wurde *Mplus* Version 8.2 (Muthén und Muthén 1998-2018) verwendet.

7.5 Ergebnisse

7.5.1 Deskriptive Statistik

Die deskriptiven Kennwerte und Korrelationen zwischen der selbstbestimmten Motivation der Schülerinnen und Schüler in Mathematik zu den drei Messzeitpunkten und den Merkmalen, die die Erfüllung der drei psychologischen Grundbedürfnisse widerspiegeln, sind in Tab. 1 dargestellt. Mit Blick auf die Mittelwerte lässt sich festhalten, dass die intrinsische Motivation, die wahrgenommene Relevanz der Lerninhalte und die soziale Eingebundenheit zur Lehrkraft im Laufe der beiden Schuljahre abnehmen, während die identifizierte Motivation und das wahrgenommene Kompetenzerleben konstant bleiben.

Die bivariaten Korrelationen zeigen durchgehend signifikante Zusammenhänge zwischen der selbstbestimmten Motivation und den Indikatoren der Bedürfniserfüllung innerhalb der drei Messzeitpunkte; mit nur einer Ausnahme: Zwischen der wahrgenommenen sozialen Eingebundenheit zur Lehrperson und der intrinsischen Motivation zum letzten Messzeitpunkt t2 liegt keine signifikante Korrelation vor. Zudem sind für die wahrgenommene Relevanz und das wahrgenommene Kompetenzerleben auch zeitübergreifende Zusammenhänge mit der selbstbestimmten Motivation signifikant, jedoch nur teilweise für die soziale Eingebundenheit zur Lehrperson. Alle unabhängigen Variablen weisen untereinander ebenfalls innerhalb der Messzeitpunkte sowie zeitübergreifende Korrelationen auf. Alle signifikanten Korrelationen weisen die erwartete Richtung auf.

Tabelle 1

Mittelwerte (M), Standardabweichung (SD), Intraklassenkorrelation (ICC) und Interkorrelationsmatrix

		M	*SD*	*ICC*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Intrinsische Motivation t0[1]	3.03	0.925	.165	1	.495***	.278***	.414***	.248***	.164**	.291***	.173**	-013	.401***	.224***	.017	.183**	.065	-.015
2	Intrinsische Motivation t1[1]	2.98	0.925	.086		1	.400***	.226***	.409***	.153**	.149**	.232***	.058	.288***	.351***	.066	.033	.137*	-.004
3	Intrinsische Motivation t2[1]	2.89	0.875	.129			1	.139*	.178**	.264***	.031	.179**	.184**	.104	.153**	.250***	.037	.097	.105
4	Identifizierte Motivation t0[1]	4.04	0.831	.110				1	.413***	.309***	.226***	.093	.060	.293***	.180**	.050	.186**	.112*	.082
5	Identifizierte Motivation t1[1]	4.02	0.819	.176					1	.415***	.152**	.315***	.115*	.221***	.283***	.078	.039	.182**	.058
6	Identifizierte Motivation t2[1]	4.08	0.764	.132						1	.009	.118*	.242***	.109	.169**	.155**	.026	.139*	.116*
7	Relevanz t0[2]	3.22	0.487	.115							1	.286***	.086	.356***	.222***	-.030	.480***	.193***	-.016
8	Relevanz t1[2]	3.00	0.587	.171								1	.186**	.220***	.399***	.125*	.264***	.531***	.117*
9	Relevanz t2[2]	3.01	0.546	.350									1	.121*	.181**	.485***	.128*	.218***	.550***
10	Kompetenzerleben t0[2]	3.13	0.506	.094										1	.360***	.137*	.428***	.228**	.138*
11	Kompetenzerleben t1[2]	3.11	0.559	.085											1	.294***	.274***	.519***	.222***
12	Kompetenzerleben t2[2]	3.17	0.552	.141												1	.093	.234***	.592***
13	Soziale Eingebundenheit zur LP t0[2]	3.38	0.437	.162													1	.403***	.155**
14	Soziale Eingebundenheit zur LP t1[2]	3.18	0.530	.148														1	.341***
15	Soziale Eingebundenheit zur LP t2[2]	3.15	0.547	.366															1

Anmerkung. *p <0.05, **p <0.01, ***$p \leq 0.001$. [1]Min = 1; Max = 5; [2]Min = 1; Max = 4.

7.5.2 Messinvarianz Test

Vor der Berechnung der Cross-Lagged Panel Modelle wurde die Messinvarianz für alle in den Analysen verwendeten Variablen einzeln getestet, um ihre Vergleichbarkeit über die drei Messzeitpunkte bestimmen zu können. Die Modellfits für die konfigurale, metrische und skalare Invarianz sind zufriedenstellend (vgl. Tab. 2). Aufgrund der geprüften CFI- und RMSEA-Differenz kann für alle Variablen von skalarer Messinvarianz über die drei Messzeitpunkte ausgegangen werden. Demzufolge sind die Voraussetzungen für die Berechnung der Cross-Lagged Panel Modelle gegeben.

Tabelle 2

Zusammenfassung des Modellfit – Längsschnittliche Messinvarianz

Model	χ^2	df	χ^2/df	RMSEA	CFI	SRMR	ΔRMSEA	ΔCFI
Intrinsische Motivation								
1 konfigural	52.322	39	1.341	.031	.990	.030		
2 metrisch	58.261	45	1.294	.029	.990	.037	.002	.000
3 skalar	73.230	51	1.436	.035	.984	.037	.006	.006
Identifizierte Motivation								
1 konfigural	45.117	39	1.157	.021	.995	.029		
2 metrisch	51.783	45	1.151	.021	.994	.042	.000	.001
3 skalar	70.475	51	1.381	.033	.983	.042	.012	.011
Relevanz								
1 konfigural	108.238	72	1.503	.038	.973	.040		
2 metrisch	114.778	80	1.435	.035	.974	.053	.003	.001
3 skalar	130.500	88	1.483	.037	.968	.059	.002	.006
Kompetenzerleben								
1 konfigural	10.579	15	0.705	.000	1.00	.027		
2 metrisch	14.710	19	0.774	.000	1.00	.038	.000	.000
3 skalar	20.706	23	0.900	.000	1.00	.047	.000	.000
Soziale Eingebundenheit zur Lehrperson								
1 konfigural	73.083	72	1.015	.007	.999	.039		
2 metrisch	82.561	80	1.032	.010	.997	.051	.003	.002
3 skalar	94.585	88	1.075	.015	.994	.058	.005	.003

7.5.3 Cross-Lagged Panel Modelle zwischen der selbstbestimmten Motivation und den erlebten Basic Needs

Selbstbestimmte Motivation und wahrgenommene Relevanzhervorhebung

Innerhalb eines Messzeitpunkts sowie zwischen benachbarten Messzeitpunkten bestehen zwischen den Variablen der selbstbestimmten Motivation und der wahrgenommenen Relevanz der Lerninhalte positive schwache bis mittlere Korrelationen. Eine Ausnahme bildet die identifizierte Motivation zu Beginn der 7. Klasse, die nur mit der wahrgenommenen Relevanz der

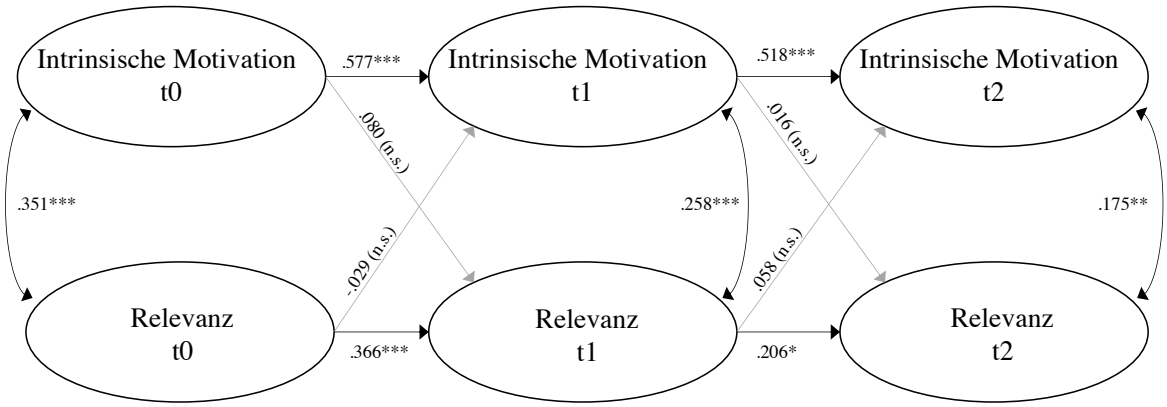
Lerninhalte zu Beginn der 7. Klasse korreliert, jedoch nicht mit dem folgenden Messzeitpunkt (Ende 7. Klasse [t1], vgl. Tab. 1). Die Passung der Cross-Lagged Modelle (Modell 1a und 1b) erweist sich sowohl für die intrinsische Motivation (χ^2 (377) = 542.553, CFI = .949, TLI = .942, RMSEA = .036; SRMR = .050), als auch für die identifizierte Motivation (χ^2 (377) = 585.964, CFI = .932, TLI = .922, RMSEA = .040, SRMR = .056) als zufriedenstellend.

Unter Kontrolle der Kovariaten[iii] zeigen sich für die intrinsische Motivation und die wahrgenommene Relevanz der Lerninhalte keine signifikanten wechselseitigen Einflüsse, während die autoregressiven Effekte signifikant sind mit der Ausnahme der Beziehung zwischen der wahrgenommenen Relevanz zu t1 und t2. Ein geringer negativer Effekt ergibt sich zwischen der wahrgenommenen Relevanz zu t1 und der identifizierten Motivation zu t2 (vgl. Abb. 1).

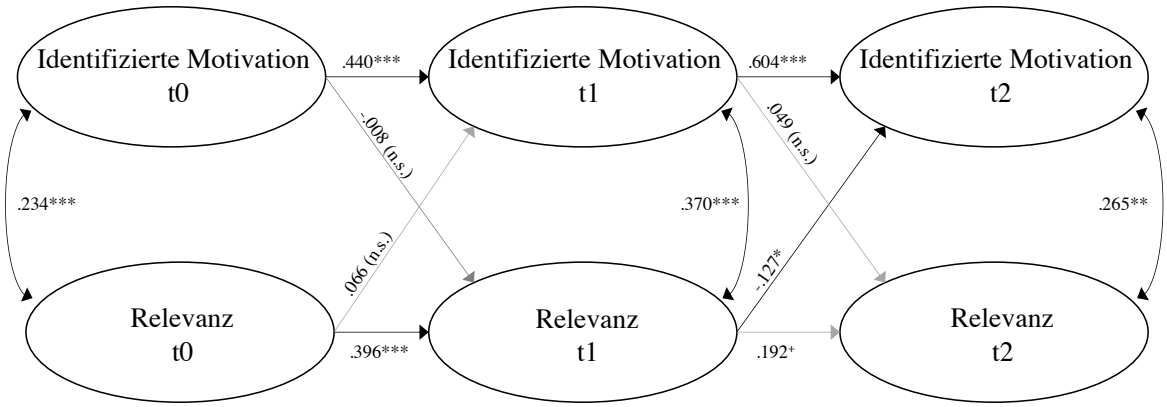
Abbildung 1

*Ergebnisse der Cross-Lagged Panel Modelle zwischen a) der intrinsischen Motivation und der wahrgenommenen Relevanz der Lerninhalte und b) der identifizierten Motivation und der wahrgenommenen Relevanz der Lerninhalte. +p < 0,10; *p < 0,05; **p < 0,01; ***p ≤ 0,001.*

a) Intrinsische Motivation und wahrgenommene Relevanz



b) Identifizierte Motivation und wahrgenommene Relevanz



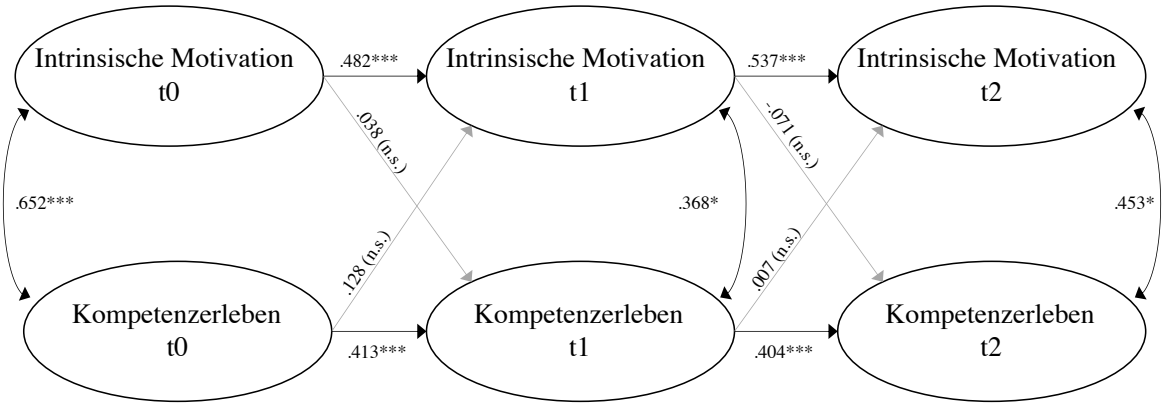
Selbstbestimmte Motivation und wahrgenommenes Kompetenzerleben

Innerhalb eines Messzeitpunkts sowie zwischen benachbarten Messzeitpunkten bestehen zwischen den Variablen der selbstbestimmten Motivation und dem wahrgenommenen Kompetenzerleben schwache bis mittlere positive Korrelationen (vgl. Tab. 1). Der Fit der Cross-Lagged Modelle 2a und 2b erweist sich bei der intrinsischen Motivation und dem wahrgenommenen Kompetenzerleben (χ^2 (226) = 333.998, CFI = .950, TLI = .939, RMSEA = .037, SRMR = .054) und der identifizierten Motivation und dem wahrgenommenen Kompetenzerleben (χ^2 (226) = 336.295, CFI = .942, TLI = .930, RMSEA = .038; SRMR = .054) als zufriedenstellend. Es zeigen sich durchgehend autoregressive Effekte; auch innerhalb der Messzeitpunkte ergeben sich signifikante Beziehungen zwischen den Variablen; jedoch kann keine wechselseitige Abhängigkeit über die Zeit festgestellt werden (vgl. Abb. 2).

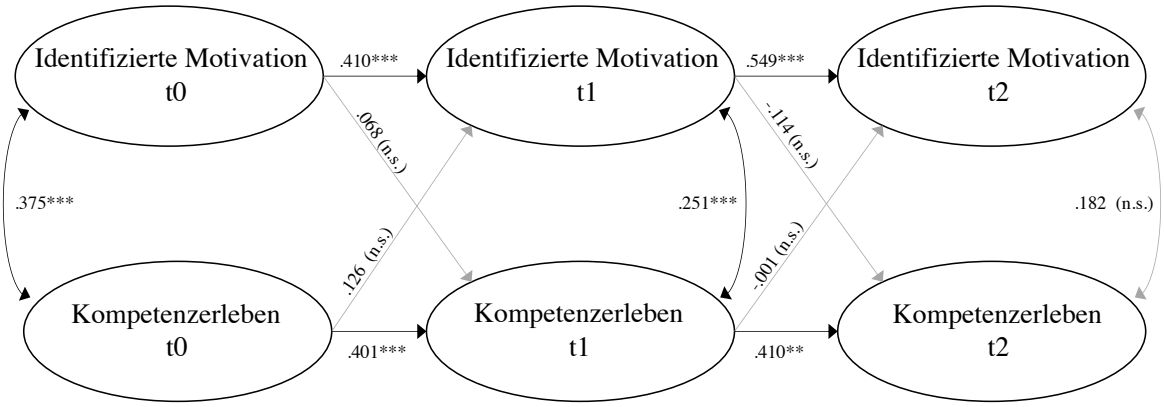
Abbildung 2

*Ergebnisse der Cross-Lagged Panel Modelle zwischen a) der intrinsischen Motivation und dem wahrgenommenen Kompetenzerleben und b) der identifizierten Motivation und dem wahrgenommenen Kompetenzerleben. +p < 0,10; *p < 0,05; **p < 0,01; ***p ≤ 0,001.*

a) Intrinsische Motivation und wahrgenommenes Kompetenzerleben



b) Identifizierte Motivation und wahrgenommenes Kompetenzerleben



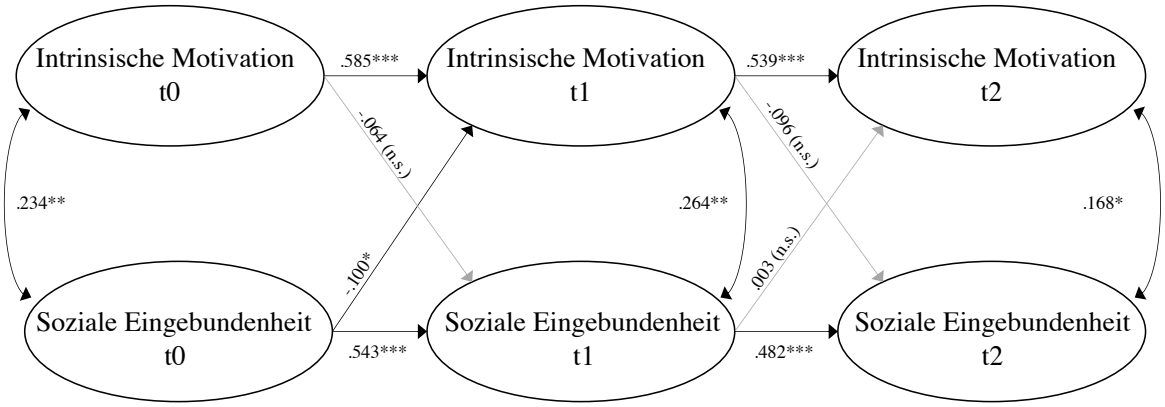
Selbstbestimmte Motivation und soziale Eingebundenheit zur Lehrperson

Die Korrelationen zwischen der selbstbestimmten Motivation und der sozialen Eingebundenheit zur Lehrperson, im Sinne der Verbundenheit mit der Lehrperson, zeigen einen schwachen bis keinen Zusammenhang über die Messzeitpunkte (vgl. Tab. 1). Die Modelle weisen für die intrinsische Motivation und die soziale Eingebundenheit zur Lehrperson (3a: χ^2 (381) = 488.010, CFI = .959, TLI = .954, RMSEA = .029; SRMR = .058) und für die identifizierte Motivation und die soziale Eingebundenheit einen guten Fit auf (3b: χ^2 (381) = 507.318, CFI = .949, TLI = .942, RMSEA = .031; SRMR = .056). Die soziale Eingebundenheit zur Lehrperson zu Beginn der 7. Klasse hat unter Kontrolle der Kovariaten einen signifikant negativen Effekt auf die intrinsische Motivation am Ende der 7. Klasse. Bei der identifizierten Motivation und der sozialen Eingebundenheit zur Lehrperson zeigen sich unter Kontrolle der Kovariaten keine signifikanten Cross-Lagged Effekte (vgl. Abb. 3).

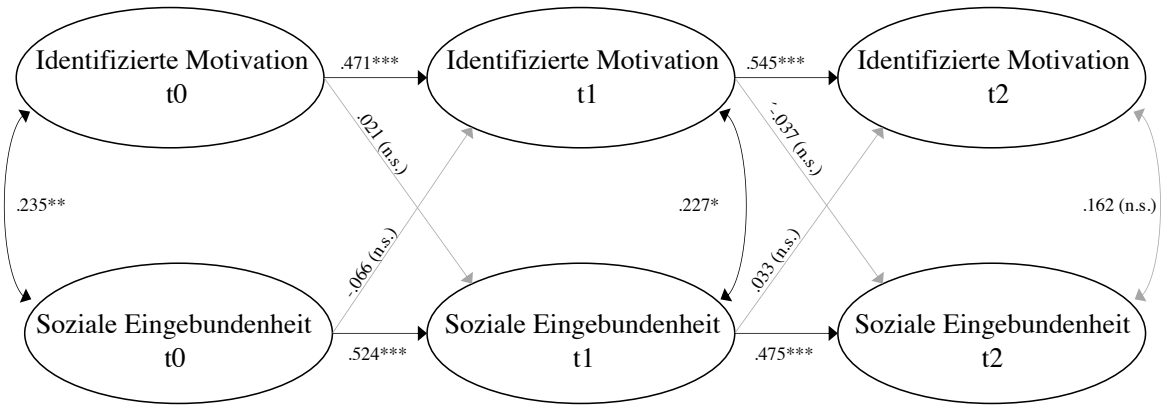
Abbildung 3

*Ergebnisse der Cross-Lagged Panel Modelle zwischen a) der intrinsischen Motivation und der wahrgenommenen sozialen Eingebundenheit zur Lehrperson und b) der identifizierten Motivation und der wahrgenommenen sozialen Eingebundenheit zur Lehrperson. +p < 0,10; *p < 0,05; **p < 0,01; ***p ≤ 0,001.*

a) Intrinsische Motivation und soziale Eingebundenheit zur Lehrperson



b) Identifizierte Motivation und soziale Eingebundenheit zur Lehrperson



7.6 Diskussion

Die vorliegende Studie hatte das Ziel, die Zusammenhänge zwischen der Wahrnehmung der psychologischen Grundbedürfnisse nach Autonomieerleben, Kompetenzerleben und sozialer Eingebundenheit zur Lehrperson und der selbstbestimmten Motivation im Mathematikunterricht zu untersuchen. Die Analysen erfolgten im Rahmen einer Interventionsstudie unter Kontrolle der Variablen Geschlecht, Mathematikleistung und Gruppenzugehörigkeit. Basierend auf den Grundannahmen der Selbstbestimmungstheorie von Deci und Ryan (1993) wurde davon ausgegangen, dass ein wechselseitiger (positiver) Effekt zwischen der Erfüllung der psychologischen Grundbedürfnisse und den selbstbestimmten Formen der motivationalen Regulation vorliegt.

Anhand der Korrelationen können zwar signifikante zeitübergreifende positive Beziehungen zwischen den Variablen aufgezeigt werden. Die Annahme, dass wechselseitige Beziehungen zwischen den psychologischen Grundbedürfnissen und der selbstbestimmten Motivation im Mathematikunterricht bestehen, muss jedoch aufgrund der Ergebnisse der Cross-Lagged-Analysen verworfen werden. Damit konnte die in der Selbstbestimmungstheorie postulierte Annahme, dass die wahrgenommene Bedürfnisbefriedigung und die selbstbestimmte Motivation positiv (wechselseitig) zusammenhängen (Deci und Ryan 2002), nur innerhalb eines Messzeitpunktes, jedoch nicht über die Zeit bestätigt werden.

Im *Längsschnitt* konnten zwei signifikante, unidirektionale Effekte festgestellt werden. Entgegen der Erwartungen sind diese allerdings negativ: Die wahrgenommene soziale Eingebundenheit zur Lehrperson zu Beginn der 7. Klasse erwies sich als (schwacher) negativer Prädiktor für die intrinsische Motivation am Ende der 7. Klasse. Zudem ergab sich auch ein negativer Zusammenhang zwischen der wahrgenommenen Relevanz der Lerninhalte am Ende der 7. Klasse und der identifizierten Motivation am Ende der 8. Klasse. Diese negativen Effekte sind unter Umständen methodisch bedingt (Suppressoreffekt), da sich in den bivariaten Zusammenhängen keine negativen Korrelationen zeigten. Vielmehr fielen die signifikanten Korrelationen alle positiv aus, auch wenn sie nur eine kleine Effektstärke (Cohen 1992) aufwiesen. Bezogen auf die soziale Eingebundenheit könnten der unerwartete Effekt sowie die fehlenden weiteren Effekte über die Zeit durch den Ablösungsprozess von primären Bezugspersonen wie der Lehrperson und die vermehrte Hinwendung zu Peers und außerschulischen Bezugspersonen erklärt werden (Kramer et al. 2013). Damit würden sich soziale Faktoren und motivationale Orientierungen entkoppeln. Allerdings haben Studien ebenso gezeigt, dass auch im Sekundarschulalter die Beziehungsqualität zur Lehrperson von hoher Relevanz für die Motivation der Schüler und Schülerinnen ist (Roorda et al. 2011). Da eine positive Beziehungsqualität als

grundlegend für die Motivation von Menschen im Allgemeinen verstanden wird (Baumeister und Leary 1995), sind weitere Studien nötig, die überprüfen, ob sich ähnliche Zusammenhänge auf Basis weiterer Stichproben bestätigen lassen.

Betrachtet man die Zusammenhänge *innerhalb* eines Messzeitpunktes im Detail, so ist die wahrgenommene soziale Eingebundenheit zur Lehrperson ähnlich stark mit der identifizierten und intrinsischen Motivation verbunden. Die stärksten Zusammenhänge finden sich zwischen dem Kompetenzerleben und der intrinsischen Motivation (z. B. auch Devloo et al. 2015; Goldman et al. 2017), während die identifizierte Motivation vor allem mit der wahrgenommenen Relevanz der Lerninhalte korreliert (z. B. Assor et al. 2002). Dieses Ergebnis ist plausibel, da bereits gezeigt werden konnte, dass vor allem Schülerinnen und Schüler mit einem hohen akademischen Selbstkonzept eine hohe intrinsische Motivation aufweisen (z. B. Skaalvik und Skaalvik 2013). Für eine erfolgreiche Integration von schulischen Zielen und den Aufbau einer identifizierten (und integrierten) Motivationslage hingegen ist die erfolgreiche Erfüllung des Bedürfnisses nach Autonomie zentral (Deci und Ryan 2002; Rakoczy et al. 2008).

Interessant ist an den Befunden des Weiteren, dass der autoregressive Pfad zwischen der wahrgenommenen Relevanz am Ende der 7. Klasse und am Ende der 8. Klasse nicht signifikant ist, während diese Beziehung noch deutlich zwischen den Messungen am Beginn und am Ende der 7. Klasse auftritt. Zwischen Ende der 7. Klasse und Ende der 8. Klasse scheinen sich folglich «Bewegungen» zu vollziehen. Schülerinnen und Schüler spezifizieren in dieser Phase ihre Bildungsaspirationen für die Zeit nach der obligatorischen Schule und es ist wahrscheinlich, dass sie die Relevanz von Lerninhalten vor allem im Zusammenhang mit diesen Bildungsaspirationen beurteilen (vgl. Gaspard et al. 2015). Je nachdem, welche Bildungsaspirationen die Schülerinnen und Schüler für sich entwickeln, können sich Verschiebungen in der wahrgenommenen Relevanz der mathematischen Inhalte abhängig vom nun stärker definierten Berufsbild ergeben. Da der Mittelwert in der wahrgenommenen Relevanz im Verlauf der 7. Klassenstufe leicht ansteigt und die Standardabweichung zugleich abnimmt, kann ebenso vermutet werden, dass die Jugendlichen zunehmend und homogener der Überzeugung sind, dass Mathematik für eine Lehrstelle oder eine Ausbildung generell wichtig ist (Berger 2012; Schiepe-Tiska und Schmidtner 2013).

7.6.1 Limitation

Trotz der Stärke der vorliegenden Studien durch das längsschnittliche Design mit drei Messzeitpunkten unterliegt sie einigen Limitationen: Die Stichprobe weist insofern Einschränkungen auf, da sie nur Schülerinnen und Schüler der 7. bzw. 8. Klasse, die im tiefsten

Leistungsniveau eingeteilt waren, umfasst. Die Ergebnisse lassen sich folglich nicht auf andere Klassenstufen oder Leistungsstufen übertragen. Zudem ist die Stichprobe mit 348 Schülerinnen und Schülern relativ klein. Auch blieben potenzielle Moderatoren in der vorliegenden Untersuchung unberücksichtigt (z. B. das fachspezifische Selbstkonzept oder die Bildungsaspirationen der Schülerinnen und Schüler), welche in künftige Untersuchungen einfließen sollten (Guay et al. 2010; Olafsen et al. 2018). Eine weitere Einschränkung stellt der fachspezifische Zugang dar, der die Übertragung der Befunde auf andere Fächer als Mathematik einschränkt. Kritisch anzumerken ist ebenfalls, dass thematische Einflüsse (z. B. die spezifischen Lerninhalte) sowie die Situation (z. B. Klasse, Tests) unberücksichtigt blieben, da alle Items auf den Mathematikunterricht im Allgemeinen formuliert waren.

Zudem muss kritisch angemerkt werden, dass nur das Proxy «Relevanz» für das ganze Konstrukt der «Autonomiewahrnehmung» eingesetzt wurde. Skinner und Belmont (1993) zeigen zwar auf, dass die persönliche Relevanz ein zentrales Kriterium für das Autonomieerleben darstellt, da sie eine Internalisierung von extern vorgegebenen Aufgaben erleichtert. Auch wenn dies gerade in der Schule ein besonders wichtiger Mechanismus sein kann, mag die Analyse von Relevanz aber für eine Gesamterfassung des Autonomieerlebens nicht ausreichen. Zukünftige Forschung könnte mehrere Skalen einsetzen, um weitere Facetten der Autonomiewahrnehmung abzudecken (vgl. z. B. Assor et al. 2002).

Eine weitere Limitation bezieht sich auf die Verwendung von «traditionellen» Cross-lagged Modellen, welche in der Literatur zum Teil kritisch diskutiert werden. Da die Regressionskoeffizienten von den Unterschieden zwischen Personen abgeleitet werden und somit keine adäquate Abbildung von intraindividuellen Entwicklungen darstellen, werden sie als unwirksam bezüglich der Aufdeckung kausaler Effekte angesehen (Ecological Fallacy) (vgl. Hamaker et al. 2015; Keijsers 2016; Berry und Willoughby 2017). Als Alternative wird die Modellierung von Random Intercept Cross-lagged Panel Modellen vorgeschlagen (Reitzle 2013; Hamaker et al. 2015). Um die Vergleichbarkeit der Ergebnisse mit bestehender Forschung zu erhöhen, wurde in dieser Studie jedoch auf traditionelle Cross-lagged Panel Modelle zurückgegriffen (vgl. Skinner und Belmont 1993; Košir und Tement 2014; Devloo et al. 2015; Olafsen et al. 2018).

Schließlich muss darauf hingewiesen werden, dass eine hierarchische Datenstruktur vorliegt, was Mehrebenenanalysen nahelegen würde. Aus zwei Gründen wurde jedoch darauf verzichtet: Die für die vorliegende Arbeit aufgestellten Hypothesen beziehen sich ausschließlich auf die Individualebene. Die hierarchische Datenstruktur wurde entsprechend durch den «Type = complex» Befehl berücksichtigt, um eine adäquate Schätzung zu erhalten (McNeish et al.

2017, S. 129). Zudem wurden Mehrebenenmodelle für umfangreiche Stichproben entwickelt, deren Minimalanforderungen durch die vorliegenden Daten nicht erfüllt werden können (Maas und Hox 2004).

7.6.2 Implikationen

Selbstbestimmte Motivation spielt eine zentrale Rolle für schulischen Erfolg. Wiederholt konnte nachgewiesen werden, dass der Erfüllung der psychologischen Grundbedürfnisse dabei eine Bedeutung zukommt (vgl. Deci und Ryan 2016). Für eine motivationsförderliche Unterrichtsgestaltung ist es deshalb wichtig zu wissen, welche spezifische Rolle den Lernkontexten zukommt. Wie kann Autonomieerleben unterstützt werden? Was begünstigt Kompetenzerleben? Was können Lehrpersonen zur sozialen Eingebundenheit der Schülerinnen und Schüler beitragen? Dabei gilt auch zu berücksichtigen, dass sich Lernende darin unterscheiden, wie sie den Grad der Erfüllung der psychologischen Grundbedürfnisse beurteilen. Entsprechend sind individuelle Merkmale und das Verhalten der Lernenden relevant, da sie zu einer Veränderung in der Wahrnehmung der psychologischen Grundbedürfnisse führen können (Goldman et al. 2017). In der vorliegenden Untersuchung wurde im Längsschnitt der Zusammenhang zwischen der Erfüllung der drei psychologischen Grundbedürfnisse *Autonomieerleben* (erfasst durch die *Relevanz der Lerninhalte), Kompetenzerleben* sowie *soziale Eingebundenheit zur Lehrperson* im Mathematikunterricht und der selbstbestimmten Motivation untersucht. Zudem wurde von Wechselwirkungen ausgegangen. Aus den Ergebnissen der vorgestellten Studie lassen sich allerdings weder eindeutige noch verallgemeinerbare Effekte zwischen den drei Grundbedürfnissen und der selbstbestimmten Motivation im Mathematikunterricht ableiten. Es steht außer Frage, dass der Zusammenhang zwischen der Unterrichtsgestaltung, dem individuellen Lernverhalten und der Lernmotivation komplex ist. Die Erkenntnisse der vorliegenden Studie machen nun besonders darauf aufmerksam, diesen nicht als subkomplex zu betrachten, sondern differenziert zu analysieren. Eine solche Differenzierung kann sich beispielsweise auf die Merkmale der Zielgruppe, des Unterrichtsfachs oder des Unterrichtssettings beziehen. Je nach den Lernerfahrungen der Schülerinnen und Schüler, den Anforderungen des Fachs und der spezifischen Gestaltung der Lernumgebung mag der Erfüllung der Grundbedürfnisse eine etwas andere Rolle zukommen und sich deren Zusammenhang mit der Lernmotivation anders gestalten. Dies könnte insbesondere für die Erforschung von situativ variablen Ausprägungen der Lernmotivation zielführend sein.

Hinsichtlich künftiger Forschungsarbeiten wäre es folglich empfehlenswert, die in der vorliegenden Studie gezeigten wie auch ausgebliebenen Effekte genauer zu beleuchten. So

könnte untersucht werden, ob der Zusammenhang zwischen den psychologischen Grundbedürfnissen und der selbstbestimmten Motivation durch ein zentrales Merkmal wie beispielsweise das Selbstkonzept moderiert wird (Möller und Trautwein 2009). Zudem müssten reziproke Beziehungen auch in weiteren Fachdomänen sowie unter Einbezug des Kontextes untersucht werden. Weiter sollte in künftiger Forschung die hierarchische Datenstruktur noch differenzierter mithilfe von Mehrebenenanalysen berücksichtigt werden. Eine Bereicherung könnte auch der Einsatz der Experience Sampling Methode darstellen, um den Zusammenhang zwischen der selbstbestimmten Motivation sowie der Erfüllung der psychologischen Grundbedürfnisse zu festgelegten Zeitpunkten oder nach bestimmten Aufgaben oder Handlungen – also unter Berücksichtigung des situativen Kontexts – zu untersuchen (Larson und Csikszentmihalyi 1983).

7.7 Literatur

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[i] In der Schweiz wurden die 26 Kantone dazu verpflichtet, zentrale Eckpunkte des Bildungsbereichs gesamtschweizerisch zu harmonisieren. Die Schweizerische Konferenz der kantonalen Erziehungsdirektoren hat deshalb das HarmoS-Projekt lanciert, um umfassende Kompetenzstufen in den Kernbereichen – u.a. Mathematik – gesamtschweizerisch zu etablieren. Dazu wurden im Lehrplan 21 erstmals vereinheitlichte Standards für das Fach Mathematik festgelegt, aus denen für die Klassenstufen 2, 6 und 9 standardisierte Leistungstest entwickelt wurden. Diese Leistungstests umfassen geschlossene sowie offene Aufgaben aus allen festgelegten Kompetenzbereichen. Für die vorliegende Studie wurde der Leistungstest verwendet, welcher für das Ende der 6. Klassenstufe konzipiert wurde, um die Leistung der Schülerinnen und Schüler zu Beginn der 7. Klasse zu beurteilen.

[ii] Wie bereits erwähnt, stammen die Daten aus einer Interventionsstudie, weshalb um die Gruppenzughörigkeit als Indikator für einen möglichen Interventionseffekt in den Modellen kontrolliert wurde.

[iii] Die Gruppenzugehörigkeit hat auf die identifizierte Motivation zu t2 einen signifikant positiven Effekt ($p < .05$), d. h., Schülerinnen und Schüler der Kontrollgruppe weisen eine höhere identifizierte Motivation zu t2 auf als Schülerinnen und Schüler der Interventionsgruppe. Das Geschlecht weist für die intrinsische Motivation zu t0 und die identifizierte Motivation zu t1 einen signifikant positiven Effekt ($p < .05$) auf, d. h., Schüler weisen zu t0 eine höhere intrinsische und zu t1 eine höhere identifizierte Motivation auf als Schülerinnen. Die Mathematikleistung zu Beginn der Untersuchung hat einen signifikant positiven Effekt auf die intrinsische und identifizierte Motivation zu t0 und t1 sowie auf das Kompetenzerleben zu t0. Je besser die Mathematikleistung zu t0 ist, desto höher sind auch das Kompetenzerleben zu t0 sowie die intrinsische und identifizierte Motivation zu den ersten beiden Messzeitpunkten ausgeprägt. Alle Regressionskoeffizienten der Kovariate liegen zwischen .084 und .222.

Testing Effects of Promoting Antecedents of Mathematics Achievement Emotions: A Change-Change Model

Held, T., & Hascher, T. (under revision). Testing effects of promoting antecedents of mathematics achievement emotions: A change-change model. *Learning and Individual Differences.*

Abstract

Based on the control-value theory of achievement emotions, the present study investigates whether an intervention setting with the aim of inter alia promoting positive emotions could change control and value appraisals of low-achieving secondary school students over two school years (Grades 7 and 8). Further, we examine the change-change assumption that positive interindividual changes in perceived control and value longitudinally predict intraindividual changes in enjoyment, anger, anxiety, and boredom. Latent change models of 348 students revealed no significant effect of the intervention on changes in perceived control or value. Furthermore, results confirmed the change-change assumption of the CVT for control and value and enjoyment, anger, anxiety and boredom, respectively: Intraindividual changes in these emotions were longitudinally predicted by intraindividual changes in perceived control and value. Therefore, it can be assumed that the strategy of influencing students' control and value appraisals may be an effective measure to promote positive emotions while reducing negative ones.

8.1 Introduction

The day-to-day school life of students is characterized by different emotions. In recent years there has been a growing interest in these emotions, as they have been shown to affect future learning and performance (Pekrun, 2017; Pekrun & Linnenbrink-Garcia, 2014). Emotions directly related to achievement activities (e.g., studying) or achievement outcomes (e.g., success or failure) are defined as *achievement emotions* (Pekrun & Perry, 2014). Achievement emotions are characterized according to their valence (positive vs. negative), level of activation (activating vs. deactivating), and object focus (activity vs. outcome-related; Pekrun, 2006; Pekrun et al., 2007; Pekrun & Perry, 2014). Empirical findings indicate that positive emotions (e.g., enjoyment) are connected with factors such as academic interest, motivation, engagement, and high achievement (e.g., Krapp, 2000; Pekrun, 2006, 2017; Pekrun & Linnenbrink-Garcia, 2012). In contrast, negative emotions (e.g., boredom) reduce interest, attention, intrinsic motivation, and are associated with surface learning (cf. Pekrun, 2017). Research has repeatedly shown that positive emotions decline during secondary education (e.g., Hagenauer & Hascher, 2010; Vierhaus et al., 2016), especially after the transitions from primary to secondary education. Regarding negative emotions such as boredom, with the exception of test anxiety, there is empirical evidence that they remain stable (e.g., Hill et al., 2016; Wigfield & Meece, 1988) or increase during secondary education (e.g., Niculescu et al., 2016; Vierhaus et al., 2016).

Because this unfavorable shift to a negative balance of achievement emotions may contribute to school alienation and eventually school dropout (Hascher & Hadjar, 2018), research that aims at understanding the antecedents of achievement emotions and their change is important in order to promote positive emotions and reduce negative emotions (Goetz et al., 2010). Frequently, the control-value theory of emotions (CVT; Pekrun, 2000, 2006) is used as the theoretical background to explain the development of emotions. In line with CVT, we investigated whether an intervention based on CVT could change *control* and *value* appraisals of low-achieving secondary school students over two school years. Further, we also tested CVT's assumption that changes in the antecedents' control and value are associated with changes in achievement *emotions* over time (the so-called change-change assumption). It is assumed that positive changes in antecedents lead to positive changes (increase) in positive emotions and that, conversely, a negative change in antecedents leads to a negative change (increase) in negative emotions. Existing research has shown that achievement emotions as well as control and value appraisals are context-specific (e.g., Goetz, Frenzel, et al., 2006; Goetz et al., 2007; Goetz, Pekrun, et al., 2006). Therefore, this study focuses on the domain-specific emotions and appraisals in mathematics in early secondary education.

8.1.1 Antecedents of Achievement Emotions

Pekrun's (2006) control-value theory (CVT) of achievement emotions is an integrative framework to investigate the relations between motivation variables, learning behavior, performance and emotions in achievement settings. CVT focuses on the structure, antecedents, and outcome of emotions. A key element of this theory is the assumption that control and value appraisals are proximal antecedents of achievement emotions (Pekrun & Stephens, 2010). Control and value represent different appraisal dimensions: *Perceived control* refers to the controllability of an action or a result that may be determined by either oneself or external factors. Therefore, perceived control covers constructs such as academic self-concepts (Shavelson et al., 1976), self-efficacy expectation (Bandura, 1977), and internal or external causal attribution (Weiner, 2010; cf. Pintrich & Schunk, 2002). *Perceived value* is similar to the value concept in expectancy-value theory (EVT; Eccles, 1983) and comprises goal relevance (Pekrun & Perry, 2014). Accordingly, perceived value refers to constructs such as personal attainment value or utility (Eccles, 1983; Pekrun, 2006). Achievement emotions are defined as being elicited by the combination of control and value appraisal, whereby different combinations of control and value appraisals lead to different achievement emotions (Pekrun, 2006; Pekrun et al., 2007; Pekrun & Stephens, 2010). For example, perceived control and positive value appraisals of a learning activity lead to positive emotions such as enjoyment, whereas negative value appraisals lead to negative emotions such as frustration (with low control value) or anger (with high control value; cf. Pekrun, 2006). Along with proximal antecedents, distal personal antecedents, such as achievement goals or gender, as well as situational factors of the environment such as feedback or teacher behavior that influence achievement emotions indirectly by affecting control and value appraisals (e.g., Frenzel et al., 2007a; Putwain et al., 2018), must be reconsidered.

8.1.2 The Roles of Enjoyment, Anger, Anxiety, and Boredom

Four achievement emotions, namely enjoyment, anger, anxiety, and boredom, have been revealed to be of primary importance and to frequently occur in mathematics instruction (cf. Frenzel et al., 2007b). Together they cover a broad variety of different achievement emotions in everyday school life and are aligned with basic emotions (Izard, 2007). Enjoyment is characterized as a positive, activating and activity-related achievement emotion with favorable effects on learning, and is therefore worth cultivating and fostering (Hagenauer & Hascher, 2010; Pekrun et al., 2007). In contrast, anger, anxiety, and boredom are negative emotions with unfavorable effects on learning and achievement. Whereas anger is an activating, activity-related emotion, anxiety is an activating, outcome-related emotion. Boredom, as the third negative

emotion, is defined as a deactivating, activity-related emotion that often occurs in everyday school life (Pekrun et al., 2007).

As outlined above, achievement emotions are expected to arise from different combinations of control and value appraisals. In terms of enjoyment, the CVT assumes that enjoyment arises when a high level of control and positive value are perceived (Pekrun, 2006). Existing research has confirmed that control and value are predictors of enjoyment (e.g., Buff et al., 2011; Putwain et al., 2018). According to CVT, anger is aroused if an activity is perceived as controllable, but negatively valued (e.g., Hall et al., 2006; Pekrun et al., 2011; Putwain et al., 2013; Shao et al., 2020). CTV assumes that anxiety is produced by the combination of negative outcome value and medium control (e.g., Hall et al., 2016; Lohbeck et al., 2016). Finally, no value and both high or low control appraisal (tasks are too easy or too hard) is assumed for boredom (e.g., Bieg et al., 2013; Pekrun et al., 2010; Shao et al., 2020).

8.1.3 Change-Change Assumption

Overall, there is sound empirical evidence of medium to strong relationships between control and value appraisals and achievement emotions (e.g., Bieg et al., 2013; Pekrun et al., 2011; Putwain et al., 2018). These well-studied relationships are accompanied by a further assumption of the CVT that has been much less investigated: CVT assumes that changes in control and value appraisals lead to changes in perceived achievement emotions (cf. Buff, 2014). An increasing level of control and value appraisals raises the level of positive emotions (e.g., enjoyment), and lowers the level of negative emotions (e.g., anger). The assumption of this change-change process of the CVT was empirically investigated by Buff (2014), who showed that positive changes in perceived control and value led to a positive change in enjoyment in mathematics learning for primary students. Niculescu et al. (2016) extended this approach by testing Buff's (2014) assumption in terms of control appraisal for boredom, hopelessness and anxiety with university students. Their results revealed that changes in perceived control are positively related to changes in enjoyment, and negatively related to changes in boredom, hopelessness and anxiety. However, regarding the change in value, no empirical evidence regarding the change-change assumption for negative emotions could be found. Significantly, as these change-change processes focus on intra-individual changes, their causes and consequences, they provide implications on how learning environments should be designed (Buff, 2014, p. 22). Thus, this assumption is particularly important for intervention research that seeks to increase both perceived control and perceived value, as such a program would be effective in promoting positive emotions (cf. Buff, 2014; Goetz et al., 2010).

8.1.4 Control-Value Intervention Research

Based on the change-change assumption, there is evidence achievement emotions can be promoted by targeting control and value appraisals. The promotion of positive emotions through value and control appraisals aligns with social-psychological interventions that, rather than concerning academic content, address students' thoughts, feelings, and beliefs in and about school (cf. Yeager & Walton, 2011). Prior research on interventions in the field of academic emotions demonstrated that students' academic emotions can be influenced by changing underlying appraisals. For example, one approach to change control-related appraisals is attributional retraining (Perry et al., 2005). Reattribution interventions showed small positive effects on positive and negative achievement emotions (Hall et al., 2007; Hamm et al., 2014; Ruthig et al., 2004). Positive emotional experiences can also be promoted through interventions in value appraisals (Cohen et al., 2006; Gläser-Zikuda et al., 2005). Likewise based on Eccles (1983) expectancy-value theory (EVT), recent interventions successfully manipulated value in different settings (Gaspard et al., 2015; Hulleman et al., 2010). These results could also be adapted to CVT interventions to foster achievement emotions (Putwain et al., 2018).

Overall, interventions that aim at promoting achievement emotions are still scarce and show heterogeneous results. The trainings tend to have few, no, or only weak effects on emotions, and appear to be subject-specific (Chalk & Bizo, 2004; Gläser-Zikuda et al., 2005; Hamm et al., 2014). Thus, more intervention research is needed that explores how to promote adolescents' emotions by changing their control and value appraisals (Pekrun, 2017; Putwain et al., 2018).

8.1.5 The Present Study: Research Questions and Hypotheses

CVT is a frequently used and validated framework in terms of relationships between environment, appraisals, emotions, and learning achievement. Overall, there is empirical evidence of medium to strong relationships between control and value appraisals and achievement emotions. In contrast, interventions based on CVT are scarce, and more research is needed to understand the interaction of antecedents and achievement emotions (Pekrun, 2017). In addition, prior interventions were predominantly designed for short periods of time (e.g., Gläser-Zikuda et al., 2005; Hall et al., 2007). However, the emotions of secondary school students' are habitualized through long-term experiences, so change needs to be addressed with long-term interventions (Gläser-Zikuda et al., 2005). Therefore, our first research goal addresses this lack of long-term intervention based on CVT, targeting both control and value appraisals. We want to investigate whether a multicomponent intervention with the aim of promoting positive

emotions and learning motivation based on inter alia CVT could change control and value appraisals of low-achieving secondary school students over two school years (Grades 7 and 8). We assume that the intervention group will show an increase in control and value appraisals compared to the control group (H1).

Our second research goal is to investigate the change-change process for the four achievement emotions of enjoyment, anger, anxiety, and boredom. We assume that positive interindividual changes in perceived control and value longitudinally predict positive intraindividual changes in enjoyment (H2a) and negative intraindividual changes in anger, anxiety, and boredom (H2b-d).

The aim of the present paper is to expand the existing knowledge in four ways: First, we apply a two-year longitudinal design with three measurement points to check whether this assumption is correct about long-term changes. Previous studies used two measurement points and checked for change assumption within a seven-week semester course (Niculescu et al., 2016) or within one year (Buff, 2014). Second, we investigate change-change assumptions with secondary-school students in the lowest ability tier in mathematics. This sample appears particularly interesting for several reasons: First-year students assigned to the lowest tier in secondary education (Grade 7) are vulnerable due to their negative selection experiences during the transition from primary to secondary education (cf. Eccles & Roeser, 2009). However, it can also be expected that the allocation of low-achivers in the heterogenous primary classroom into more homogeneous classes in secondary education may lead to (positive) changes in appraisals and achivement emotions (cf. big-fish-little-pond effect; Marsh, 1987). Additionally, existing research indicated that with low-achievers, the positive emotions are critical (Hagenauer & Hascher, 2010), and a high expression in boredom was recognized (Pekrun et al., 2010). Third, we investigate the achivement emotions of enjoyment, anger, anxiety, and boredom. Buff (2014), in contrast, focused only on the postive emotion of enjoyment and Niculescu et al. (2016) investigated the negative emotions of anxiety, boredom and hoplessness, but only in combination with changes in perceived control. Thus, to the best of our knowledge, there is a scarcity of research that simulaneously investigated the development of learning enjoyment, anger, anxiety and boredom, and no research on change-change assumption between negative emotions and value; for anger, there is no evidence either in control or in value changes. Fourth, we tested for differntial effects of the intervention program on control and value appraisals. This focus on emotional change is new, as in earlier publications, only the effects of the multicomponent intervention on motivational variables (intrinsic, identified, introjected, and extrinsic regulation, and self-concept) over one (Grade 7) or two intervention

years (Grade 7 and 8) have been presented (Brandenberger et al., 2018a; Sutter-Brandenberger et al., 2019; Held & Hascher, submitted). In addition, the relationships between motivational variables and basic need satisfaction (Held et al., in press) as well as between motivational variables and negative emotions (Brandenberger et al., 2018b) have been examined longitudinally. Therefore, the present paper investigates topical questions regarding sources of emotion change: Are there intraindividual changes in control or value appraisals due to an intervention, and can the underlying change-change assumption over two years (Grade 7 and 8) be confirmed?

8.2 Method

8.2.1 Participants and Procedure

The present study is part of the longitudinal intervention project "Maintaining and Fostering Students' Positive Learning Emotions and Learning Motivation in Maths Instruction During Early Adolescence (EMo-Math, 2015-2019)" funded by the Swiss National Science Foundation (grant number 156710). For the first recruitment step, school representatives of "cooperation schools" (a school network participating in teacher education) were informed about the intervention project in a meeting at the University of Bern. These representatives invited mathematics teachers to participate in the study. Interested teachers were able to register their class for the study. The study is set within a quasi-experimental design with two experimental groups and one control group. The sample consists of 348 students, with a mean age of 12.75 (*SD* = .64) at the first measurement point, from 22 classes in the lowest ability tier of education ("Realschule") in the German-speaking part of the canton of Bern. All students completed a questionnaire three times over the two school years: at the beginning of Grade 7, at the end of Grade 7, and at the end of Grade 8. Data collection took place during regular mathematics classes and was carried out by trained project staff. Participation was voluntary and since all students were underage at the beginning of the study, their parents or guardians had to sign a declaration of consent. All data provided by the students were anonymized. Of the total, 179 of the students are female (51.4%) and 169 are male (48.6%).

134 students participated in a combined student–teacher intervention; 122 students participated in a student intervention, and 92 students were in the control group. The 256 students from the two intervention groups attended identical workshops: two in the autumn term and two in the spring term in each school year. The content of the workshops was primarily based on basic need satisfaction according to SDT (Deci & Ryan, 2002) and the support of positive emotional experience on control value theory (Pekrun, 2006). All student workshops attempted

to target the three basic needs and reflection of control and value appraisals by including group work, reflection on one's own capabilities and learning (control appraisals), as well as reflection on the importance and value of mathematics (value appraisals). The student workshops consisted of a mix of theory (theoretical inputs, transfer activities, motivational self-regulation strategies), hands-on activities like applying learning strategies to authentic mathematic tasks, group collaboration and individual work (e.g., case studies), video examples, and reflection about their own learning and the importance and value of mathematic for academic learning for everyday life and for their future professional lives (for more detail about the multicomponent intervention content, see Table 1, Brandenberger et al., 2018, and Sutter-Brandenberger et al., 2019). Through these workshop contents, psychological processes should be triggered in the sense of social-psychological interventions (cf. Yeager & Walton, 2011), which may influence the trajectories of students' experiences.

Table 1

Overview of the Workshop Aims

Grade 7	September - December	Workshop 1a	Students get an awareness of the multiple experiences in school, with a special focus on mathematics; Students learn more about scholastic learning and rethink their motivation and emotions concerning learning mathematics.
		Workshop 1b	Students reflect on subjective learning experiences in mathematics classes, determine positive attitudes toward mathematics, and rethink their learning goals in mathematics.
	March - May	Workshop 2a	Students enhance knowledge and improve their use of learning strategies in mathematics.
		Workshop 2b	Students learn to use emotional and motivational self-regulation strategies in mathematics.
Grade 8	September - December	Workshop 3a	Students improve their causal attributions to learning and their value- and control-cognition in mathematics.
		Workshop 3b	Students understand the relevance of mathematics learning and can link this relevance to their own lives.
	March - May	Workshop 4a	Repetition on learning strategies, emotional and motivational self-regulation strategies.
		Workshop 4b	Repetition on value cognitions in math and emotional and motivation self-regulation strategies.

8.2.2 Measures

In line with previous research, perceived control was measured using two scales (self-concept and self-efficacy) that served as manifest indicators. Students' self-concept and self-efficacy in mathematics were assessed in accordance with PISA 2012 (Schwantner et al., 2013) with four items for self-concept (e.g., "I have always believed that mathematics is one of my best subjects," $\alpha_{t0/t1/t2}$ = .83/.85/.85) and four items for self-efficacy (e.g., "In mathematics I am sure that I can understand even the most difficult material," $\alpha_{t0/t1/t2}$ = .79/.80/.82). The reliabilities for perceived control at all three measurement points amount to $\alpha_{t0/t1/t2}$ = .88/.89/.89 and thus indicate a good to excellent internal consistency of the measurement (Tavakol & Dennick, 2011).

Perceived value was also measured using two scales (utility and attainment value) as manifest indicators. Utility value was assessed with four items (e.g., "The learning contents in mathematics will help me in my life," Gaspard et al., 2014, $\alpha_{t0/t1/t2}$ = .77/.82/.84) and attainment value was assessed with four items (e.g., "It's important to me to be good at mathematics," Gaspard et al., 2014, $\alpha_{t0/t1/t2}$ = .84/.79/.81). The reliabilities for perceived value at all three measurement points amount to $\alpha_{t0/t1/t2}$ = .85/.87/.89 and thus indicate a good internal consistency of the measurement (Tavakol & Dennick, 2011). Both control and value were rated on a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree).

Students' achievement emotions in mathematics were assessed using a shortened version of the Achievement Emotions Questionnaire – Mathematics (AEQ – M; Pekrun et al., 2005). All items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Enjoyment was assessed through four items (e.g., "I'm looking forward to the mathematics lesson," $\alpha_{t0/t1/t2}$ = .92/.90/.87). Students' anger in mathematics was assessed with four items (e.g., "Because I'm angry, I get restless in mathematic class," $\alpha_{t0/t1/t2}$ = .82/.83/.82). Anxiety was assessed by five items (e.g., "I feel nervous in mathematics class," $\alpha_{t0/t1/t2}$ = .85/.81/.82) and boredom with three items (e.g., "Mathematics class bores me," $\alpha_{t0/t1/t2}$ = .76/.83/.82).

Gender, students' mathematics achievement, and intervention group membership were included as covariates. Gender (female = 0; male = 1) was included because existing research showed gender-specific differences in achievement, control and value beliefs, and perceived emotions (OECD, 2014). Students' mathematic achievement was tested at the beginning of Grade 7 by means of a standardized achievement test of the HarmoS project, a national large-scale assessment. Average standard score was scaled to the mean of 500 points (*SD* = 100). The sample mean is 432 points (*SD* = 60) and corresponds to the expected range for students in this

school type (Bauer et al., 2014). Since the intervention is based on CVT, and thus intends to change students' control and value appraisals, the intervention group membership was included. Because both intervention groups received the same intervention on student side, group membership was dichotomized (intervention group yes/no).

8.2.3 Data Analyses

With the exception of the reliability and descriptive statistics calculation in R (R Core Team, 2019), all analyses were conducted in Mplus 8 (Version 1.6; Muthén & Muthén, 1998–2018).

Missing Data

Based on teacher assessment of academic ability, at the end of primary education (Grade 6) students in Switzerland are assigned to different tiers (school types) of lower secondary education. Due to the permeability of the Swiss school system, however, students are still able to move between tiers after this transition. These changes typically occur during the first months of Grade 7. As this study exclusively addresses students in the lowest tier, called "Realschule", only those students who remained in this type of school throughout Grade 7 were included in our analyses. Of an initial cohort of 452 students, 348 remained in the "Realschule" and completed both surveys in Grade 7 (measurement points t0 and t1). At the end of Grade 8 (measurement t2) 23% of the dependent variables were missing (student absence due to moving to a different tier, illness, work experience, trial apprenticeship, or change of school). Missing data at the end of Grade 8 were assessed with the FIML estimation in Mplus (Muthén & Muthén, 1998–2018). For descriptive statistics, missing data were assessed using multiple imputation by chained equation in R (package *mice* [van Buuren & Groothuis-Oudshoorn, 2011], version 3.9.0, number of imputed datasets *(m)* and iteration *(maxit)* = 20).

Measurement Invariance

In a first step, confirmatory factor analyses were conducted at all three measurement points with all latent constructs to check the assumed factor structure. Model fit was adequate-to-good for all latent constructs based on cut-off criteria: Comparative fit index (CFI) > .90, root mean square error of approximation (RMSEA) < .07, standardized root mean square residual (SRMR) < .08, and factor charges (λ) > .50 (Tabachnick & Fidell, 2012).

In a second step, measurement invariance across time was tested for all latent constructs to control whether the latent constructs were stable over time and whether they could be compared over the measurement times (Little, 2013) . Therefore, a series of increasingly restrictive

nested models were tested: First, configural model (configural invariance), which allowed parameters to be estimated freely across the three measurement points was used as baseline model. Second, weak invariance model (metric invariance), which constrained all factor loading to be equal across time. Third, strong invariance model (scalar invariance) whereby factor loadings, and intercepts were constrained to be equal. Fourth, a strict invariance model (invariance of unique variances) that also constrained the residual variances over time (Byrne, 2008; Sass, 2011). In order to investigate mean differences over time, at least scalar invariance must exist (Grimm et al., 2017; Sass, 2011). To test the different degrees of measurement invariances, any changes in fit indices, the comparative fit index (CFI), and the root-mean-square error of approximation (RMSEA) were compared between the nested models. Change in ΔCFI < .01 and the change in ΔRMSEA <.01–.015 were set as limits (Chen, 2007). Within this range, it can be assumed that the more restrictive model does not present a significantly poorer fit than the less restrictive model (Little, 2013).

Results of the measurement invariance analyses suggest scalar invariance for perceived value and anxiety, and strict invariance for perceived control, enjoyment, anger, and boredom (see Table 2).

Latent Change Models

Given the nested structure of the data (N = 22 classrooms) and the non-independence of observations, the command "Type = Complex" was used for all analyses in Mplus (Muthén & Muthén, 1998–2018).

In order to test our hypotheses, latent change models (Steyer et al., 2000) were conducted. These latent change models (or true change models or latent difference models) can provide the analysis of interindividual differences in intraindividual change, since intraindividual change between two measurement points is modeled as a latent variable (McArdle, 2009; Reuter, 2010; Steyer et al., 2000). The modeling of the present study is based on a neighbor change model (Geiser, 2010). Hence, the changes from the first to the second and from the second to the third measurement point were modeled as two latent variables.

The latent change models were estimated separately for the different emotions. Model fit was assessed by examining the comparative fit index (CFI), and the root mean squared error of approximation (RMSEA). A satisfactory model fit is indicated by a CFI > .90 (Tabachnick & Fidell, 2012) and a RMSEA < .07 (Steiger, 2007). Mathematics achievement, gender, and group membership were used as covariates in all models. Further, for the latent change in emotions, the baseline level of control and value appraisals were also included.

Table 2

Longitudinal Measurement Invariance

Model	χ^2	df	χ^2/df	RMSEA	CFI	ΔRMSEA	ΔCFI
perceived control							
1 configural	439.03	225	1.95	.052	.937		
2 metric	464.66	239	1.94	.052	.934	.000	.003
3 scalar	487.06	253	1.93	.052	.931	.000	.003
4 strict	509.22	269	1.89	.051	.930	.001	.001
perceived value							
1 configural	460.06	222	2.07	.056	.927		
2 metric	481.49	236	2.04	.055	.925	.001	.002
3 scalar	518.98	249	2.08	.056	.918	-.001	.007
4 strict	606.68	265	2.29	.061	.896	-.005	.022
enjoyment							
1 configural	69.75	39	1.79	.048	.984		
2 metric	74.30	45	1.65	.043	.985	.005	-.001
3 scalar	80.96	51	1.59	.041	.985	.002	.000
4 strict	78.57	59	1.33	.031	.99	.01	-.005
anger							
1 configural	56.16	39	1.44	.036	.984		
2 metric	67.41	45	1.50	.038	.979	-.002	.005
3 scalar	83.79	51	1.64	.043	.970	-.005	.009
4 strict	90.12	59	1.53	.039	.971	.004	-.001
anxiety							
1 configural	88.52	72	1.23	.026	.989		
2 metric	103.83	80	1.30	.029	.985	-.003	.004
3 scalar	116.70	87	1.34	.031	.981	-.002	.004
4 strict	202.92	97	2.09	.056	.932	-.025	.049
boredom							
1 configural	24.04	15	1.60	.042	.988		
2 metric	24.63	19	1.30	.029	.993	.013	.003
3 scalar	30.32	23	1.32	.030	.990	-.001	.003
4 strict	38.21	29	1.32	.030	.988	.000	.002

8.3 Results

Descriptive statistics and correlations for all variables are presented in Table 3. As expected, perceived control and value are positively correlated with enjoyment and negatively with the negative emotions. Furthermore, perceived control and value correlate positively with gender and mathematics achievement at the first measurement point.

Table 3

Descriptive Statistics

		M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	control t0	2.58	.58		.54***	.39***	.54***	.38***	.27***	.65***	.36***	.25***	-.25***	-.17**	-.08	-.20***	-.16**	-.06	-.28***	-.23***	-.18**	.27***	.20***
2	control t1	2.71	.60			.59***	.37***	.51***	.29***	.43***	.64***	.35***	-.26***	-.42***	-.17**	-.24***	-.42***	-.25***	-.23***	-.37***	-.24***	.19***	.31***
3	control t2	2.78	.58				.22***	.32***	.51***	.27***	.36***	.59***	-.23***	-.33***	-.30***	-.22***	-.34***	-.31***	-.27***	-.29***	-.35***	.20***	.28***
4	value t0	3.23	.53					.56***	.32***	.50***	.36***	.19***	-.22***	-.19***	-.12*	-.12*	-.09	-.08	-.36***	-.24***	-.18**	.12*	.11*
5	value t1	3.23	.53						.50***	.35***	.55***	.33***	-.22***	-.41***	-.20***	-.17**	-.25***	-.14*	-.26***	-.41***	-.28***	.19***	.12*
6	value t2	3.18	.57							.23***	.28***	.42***	-.10	-.25***	-.41***	-.11*	-.20***	-.32***	-.13*	-.20***	-.40***	.24***	.06
7	enjoyment t0	3.04	1.06								.53***	.30***	-.36***	-.27***	-.15**	-.26***	-.17**	-.09	-.48***	-.31***	-.21***	.13*	.20***
8	enjoyment t1	3.05	1.00									.44***	-.32***	-.53***	-.25***	-.22***	-.32***	-.18**	-.33***	-.55***	-.35***	.09	.16**
9	enjoyment t2	3.04	.91										-.23***	-.35***	-.41***	-.15**	-.22***	-.18**	-.22***	-.33***	-.54***	.14*	.16**
10	anger t0	1.94	.90											.40***	.29***	.73***	.35***	.21***	.64***	.36***	.21***	.16**	-.18**
11	anger t1	1.79	.87												.43***	.32***	.60***	.30***	.30***	.76***	.43***	.05	-.15**
12	anger t2	1.95	.87													.20**	.30***	.58***	.21***	.34***	.72***	.13*	-.12*
13	anxiety t0	1.99	.93														.40***	.28***	.52***	.27***	.15**	.11*	-.19***
14	anxiety t1	1.68	.72															.41***	.26***	.46***	.21***	-.01	-.23***
15	anxiety t2	1.72	.71																.20***	.20***	.40***	.02	-.16**
16	boredom t0	2.10	.95																	.37***	.23***	.07	-.11*
17	boredom t1	2.06	1.01																		.48***	.04	-.09
18	boredom t2	2.17	1.00																			-.01	-.06
19	gender	1.49	.50																				.05
20	mathematics achievement t0	432.64	60.61																				

*$p < .05$; **$p < .01$; ***$p \leq .001$

8.3.1 Latent Change Models of Control and Value

To test the effectiveness of the intervention, latent change models were applied. We calculated a latent change model of perceived control and value. Two latent change variables reflecting the change between t0 and t1 (Δcontrol 1/ Δvalue 1) and t1 and t2 (Δcontrol 2/ Δvalue 2) were specified. The intervention setting was used as a predictor that explains the change in perceived control and value across time relying on latent factors accounting for measurement errors (cf. Figure 1). We assume that the intervention group will show an increase in control and value appraisals compared to the control group (H1).

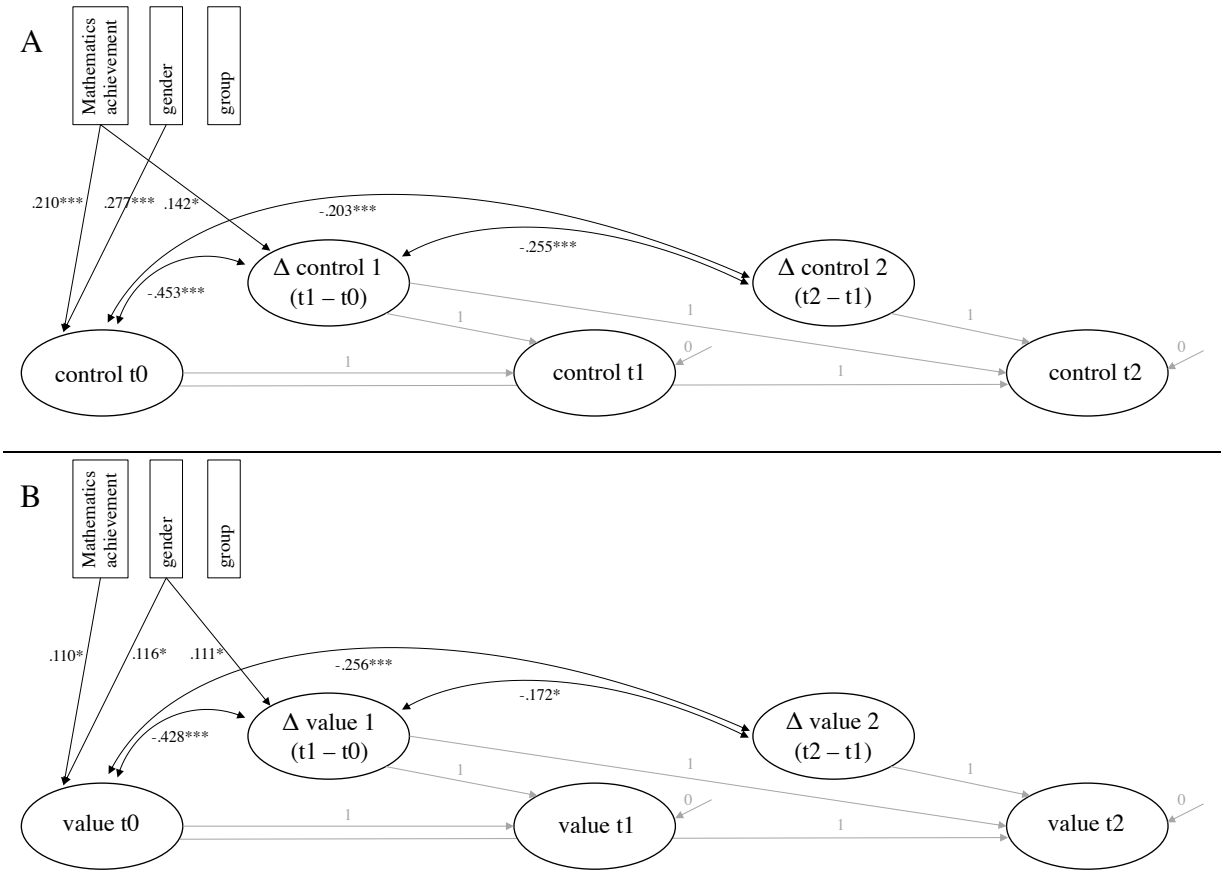
The latent change model of perceived control (χ^2 (332) = 621.14, $p \leq .001$, CFI =.92, RMSEA = .05) and perceived value (χ^2 (312) = 599.53, $p \leq .001$, CFI =.91, RMSEA = .05) yield an adequate fit (Tabachnick & Fidell, 2012). With regard to our hypothesis, however, no significant intervention effect could be found: Therefore, H1 must be rejected.

Additionally, perceived control at t0, as well as perceived value at t0, reveal a negative significant correlation with the change of the same construct ($r_{\Delta control1}$ = -.453, $p \leq .001$; $r_{\Delta control2}$ = -.203, $p \leq .001$; $r_{\Delta value1}$ = -.428, $p \leq .001$; $r_{\Delta value2}$ = -.256, $p \leq .001$). These negative relations indicate that the higher control and value at t0, the more negatively they develop, and vice versa. For the model of perceived control and value, the included covariates show a significant effect of mathematics achievement at the beginning of the study and of gender on perceived control and perceived value at the first measurement point (t0). The higher the mathematics achievement at t0, the higher the perceived control (β = .210, $p \leq .001$) and perceived value (β = .110, p = .032) at t0. In addition, prior mathematics achievement has a significant effect on change in perceived control between t0 and t1 (Δ control 1). The better the mathematics achievement at t0, the more positive the change in perceived control between the first two measurement points (β = .142, p = .023). In terms of gender, results reveal that boys at t0 reported significantly more perceived control (β = .277, $p \leq .001$) and more perceived value (β = .116, p = .049) than girls. Furthermore, gender has a significant effect on the change of perceived value between the first two measurement points (Δvalue 1). Boys show a significant positive change in perceived value between t0 and t1 compared to girls (β = .111, p = .036).

Under control of the covariates, the latent factor scores (control and value at t0) and latent change scores of perceived control (Δcontrol 1 / Δcontrol 2) and perceived value (Δvalue 1 / Δvalue 2) were extracted, and in a next step they were included in the latent change models to investigate the separate change-change process for the four achievement emotions.

Figure 1

*Latent Change Models of Perceived Control (A) and Perceived Value (B). *p < .05; **p < .01; ***p ≤ .001. Non-significant Paths Are Not Displayed.*



8.3.2 Change-Change Model of Enjoyment

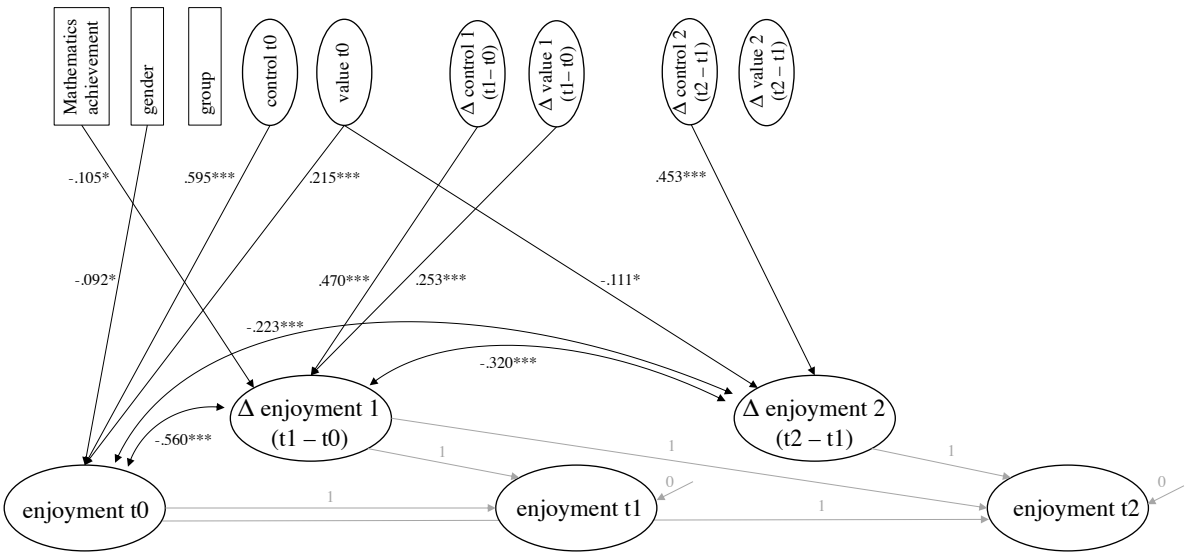
We assume that positive intraindividual changes in perceived control and value longitudinally predict positive intraindividual changes in enjoyment (H2a). The latent change model of enjoyment (χ^2 (148) = 176.86, p = .05, CFI =.99, RMSEA = .02) yields an adequate fit (Tabachnick & Fidell, 2012). As shown in Figure 2, intraindividual change in enjoyment between the first and second measurement point is significantly predicted by intraindividual change in control (β = .470, $p \leq .001$) and change in value (β = .253, $p \leq .001$). The more positive perceived control and value develop between the first two measurement points, the more positive the change in enjoyment in the same time period. Between the second and third measurement point, change in enjoyment is only significantly predicted by change in control (β = .453, $p \leq .001$). Perceived value at t0 significantly and negatively predicts change in enjoyment between t1 and t2 (β = -.111, p = .03), whereas the change in value between t1 and t2 does not significantly predict change in enjoyment between t1 and t2 (β = .117 p = .19). This result indicates that the

higher the perceived value at t0, the more negative enjoyment develops between t1 and t2, while a change in perceived value could not predict a change in enjoyment between these two measurement points.

Additionally, change in enjoyment between t0 and t1 is negatively predicted by mathematics achievement at the beginning of the study ($\beta = -.105$, $p = .036$). The higher the mathematics achievement at t0, the more negative the change in enjoyment between the first two measurement points. Furthermore, enjoyment at t0 and change in enjoyment are negatively related ($r_{\Delta enjoyment1} = -.560$, $p \leq .001$; $r_{\Delta enjoyment2} = -.223$, $p \leq .001$). This negative relation indicates that the higher the enjoyment at t0, the more negatively it develops, and vice versa.

Figure 2

*Change-Change Model of Enjoyment with Covariates and Extracted Latent Factor Scores and Latent Difference of Perceived Control and Value. *p < .05; **p < .01; ***p ≤ .001. Non-significant Paths Are Not Displayed.*



8.3.3 Change-Change Model of Anger

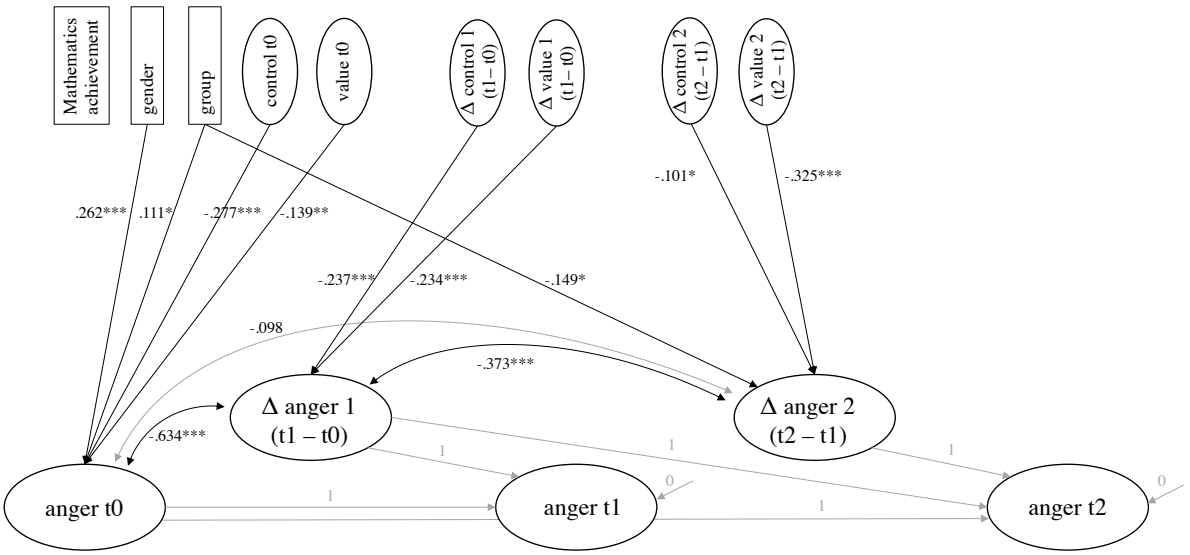
We assume that positive intraindividual changes in perceived control and value longitudinally predict negative intraindividual changes in anger, anxiety, and boredom. The latent change model of anger (χ^2 (148) = 218.30, $p \leq .001$, CFI =.95, RMSEA = .04) also yields an adequate fit (Tabachnick & Fidell, 2012). Model results (cf. Figure 3) reveal that changes in anger between the first and second, and the second and third measurement points are significantly negatively predicted by change in control ($\beta_{\Delta control1} = -.237$, $p \leq .001$; $\beta_{\Delta control2} = -.101$, $p = .048$) and change in value ($\beta_{\Delta value1} = -.234$, $p \leq .001$; $\beta_{\Delta control2} = -.325$, $p \leq .001$). The more positive perceived control and value develop, the more anger decreases[i]. These results confirm the

change-change assumption of the CVT for perceived control and perceived value and anger (H2b).

With respect to the covariates, significant effects on anger at t0 could be found. Perceived control and perceived value at t0 have a negative effect, i.e., the higher the perceived control and value, the lower the anger at t0. Gender and group membership reveal a significant positive effect, i.e., boys and the students in the control group show more anger at t0. Furthermore, group membership has a significant negative effect on the change in anger between t1 and t2. Change in anger between these two measurement points develops more advantageously in the control group compared to the intervention group. In addition, anger at t0 and the change between the first two measurement point correlate. This negative correlation indicates that the higher the values of anger at t0, the more advantageously it develops, and vice versa ($r_{\Delta anger1}$ = -.634, $p \leq .001$).

Figure 3

*Change-Change Model of Anger with Covariates and Extracted Latent Factor Scores and Latent Difference of Perceived Control and Value. *p < .05; **p < .01; ***p ≤ .001. Non-significant Paths Are Not Displayed.*



8.3.4 Change-Change Model of Anxiety

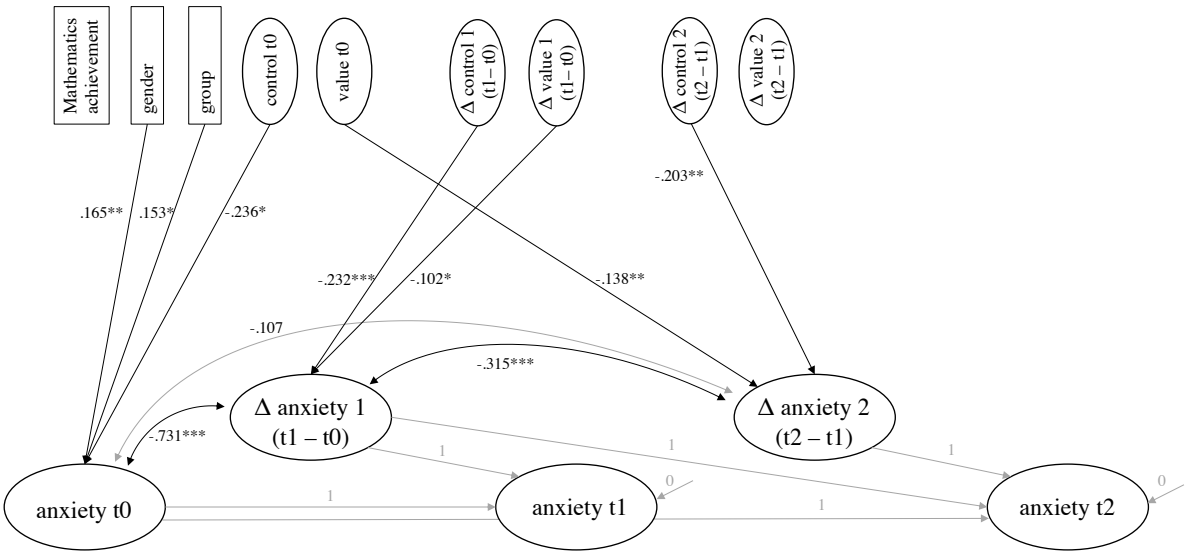
The latent change model of anxiety (χ^2 (203) = 327.93, $p \leq .001$, CFI =.94, RMSEA = .04) yields an adequate fit (Tabachnick & Fidell, 2012). As shown in Figure 4, intraindividual change in anxiety between the first and second measurement point are significantly negatively predicted by intraindividual change in control (β = -.232, $p \leq .001$) and change in value (β = -.102, p = .040). The more positive perceived control and value develop between the first two

measurement points, the greater the decrease in anxiety that can be found at the same time period. Also, change in anxiety between the second and third measurement point is significantly predicted by the change in control between the same measurement points (β = -.203, p = .006). These results partially confirm the change-change assumption of the CVT for perceived control and perceived value and anxiety (H2c).

Perceived value at t0 significantly predicts change in anxiety between t1 and t2 (β = -.138, p = .026), but the change in perceived value is not a significant predictor (β = -.078, p = .114). Thus, higher perceived value at t0 leads to a more desirable change in anxiety between t1 and t2. In terms of gender, boys report significantly more anxiety at t0 than girls, and the control group also shows significantly more anxiety at t0 than the intervention group. In addition, anxiety at t0 and the change between the first two measurement points correlate. This negative correlation indicates that the higher the values of anxiety at t0, the more advantageously it develops, and vice versa ($r_{\Delta anxiety1}$ = -.731, $p \leq .001$).

Figure 4

*Change-Change Model of Anxiety with Covariates and Extracted Latent Factor Scores and Latent Difference of Perceived Control and Value. *p < .05; **p < .01; ***p ≤ .001. Non-significant Paths Are Not Displayed.*



8.3.5 Change-Change Model of Boredom

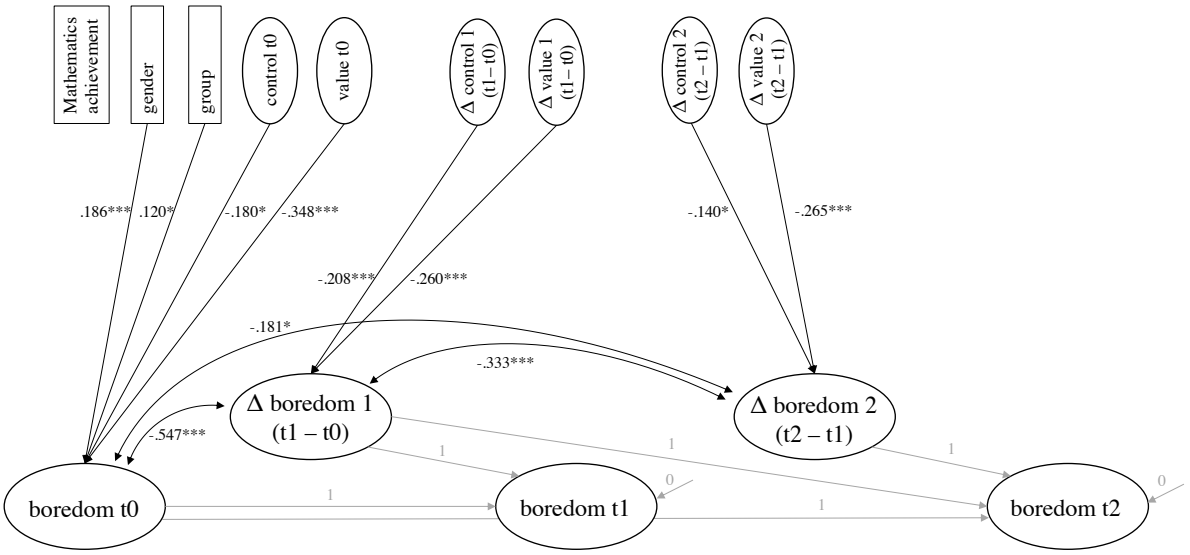
The latent change model of boredom (χ^2 (91) = 131.57, p = .004, CFI =.96, RMSEA = .04) yields an adequate fit (Tabachnick & Fidell, 2012). Intraindividual change in boredom between two adjacent measurement points are significantly negatively predicted by intraindividual change in control ($\beta_{\Delta control1}$ = -.208, $p \leq .001$; $\beta_{\Delta control2}$ = -.140, p = .016) and change in value ($\beta_{\Delta value1}$ = -.260, $p \leq .001$; $\beta_{\Delta value2}$ = -.265, $p \leq .001$). The more positive perceived control and

value develop between the measurement points, the more advantageous the change in boredom at the same time period. These results confirm the change-change assumption of the CVT for perceived control and perceived value and boredom (H2d).

In terms of gender, boys report significantly more boredom at t0 than girls, and the control group also shows significantly higher boredom at t0 than the intervention group. Furthermore, boredom at t0 and change in boredom are negatively related ($r_{\Delta boredom1}$ = -.547, $p \leq .001$; $r_{\Delta boredom2}$ = -.181, p = .015). This negative relation indicates that the higher the boredom at t0, the more advantageously it develops, and vice versa (cf. Figure 5).

Figure 5

*Change-Change Model of Boredom with Covariates and Extracted Latent Factor Scores and Latent Difference of Perceived Control and Value. *p < .05; **p < .01; ***p ≤ .001. Non-significant Paths Are Not Displayed.*



8.4 Discussion

One of our research goals was to investigate whether a two-year intervention program related to CVT may change control and value mathematics appraisals of low-achieving secondary school students. Although changes in control and value appraisals over two school years could be found, these changes could not be attributed to participation in the intervention program (rejection of H1). Whereas prior research has shown that control appraisal could be affected e.g., by attributional retraining through a writing assignment (e.g., Hamm et al., 2014), the result of our study did not show effects of a training program. Instead, change in control appraisals in the first year of secondary education was predicted by mathematics achievement, and change in value appraisal in the first year of secondary education was predicted by gender. One reason

for the program's lack of impact may be related to the program's design. The broadness of the contents of the workshops, primarily based on basic need satisfaction according to SDT (Deci & Ryan, 2002) as well as the support of positive emotional experience in control value theory (Pekrun, 2006), might not have been sufficiently tailored to influence student appraisals. Multicomponent interventions do less to address single variables but instead aim at a general opportunity to improve emotions, motivation and attitudes toward school. Thus, specific effects may be difficult to achieve.

Another reason for the programs lack of impact may be related to the characteristics of our sample. In their study, Hall et al. (2007, p. 289) revealed that elaborative learning skills moderate the effect of attributional retraining, and that low elaborating students may represent a risk group that benefits less from interventions. Based on the assumption that self-regulatory strategies such as elaboration strategy are predictors of achievement (Nota et al., 2004), it could be assumed that our low achievement sample (lowest ability tier) may represent low elaborators and therefore cannot respond adequately to such an intervention. Thus, the moderation effect of elaboration strategies may also explain the lack of effect of the intervention on our sample. Regarding the promotion of the value appraisal, short interventions based on EVT suggested that a psychoeducational presentation and relevance-inducing tasks (writing task or evaluation of interview quotations) had a positive effect on students' value (e.g., Gaspard et al., 2015). However, the effects of short interventions may differ from long-term interventions. Short-term effects may not have been detected in our study, which covered two school years. Further, a fatigue effect (Hagenauer, 2010) may have set in, and students may have considered the workshops to be too long, or there may also have been a form of fade-out phenomenon (Bailey et al., 2020).

Against the background of CVT, our second research goal focused on the antecedents of achievement emotions. We investigated the change-change assumption regarding the four achievement emotions of enjoyment, anger, anxiety, and boredom over two school years. We assumed that positive intraindividual changes in perceived control and value longitudinally predict positive intraindividual changes in enjoyment (H2a) and negative intraindividual changes in anger, anxiety, and boredom (H2b-d). Our results are in line with CVT and previous research (Buff, 2014; Niculescu et al., 2016). Intraindividual changes in the four achievement emotions are longitudinally predicted by changes in perceived control and value. The results show that for all four investigated achievement emotions, these longitudinal effects are more pronounced in the first year of secondary education and that one-year change-change effects are stronger than two-year change-change effects. After transition into secondary education, students seem

to be differently responsive to changes in appraisals. These findings may support the idea to tailor interventions programs also regarding educational settings and trajectories.

Similar to Buff (2014), we found the "unexpected" negative effect of enjoyment at t0 in terms of its change. Complementarily, we note that the baseline measurement of enjoyment also negatively correlated with the change between the end of Grade 7 and the end of Grade 8 (Δenjoyment 2). This effect indicates that the higher enjoyment at the beginning of Grade 7, the more negatively enjoyment develops over two school years (i.e., interindividual differences in change). Thus, students with initially high mathematics enjoyment are at risk of losing it during secondary education. For the negative emotions we found, corresponding to Niculescu et al. (2016), negative correlations between t0 and their changes between the first two measurement points for anger, anxiety, and boredom. In terms of boredom, this negative correlation can also be found regarding the change between the end of Grade 7 and Grade 8 (Δboredom 2). Therefore, the higher the values in negative emotions at the beginning of Grade 7, the more positively they develop. Thus, students with initially higher negative emotions show a more advantageous development. It is possible, however, that this result is based on a correction or approximation to the mean effect, where high initial values are corrected downwards and vice versa (Niculescu et al., 2016). It is also likely that the correction to the mean effect may result from a more differentiated perception of one's own emotions based on developmental processes during adolescence or adaptation processes after the transition from primary to secondary education.

8.4.1 Limitations

In spite of the advantages of the present study, such as the longitudinal approach over two school years, some limitations must be taken into account. First, in terms of our study design, the measurement took place at the beginning of Grade 7, right after the transition to secondary education. This transition is accompanied by big changes for students, such as new teachers, new classmates, and usually a new school environment as well. The effect of these changes on the baseline measurement cannot be excluded. Further, the second and third measurements took place at the end of Grade 7 and Grade 8, respectively. The long time span between measurement points may have been too great to permit identifying treatment effects, and intervention effects may have faded. Further, the two intervention groups were grouped together in the present study due to their similarity in the students' workshops. As teachers of one student intervention group also have been introduced to basic need theory and CVT, changes in teaching behavior cannot be excluded as effects on student appraisals and emotions.

Second, our study focuses on secondary school students in the lowest ability tier and refers to the achievement emotions in mathematics. The specific characteristics of the sample might also explain why mathematics achievement was significant only for changes in the positive achievement emotion, namely enjoyment. Therefore, our results are limited regarding other age groups, other ability tiers, and other domains. Due to this fact, the results cannot be generalized.

Third, the change-change assumption assumes causality between control and value appraisals on emotions. However, this causality cannot be conclusively confirmed due to the potential influence of third variables such as teacher-student relationship. Further, it must be noted that control and value appraisals are not only antecedents of emotions, but also turn out to be consequences of emotions due to the postulated feedback loop in the relationship of appraisals and emotions (Goetz et al., 2010; Pekrun & Stephens, 2010).

8.4.2 Implications and Future Research

The confirmed change-change assumptions over two school years provide important information for future research and practice. It can be assumed that the strategy of influencing students' perceived control and value appraisals may be an effective measure to promote positive emotions and reduce negative emotions. Future research must explore how this could be implemented into daily teaching practices and instructional design. Unfortunately, our multicomponent approach did not lead to the intended outcomes in terms of an increase in control and value appraisals. Consequently, the development of effective treatment programs requires further attention. Future research should consider other factors influencing control and value appraisals in order to investigate a possible mediating role of control and value appraisals on emotions. Such factors also could include domain-specific training such as improving students' mathematics problem-solving skills. Also, complementary research could apply a person-centered approach such as latent profile analysis to determine possible person-specific effects of an intervention. Regarding heterogeneity of society and student population, it must be taken into account that an intervention does not target all students equally. An intervention may have an effect on certain subgroups while having no effect on other subgroups. By examining individuals' prerequisites and their interactions with the intervention, differential effects may be identified (cf. aptitude-treatment interaction research).

8.4.3 Conclusion

Overall, the present paper indicates the relevance of control and value appraisals as antecedents of achievement emotions. By confirming the change-change assumption over two school years, it becomes evident that positive changes in control and value appraisals can lead to desirable changes in positive as well as in negative emotions, i.e., an increase in positive emotions and a decrease in negative emotions. Thus, this study contributes additional empirical evidence that achievement emotions can be changed by changes in their antecedents and that corresponding intervention approaches may be promising. This finding should be addressed in future research as well as in practice.

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[i] Because anger, anxiety and boredom are negative emotions, lower values are more desirable, and therefore a negative change is more advantageous.

Stability and Change of Low-Achieving Secondary School Students' Motivation Profiles for Mathematics: Effects of an Intervention

Held, T., & Hascher, T. (under review). Stability and change of low-achieving secondary school students' motivation profiles for mathematics: Effects of an intervention. *Journal of School Psychology*.

Abstract

How do students differ in terms of motivation and how do these differences affect the effectiveness of a motivation training program? These questions are drivers of our research. There is high agreement that motivation is an important factor for successful learning processes and outcomes. However, given the heterogeneity of individuals, far less is known about systematic differences between learners in the reasons for their learning effort. This study aimed to identify motivation profiles of a specifically vulnerable student group, namely low-achieving students in the learning of mathematics. Within the framework of the self-determination theory, we investigated how these profiles change during Grades 7 and 8. Further, the study examined whether a particular intervention setting that aimed at promoting positive emotions and motivation in learning had an impact on the patterns of change in the specific motivation profiles compared to the control setting. A latent profile analysis based on self-reported intrinsic, identified, introjected, and extrinsic regulation of 348 students revealed three motivation profiles: low-mixed, high-mixed, and self-determined. Results of the latent transition analysis indicated that the majority of students tended to remain in the same profile and also revealed different effects of the intervention on different motivation profiles. The intervention seemed to be better tailored to students in the low-mixed motivation profile than to students in other profiles. This result sheds light on the nature of differential effects between students and adds new knowledge to aptitude-treatment interaction research.

Keywords: aptitude-treatment interaction; intervention; motivation profiles; patterns of change

9.1 Introduction

Individual prerequisites, such as motivation, are important factors in successful learning processes and outcomes. Students' reasons for making the effort to learn can differ between individuals as well as situations. Due to the expectation that both intrinsic and extrinsic incentives can be meaningful for a learning activity, it is to be expected that different forms of regulation may coexist within an individual (Hidi & Harackiewicz, 2000; Murayama, 2019). Although evidence of a generally close relationship between motivation and achievement exists (e.g., Steinmayr & Spinath, 2009), less is known about the motivation profile of vulnerable groups, such as low-achieving students. Based on self-determination theory (SDT), this paper addresses these gaps by examining latent motivation profiles of low-achieving students in lower secondary education. We pay particular attention to differences in the development of their mathematics motivation over two years and to the specific effects of an intervention that aimed at promoting motivation in mathematics learning. Given the fact that interventions do not have robust effects (Fuchs & Fuchs, 2019), we investigate whether students within different motivational profiles respond differently to the intervention and, thus, whether the intervention is better tailored for specific motivational profiles. Therefore, this study extends the traditional intervention evaluation by incorporating the aptitude-treatment interaction (ATI) research and provide a greater understanding of the individual development of motivation. This knowledge is especially important for low-achievers in order to minimize achievement gaps due to individual aptitudes, maximize individual learning success, and empower these students for lifelong learning (cf. Preacher & Sterba, 2019).

9.1.1 Self-Determination Theory

Different motivational orientations have been defined, for example, those in the self-determination theory (SDT) of motivation established by Deci and Ryan (1985). In SDT, the dichotomous distinction between intrinsic and extrinsic motivation was replaced by a continuum of five types of regulation: intrinsic, integrated, identified, introjected, and external. These regulation forms differ in their level of self-determination (Deci & Ryan, 1985, 2002). According to this model, the lowest level of self-determination is found in external regulation, when a given behavior is determined entirely by external factors and occurs exclusively as a result of a reward or punishment. A low level can also be found in introjected regulation, which has a greater level of external control and includes behaviors pursued because they are necessary due to internal pressure, such as a guilty conscience. Identified regulation contains a greater level of internal control and is regarded as a self-determined form of extrinsic motivation, as an

individual's behavior is considered personally important, and the goals have been temporarily or permanently integrated into the individual's self while still fulfilling an instrumental purpose. Integrated regulation is characterized by the individual having integrated former external goals into a coherent self. Finally, intrinsic regulation is considered the prototype of self-determined behavior in which the act itself is a pleasure (Deci & Ryan, 2009). In the educational context, intrinsic, integrated, and identified regulation are considered to be the desired forms because, in these forms, the behavior is regarded as self-determined and meaningful and leads to improved learning outcomes (Deci & Ryan, 2000).

Despite the availability of a more differentiated model of motivational orientation, previous research has frequently defined intrinsic motivation as the opposite of extrinsic motivation (e.g., Harter, 2010) or has focused on only one type (e.g., Marcoulides et al., 2008). Based on the assumption of SDT that motivation is not dichotomous and both intrinsic and extrinsic incentives can be meaningful for an action, it is to be expected that a person may be motivated by multiple factors and different forms of regulation may coexist within an individual (Hidi & Harackiewicz, 2000). For example, students may simultaneously learn mathematics because they enjoy mathematics (intrinsic regulation), good grades are important to them (identified regulation), they would otherwise feel guilty (introjected regulation), and they get a reward for getting a good grade (external regulation). Although these factors may influence learning activity to varying extents, they all contribute to the activity and should be considered. In this assumption of multiple driving forces, the manifestation of all regulation forms is crucial. It can be assumed that one or another regulation form is more pronounced than the others, but all may be present at the same time because they are not mutually exclusive. However, the modelling of this multi-dimensionality, and the fact that students can at the same time have multiple reasons for their learning behavior, has been a challenge for empirical research.

Previous research on motivation based on SDT (e.g., Baard et al., 2004; Ryan et al., 2006) has used predominantly variable-centered approaches, which aim to assess the relationship between individuals' positions on latent dimensions or variables (Magnusson, 2003, p. 14). A variable-centered perspective is useful in understanding how particular types of motivational regulation relate to outcomes. However, it does not adequately assess whether some sets of regulations are more usual than others or whether an individual's regulation changes over time (Moran et al., 2012; Otis et al., 2005). This has led to a lack of a more "holistic, interactionistic [sic] view in which the individual is seen as an organized whole, functioning and developing as a totality" (Bergman & Magnusson, 1997, p. 291). This lack, however, can be addressed with a person-centered approach. A person-centered approach is indispensable when aiming to

examine the complexity of individual development (Bergman & Magnusson, 1997, p. 291). Whereas the variable-centered approach identifies variables of interest and assumes that the predictors have a homogeneous effect on the outcomes across individuals, the person-centered approach identifies individuals with common attributes and assumes that the predictors have heterogeneous effects on the outcomes across subgroups (Laursen & Hoff, 2006; Magnusson, 2003; Moran et al., 2012). Therefore, the person-centered analyses investigate how variables group within individuals, instead of considering how variables are related to each other. Instead of deciding how to combine the variables, the data identifies profiles by grouping individuals who demonstrate similar patterns of variables. The person-centered approach can serve as a complementary view to the variable-centered approach (Helmke & Weinert, 1997). Furthermore, person-centered approaches can open new perspectives that are useful in discovering possible intervention effects in different subgroups and can reveal more specific results than variable-centered findings. Therefore, the person-centered approach offers an opportunity to explore motivation profiles, explained in the following section.

9.1.2 Motivation Profiles

During the last decade, motivation research increasingly aims to identify different patterns of motivational orientation. However, some weaknesses regarding the identification of motivation profiles have to be considered. Based on different theoretical considerations and statistical approaches, existing research investigated different motivational variables (e.g., self-concept, interest, intrinsic value, goal orientation). Despite the common idea to identify distinct patterns of motivation, this has led to a heterogeneous picture regarding relationships and comparisons between studies (e.g., Lazarides et al., 2020; Lazarides et al., 2019; Linnenbrink-Garcia et al., 2018). Regarding motivation profiles within a theory, such as SDT which is a focus of our study, previous research on motivation profiles tends to reduce the four types of regulation into two principal categories: autonomous regulation (with composite scores gained by averaging the subscales of intrinsic and identified regulation) and controlled regulation (composite scores average the subscales of introjected and external regulation; e.g., Hayenga & Corpus, 2010; Ratelle et al., 2007; Vansteenkiste et al., 2009). Subsequently, three to four motivation profiles across different school-types have been documented according to the intensity of the categories: high autonomous and low controlled motivation, high autonomous and high controlled motivation, low autonomous and high controlled motivation, and low autonomous and low controlled motivation (Corpus et al., 2016; Hayenga & Corpus, 2010; Ratelle et al., 2007; Vansteenkiste et al., 2009). In terms of students' learning outcomes, it has been found that high autonomous

motivation profiles are linked to better performance, such as increased persistence and achievement (Guay et al., 2008). Additionally, a high autonomous and low controlled profile has been shown to be associated with higher academic achievement (η^2 = .08 / .06 / .06; Gillet et al., 2017; Hayenga & Corpus, 2010, p. 377; Wormington et al., 2012, p. 434), lower test anxiety (η^2 = .09), less procrastination (η^2 = .15), and less tendency to cheat (η^2 = .12; Vansteenkiste et al., 2009, p. 678). The two profiles with low autonomous motivation have been revealed as unfavorable profiles due to a lack of improvement in learning. Of these two, the low autonomous and high controlled motivation profile is associated with more procrastination (η^2 = .15) and more test anxiety (η^2 = .09) and was, therefore, considered the most disadvantageous profile (cf. Vansteenkiste et al., 2009, p. 678). The comparison between the two high autonomous motivation profiles also confirmed that the concurrent prevalence of high controlled motivation is associated with maladaptive strategy use and ability-validation goals (Corpus et al., 2016), more pressure and stress and more procrastination (η^2 = .15), and test anxiety (η2 = .09; Vansteenkiste et al., 2009, p. 678).

Variable-centered research shows a decline in students' motivation throughout schooling, particularly after the transition to secondary education (Eccles, Midgley, et al., 1993; Jacobs et al., 2002). However, these findings indicate the average development of all students represented in the sample and do not provide information on individual subgroups and their development. Person-centered studies that can provide such evidence found that motivation profiles are relatively stable (Corpus & Wormington, 2014; Gillet et al., 2017; Lazarides et al., 2019; Marcoulides et al., 2008; Nurmi & Aunola, 2005). Furthermore, it could be seen that motivation profiles—regardless of the type of profile—became more stable with age: Younger children have been shown to change more frequently (Age 9: 19.6%–24%) between profiles than older ones (Age 16: 0% – 5.6%; Marcoulides et al., 2008, p. 418). It has also been found that less favorable profiles (in terms of motivational orientation) are more stable (55.1%–71.6%) than those that are more desirable (Hayenga & Corpus, 2010; Lazarides et al., 2019, p. 378). Regarding changes in motivation profiles, it was found that a change to a less favorable profile occurs more often (4.5%–30.3%) than a change to a more desirable profile (0% – 11.9%; Bråten & Olaussen, 2005; Hayenga & Corpus, 2010, p. 378), and a change between two adjacent profiles (e.g., the low motivation profile and an intermediate motivation profile) occurs more often (4.3%–21.4%) than a more radical change between two distant profiles (e.g., from the low motivation profile to the high motivation profile or vice versa [0% – 2.6%]; Marcoulides et al., 2008, p. 418).

Despite the interesting and valuable findings of prior research on SDT-based motivation profiles, it must be noted that the two-by-two structure applied (autonomous and controlled motivation) can lead to an underestimation of motivational heterogeneity because different forms of regulation can co-occur. Although this two-by-two structure may ease profile estimation, it may also be associated with a reduction in the depth of the results and a lack of potentially important insights into more complex motivation patterns in academic learning (Howard et al., 2016). This supports the idea of testing a more open strategy to identify motivation profiles. In addition, previous studies have investigated motivation profiles collectively for entire middle schools, high schools, or colleges; in contrast, our sample covers specifically low-achieving students in lower secondary education (Grades 7 and 8). Due to the highly selective school system in Switzerland, students are assigned to different tiers (school-types) of lower secondary education based on teachers' assessments of academic ability at the end of primary education (Grade 6). Our study addresses students in the lowest tier and thus includes a particular at-risk group of students. Low-achieving students differ significantly from non-low-achieving students in their academic self-perceptions, attitudes toward school, and motivation (McCoach & Siegle, 2001). The study, therefore, aims to show whether similar profiles to the existing research can be found in this at-risk group or whether all or a majority of low-achieving students display an undesirable motivation profile. Also, interventions in this at-risk group might be of particular importance because the promotion of motivation could be beneficial for them.

9.1.3 Motivation Interventions

In recent decades, interest in maintaining and fostering students' motivation in the field of education has increased (Lazowski & Hulleman, 2016; Wentzel & Wigfield, 2007). Based on the findings that motivation tends to decrease particularly during secondary education (e.g., Eccles, Wigfield, et al., 1993; Gnambs & Hanfstingl, 2016), researchers have developed intervention programs intending to contradict this development. Intervention programs are based on different motivation theories, such as self-efficacy (Bandura, 1977), expectancy-value (Eccles, 1983), self-determination (Deci & Ryan, 1985), and achievement goals (Elliot, 2005), and target the motivation of students to improve their learning outcomes (for an overview see Lazowski & Hulleman, 2016).

A meta-analysis of 92 intervention programs (Lazowski & Hulleman, 2016, p. 624) showed that programs based on motivation theories offer promising results in terms of fostering educational outcomes (d = 0.49). Interestingly, no systematic effect size differences when

comparing different programs have been found. It is, therefore, assumed that by targeting psychological mechanisms, the educational outcomes can be improved and motivation intervention programs can be implemented across different subjects and age groups (Lazowski & Hulleman, 2016). Intervention programs that target students' feelings, thoughts, and beliefs in and about school and learning and thus have a long-term effect on motivation and achievement, have already been discussed by Yeager and Walton (2011). They found that small social-psychological interventions—also called brief interventions—that did not focus on academic content but aimed at changing underlying psychological processes were suitable to enhance academic achievement. Social-psychological interventions can trigger recursive social, psychological, and intellectual processes that might change the trajectory of perceptions and outcomes in school (Yeager & Walton, 2011).

Despite these promising results regarding the effectiveness of motivational interventions, it must be critically noted that the number of intervention studies is relatively small, especially when compared to correlative and nonexperimental studies in this research field (Lazowski & Hulleman, 2016). Moreover, intervention studies with a marginal or no impact have a more difficult prerequisite for publication, as effect size is a significant predictor of the difference between published and unpublished studies (d = 0.64) which might lead to a bias in favor of overestimated effectiveness (Chow & Ekholm, 2018, p. 737; Cook & Therrien, 2017; Polanin et al., 2016). Moreover, intervention studies tend to lack robust effects, and program efficacy studies found that in most programs, several students did not respond to treatments (Fuchs & Fuchs, 2019). Thus, students' preconditions and their responsiveness to intervention, such as the implementation of newly acquired strategies into the individual learning process, may also contribute to intervention effects (Dane & Schneider, 1998). Thus, in addition to the general effectiveness of an intervention program, differential effects must be considered. The question of whether an intervention program has the same effects on different students follows aptitude-treatment interaction (ATI) research (Cronbach & Snow, 1977).

9.1.4 Aptitude-Treatment Interaction

ATI research assumes that the benefit of a treatment (e.g., intervention program) depends on a student's aptitude and students may differ in their readiness to benefit from a treatment at a specific time (Snow, 1991a). Thus, students' aptitudes moderate (i.e., interacts with) the effects of the intervention (Fuchs et al., 2014). It should be noted that in this paper, we use the origin and broad concept of aptitude (for an overview of term development see Snow, 1992) that encompasses conative and affective characteristics of persons, such as achievement motivation,

interest, and attitudes about self and school, and not only cognitive abilities, such as intelligence (Snow, 1991a, 1991b, 1992). In the context of mathematics interventions, for example, Fuchs et al. (2014) revealed an aptitude-treatment-interaction regarding 4th graders' fraction knowledge in which working memory as aptitude moderated the effects of the intervention. Chow and Wehby (2019) demonstrated with 2nd Grade students that individual differences in language ability moderated the effectiveness of their mathematics intervention. Regarding motivation as aptitude, research is scarce and remains as a direction for future research (Fuchs et al., 2019; Kalyuga, 2007; Preacher & Sterba, 2019). First results encourage to investigate the mediating role of motivation. For example, Lapka et al. (2011) demonstrated differential effects of an online SRL intervention: Psychology students with a competence-oriented profile and students with motivational deficits benefited from the treatment, whereas no effects were found among the motivationally balanced students.

Based on this understanding of ATI research, we combine the ATI framework with the motivational construct of SDT. Therefore, we expect that motivational aptitude represented through motivation profiles may influence the effectiveness of motivational interventions. Due to differences in motivation, there may be different responses to motivation intervention. For some students, different recursive social, psychological, and intellectual process may be triggered (i.e., interaction of the intervention with aptitudes), producing different effects between students. This evaluation of a program's differential effectiveness for subgroups by using a person-centered approach may help gain new insight into intervention success.

9.1.5 The Present Study: Research Questions and Hypotheses

The existing research on the development of student motivation leaves several questions unanswered. Given that motivation has multiple determining factors, a deeper understanding of its structure and development seems crucial. The aims of this study are threefold: First, we want to examine students' motivation profiles based on SDT in mathematics of low-achieving students in early secondary education. Given that previous research has typically found three to four motivation profiles (Corpus et al., 2016; Hayenga & Corpus, 2010; Ratelle et al., 2007; Vansteenkiste et al., 2009; Wormington et al., 2012), we assume we will find a similar number of profiles (H1a). Moreover, we expect that these profiles will represent not only different levels of prevalence in motivation but also various combinations of regulation types (H1b). Secondly, we want to investigate the patterns of change in the motivation profiles over the first two school years in lower secondary education, namely during Grades 7 and 8. According to previous research (Lazarides et al., 2019), the profiles are expected to remain relatively stable over time

(H2a). Yet, if changes occur, it is assumed that students will move from motivationally favorable profiles to less favorable ones (H2b)—as this would align with previous evidence provided by variable-centered research that documents a decrease in intrinsic motivation (Gottfried et al., 2001). Thirdly, we want to analyze the effects of an intervention program implemented to promote positive emotions and motivation to learn and will investigate whether students within different motivational profiles respond differently to this intervention. Based on a variable-centered approach, one previous study has found that a two-year intervention prompted an increase in intrinsic motivation in Grade 7 (the first year of the intervention) but not in Grade 8 (see Sutter-Brandenberger et al., 2019). A shift to a person-centered approach may allow us to extend these findings by considering how an intervention might affect different subgroups (i.e., those with different motivational profiles). In line with ATI research (Cronbach & Snow, 1977), we expect different transition patterns between the profiles in the intervention group (H3).

Our study expands previous research on motivation profiles in several aspects: Whereas earlier studies have primarily used cluster analysis (e.g., Corpus et al., 2016; Hayenga & Corpus, 2010; Moran et al., 2012) and were based on many different motivation variables, such as self-concept, task value, or attainment value (e.g., Chow et al., 2012; Lazarides et al., 2018), we apply a latent profile analysis (LPA) based on the motivational variables of SDT. Furthermore, prior studies using an SDT framework (e.g., Hayenga & Corpus, 2010; Vansteenkiste et al., 2009) have limited their analyses by the dichotomization of autonomous motivation (the average of intrinsic and identified regulation) and controlled motivation (the average of introjected and external regulation). To avoid the potential loss of information caused by such dichotomization, we apply LPAs without restricting the possible combinations of the four forms of regulation. Further, in prior research papers, the data have been z-standardized, which may have led to a misinterpretation of the differences between profiles (Moeller, 2015). Moreover, regarding context, previous research on motivational profiles within SDT has focused on middle school children (Hayenga & Corpus, 2010) or high-school and college students (Ratelle et al., 2007) and addressed general motivation (Vansteenkiste et al., 2009). Aiming to extend current knowledge, we examine the motivation profiles in early secondary education specifically in the subject of mathematics, with low-achieving students as a special at-risk group. Additionally, existing research has not yet investigated whether motivation profiles are relevant predictors of the effectiveness of motivation interventions. To help answer this question, we analyze whether students within motivation profiles respond in different ways to an intervention aimed at fostering self-regulated motivation in the mathematics classroom. In summary, our objectives are to gain a deeper understanding of the prevalence and development of different motivation

profiles for learning mathematics in low achievers in early secondary education. Moreover, we want to discover how motivation profiles affect the response to an intervention aimed at fostering self-determined motivation in school.

9.2 Method

9.2.1 Participants and Procedure

The present study is part of the intervention project "Maintaining and Fostering Students' Positive Learning Emotions and Learning Motivation in Maths Instruction During Early Adolescence (EMo-Math)," funded by the Swiss National Science Foundation (grant number 156710). The study is set within a quasi-experimental design with two experimental groups and one control group. It focuses on three measurement points during Grades 7 and 8. This age period is crucial for psychological interventions because the time after a transition to a new school has been demonstrated to be a favorable window for change (Cohen et al., 2009; Walton & Cohen, 2011).

For the first step of recruitment, school representatives of "cooperation schools" (a school network participating in teacher education) were informed about the project in a meeting at the University of Bern. These representatives invited mathematics teachers to participate in the study. Committed teachers could choose in which setting they wanted to participate. As none of the committed teachers (n = 16) signed up for the control group, math teachers at similar levels from the same school or a school in the same district were recruited (n = 6). Because all students were underage at the beginning of the study, their parents or guardians had to sign a declaration of consent. All data provided by the students were anonymized. The sample consists of 348 students, with a mean age of 12.75 (SD = .64) at the first measurement point, from 22 classes in the lowest ability tier of education in the German-speaking part of the canton of Bern. Of the total, 179 of the students are female (51.4%) and 169 are male (48.6%), 134 students participated in a combined student–teacher intervention, 122 students participated in a student intervention, and 92 students were in the control group. The 256 students from the two intervention groups attended identical workshops during two regular consecutive mathematics lessons: two in the autumn term and two in the spring term. The content of the workshops for students and teachers was primarily based on basic need satisfaction according to SDT (Deci & Ryan, 2002) and the support of positive emotional experience according to control value theory (Pekrun, 2006). Thereby, all student workshops attempted to target the three basic needs by including group work (need for relatedness), reflection on one's capabilities and learning (need for competence), and the reflection on the importance and value of mathematics (need

for autonomy). The student workshops consisted of a mix of theory (theoretical inputs, transfer activities, motivational self-regulation strategies), hands-on activities, such as applying proposed learning strategies to real mathematic tasks, group collaboration (e.g., case studies), video examples, and reflection about their learning and the importance and value of mathematics for academic learning, everyday life, and their future professional lives. For more detail about the workshop content, see Brandenberger et al. (2018) and Sutter-Brandenberger et al. (2019) and Figure 1. According to social-psychological interventions (Yeager & Walton, 2011), these workshop contents aimed at triggering psychological processes, which, in turn, are expected to influence the trajectories of students' experiences and outcomes. The workshops (for both teachers and students) were carried out by three trained members of the project staff. The treatments followed a structured implementation plan and were realized with the identical materials developed and tested in advance to ensure the intervention protocol.

All students completed a paper-pencil questionnaire three times over the two school years: at the beginning of Grade 7, end of Grade 7, and end of Grade 8. Data collection was conducted by university research members during regular mathematics classes.

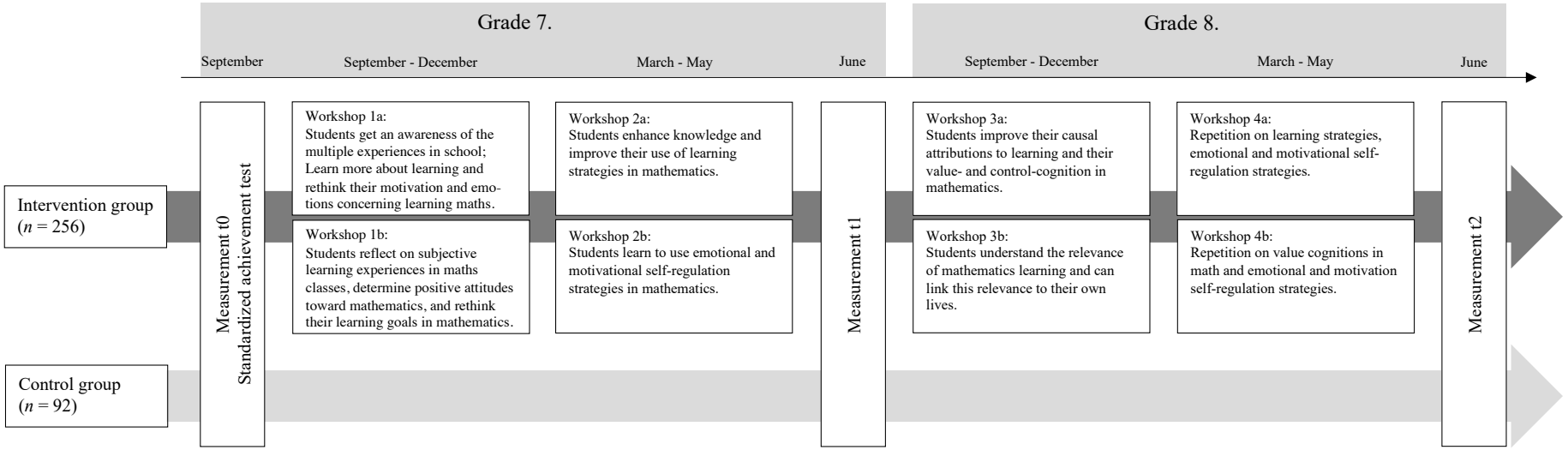
9.2.2 Measures

In line with the SDT framework, students' motivation in mathematics was measured using the four motivation styles of the German Self-Regulation Questionnaire (Müller et al., 2007), an adapted version of the Academic Self-Regulation Questionnaire developed by Ryan and Connell (1989). All items were rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) with the introductory "Now it's about you and your learning in mathematic class". Intrinsic regulation was assessed through five items (e.g., "I work in mathematics because I want to learn new things"; $\alpha_{t0/t1/t2}$ = .89/.86/.88) and identified regulation through four items (e.g., "I work in mathematics because it will give me better career choices"; $\alpha_{t0/t1/t2}$ = .82/.83/.83). Introjected regulation was comprised of four items (e.g., "I work in mathematics because otherwise I would have a guilty conscience"; $\alpha_{t0/t1/t2}$ = .67/.69/.73) and external regulation three items (e.g., "I work in mathematics because otherwise I would get into trouble at home"; $\alpha_{t0/t1/t2}$ = .68/.69/.73).

The students' mathematics performance was tested at the beginning of Grade 7 using a standardized achievement test of the HarmoS project[i]. The average standard score was scaled to the mean of 500 points (*SD* = 100) in accordance with the HarmoS project. The sample mean at t0 is 432 points (*SD* = 60.47) and corresponds to the expected range for students in this school type in the canton of Bern (Bauer et al., 2014).

Figure 1

Intervention Timeline



9.2.3 Data Analyses

Missing Data

At the end of primary education (Grade 6), based on teacher assessment of academic ability, students in Switzerland are assigned to different tiers (school-types) of lower secondary education. Due to the permeability of the Swiss school system, however, students are still able to move between tiers after this transition. These changes typically occur during the first months of Grade 7. As this study exclusively addresses students in the lowest tier, only those students who remained in this type of school throughout Grade 7 were included in our analyses. Of an initial cohort of 452 students, 348 remained in the lowest tier and completed both surveys in Grade 7 (measurement points t0 and t1). At the end of Grade 8 (measurement t2), 23% of the dependent variables were missing (student absence due to moving to a different tier or change of school during Grade 8, illness, and practical experience as well as trial apprenticeship during data collection in class). Existing research supports the use of methods like multiple imputation and maximum likelihood to treat missing data (Allison, 2010; Schafer & Graham, 2002). Full-information maximum-likelihood (FIML) produce approximately unbiased results, particularly at small sample sizes, and perform well with a moderate amount of missing data (20% -25%; Buhi et al., 2008; Schlomer et al., 2010). Therefore, missing data at the end of Grade 8 were assessed with the FIML estimation in Mplus (Muthén & Muthén, 1998–2018). For the descriptive statistics of the variables, missing values were estimated using the expectation-maximization algorithm in SPSS.

Given the nested structure (N = 22 classrooms) of the data and the nonindependence of observations, the command “Type = Complex” was used for all analyses in Mplus. This approach adjusts standard errors to account for the nested structure of the data (Muthén & Muthén, 1998–2018). Multilevel analytical modelling was omitted because we were solely interested in effects at the individual level (McNeish et al., 2017).

Confirmatory Factor Analysis

First, confirmatory factor analysis (CFA) was conducted with the robust maximum-likelihood estimator (MLR) in Mplus 8.0 (Muthén & Muthén, 1998–2018). The MLR estimator is recommended because it provides better standard errors and is suggested for analyses using “type = complex” (Muthén & Muthén, 1998–2018). The fit indices of root mean squared error of approximation (RMSEA) < .07, SRMR < .08, comparative fit index (CFI) > .90, and factor loadings (λ) > .50 were used to assess the model fit (Tabachnick & Fidell, 2012). CFA on the motivational constructs was conducted in one model for all regulation forms (intrinsic, identified,

introjected, and external) and separately for all three measurement points. For the extrinsic motivation scale that originally was comprised of six items, items with low factor loadings ($\lambda <$ .50) were identified. After adjustment, the remaining three items achieved satisfactory to good fit values at all three measurement points.

Measurement Invariance

Secondly, measurement invariance across time was tested to control whether the latent variables were stable over time and whether the latent constructs could, therefore, be compared over the measurement times (Little, 2013). A sequential procedure starting with the least restrictive solution was used (Little, 2013). For the first model without constraints (configural invariance), model specifications were modelled identically at all three measurement points to ensure all parameters were freely estimated. In the second stage (metric invariance), the factor loadings were equated over the three measurement points. With scalar invariance at the third step, the intercepts were also equated, as a comparison of means requires that scalar invariance is ensured (Sass, 2011). To test for measurement invariance, any changes in fit indices (CFI and RMSEA) were compared between the nested models. The change in ΔCFI < 0.01 and the change in ΔRMSEA < 0.01–0.015 were set as limits (Chen, 2007). Within this range, it can be assumed that the more restrictive model does not present a significantly poorer fit of the data than the previous model (Little, 2013). The measurement invariance was computed in Mplus 8.0 (Muthén & Muthén, 1998–2018). The results of the measurement invariance analyses suggested scalar invariance for all variables, thus allowing for the comparison of the mean values over the three measurement points (see Table 1).

Table 1

Longitudinal Measurement Invariance

Model	χ^2	df	RMSEA	CFI	ΔRMSEA	ΔCFI
Intrinsic regulation						
1 configural	85.162	72	.023	.994		
2 metric	94.919	80	.023	.993	.000	-.001
3 scalar	111.486	88	.028	.989	.005	-.004
Identified regulation						
1 configural	45.186	39	.021	.995		
2 metric	52.027	45	.021	.994	.000	-.001
3 scalar	70.978	51	.034	.984	.013	-.010
Introjected regulation						
1 configural	80.895	27	.076	.940		
2 metric	82.675	33	.066	.944	-.010	.004
3 scalar	89.072	39	.061	.944	-.005	.000
Extrinsic regulation						
1 configural	26.249	15	.046	.982		
2 metric	28.788	19	.038	.984	-.008	.002
3 scalar	31.438	23	.032	.986	-.006	.002

Latent Profile Analysis and Latent Transition Analysis

For the principal analyses (LPA and latent transition analysis [LTA]), we used Mplus 8.0 (Muthén & Muthén, 1998-2018) with a setting of measurement error-corrected factor scores, according to the method of Little et al. (2006). LTA is a longitudinal extension of LPA, which indicates that an underlying grouping variable is not observed but can be derived from several indicators. In the subsequent LTA, the LPA is used to model longitudinal data by estimating the transitions of latent profile membership over time (Lanza et al., 2010, p. 95). As a person-centered clustering procedure, it allows for a probabilistic assignment of single individuals to a priori unknown subpopulations (with a common latent profile) and enables transitions in latent profile membership to be modelled over time (cf. Collins et al., 2000). Furthermore, grouping

variables (here: intervention groups) can be included in the analyses (KNOWNCLASS function in Mplus).

To compute the LPA, a series of models (starting with a one-profile model and then increasing the number of profiles until the fit indices showed poor fit) were tested for each measurement point to identify the model with the best fit (Nylund, Bellmore, et al., 2007). The number of models was statistically determined based on a combination of fit indices: the Bayesian information criterion (BIC), the sample-size-adjusted Bayesian information criterion (aBIC), the consistent Akaike information criterion (CAIC), and the entropy value. Smaller values in the BIC, aBIC, and CAIC fit indices indicate a better model fit (Nylund, Asparouhov, et al., 2007), while the entropy value summarizes the quality of the classification (precision with which the cases are classified into the profiles), with a measure close to 1 indicating a good fit (Muthén, 2000). Although it is not recommended to use the entropy value as a determinant of the optimal number of profiles (Lubke & Muthén, 2007), it is still informative because it contains a valuable summary of classification accuracy (Morin et al., 2016). Because the class enumeration procedure may be affected by sample size and BIC as well as aBIC and CAIC may continue to decrease without reaching a minimal point, information criteria are added by a graphical illustration. As suggested by Morin et al. (2016, p. 242), BIC and CAIC were illustrated by "elbow plots" that help to demonstrate the gains associated with additional profiles. Furthermore, the content level determines the number of patterns by using the interpretability of the individual patterns and the number of persons per pattern as criteria (Boscardin et al., 2008). Subsequently, the transition probabilities were estimated between the profiles. Finally, the grouping variable (intervention group) was included, and the transition probabilities were approximated.

9.3 Results

Applying the outlier labelling rule of Hoaglin and Iglewicz (1987), no outliers could be identified. Across all measurement points (see Table 2), the complete sample showed the highest mean values in identified regulation, with intermediate values for intrinsic and introjected regulation, and low levels of external regulation. The mean values of intrinsic and identified regulation in the sample showed no significant change over time. However, the t-test for paired samples indicated a significant difference between the first and second measurement points for introjected ($t_{t0/t1} = 5.35$; $p_{t0/t1} \leq .001$) and external regulation ($t_{t0/t1} = 4.86$; $p_{t0/t1} \leq .001$). Introjected and external regulation declined between the first and the second time points and then remained stable. All motivational constructs showed inter-correlation over the three

measurement points (see Table 2). Mathematics performance at the beginning of Grade 7 was positively correlated with intrinsic and identified regulation at all three measurement points and with introjected regulation at the second measurement point.

Table 2

Mean Values, Standard Deviation, and Intercorrelations

		M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	intrinsic regulation t0[a]	3.03	0.91	-	.42**	.46**	.11*	.52**	.26**	.16**	.02	.38**	.20**	.13*	.03	.15**	.21**
2	identified regulation t0[a]	4.04	0.84		-	.35**	.08	.26**	.43**	.15**	.03	.19**	.40**	.07	-.01	.13*	.05
3	introjected regulation t0[a]	2.91	0.83			-	.47**	.23**	.19**	.41**	.21**	.18**	.13*	.31**	.11*	.04	.15**
4	external regulation t0[a]	2.41	0.93				-	-.05	-.02	.15**	.38**	-.02	-.08	.07	.37**	-.05	.18**
5	intrinsic regulation t1[a]	3.00	0.92					-	.43**	.26**	-.06	.54**	.22**	.15**	-.08	.13*	.17**
6	identified regulation t1[a]	4.01	0.82						-	.17**	-.07	.26**	.53**	.02	-.05	.16**	.16**
7	introjected regulation t1[a]	2.64	0.89							-	.43**	.17**	.13*	.49**	.25**	-.11*	.08
8	external regulation t1[a]	2.14	0.96								-	-.01	-.06	.24**	.54**	-.09	.11*
9	intrinsic regulation t2[a]	2.92	0.85									-	.33**	.36**	-.01	.17**	.18**
10	identified regulation t2[a]	4.05	0.76										-	-.11*	-.08	.14**	.12*
11	introjected regulation t2[a]	2.69	0.84											-	.37**	-.03	-.09
12	external regulation t2[a]	2.16	0.92												-	-.10	.12*
13	mathematics performance t0	432	60.47													-	.05
14	gender	1.49	0.50														-

Note: [a]Range 1 to 5. *p <0.05, **p <0.01.

9.3.1 Motivation Profiles

Because previous research has generally yielded three to four motivation profiles, we examined solutions with up to five profiles. Table 3 displays fit information (BIC, aBIC, CAIC, and entropy value) for all models over three measurement points. While BIC, aBIC, and CAIC values continued to decrease with the addition of profiles, the plotted results show a plateau at three profiles and, therefore, suggest a three-profile solution as optimal (cf. Figure 2; Morin et al., 2016). The examination of the three to five profile solutions also revealed that the three-profile solution resulted in well-defined, qualitatively different, and theoretically meaningful profiles, while the addition of a fourth or fifth profile resulted in the arbitrary division of the existing profiles into smaller profiles differing only quantitatively from one another. The three-profile solution also provides a reasonable level of classification accuracy, with an entropy value of 0.864. Based on the plot, the interpretability of classes, the fit information, and entropy value, the three-class solution was selected.

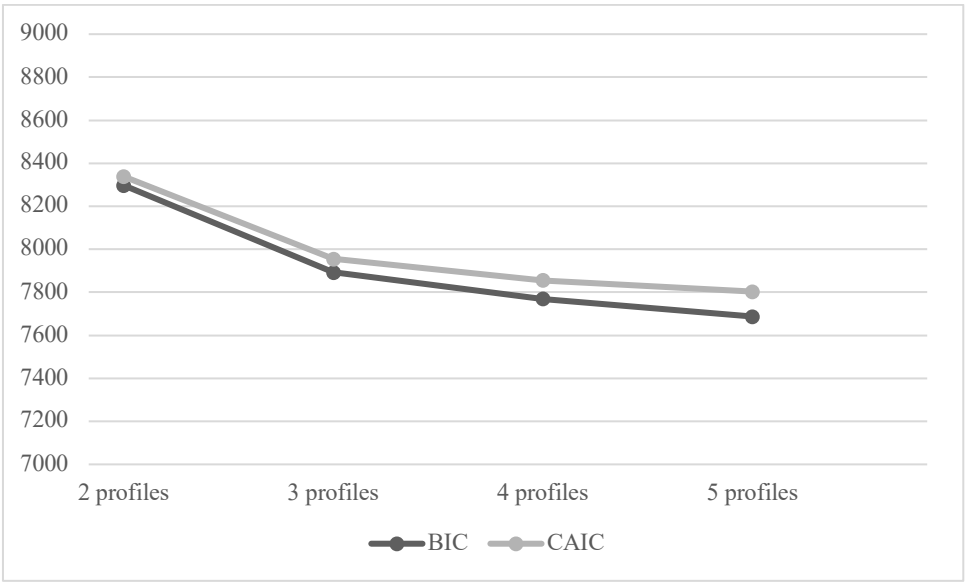
Table 3

Model Fit Criteria of the Two to Five Class Solutions in Latent Profile Analysis Over Three Measurement Points

Number of profiles	Cluster sizes	df	BIC	aBIC	CAIC	Entropy
2	$K1_{t0} = 174$; $K2_{t0} = 174$ $K1_{t1} = 197$; $K2_{t1} = 151$ $K1_{t2} = 202$; $K2_{t2} = 146$	41	8297.34	8167.27	8338.34	0.814
3	$K1_{t0} = 121$; $K2_{t0} = 125$; $K3_{t0} = 102$ $K1_{t1} = 96$; $K2_{t1} = 148$; $K3_{t1} = 104$ $K1_{t2} = 93$; $K2_{t2} = 148$; $K3_{t2} = 107$	62	7892.73	7696.05	7954.73	0.864
4	$K1_{t0} = 86$; $K2_{t0} = 104$; $K3_{t0} = 105$; $K4_{t0} = 53$ $K1_{t1} = 99$; $K2_{t1} = 102$; $K3_{t1} = 68$; $K4_{t1} = 79$ $K1_{t2} = 121$; $K2_{t2} = 101$; $K3_{t2} = 73$; $K4_{t2} = 53$	87	7768.64	7492.65	7855.64	0.858
5	$K1_{t0} = 37$; $K2_{t0} = 89$; $K3_{t0} = 64$; $K4_{t0} = 107$; $K5_{t0} = 51$ $K1_{t1} = 69$; $K2_{t1} = 58$; $K3_{t1} = 48$; $K4_{t1} = 109$; $K5_{t0} = 64$ $K1_{t2} = 18$; $K2_{t2} = 54$; $K3_{t2} = 101$; $K4_{t2} = 118$; $K4_{t0} = 57$	116	7687.38	7319.39	7803.38	0.873

Figure 2

Elbow Plot

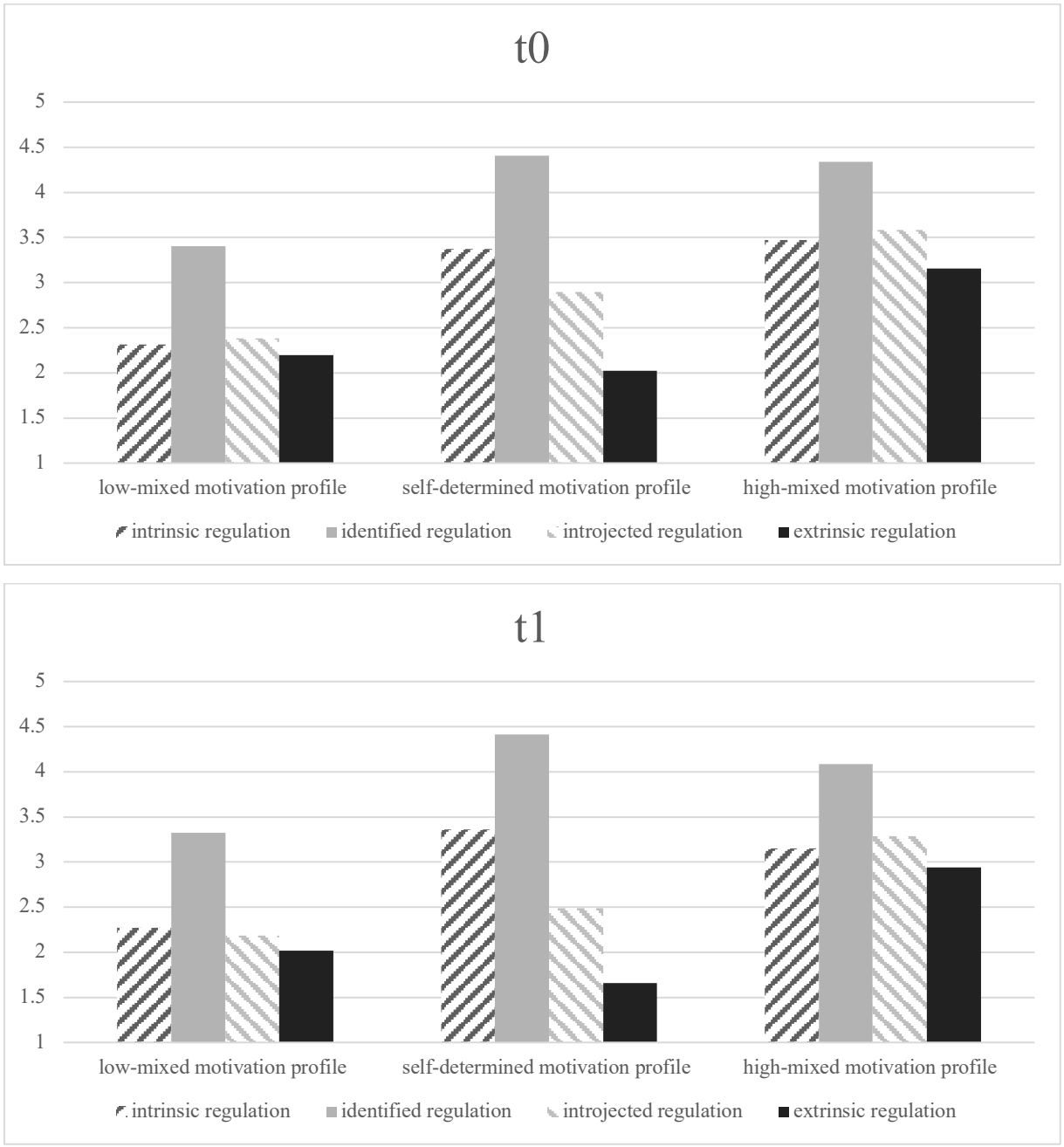


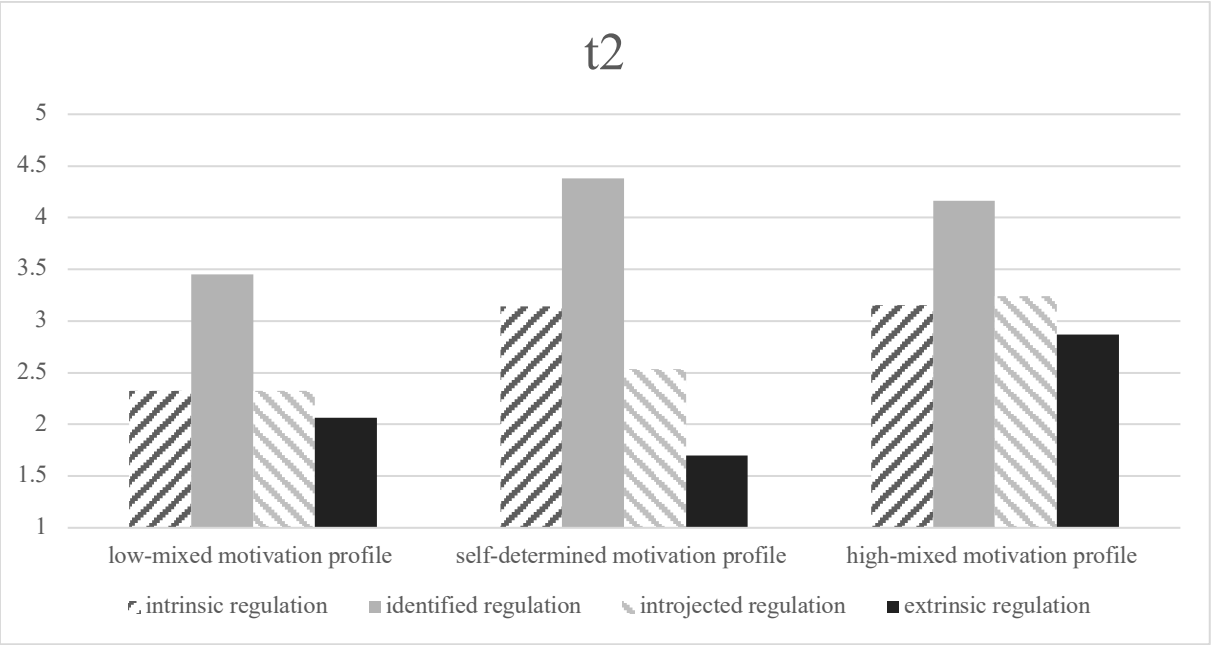
Estimates of the motivation regulation of the three profiles are displayed in Figure 3 and are used to characterize the different profiles. The majority of students ($n_{t0} = 125$; $n_{t1} = 148$; $n_{t2} = 148$) displayed a *self-determined motivation profile* characterized by high levels of intrinsic and identified regulation and low levels of introjected and extrinsic regulation. At the first measurement point, an almost equal number of students ($n_{t0} = 121$) were found in the *low-mixed motivation profile*, which was characterized by low intrinsic, low introjected, and low extrinsic regulation and the lowest level in identified regulation. Over time, however, the number of students within this profile decreased ($n_{t0} = 121$; $n_{t1} = 96$; $n_{t2} = 93$). The third profile, the *high-mixed motivation profile*, was characterized by high values in all four regulation forms ($n_{t0} =$

102; n_{t1} = 104; n_{t2} = 107) with profile plots displaying a similarly high level at all three measurement points (cf. Figure 3).

Figure 3

Motivation Profiles Over Time





9.3.2 Changes in Motivation Profiles

Estimated transition probabilities for the three measurement points are provided in Table 4. Diagonal values in each matrix show the probability of a student remaining in a motivation profile (stability over time), whereas values off the diagonal represent the likelihood of change from one profile to another. The results show several trends: First, the most common outcome was to remain within a profile. Secondly, change from a more favorable profile to a less favorable profile was less likely than a change from a less favorable to a more favorable profile. Thirdly, more changes in profile occurred between the first and second measurement points than between the second and third measurement points. Finally, no student in the self-determined motivation profile changed to the low-mixed motivation profile.

Table 4

Transition Probabilities Between Profiles a) t0 to t1and b) t1 to t2

			t1		
			low-mixed motivation profile	high-mixed motivation profile	self-determined motivation profile
a)	t0	low-mixed motivation profile	.726	.122	.152
		high-mixed motivation profile	.079	.688	.233
		self-determined motivation profile	0	.155	.845
			t2		
			low-mixed motivation profile	high-mixed motivation profile	self-determined motivation profile
b)	t1	low-mixed motivation profile	.917	.083	0
		high-mixed motivation profile	.046	.935	.019
		self-determined motivation profile	0	.015	.985

9.3.3 Differences in Changes in Motivation Profiles Between Groups

Unpaired t-tests at the first measurement point revealed that there were no statistically significant differences between the intervention and control group for any of the motivational variables ($p > .05$).

Therefore, we examined the probability of students' transition between profiles based on their intervention group membership (see Table 5). Again, the diagonal indicates the probability of remaining within a profile, whereas a position adjacent to the diagonal indicates the probability of a specific transition. Similar to the findings reported above, the probability of students remaining within a profile was highest and, across all the groups, changes occurred more often between the first two measurement points than between the second and the third measurement points. However, the probability of a student changing from the low-mixed motivation profile to a more favorable motivation profile (i.e., high-mixed or self-determined) was higher in the intervention group than the control group. This effect was found both between the first and second as well as between the second and third measurement points.

Table 5

Transition Probabilities of Intervention and Control Group a) t0 to t1 and b) t1 to t2

			t1					
			intervention group			control group		
			low-mixed motivation profile	high-mixed motivation profile	self-determined motivation profile	low-mixed motivation profile	high-mixed motivation profile	self-determined motivation profile
a)	t0	low-mixed motivation profile	.713	.113	.174	.887	.113	.000
		high-mixed motivation profile	.097	.784.	.224	.045	.698	.257
		self-determined motivation profile	.000	.216	.784.	.000	.058	.942
			t2					
			intervention group			control group		
			low-mixed motivation profile	high-mixed motivation profile	self-determined motivation profile	low-mixed motivation profile	high-mixed motivation profile	self-determined motivation profile
b)	t1	low-mixed motivation profile	.866	.082	.052	.940	.060	.000
		high-mixed motivation profile	.072	.928	.000	.000	.907	.093
		self-determined motivation profile	.000	.013	.987	.000	.013	.987

9.4 Discussion

The major contribution of this study is the application of a person-centered approach within a longitudinal study that aimed to examine the prevalence of and changes in motivation profiles in mathematics of low-achieving secondary school students. Specifically, our focus was on the effectiveness of the intervention across different subgroups and whether it is better tailored to specific students than others.

9.4.1 Motivation Profiles

In line with our expectations (H1a), we found three motivation profiles, and students were distributed more or less evenly across the three profiles. This number of motivation profiles corresponds to those found in previous research (e.g., Ratelle et al., 2007). Our findings revealed one profile with high levels and one profile with low levels in all four regulation types. The

third profile shows a combination of high levels in intrinsic and identified regulation and low levels in introjected and extrinsic regulation (H1b). Our results differ from other studies that discovered four profiles (e.g., Vansteenkiste et al., 2009), as our analyses did not confirm a profile with both a low level of autonomous motivation and a high level of controlled motivation. Given that our study focuses on students allocated to the lowest achievement group in secondary education, this result is interesting. According to existing research, a combination of low autonomous motivation and high controlled motivation is the most disadvantageous profile, as it is associated with lower achievement and more procrastination and test anxiety (cf. Hayenga & Corpus, 2010; Vansteenkiste et al., 2009). It could have been expected that this profile would be common among low-achieving students. Future research is needed to understand whether our findings point to a more general phenomenon or are based on the selectivity of the sample, the specificity of school culture, or the domain of mathematics. Further, it must be considered that existing research used composite scores of autonomous and controlled motivation (dichotomization) rather than using all four variables of SDT. Although our approach with all variables provides a more refined picture than with the composite score, it limits the comparability with results of other studies. Another advantage and difference to existing research is that we explicitly did not apply z-standardization to let the scores within the profiles represent the actual score on the scale instead of the simpler information of above or below average. Thus, for example, the value of extrinsic regulation of self-determined motivation profile of 2.0 indicates a low value of agreement (Moeller, 2015). In sum, profile mapping without z-standardization leads to less misinterpretation of differences between profiles; therefore, we chose this approach despite the resulting limits in comparability with previous research. In this context, it must be noted that the values of intrinsic regulation range in the middle of the scale (≈ 3.3) for the self-determined and the high-mixed motivation profile (but noticeably higher than in the low-mixed motivation profile [≈ 2.3]). Thus, all three profiles show only small agreement regarding intrinsic regulation. On contrary, identified regulation shows a clearly higher agreement than the other forms of regulation in all three profiles and, thus, at least partial agreement. All low-achieving students seems to be aware of the instrumental purpose of mathematics for their life. This result is also in line with Ratelle et al. (2007) who demonstrated a similar pattern for intrinsic and identified regulation within their general motivation profiles of high school students.

Overall, it must be highlighted that in this potentially at-risk group, the presence of our identified advantageous motivation profiles and the many students in these two profiles at the baseline measurement ($n_{\text{self-determined motivation profile}} = 125$; $n_{\text{high-mixed motivation profile}} = 102$) is an

encouraging finding, as existing research has pointed to the advantages (e.g., academic achievement) of these profiles (Vansteenkiste et al., 2009). However, whether these advantages also hold for low-achieving students for all phases of the learning process and different forms of learning outcomes (e.g., achievement, positive emotions, self-regulated learning) needs to be explored with further research. It might be that, in certain situations, being low-mixed motivated can be positive, as it may help to focus on the particular task instead of getting lost in one's interest or to perform better on different task difficulties (cf. effects of goal orientation on performance; Steele-Johnson et al., 2000).

9.4.2 Stability and Changes in Motivation Profiles

Next, we examined the stability and changes in motivation profiles as well as the quality of changes. In line with our expectations (H2a), the results suggest that the three motivation profiles were highly stable over time and the majority of students remained within the profile they showed at the beginning of lower secondary education. This finding is in line with previous person-centered studies (e.g., Lazarides et al., 2019) that report rare changes in profile. If changes occurred, they were more frequent during Grade 7 (between the first and second measurement points) than Grade 8 (between the second and third measurement points). This result supports the earlier findings of Marcoulides et al. (2008) that motivation profiles become more stable with increased age. It seems to be a general trend that motivation stabilizes during secondary education, as a similar trend was found with interest development (Xu & Tracey, 2016). Our results, however, also reveal new patterns of stability and change (H2b): In contrast to previous studies from Hayenga and Corpus (2010) and Lazarides et al. (2019), which found less favorable profiles (with low scores of intrinsic motivation) to be more stable than those that are more favorable (with high scores of intrinsic motivation), the results of our study show that the most favorable profile from an SDT perspective (the self-determined motivation profile) was the most stable. This result is most likely related to the intervention, which aimed at a positive change in self-determined motivation, indicating the effectiveness of the intervention for the unfavorable motivation profile. Regarding changes in motivation profiles, previous research has documented that changes to less favorable profiles occur more frequently than those in the opposite direction (Bråten & Olaussen, 2005; Hayenga & Corpus, 2010). Our results, however, showed more changes from less favorable to more favorable profiles (12.2%–23.3%) than vice versa (0%–15.5%) between the first and second measurement points (H2b). This result might have been expected given that approximately three quarters of the students had received an intervention aimed at promoting motivation in learning, and it may, therefore, be

argued that the result cannot be directly compared with previous research. Interestingly, a closer examination shows that students in the control group also tended to change to more favorable profiles (0%–25.7%), rather than the reverse (0%–5.8%), between the first and second measurement points. As a possible explanation of this general pattern of more favorable changes in our study, the *big-fish-little-pond* effect (Marsh, 1987) might be a factor, as the sample consisted of secondary students in the lowest achievement level in Grades 7 and 8. Students in Switzerland are allocated at the end of their primary education (Grade 6) to one of three types of school according to teachers' recommendations and student performance in three main subjects (mathematics, school language, and first foreign language). In a mixed-ability primary class, students with poor performance in mathematics usually orient themselves upwards. After the transition to a secondary school, which selects by ability, the frame of reference changes, as students are at approximately the same academic level, reducing upward comparisons (Becker & Neumann, 2018). This new situation may have contributed to an increase in self-concept, which can have a positive effect on motivation (Skaalvik & Skaalvik, 2005). It would be interesting for future research to monitor changes in motivation profile more closely and identify the reasons for change from the students' perspectives using, for example, additional qualitative data, such as interviews.

9.4.3 Effects of the Intervention

As well as the general development of motivation development in mathematics, we investigated whether students with different motivation profiles (aptitude) respond differently to an intervention aimed at fostering self-determined motivation. Based on ATI research, we expected different transition patterns between the profiles within the intervention group (H3). Our results showed that, within the intervention group, most changes occurred for students in the low-mixed motivation profile. During Grade 7 (between the first and second measurement points), 11.3% changed from the low-mixed to the high-mixed motivation profile and an additional 17.4% changed to the self-determined motivation profile. Thus, 28.7% of students in the least desirable motivation profile improved by shifting into a more desirable profile (showing higher motivation or more self-determined motivation) during Grade 7. In contrast, only 11.3% in the control group changed from the low-mixed to the high-mixed motivation profile and no student changed to the self-determined motivation profile. During Grade 8 (between the second and third measurement points), an additional 8.2% of the students in the intervention group changed from the low-mixed to the high-mixed motivation profile and 5.2% changed to the self-determined motivation profile. In comparison, in the control group, only 6% changed to the high-

mixed motivation profile and none of the students changed to the self-determined motivation profile. These results indicate the effectiveness of the applied program for students with a low-mixed motivation profile, as a total of 42% of students in the intervention group who were characterized by a low-mixed motivation profile at the beginning of secondary education (Grade 7) moved to a more desirable motivation profile. The findings also support the notion that changes to a more desirable motivation cluster can be achieved through an intervention program and that a longer intervention can be valuable in giving more students an opportunity to improve their motivation. As Yeager and Walton (2011, p. 274) observed, the effectiveness of an intervention depends on the goal to "change students' mindsets to help them take greater advantage of available learning opportunities." This may need not only specific methods but also sufficient time for individual development.

However, the results also illustrate the possible problematic side-effects of an intervention (cf. Zhao, 2018), as some students in the high-mixed and the self-determined motivation profiles showed negative development. For example, between first and second measurement points, 21.6% of students in the intervention group changed from the self-determined to the high-mixed motivation profile, thus showing an unintended increase in extrinsic forms of motivation regulation. This result may be interpreted as a first indicator that interventions can be counterproductive if they are neither tailored to students' preconditions nor explicitly addressed to target groups. As Yeager and Walton (2011, p. 293) pointed out, social-psychological interventions are not "inputs that go into a black box and automatically yield positive results." Rather, they depend on students' and teachers' capacities, mindsets, meanings, and recursive processes of a specific context so they can also lead to undesirable reactions. Like the publication of positive effects, possible side-effects need to be reported, and we would like to encourage a standard in the educational contexts that possible adverse effects need to be reported in addition to the evidence of the intervention (cf. Zhao, 2018). However, further research is needed to understand this negative development.

In sum, the low-mixed profile was the most likely to benefit from the intervention, as the students in this group had the most potential to increase their intrinsic motivation, while the other two already displayed higher scores. Given the aim of the intervention to promote self-determined motivation (and not to reduce extrinsic motivation), this shows a successful implementation of the intervention for this subgroup.

In terms of theoretical implication, different motivation regulation forms can coexist and motivation patterns can be found in low-achieving students. In this context, low-achieving students show motivation profiles similar to non-low-achieving students (Ratelle et al., 2007).

Thus, students in this at-risk group in terms of achievement may also exhibit favorable motivation profiles that can be leveraged for academic learning (e.g., self-regulated learning). Consequently, the assumption within SDT that low-achieving students are less motivated or more extrinsically motivated due to insufficient fulfilment of the basic psychological needs (needs for autonomy, competence, and relatedness) must be critically scrutinized (Garon-Carrier et al., 2016; Poorthuis et al., 2015; cf. Weidinger et al., 2017).

9.4.4 Limitations

Although our longitudinal study could extend the knowledge of existing research about motivation subgroups, several limitations need to be addressed: First, our profiles are based on variables of the SDT framework and our results are, therefore, only partially comparable with other studies. While an emphasis on SDT might help to better understand the development of forms of motivational regulation, it neglects the fact that student motivation is multifaceted and that other forms of motivation, such as goal orientation, are equally important. Secondly, our sample consisted exclusively of students in the lowest educational tier in Grades 7 and 8 with a focus on motivation in mathematics, and no conclusions can be drawn about other academic ability levels or academic subjects because motivation is domain-specific (Wigfield, 1997). A study with a larger and more diverse sample would be needed to validate the profiles identified in this study for other student groups, subjects, and ability levels. Thirdly, the transition probabilities between intervention and control groups are descriptive, as no inferential statistical procedures could be applied to compare the probabilities of the two groups. Further analysis would be necessary to determine whether the probabilities differ significantly. In addition, it cannot be completely excluded that other factors than the intervention may have impacted the changes in motivation profiles. Fourthly, due to the sample size, two student intervention groups were combined, as they received identical treatment. However, this procedure limits the interpretation of the findings, as it is still possible that the combined teacher–student intervention group may have shown different changes from the student-only intervention group. Fifthly, it must be pointed out that the motivation profiles are based exclusively on students' self-reported motivation and no other external data were included to validate the profiles (Lazarides et al., 2019). Thus, more objective data (e.g., teacher evaluation or classroom reports) could be included in future studies to better back up the profiles. Overall, it must be considered that students have been divided into subgroups based on selected characteristics. Whether this similarity reflects authenticity or whether additional characteristics might influence the effectiveness of the intervention in the subgroups remains unanswered.

9.5 Conclusions

The results of our study contribute to existing research by identifying relatively stable domain-specific motivation profiles. They also extend previous knowledge by showing that low-achieving secondary students can develop desirable motivation patterns and, by illustration, that students with different motivation profiles respond differently to an intervention program. In terms of educational practice, our findings indicate that students in the low-mixed motivation profile are responsive to interventions that promote motivation. This knowledge is useful for the development of future interventions. Future intervention contents could potentially be more specifically designed for different target groups within student populations. Furthermore, the results demonstrate the usefulness of the person-centered approach for intervention research, as it enables the effectiveness of interventions to be tested with regard to specific subgroups. In summary, the person-centered approach complements the variable-centered results and helps provide a greater understanding of the development of motivation at the individual level. Moreover, it demonstrates that not all students may equally benefit from instruction and treatments and that instruction should be adapted to the needs of individual students or specific subgroups. A student needs to be respected with his or her entire personality, experiences, and aptitudes, and we must remember he or she may respond differently to learning opportunities and intervention programs.

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[i] In Switzerland, the main responsibility for education lies with the cantons. As a result, each of the 26 cantons has developed its own curriculum. To harmonize compulsory education nationwide, the HarmoS project was initiated to establish comprehensive competency levels and standards in specific core areas (including math) for compulsory schools. Based on these standards and curricular objectives, a math achievement test was designed for students in Grades 2, 6, and 9. For the present study, the achievement test designed for students at the end of Grade 6 was used to assess the participants at the beginning of Grade 7.

10 Discussion

Motivation is an important factor for successful learning processes and outcomes as well as for lifelong learning and active participation in society (Koenka, 2020; Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016). However, many students experience a decline in motivation and positive emotions as they progress through school, especially in mathematics (Gillet et al., 2012; Gottfried et al., 2001; Scherrer & Preckel, 2019). Therefore, the present dissertation aimed to contribute to the development and promotion of students' motivation and positive emotions and evaluate the effectiveness of an intervention in mathematics in the lowest-ability tier of lower secondary education. Using a quasi-experimental design, a multicomponent intervention that aimed at promoting positive emotions and motivation was implemented in 16 classes. The effectiveness of the intervention was tested in comparison to six classes in the control group. Three empirical studies using data from this intervention project were conducted as part of this dissertation. The findings of these studies will be summarized and discussed in the following section. Next, the strengths and limitations of the dissertation, followed by the implications of the findings for theory development, future research, and educational practice will be discussed.

10.1 Discussion of Findings

The synthesis and discussion of the findings across the three empirical studies is divided into three main themes: a) the interplay between motivational factors and motivation and between emotional factors and different emotions (Research Questions 1 and 2), b) the development of motivation and emotions and related constructs across time (Research Question 3), and c) the effectiveness of a multicomponent intervention during Grades 7 and 8 for students in the lowest-ability tier in mathematics (Research Questions 4 and 5).

10.1.1 Interplay Between Motivational Factors and Motivation and Between Emotional Factors and Different Emotions

SDT assumes that the fulfillment of basic psychological needs leads to internalization of external values and, therefore, to more self-determined forms of motivational regulation (Ryan & Deci, 2019). Similarly, CVT assumes that control and value appraisals are antecedents of emotions and their combination leads to different emotions (Pekrun & Perry, 2014). As suggested by Frenzel and Stephens (2013), it is advisable not only to target students' motivation and emotions directly but also to address its antecedents and related constructs. However, this requires

reliable knowledge regarding the relationships between constructs both cross-sectionally and over time. Thus, in line with previous research (e.g., Chen et al., 2015; Putwain et al., 2021), Studies I and II investigated the relationships between motivational factors and self-determined forms of motivational regulation as well as between emotional factors and emotions to better understand the interplay and identify potential aspects to promote motivation and emotions.

As Wigfield and Koenka (2020) noted, motivation models such as SDT are dynamic and more attention must be devoted to the bidirectional, cumulative, and dynamical nature of constructs in these models. Thus, Study I explored the relationship between basic psychological needs and intrinsic and identified regulation in mathematics across Grades 7 and 8. However, cross-lagged panel models for both forms of self-determined motivational regulation paired with perceived relevance of the learning content (as a proxy of perceived autonomy), perceived competence, and perceived social relatedness with the teacher revealed no reliable longitudinal effects. Nevertheless, the models indicated that the constructs are interrelated. By illustrating that the perceived fulfillment of students' basic psychological needs is correlated with students' self-determined forms of motivational regulation within time points, this study confirmed a relationship between students' perceived fulfillment of basic psychological needs (i.e., the instructional setting in mathematics) and autonomous motivation in mathematics (cf. Chen et al., 2015; Niemiec & Ryan, 2009; Ryan & Deci, 2020; Skinner et al., 2017).

However, the results indicated no effect over time existed and only the timely instructional setting is related to autonomous motivation. In contrast, other studies (Olafsen et al., 2018; Schweder & Raufelder, 2021; Wang et al., 2019) suggested differential effects of perceived fulfillment of basic psychological needs on different forms of motivational regulation. These studies, however, investigated motivation in general and not subject-specific and across different time periods (e.g., half a semester or several weeks). Furthermore, basic psychological needs are often measured as one construct (i.e., with composite scores; Olafsen et al., 2018; Wang et al., 2019), limiting the comparability of results. In addition, Schweder and Raufelder (2021) revealed differences between adolescent girls and boys in the relationship between needs satisfaction and motivation. These diverse results highlight the importance of more differentiated research to understand the relationship between the perceived fulfillment of basic psychological needs and motivation. Thereby, the importance of individual characteristics and social context in the investigation of relationships must be considered (Nolen, 2020; Wigfield & Koenka, 2020). As Ryan (2012, p. 5) described, "motivation is itself a phenomenon that resists simple reductionism, because an inventory of components and their functions does not by itself explain their emergent orchestration and directedness".

Study II adopted CVT (Pekrun, 2006) to examine the relationship between changes in control and value appraisals and changes in different achievement emotions (i.e., enjoyment, anger, anxiety, and boredom) in mathematics. Latent change models confirmed the change-change assumption between appraisals and different emotions. In line with existing research (Buff, 2014; Niculescu et al., 2016), intraindividual changes in achievement emotions are longitudinally predicted by intraindividual changes in control and value appraisals. Therefore, control and value appraisals are potential factors for the promotion of positive emotions and the reduction of negative emotions (cf. Kim & Hodges, 2012; Pekrun, 2006; Raccanello & Hall, 2020). Based on the close relationship between emotions and motivation (cf. Chapter 2), the promotion of control and value appraisals may also have positive effects on the promotion of motivation (Kulakow & Raufelder, 2020; Sutter-Brandenberger et al., 2018).

Overall, based on theoretical assumptions (Pekrun, 2006; Ryan & Deci, 2017), basic psychological needs and control and value appraisals may be empirical constructs for promoting self-determined forms of motivational regulation and positive emotions in school. This leads to the next topic of this dissertation, namely the development of motivation and emotions and related constructs across time.

10.1.2 Development of Motivation, Emotions, and Related Constructs Over 2 School Years

Examining changes over time and which constructs remain stable within and across individuals is particularly important when examining trajectories during or after planned interventions (Ryan, 2012). Therefore, the present dissertation (Studies I, II, and III) contributed to the development of the constructs by examining intraindividual and interindividual trends of motivation and emotions across time.

Study I provided important insights into individuals' standings in self-determined forms of motivational regulation and perceived fulfillment of basic psychological needs across Grades 7 and 8. These constructs demonstrated moderate temporal stability, indicating that changes in the constructs occurred over time (Hamaker et al., 2015). Thus, these findings suggest that students' standing on the constructs changed over 2 years and these constructs can be influenced by an intervention because they are not inherently stable over time. These findings are particularly important for autonomous motivation as target variables of the intervention, as this is a mandatory requirement for effectiveness (Lipsey, 1990).

In terms of perceived fulfillment of basic psychological needs, the results also indicated that changes are present over time and, therefore, perceived fulfillment of basic psychological

needs may change during an intervention period. Among the three basic psychological needs, social relatedness between teachers and students seems to be more stable over time than the perception of competence and relevance of the learning content. This indicates that the relationship with teachers is still important for secondary school students and remains relatively stable (Roorda et al., 2011). In contrast, the perceived relevance of the learning content is less stable. This indicates that changes in students' standing on this construct occurred more frequently over time and thus offers greater potential for intervention. This finding that the relevance of content or tasks is highly modifiable is also supported by existing research (e.g., Alexander, 2018). In sum, these motivational constructs with their moderate stability provide good target variables for an intervention. However, the autoregressive parameter only represents the stability of the rank order of individuals from one occasion to the next and not the amount of within carry-over effect (Hamaker et al., 2015).

By modeling the intraindividual change, Study II sought to gain information on the nature of within and between-person differences in changes in control and value appraisals as well as different emotions in mathematics over time. Results revealed that intraindividual changes in perceived control and value longitudinally predicted intraindividual changes in enjoyment, anger, anxiety, and boredom. Moreover, results revealed that students differed in how they changed their appraisals and emotion: The relatively high negative correlations between enjoyment at the beginning and the latent changes indicated that students with low levels of enjoyment at the first measurement point developed more advantageously (i.e., increase in enjoyment) and vice versa for students with high initial levels (i.e., decrease in enjoyment). The same picture was revealed for negative emotions, but because higher values in negative emotions are less advantageous, students with low initial levels of negative emotions showed a disadvantageous development (i.e., increase in negative emotions) and vice versa for students with high initial levels (i.e., decrease in negative emotions). These between-person patterns of control and value appraisals as well as all emotions are consistent with previous findings (Buff, 2014; Niculescu et al., 2016).

Based on the results of Study II, it must be assumed that between-person differences in change exist over time. This pattern is more pronounced for the different emotions than for the appraisals, suggesting that this between-person difference is less severe in the appraisals. However, this pattern illustrates the homogenous development of emotional and motivational constructs must be critically considered even in, what appears at first glance to be, a homogenous group of low-achieving students in mathematics (Beller & Baier, 2013). Thus, differentiated

analyses of the development across time are needed to explore causes for between- and within-person differences (Ruzek & Schenke, 2019).

Although the importance of a self-determined form of motivational regulation is undeniable (Froiland & Worrell, 2016), controlled forms of motivation may also play a crucial role in students' learning activities (Mouratidis et al., 2021). Moreover, different types of motivation might co-occur, so that any given behavior can be energized by more than one type of motivational regulation (Deci & Ryan, 2012; Reeve, 2018). Therefore, when examining developmental trends and planning intervention studies, it is also important to consider the overall picture of students' motivation and their interplay over time (Bergman & Magnusson, 1997).

Results of Study III revealed a set of three motivation profiles that were fully replicated across three measurement points. Therefore, this study provided information about the within-sample stability by showing the same number of profiles (configural similarity), characterized by the same regulation configuration (structural similarity) across Grades 7 and 8. This finding supports the within-sample stability of the profile structure over 2 school years (Gillet et al., 2017; Lazarides et al., 2019). However, Study III also revealed a substantial level of changes across time at the individual level—especially during Grade 7 (Marcoulides et al., 2008). Between profiles, the self-determined motivation profile showed high stability (84.5% remained in this profile during Grade 7), whereas the low-mixed (72.6%) and high-mixed motivation profiles (68.8%) remained moderately stable. This high stability of the self-determined motivation profile is contrary to previous findings (Hayenga & Corpus, 2010; Lazarides et al., 2019), which found that less favorable profiles with low levels of intrinsic motivation remain more stable. Accordingly, this result might be a sign of the effectiveness of the intervention, which aimed at promoting autonomous motivation.

Overall, these results revealed evidence for substantial changes at the intraindividual level across time. These findings on development thus provided information that the constructs have the potential to be targeted by an intervention (Alexander, 2018). This leads to the next question of the present dissertation; namely, what are the effects of a multicompetent intervention on motivation, emotions, and their related constructs?

10.1.3 Effectiveness of a Multicomponent Intervention on Motivation and Emotions

Previous research demonstrated that motivation intervention can be an effective tool for promoting motivation in different subjects and across different age groups (Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016). Based on these findings, the present dissertation (Studies I, II, and III) contributed in part to examining the effectiveness of a multicomponent

intervention on motivation and emotions of lower secondary school students in the lowest-ability tier in mathematics.

Study I examined the effects of the intervention on students' perceived fulfillment of their basic psychological needs and autonomous motivation, while Study II investigated the effects of the intervention on control and value appraisals and different emotions in mathematics. Neither Study I nor Study II revealed significant effects of the intervention (see also Sutter-Brandenberger et al., 2019). As previously mentioned in Study II, several possible reasons could explain this lack of effect (e.g., program design, sample characteristics, or fatigue effect due to the design).

Based on the considerations of ATI research, Study III investigated the effects of the intervention in different subgroups. Results suggested an ATI between students' motivation and the intervention: Students in the low-mixed motivation profile appear to benefit most from the intervention, whereas some students in the high-mixed and the self-determined motivation profiles revealed a negative development. Therefore, the intervention seemed to be effective for students with low levels of all regulation types, whereas the intervention might be counterproductive for students with already high levels of self-determined forms of motivational regulation. If only average results are considered when examining effectiveness, this could lead to misinterpretations regarding the effectiveness of an intervention program (Cohen et al., 2017; Mittag & Bieg, 2010; Zhao, 2017). Moreover, investigating differential effects based on students' aptitudes is not only important to detect desired effects in various subgroups but also to avoid possible negative effects in other subgroups (Durik et al., 2015). Based on their aptitudes, students differ in their readiness to benefit from an intervention (Nagengast et al., 2018) and, for some, there may also be negative aptitude-treatment interactions that should be avoided. Furthermore, other interventions targeting motivation in mathematics resulted in negative side effects in German (Gaspard et al., 2016). Therefore, future research should investigate possible problematic effects of the intervention on specific subgroups as well as side effects on other subjects or outcome variables (e.g., well-being).

Overall, the present dissertation supports the assumption that different antecedents and various emotional and motivational constructs are suitable for the promotion of motivation (Frenzel & Stephens, 2013). However, based on Study III, it should be noted that when testing for intervention effects on these constructs, aptitude-treatment interactions should be considered to detect a potential difference in program efficacy (Cronbach, 1957; Souvignier, in press) because not all students may equally benefit from an intervention. These findings also highlight

the challenges of "one-size-fits-all" solutions in education and point to the relevance of tailored, individualized interventions in school (Cohen et al., 2017; Zhao, 2017).

10.2 Strengths and Limitations of the Present Dissertation

When interpreting the findings of the studies conducted within the present dissertation, some strengths as well as limitations should be noted. The present dissertation generally benefited from the use of a longitudinal quasi-experimental design including intervention and control groups and three measurement points over 2 school years. The intervention design should be considered a strength, especially in light of the decline in intervention research (Hsieh et al., 2005; Lazowski & Hulleman, 2016; Ryan & Deci, 2019). Furthermore, the present intervention integrated several theories and constructs, supporting a multidimensional perspective on students' motivation instead of relying on a single theoretical framework and seeing the theories and the relevant construct in relative isolation from one another. Although different theoretical approaches can be separated from a theoretical point of view, in practice they are intertwined and enrich one another (Anderman, 2020; Fredricks et al., 2019; Hulleman & Barron, 2015). Furthermore, the data were analyzed using an appropriate state-of-the-art statistical methodology (e.g., person-centered approach; Koenka, 2020).

In addition to the advantages of the intervention design, it also implies some limitations. First, due to the large time investment involved in participating in the present intervention project, it was not possible to randomly assign teachers and their classes to the intervention or control groups. Future research should, therefore, use a cluster-randomized trial or at least control for possible teacher characteristics.

The second challenge was associated with the recruitment of teachers, also due to the longitudinal nature of the intervention project, which resulted in a relatively small sample size. According to a priori power analysis using the power analysis program G*Power (version 3.1; Faul et al., 2007), the sample size to detect small effects was adequate. However, for person-centered analyses (e.g., latent profile and latent transition analyses) the usual a priori power analyses cannot be performed and, so far, no consensus regarding the minimum required sample size exists (Dziak et al., 2014; Park & Yu, 2018). Based on the focus of the project on student workshops, the uniformity of the student workshops, and the relatively small sample size, the two intervention groups (student-only and student/teacher intervention group) were combined within the studies of this dissertation. Hence, identification of the teacher workshop effects was

not possible, which could lead to biased results. Future research with a larger sample size is required to confirm the results.

Third, the study design included a long time span across Grades 7 and 8, which may have been too long to detect intervention effects, as the effects had already faded by the time of the next measurement (Hagenauer, 2010). Moreover, the three studies are based on students' self-reported data. Although self-report methods are of practical value in classrooms and reliable for assessing students' emotional and motivational experiences (Ainley & Ainley, 2019; Wigfield & Cambria, 2010), self-reported data may not be completely valid or fully reflect their internal motives (Ainley & Ainley, 2019; Reeve, 2018). Therefore, future research should include additional measures (e.g., real-time behavioral indicators), other critical players (e.g., teachers and parents) as well as additional methods (e.g., direct observation) to examine students' emotions and motivation in a timely manner as well as across time (Kosovich et al., 2019).

Fourth, although the integration of different theories and constructs can be considered a strength, it is also accompanied by limitations. Because of the theoretical broadness, it remains unclear which aspect contributed to the intervention effects and which did not. Furthermore, no standardized treatment check was conducted to control the implementation of the intervention. This limits the understanding of the effectiveness of specific intervention parts and how well certain intervention components were applied and transferred to the classroom (Hertel, 2010). Therefore, future research should implement standardized treatment checks (e.g., videotaping or observation protocols) to address this limitation.

Fifth, the studies focused on students in the lowest-ability tier in mathematics in lower secondary education in the Swiss canton of Bern (German-speaking part). It must be noted that this might represent a specific target group because all students within this sample are negatively selected into mathematics classes and were sampled from a particular cultural context. Therefore, replication studies involving other cultural, age, and ability groups are required, as no generalization can be made based on the present studies. In addition, the intervention focused on mathematics because of its relevance for future life and the domain-specificity of motivation. However, this domain-specific approach limits the results to mathematics, and future research should evaluate corresponding interventions in other subjects. Despite these limitations, the findings of the present dissertation have implications for theory development, future research, and educational practice.

10.3 Implication for Theory Development

Motivation has received substantial attention during the last decades and has persisted to become an important research area in school and instruction research (Koenka, 2020). Despite the numerous and valuable research studies, several enduring questions remain unanswered. One of the main issues concerns the multitude of theories within motivation research and the question of the legitimacy of several theories when compared (Anderman, 2020; Wigfield & Koenka, 2020). The present dissertation contributes to this question by incorporating different aspects of various motivation theories (e.g., attribution theory, CVT, and SDT) within one intervention. Although targeting students' motivation with a multicomponent intervention does not fulfill the request for a synthesis of the theories (Dweck, 2017), the complexity of motivation is considered by avoiding a reduction to individual aspects (Linnenbrink-Garcia & Wormington, 2019; Ryan, 2012).

In line with the first and second research questions, the present dissertation provided an in-depth analysis of students' motivation and emotion and related constructs. Therefore, Studies I and II supported the underlying theories and provided additional information across time. Both studies support the effort of motivation research to distinguish among determinants, correlates, and outcomes of motivation toward a deeper understanding of motivation and its promoting factors in school and learning processes. Furthermore, the use of longitudinal data that provided information across time is of particular importance because it supports the dynamic and situated view of the theoretical models. The two-dimensional presentation and the frequent use of cross-sectional data to verify the models create a static impression, which is explicitly denied by several authors (Ainley & Ainley, 2019; Eccles & Wigfield, 2020; Graham, 2020). Based on the assumption that "today's choices and performances become tomorrow's past experiences" (Eccles & Wigfield, 2020, p. 3), motivation and emotions must be seen and discussed in a cyclical relation (Reeve, 2018; Wigfield & Koenka, 2020).

Moreover, the present dissertation supports the view of SDT and goal orientation theory that, in any given action, there is more than one way to be motivated at the same time (Reeve, 2018; Ryan & Deci, 2017; Urdan & Kaplan, 2020). The simultaneous influence of different forms of regulation and their concurrent impacts on the quality and consequences of a given behavior highlights the complexity of motivation and its investigation. In this context, also the simple dualism used to distinguish between autonomous and controlled motivation must be scrutinized. Is controlled motivation always detrimental, or are there occasions when controlled motivation, in combination with autonomous motivation, produces positive outcomes? Recent research also suggested that controlled motivation may not fully undermine motivated behavior

when autonomous motivation remains high (Mouratidis et al., 2021; Phillips & Johnson, 2018). Perhaps, the differential effect of controlled motivation—especially introjected motivation (Buzdar et al., 2017; Malmberg & Martin, 2019)—may be explained as a function of the other types of regulation (Gillet et al., 2017). This dualism must also be scrutinized in the context of emotions since a more complex pattern must be assumed and positive emotions can sometimes be detrimental and negative emotions can be beneficial to important outcomes (Pekrun, 2006; Rowe & Fitness, 2018).

Finally, this dissertation considers emotions within motivation research as an important influencing factor. Attribution theory and goal orientation theory include emotions to explain motivated behavior. In contrast, EVT and SDT attribute only an implicit role to emotions. Thus, the role of emotions in EVT and SDT should be clarified and might enrich future theory development (Isen & Reeve, 2005).

10.4 Implication for Future Research

Implications for future research will be discussed referring to the three lines of research within this dissertation. First, the findings highlight the interplay between motivation and emotions and related constructs. As previous research suggested, relevant constructs promote autonomous motivation and positive emotions (e.g., Chen et al., 2015; Putwain et al., 2021). However, based on inconsistent findings of relationships across time, individual characteristics, such as gender (Schweder & Raufelder, 2021), and contextual factors (Hattie et al., 2020) must be considered in the investigation of longitudinal effects (Linnenbrink-Garcia & Wormington, 2019). In light of this, Vu et al. (2021) pointed to the need for further longitudinal research with multiple motivation constructs as associated predictors to the investigation of reciprocal relationships. In addition, due to the complexity of motivation, further research is needed to discover other relevant factors as well as intraindividual hierarchies in motivational components (Wigfield & Koenka, 2020).

Second, the investigation of the development of motivation and emotions points, on the one hand, to the issue of within-person differences and what leads to differences in motivation and emotions within an individual across time. On the other hand, the results also revealed between-person differences in the development. Therefore, advanced statistical methods, such as multilevel or person-centered analyses, are required to address developmental trends in motivation and emotions within and between individuals (Ryan, 2012).

Third, tailoring interventions to specific target groups is a critical issue of future intervention research (Cohen et al., 2017; Walton & Wilson, 2018). Results revealed no effect of the intervention on the motivational and emotional factors for the whole intervention sample. However, Study III suggested differential effects of the intervention between subgroups: The intervention interacted with students' motivational aptitude and revealed differential effects between profiles. Given that the intervention was effective for students of the low-mixed motivation profile, it suggests the intervention meets the requirements for targeted, tailored, and timely intervention only for this student group (Cohen et al., 2017). Future intervention research should be tailored in its conception to a specific target group rather than assuming that students in a particular setting share similar characteristics and patterns (Linnenbrink-Garcia & Wormington, 2019). For example, in the present research, some students participated who did not exhibit a negative motivation tendency regarding motivation (e.g., students in the self-determined motivation profile), whereas other students might have needed an intervention only in terms of utility or their attributions. Thus, different interventions could be implemented depending on the cause of the decline in motivation and positive emotions in future research instead of applying all approaches with a multicomponent intervention for all students. This could also reduce the duration and intensity of the intervention, as there is no linear relationship between duration/intensity and effect[5] (Hascher et al., 2019). Furthermore, this could reduce the required commitment of the participants and the number of possible disruptive factors (Hascher et al., 2019; Hecht, Priniski, et al., 2019). Moreover, in the sense of "if it's not broke, don't fix it" (Scholer & Higgins, 2012, p. 72), delivering a particular intervention only to those who will benefit not only leads to better effect sizes and better time and cost management but also reduces the potential of negative side effects (Garcia & Cohen, 2013).

Fourth, the investigation of intervention effects remains a critical issue for future research. Based on the detected aptitude-treatment interactions, future research should incorporate different aptitudes to investigate the effectiveness of interventions rather than just considering the average effect (Fuchs & Fuchs, 2019; Zhao, 2017). In this regard, the investigation of ATI should be part of the guidelines for testing the effectiveness of interventions—not only to detect desirable effects in subgroups but also possible undesirable side effects.

Fifth, further research is needed to understand the mechanisms of motivation interventions, as most studies focus only on the effectiveness of the intervention and neglect the underlying mechanism (Hascher et al., 2019). Are there recursive processes (feedback loops),

[5]However, the deduction that shorter is always better must also be viewed critically (Yeager et al., 2018). Rather, it is a balance depending on the desired goal and the target group.

nonrecursive chains of effects (domino effects), or latent intrapersonal effects (changed habits) that lead to the results? These are relevant questions for future intervention research, as the precise understanding of the intervention mechanism may enable researchers to design interventions more effectively (Hecht, Priniski et al., 2019). Future research should, therefore, include elements (e.g., qualitative data) that provide additional information on the mechanism to gain deeper insights.

10.5 Implications for Educational Practice

Interventions to promote students' motivation and positive emotions are highly relevant for educational practice, as motivation and positive emotions are important predictors of students' learning, effort, achievement, and choices in and outside school (Koenka, 2020; Reeve, 2018; Schunk et al., 2014). Although future research is needed to extend the findings of this dissertation, several implications for educational policy and practice can be deduced.

In line with previous research (e.g., Chen et al., 2015), Study I has indicated the fulfillment of basic psychological needs plays a crucial role in autonomous motivation. In particular, teachers contribute to the extent to which these basic psychological needs are met by designing their instructions accordingly (Su & Reeve, 2011). Therefore, it should be an ongoing task for teachers to create an environment that allows students to become and/or stay motivated. Research-based approaches to promoting students' motivation through need-supportive and control-/value-supportive instruction should also be implemented in teacher education and training, thus contributing to the professionalization of the teaching profession (Kunina-Habenicht & Terhart, 2020). However, due to the complexity of motivation and the multitude of motivation theories, teachers may be more likely to remember and apply knowledge if theories were presented in a less technical manner. Therefore, it would be beneficial for educational practice if researchers would "translate" their theories and findings so that they are accessible and meet teachers' needs (e.g., Clearing House Unterricht [Technische Universität München, 2021]; Anderman, 2020; Gräsel, 2021).

Further, the present intervention targeted different aspects of students' motivation (e.g., goals, attributions, basic needs, and value) by using standardized materials. Parts of the intervention could also be implemented by teachers as part of their regular mathematics classes. This would also have the advantage that teachers have already established a relationship with the students and know them well. Therefore, they could better align teaching and intervention and subliminally promote the transfer of the intervention into everyday life. However, given

the fact that the intervention contains psychoeducational elements, it must be tested whether the implemented interventions have the same effects when implemented by teachers. To this end, however, motivation training manuals and standardized materials should be created that explicitly address teachers to conduct motivational training without researchers (Hascher et al., 2019; Walton & Wilson, 2018). In addition, teachers would need diagnostic competencies regarding motivational characteristics to adequately promote students' motivation. Further research is needed to prove the empirical relevance and enable appropriate conceptualization and measurement of these diagnostic competencies (Praetorius & Südkamp, 2019).

In terms of educational policy, motivation research questions are highly relevant, although there have been few attempts to conduct motivation research directly related to current policy issues (Anderman, 2020). The results of motivation research often do not coincide with educational practice. For example, SDT research revealed that high-stakes testing and grading practice have a negative effect on students' basic psychological needs and thus students' autonomous motivation and well-being (Klapp, 2015; Ryan & Brown, 2005), and yet it is impossible to imagine today's school system without grades and tests (Ryan & Deci, 2019; Ryan & Deci, 2020). More collaboration is needed between motivation researchers and educational policymakers to discuss how current educational practice affects students' motivation and emotions and how to address and respond to various motivational challenges (Wigfield & Koenka, 2020). Instead of just trying to "fix" students, we should also strive to improve the learning context (Nolen, 2020; Tierney et al., 2020; Wigfield & Koenka, 2020).

In sum, despite its great practical importance, motivation remains a "central scientific mystery" and challenge in everyday school life (Ryan, 2012, p. 10). Since motivation is a complex phenomenon, further theoretical considerations, practical implementations, and research are needed to improve the understanding of relationships, developmental trends, and how motivation can be fostered.

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List of Figures

List of Tables

Appendix A

Overview of the Interventions Presented

Authors	Target group	Target variable(s)	Method			
			Theory	Duration & Intensity	Focus	Technique
Hamm et al. (2020)	STEM students (N = 496)	- Perceived control - Perceived value - Achievement motivation - Graduation status	Attribution theory	One session	Subject-specific	Prompting new meanings: Prompting with information
Canning et al. (2018)	Biology and medical science students (N = 577)	- Biology course grade - Continuation to the second course - STEM major persistence	Expectancy-value theory	15 weeks (three 5-week units)	Subject-specific	Promoting new meanings: Leading questions
Bernacki et al. (2016)	Middle school students in science course (N = 53)	- Achievement goals (2x2 model) - Science interest	Goal orientation theory	One to two sessions a week over a semester	Subject-specific	Active reflection exercise: Writing on open-ended, structured prompts
De Naeghel et al. (2016)	Fifth-grade students in reading (N = 664)	- Reading motivation	Self-determination theory	One session	Subject-specific	*Teachers:* Prompting new meanings: Prompting with information *Students:* Prompting by altering situation
Kim and Hodges (2012)	College students in mathematics (N = 95)	- Academic emotions - Motivation	Control-value theory	One session	Subject-specific	Prompting new meanings: Prompting with information