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Learning Environments in Contrast

—

How Adolescent Students Differ in their Self, Emotions, Motivation, and Learning Behavior in Teacher-Directed Learning and Student-Centered Learning Classes

presented by

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Contents

1 General Introduction

Since the first *Programme for International Student Assessment* (PISA) conducted by the Organisation for Economic Co-operation and Development (OECD), there has been a growing awareness of the individual needs of students and supporting them in the classroom context. This awareness has been propelled mainly by the discussion about dissolving parts of the selective school system in Germany. However, the mind game about how we can actually address students' individuality often finds a rather sudden end, if we consider how teaching, learning, and instruction are implemented in most schools.

Most learning environments are typically characterized by teacher-directed learning (TDL), meaning that the teacher assumes a central position in the classroom and orchestrates learning to a large degree. He or she determines learning goals, selects appropriate learning material, chooses methods to enhance variability in the classroom, and evaluates individual performance. However, this TDL environment has faced major criticism since the results of the first PISA study were published. The PISA study highlighted two major problems of the German educational system: First, German students exhibited relatively weak results in terms of competence development. Second, the German educational system was characterized by high social disparities, meaning that the social background of students determines academic success to a high degree (Artelt et al., 2001).

These results generally questioned the effectivity of the conventional TDL environment and initiated a) reforms with regard to the establishment of competence standards (Klieme et al., 2007) and b) tendencies to dissolve parts of the selective school system in Germany (Dumont, 2018; Maaz, Baumert, & Trautwein, 2009). These changes have led to a situation in which schools and teachers must 1) adapt to changed curricula and 2) adapt their instruction and classroom organization to even more heterogeneous learning groups.

The TDL paradigm, however, originates from the position that depending on their age (e.g., their grade), students should have equal learning goals and comparable prior knowledge—the TDL environment thus requires homogeneous learning groups. This homogeneity assumption basically builds the basis of the German school system (Klemm, 2015). If students fail to meet the educational standards, re-allocation to other educational tracks or repeating the year is a potential consequence to uphold the assumed homogeneity of classes. However, if we consider the variability of achievement within and between educational tracks, then the existence of homogeneous learning groups is questionable (Artelt et al., 2001; Reiss, Weis, Klieme, & Köller, 2019). In fact, the heterogeneity among students has been growing in the last decades (Reiss et al., 2019). Moreover, heterogeneity relates not only to achievement and competence development, but also to various other student dispositions, such as approaches to learning, motivation, emotions, and self-beliefs. Learning environments that address both competence development and heterogeneity are thus needed (Dumont, 2018).

Accordingly, some schools have transformed their learning and teaching processes by establishing student-centered learning (SCL) environments, which aim to address competence development and students' heterogeneity. These SCL environments have been present for decades and have been particularly promoted by progressive education (see Barz, 2018). Particularly in Germany, concepts such as Montessori education, Jenaplan schools, and Waldorf education are prominent examples of the progressive education movement throughout the country. However, in recent years, another SCL environment has gained popularity among German schools; it uses competency matrices as the main method of instruction and aims to meet the demands of competence development and students' heterogeneity. These competency matrices enable a consequent means of individualizing learning and enabling competence development across various domains (e.g., subjects) and

age groups. The basis of the matrices builds competence standards that have been developed in response to the first PISA study (Klieme et al., 2007).

This increased demand for finding alternative approaches to deal with heterogeneity has also manifested itself in increased research interest. In recent years, idiographic studies that highlight the individuality of students and seek to understand how students differ have gained resonance. For example, students have been shown to exhibit considerable differences regarding who motivates them (Raufelder, Jagenow, Drury, & Hoferichter, 2013) and how they differ in terms of their motivation and self-conceptions (Lazarides, Dicke, Rubach, & Eccles, 2019). Although large-scale assessments such as PISA mostly refer to heterogeneity in terms of achievement, these idiographic studies indicate that noncognitive learner characteristics may be of similar importance, as they are often considered antecedents and/or consequences of achievement. In particular, the repeatedly exhibited decreases in motivation and self-beliefs after school transitions and throughout adolescence make research in learning environments rather indispensable (Eccles & Midgley, 1989; Gillet, Vallerand, & Lafrenière, 2011; Gnambs & Hanfstingl, 2015; Watt, 2004; Zusho & Pintrich, 2001).

The question arises as to whether adolescent students in these SCL environments are better supported in their individual education and development—particularly in their self-beliefs, motivation, learning strategies, and emotions in class—compared to students in a conventional TDL environment. This study is designed to respond to this question by examining questionnaire data from adolescent German students from TDL and SCL environments. In doing so, the results not only offer insights into how students from different learning environments differ in their educational development, but also allow one to draw conclusions about the learning environments themselves. This study thus contributes to basic research in the field of education because the transformation process of schools from TDL to SCL has hardly been accompanied by empirical research.

2 Different Learning Environments in German Secondary Schools

2.1 From TDL to SCL

For decades, the German educational system has been centered around homogeneous learning groups (also called ability grouping) because such groups have been considered a favorable premise for individual development (Klemm, 2015). The consequence has been that, particularly with regard to secondary schooling, the educational system used to consist of different educational tracks: two low-track (e.g., Hauptschule, Realschule) and one high-track school form (e.g., Gymnasium).[1] Apart from these tracks, various other mixed-track school forms have existed and, in part, still exist. Interestingly, this allocation of students to different educational tracks has only been present in secondary education and not in primary education, although differences in certain areas of education account for up to three years when children enter primary school (Brügelmann, 1984).

Although the positive effects of homogeneous learning groups and ability grouping on achievement are low (Hattie, 2009), the selective structure of the educational system has widely endured, supposedly also because teachers often argue that the presence of homogenous learning groups helps them to address their students' needs more adequately (Chorzempa & Graham, 2006). The latter mainly results from the organization of the learning environment in most schools. Furthermore, while the quality of teaching and learning depends on numerous factors and varies considerably, TDL environments can typically be characterized by the presence of one or at least a limited range of goals for students that should capture the range of already existing prerequisites of the students. Based on these

[1] The low-track school forms correspond with ISCED level 2 *Lower Secondary Education,* whereas the high-track school form corresponds with level 2 up to grade 10, and with level 3 *Upper Secondary Education* in grade 11–12/13 (United Nations Educational Scientific and Cultural Organization, 2012)

goals, teachers orchestrate different phases, initiate learning activities, and evaluate student performance.

The results of the first PISA study (OECD, 2001) led to a myriad of criticisms of the German educational system and hence the TDL environment (Liebenwein, 2018). As mentioned above, the criticisms related to two major problems. First, German students scored relatively low in comparison to other countries and generally lacked the skills to apply their knowledge (OECD, 2001). Educational processes were consequently considered to be too focused on knowledge and surface approaches to learning instead of competence development and deep approaches to learning. To address this problem, educational standards for various grades and subjects were established, which should henceforth be the central measure to evaluate and regulate the educational system in Germany (Klieme et al., 2007). Current research in competence measurement and competence conceptualizations (Leutner, Fleischer, Grünkorn, & Klieme, 2017; Leutner, Klieme, Fleischer, & Kuper, 2013; Zlatkin-Troitschanskaia et al., 2017; Zlatkin-Troitschanskaia, Shavelson, & Kuhn, 2015) continues to demonstrate how difficult it is to identify specific levels of competences and that they are almost never transferable to different topics and domains. This problem intensifies in the context of schools, which nonetheless aim to develop competences.

The second major problem that PISA highlighted was and still is that the educational system is characterized by high social disparities (OECD, 2001; Reiss et al., 2019), meaning that students' social-economic and migrant backgrounds determine their academic success to a high degree. This problem in turn has initiated tendencies to dissolve parts of the selective school system in Germany because they have been considered a major source of social inequalities (Maaz et al., 2009). As a result, classes and learning groups have become even more heterogeneous—a development that was further amplified by the ratification of the United Nation's *Convention on the Rights of Persons with Disabilities* (United Nations,

2006), which compelled the member states to establish inclusive school systems. Heterogeneity has thus grown further because children with special educational needs (e.g., learning difficulties, physical disabilities, and behavioral problems) are decreasingly schooled in special schools.

Lastly, empirical research in education and educational psychology repeatedly substantiates two major prerequisites that affect the quality of learning to a high degree and that are relevant in this context: The importance of noncognitive learner characteristics (e.g., motivation, emotions, self-beliefs, and approaches to learning) and the acknowledgement of inter- and intraindividual differences in terms of both achievement (e.g., competence development) and those noncognitive learner characteristics. These inter- and intraindividual differences, however, stand in contrast to the homogeneity assumption on which the educational systems in Germany and many other countries are built.

Schools and teachers face the daily challenge of finding ways to adapt their learning environments to 1) competence development and 2) students' heterogeneity. To approach this challenge, learning environments need to provide differential and individual goals for each student, as one collective goal cannot address the heterogeneity of students—neither in terms of achievement nor in terms of noncognitive learner characteristics.

In recent years, an increasing number of schools in Germany have adopted an SCL environment that supposedly tackles this challenge more adequately than the conventional TDL. This SCL environment bases its learning processes on competency matrices that are built on the established competence standards. The matrices divide a subject's educational domains on a vertical axis and the levels of a certain domain on a horizontal axis (Krille, 2016). The resulting matrix is thus a complex system of elements, each of which comprises an educational goal (Fig. 1).

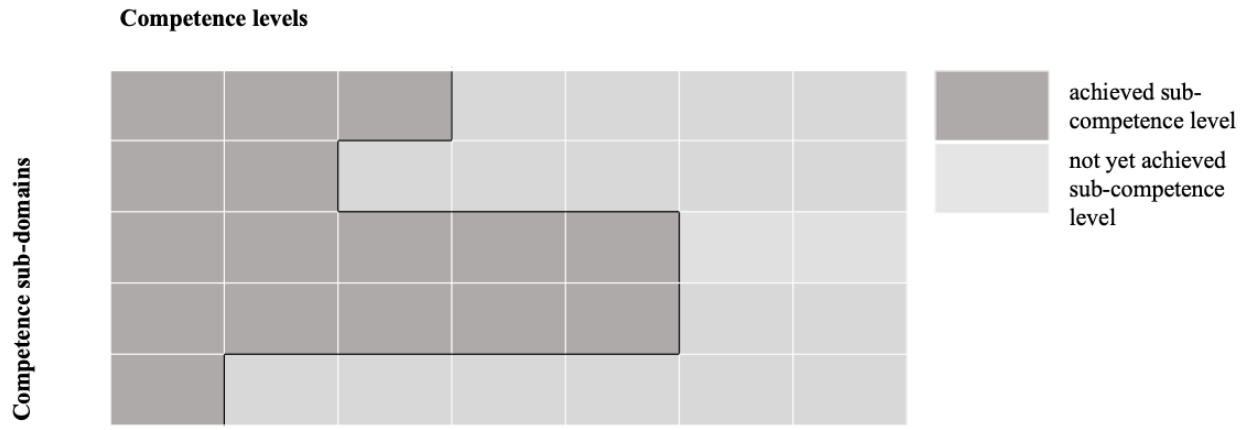

Figure 1. Visualization of a competency matrix.

2.2 Learning and Instruction with Competency Matrices

Competency matrices have long been present in educational processes (Lesmond, McCahan, & Beach, 2017; Stevens, Levi, & Walvoord, 2013). However, their use has been mainly limited to an instrument for evaluation—to assess individual competence levels (Panadero, Alonso-Tapia, & Reche, 2013; Panadero & Jonsson, 2013). For the past decade, however, an increasing number of schools have been using competency matrices as an instrument to coordinate instruction and initiate learning processes in schools. This tendency has led to the federal state of Baden-Württemberg publishing its statewide curricula in the form of competency matrices (Landesinstitut für Schulentwicklung, 2016).

As an instructional instrument, the competency matrices have been supplemented with learning paths, which operationalize tasks that are required to meet the demands of the educational goals in question (Schweder, Raufelder, Kulakow, & Wulff, 2019). Teachers are then required to create or examine learning material that warrants that students have the necessary ability to progress through the learning paths and competence levels without the teachers' instruction.

Before learning processes are initiated, a determination of the students' individual position on the competence matrices is necessary. Schools handle this process differently—

some base this evaluation on summative assessments (e.g., tests), while others allow students to determine their initial position by means of self-evaluation. Summative assessment might be a more reliable and precise determination of prior knowledge and skills, while the self-evaluative determination of the initial competence levels might be beneficial in terms of fostering reflective and metacognitive skills in students. From this point onwards, students are enabled to individually and independently progress through the matrices to the attainment of educational goals as they can work in different subject-domains as well as on different levels in terms of task difficulty.

The learning process can thus be reflected by Zimmerman's model of self-regulated learning (Zimmerman, 2000). Self-regulated learning is typically defined as a process in which students "personally activate and sustain cognitions, affects, and behaviors that are systematically oriented toward the attainment of learning goals" (Schunk & Zimmerman, 2009, p. vii). In Zimmerman's (2000) model, learning processes are conceptualized as three distinct and cyclical phases. A self-regulated learner typically starts off in the forethought phase in which a task analysis is performed with subsequent goal setting and strategic planning of the learning process. Furthermore, this phase is characterized by motivational beliefs that affect students' willingness to perform. The second phase—the performance phase—requires students to maintain self-control and self-observation in the learning process. They may thus have to apply task strategies, perform self-instruction, conduct time management, and seek help if necessary. The third phase—the self-reflection phase—encompasses self-judgments and self-reactions to the learning processes (Zimmerman, Schunk, & DiBenedetto, 2017). In this phase, new adjustments to the learning process are necessary to determine whether to either initiate a loop to repeat or continue towards more demanding or simply different subject matters.

With regard to the SCL environment based on competency matrices, the learning process is structured similarly (see Fig. 2). Students and/or teachers must first determine an initial position on the competency matrix and decide which competence domain to follow. Thereafter, independently or with the help of their teachers, students must select the goals that are attainable and gather respective material that enables them to approach a new competence level. In the performance phase, students must individually maintain focus and try to master the tasks incorporated into the learning material. Afterwards, they compare their results with prepared solutions, peer feedback, or teacher feedback. Depending on these results and their individual evaluation, students may proceed to new competence levels or domains, or they spend more time practicing.

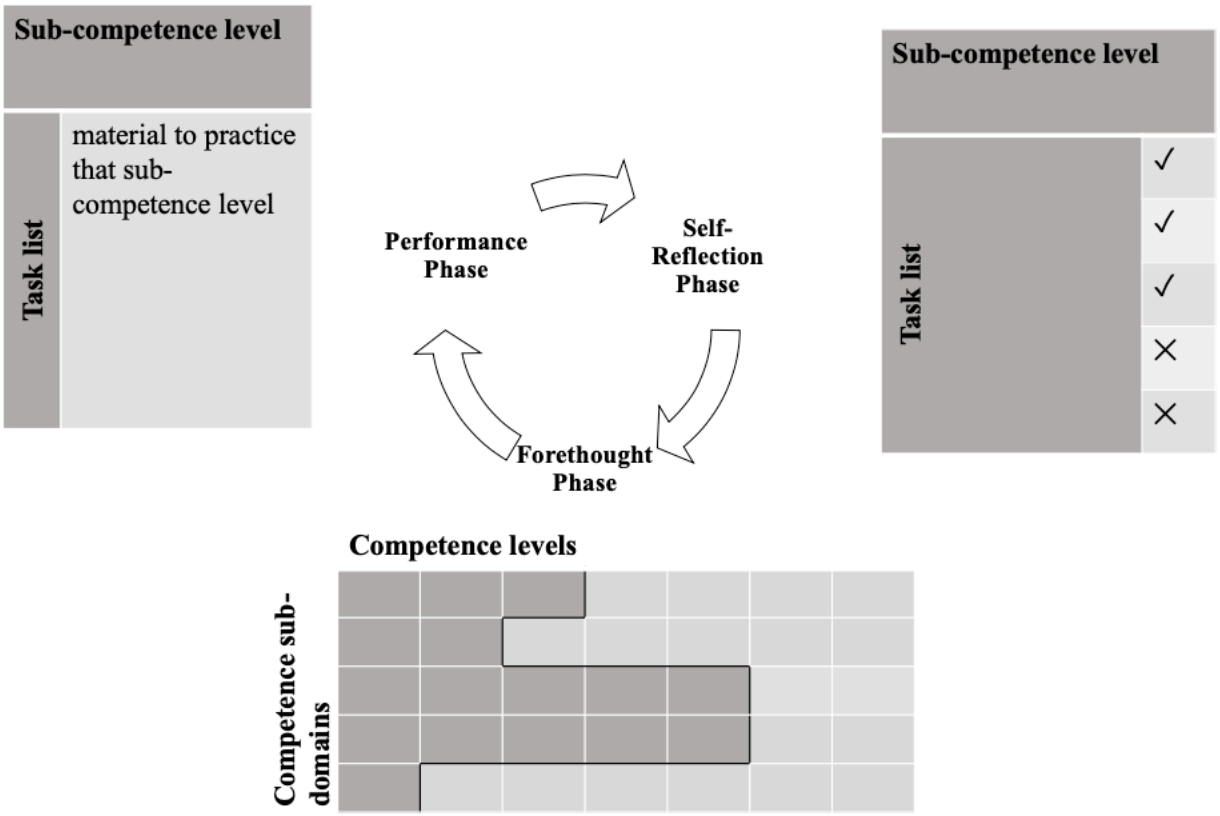

Figure 2. Structure of the learning process in SCL as conceptualized in Zimmerman's (2000) model of self-regulated learning.

In an ideal imaginative situation, students may progress towards the educational standards in various domains and subjects without any help. However, considering that self-regulative learning is not immanent in students and has to be practiced, teachers assume a central role in this educational setting. Their central task is to help individual students during these phases, if they face difficulties. As diverse as persons are, these difficulties may lie in different areas: Students may, for example, need support in determining their individual initial position on the competency matrix, support in maintaining focus, or additional explanation or assistance regarding the tasks they are working on. This list may be continued indefinitely.

The major advantage of this SCL environment is that for each student, individual learning goals can be set—goals that are consistently fitted not only to the student's prior knowledge and skills (e.g., achievement), but also to noncognitive characteristics (e.g., motivation, self-beliefs, emotions, and approaches to learning), because the student does not have to rely on his or her teachers to provide verbal input and orchestrate activities. Teachers hence gain resources that they do not have in traditional settings. On the one hand, in conventional TDL environments, teachers are responsible for the majority of factors mentioned in Zimmerman's model. In such settings, the way in which students' heterogeneity can be adequately addressed is questionable. In the SCL environment on the other hand, teachers can focus on the individual needs of students (e.g., additional explanation, feedback, and motivation), whereas other students may continue without the teachers' assistance. This is also why schools have usually discarded the conventional division of subjects in favor of an overarching timeframe in which students decide for themselves (or with the help or intervention of their teachers) which subjects or subject-specific domains to follow.

However, research on various learning environments is scant. This lack relates to both whether SCL environments actually address heterogeneity better than TDL environment and whether this subsequently affects motivation, self-beliefs, and learning behavior.

3 Theoretical Background

This chapter provides an overview of the psychological constructs on which the studies in this dissertation are based, namely motivation, the self, achievement emotions, and learning behavior. For each construct, the theoretical background is outlined in its relevance for the present study. A major objective of this study is to examine how these constructs and their direct and indirect relationships vary across different learning environments. Therefore, the focus is placed on their definition and the importance of the learning environment.

3.1 Motivation

Motivation is a central component of students' participation in school. Broadly speaking, motivation refers to "a set of interrelated desires, goals, needs, values, and emotions that explain the initiation, intensity, persistence, and quality of behavior" (Wentzel & Miele, 2016, p. 1). The internal and external drives that accompany the process of students' behavior therefore becomes central for educators and researchers alike. Foremost in scholastic education, motivation has repeatedly been shown to decrease constantly throughout adolescence; this often has repercussions on students' behavior in class (Gillet et al., 2011; Gnambs & Hanfstingl, 2015; Watt, 2004; Zusho & Pintrich, 2001). With the nadir of these declines occurring around grade 9, adolescence becomes the prime focus of intervention and research, although particularly the transition from primary school to secondary schooling has likewise been shown to significantly contribute to this motivational decline (Eccles & Midgley, 1989).

3.1.1 Self-determination theory

Self-determination theory (SDT) is one of the most influential theories in motivational research (Deci & Ryan, 1985; Ryan & Deci, 2017). It is described as a macro theory that assumes individuals' inherent growth tendencies. Following Deci and Ryan (Deci & Ryan, 1985), personal growth, behavioral quality, and general well-being are the outcomes determined by the question of whether the decisions and processes leading to them are self-determined. Those outcomes are in turn dependent on the presence of the following three basic psychological needs, which can be considered as environmental preconditions that facilitate intrinsic motivation: 1) competence, 2) autonomy, and 3) social relatedness (Deci & Ryan, 1985). The need for competence refers to the satisfaction of feeling effective in one's interaction with the environment (Deci & Ryan, 1980; Ryan & Moller, 2017). Autonomy refers to willingness and volition in one's own action and behaviors (DeCharms, 1968; Deci & Ryan, 1985; Ryan & Connell, 1989). The need for autonomy thus requires the self-endorsement and ownership of one's action (Ryan & Deci, 2017). The need for social relatedness refers to connection and involvement with other people, as well as a sense of belonging (Ryan & Deci, 2000).

The needs for autonomy and competence in particular have been shown as central antecedents for intrinsic motivation. A subtheory of SDT, namely cognitive evaluation theory (CET), aimed to identify factors that facilitate or undermine intrinsic motivation, thereby explaining variability in the construct. Supporting the need for competence depends on certain contextual characteristics (Ryan & Moller, 2017). First, this need requires adequate situations to perform, for example, optimal challenges in relation to the individual prerequisites. Second, proper performance feedback is required that focuses on effectance promotion and on the process rather than the outcome. However, a distinctive feature of CET

has been that the need for competence has a stagnating effect on intrinsic motivation, unless accompanied by increasingly present support for autonomy (Fisher, 1978; Ryan, 1982).

Within another sub-theory of SDT, namely organismic integration theory (OIT), Ryan and Deci (2000) distinguish intrinsic motivation from extrinsic motivation and amotivation, although the latter represents the state of lacking the intention to act. Following OIT, extrinsic motivation can be further differentiated as different behaviors (e.g., active commitment vs. passive compliance) vary in their degrees of valuing and regulating expected behavior (Ryan & Deci, 2000). In contrast to popular belief and other theoretical frameworks that consider extrinsic motivation as inherently unautonomous, OIT proposes that extrinsic motivation can be differentiated by a continuum between amotivation and intrinsic motivation determined by the relative autonomy or by the degree of external regulation (Ryan & Connell, 1989; Vallerand, 1997). External regulation, which is the least autonomous and least self-determined form of extrinsic motivation, is characterized by a dependency on external demands or rewards, with links to concepts such as operant conditioning. The subsequent, more autonomous form of extrinsic motivation is introjected regulation. In this type of extrinsic motivation, regulation is accepted but valued as one's own. Resulting behaviors are thus largely performed to avoid guilt or shame or to attain ego enhancement (Ryan & Deci, 2000). Identified regulation further continues along the autonomy continuum; this type of self-regulation is characterized by weak external regulations. While the regulations are considered external rather than internal, they are valued as personally important. Lastly, the least externally regulated type of extrinsic motivation is labeled integrated regulation, which encompasses the total identification of external regulations with one's own values and beliefs.

These theoretical considerations become more prominent in light of research about learning environments. Empirical studies have widely validated the importance of the basic needs for intrinsic motivation and for intrinsic motivation as a desirable educational outcome

itself for its relations with interest, enjoyment, well-being, and performance (Deci & Ryan, 1985). These results, however, promote the call for educational institutions to incorporate the demands made by SDT. However, the application of SDT's demands poses a great challenge for schools as their learning environments are not tailored for self-determination, but rather societally prescribed expectancies (Ryan & Deci, 2017). Nevertheless, an abundance of research has provided evidence of the way in which teachers can adapt to an autonomy-supportive teaching style (Guay, Ratelle, & Chanal, 2008; Reeve, 2009; Reeve & Halusic, 2009; Reeve & Jang, 2006), the importance of social relations within the classroom context (Raufelder et al., 2013), and the role of formative assessment strategies (Ryan & Moller, 2017).

However, while SDT emphasizes the importance of the learning environment (Ryan & Deci, 2017), there are hardly comparative studies, apart from intervention studies, that evaluate potential differences (Early et al., 2016; Edmunds, Ntoumanis, & Duda, 2008). One of the few studies—by Wijnia, Loyens, and Derous (2011)—that explicitly conducted that evaluation found ambiguous results between a conventional and a problem-based learning environment. However, meta-analytic approaches usually treat differences in associations between the basic needs, intrinsic motivation, and other favorable educational outcomes as statistical noise (Deci, Koestner, & Ryan, 1999; Patall, Cooper, & Robinson, 2008) and do not control for potential differences in learning environments. A significant research gap consequently needs to be addressed.

3.1.2 Achievement motivation

While SDT is often regarded as a theory about the quality of motivation, achievement motivation can be considered as a quantitative approach to motivation. In terms of a definition, achievement motivation can be seen as a driving force for initiating, energizing, or

sustaining an action that subsequently determines cognitive, emotional, and behavioral involvement in educational processes (Wigfield & Eccles, 2002b). From that point of view, achievement motivation can be seen as an externalization of motivation that can itself encompass various facets and vary in the extent of externalization.

Following Wigfield et al. (2015), children's scholastic achievement motivation relates to the choices regarding the tasks and activities the children perform, the persistence in those activities as well as the intensity of their engagement, and their performance in these activities. Achievement motivation has consequently become a multi-dimensional construct that reflects various domains: First, it relates to a cognitive dimension that encompasses students' goals and goal orientations (Eccles & Wigfield, 2002). These goal orientations refer to the purpose for engaging or refusing to engage in achievement behavior (Elliot, Murayama, & Pekrun, 2011). For example, mastery goals are goals whose purpose is to develop competence and mastery, whereas performance goals encompass the demonstration of personal competence. Second, achievement motivation relates to an affective dimension that involves, for instance, the enjoyment of tasks (Eccles & Wigfield, 2002). Third, it relates to a behavioral dimension that encompasses students' willingness to persist in the face of task-related difficulties (Eccles & Wigfield, 2002; Wentzel & Wigfield, 2009)

These theoretical considerations on achievement motivation have also led to a vast body of empirical research. Concerning the cognitive dimension, mastery goal orientation in particular is of utmost importance for students' motivation (Chouinard, Karsenti, & Roy, 2007; Lüftenegger et al., 2016) and their achievement (Castejon, Gilar, Veas, & Minano, 2016; Valle et al., 2016). The affective motivational dimension with, for instance, enjoyment has also exhibited at least moderate correlations with students' academic performance (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Pekrun, Goetz, Titz, & Perry, 2002). Finally, the behavioral dimension, with effort and persistence as a key construct, has been

demonstrated to be directly related to students' performance in scholastic education (Hughes, Luo, Kwok, & Loyd, 2008; Trautwein, 2007).

While achievement motivation assumes a central role in many educational theories (e.g., expectancy-value theory and stage-environment fit theory), hardly any studies examine differential associations between achievement motivation and other educational constructs. Although studies exist that contrast different cultural contexts (Bakadorova, Hoferichter, & Raufelder, 2019) and highlight compositional differences in learning environments (e.g., socioeconomic status and ethnic composition; Wang & Eccles, 2012), most studies focus on identifying the favorable preconditions of learning environments rather than favorable learning environments themselves.

3.1.3 Stage-environment fit theory

A possible explanation for the decreases in motivation and capability beliefs can be found in stage-environment fit theory (Eccles & Midgley, 1989; Eccles & Roeser, 2011). As indicated earlier, particularly the transition from primary to secondary school and the onset of adolescence pose a major threat for motivational trajectories. Following Eccles and Midgley (1989), the majority of maladaptive motivational development can be attributed to ability grouping or tracking, summative assessment, lack of autonomy in one's learning process, and generally whole-class instruction. They consequently assume that the contextual prerequisites are not flexible enough to allow for varying individual development.

Studies conducted under the lens of stage-environment fit theory have largely provided evidence of decreases in various motivational outcomes, such as school participation, school belonging, self-regulated learning, and self-efficacy (Booth & Gerard, 2014; Wang & Eccles, 2012). Similar to general classroom research, evidence suggests that factors such as mastery goal structure, promotion of autonomy, and general teacher support

tend to have significant importance for students' adaptive behavior in their educational development from primary schools to secondary schools with the accompanying changes due to adolescence (Symonds, 2009; Wang, 2009; Zimmer-Gembeck, Chipuer, Hanisch, Creed, & McGregor, 2006). However, the theoretical framework of stage-environment fit has only been used to identify variables rather than environments that seem to foster a better fit of students' stage and the environment in which they are learning.

3.2 The Self

A closely related set of constructs of noncognitive learner characteristics is part of self-worth theory (Covington, 1992, 1998, 2000). Although those constructs are quite distinct from the motivational constructs discussed before, they are essential in linking motivation to learning behavior (Wigfield & Eccles, 2002a). According to self-worth theory, all achievement-related behavior is preceded by an ongoing developmental need that involves establishing and maintaining a sense of personal worth (Eccles & Wigfield, 2002, p. 122). Particularly in the context of schools, this sense of worth often relates to the ability to be successful in terms of grades. Psychological constructs that relate to self-worth theory, however, vary considerably. One major construct that is a key determinant of self-worth is the self-concept (McGrew, 2008), which should be carefully distinguished from self-efficacy. Both constructs have been demonstrated to be important for students' motivation, emotion, and performance, and while they share many similarities—above all that they relate to perceived competence—they are not as analogous as often described (Bong & Skaalvik, 2003).

3.2.1 Academic self-concept

Self-concept generally relates to the sum of a person's evaluations about him- or herself (Epstein, 1983; Shavelson, Hubner, & Stanton, 1976). This view encompasses both self-esteem as an affective dimension of a more global self and self-concept as a cognitive dimension (Meyer, 1984). However, past research has begun to differentiate between the constructs with the aim of enabling the development of prevention and intervention strategies (Bong & Clark, 1999). From another angle, these distinctions have also focused on the varying domains and hierarchies of self-concepts (Shavelson et al., 1976; Shavelson & Marsh, 1986; Song & Hattie, 1984). Especially in the distinction from other self-beliefs, self-concept is characterized by 1) frames of reference, 2) causal attributions, 3) reflected appraisals from significant others, 4) mastery experiences, and 5) psychological centrality (Bong & Skaalvik, 2003).

In the context of scholastic education, the academic self-concept—which is synonymously used as school self-concept—is of particular interest. This self-concept facet relates to individual evaluations of cognitive abilities (Schöne, Dickhäuser, Spinath, & Stiensmeier-Pelster, 2012). While the various facets of the self-concept do not all necessarily relate to academic achievement, the academic self-concept has been demonstrated to be an important predictor for educational outcomes, such as persistence and effort, academic achievement, and career aspirations (Denissen, Zarrett, & Eccles, 2007; Marsh, Hau, Artelt, Baumert, & Peschar, 2006; Simpkins, Davis-Kean, & Eccles, 2006; Valentine, DuBois, & Cooper, 2004). In particular, because of these empirical results, the examination of educational trajectories and the resulting implications for scholastic education becomes important. Studies have shown that at a pre-adolescent age, academic self-concept and achievement-related outcomes display only weak correlations, while they become stronger and more stable during adolescence (Marsh, 1989; Marsh & Hocevar, 1985). This growth in

association is thought to be linked with students' maturation. As they mature, they learn to evaluate their capabilities more properly. This period in which the stability of the self-concepts develops is characterized by two major events: 1) the transition from elementary to secondary schools and 2) the accompanied onset of adolescence.

Self-concept theorizing emphasizes the role of the social context in students' development (Marsh, Xu, & Martin, 2012). More recent empirical research has adopted this influence with special regard to the big-fish-little-pond effect (BFLP; Marsh & Craven, 2002; Marsh & Parker, 1984; Marsh et al., 2008). Following the BFLP, the individual academic self-concept is vulnerable to social comparisons. In a scholastic context, this effect translates to the comparison of two students with comparable academic success (e.g., grades), one being in a high-achieving class and the other being in a low-achieving class. Research could show that the high-achieving class has detrimental effects on the individual self-concept (Dumont, Protsch, Jansen, & Becker, 2017; Hoferichter, Lätsch, Lazarides, & Raufelder, 2018; Marsh, Trautwein, Lüdtke, Baumert, & Köller, 2016; Stäbler, Dumont, Becker, & Baumert, 2017). In particular, in light of a) the importance of the academic self-concept and b) the transition from elementary school to secondary schools with a high influx of summative assessment, both of which make social comparisons more salient, adolescence becomes a highly sensitive period for the development of one's academic self-concept.

While those compositional effects of the educational context in schools are well researched, differences in terms of learning environments are not (Eccles & Roeser, 2011). Although studies (e.g., Trautwein, Lüdtke, Köller, & Baumert, 2006) have highlighted that there are differential effects of learning environments on academic self-concept, these differences are mostly attributed to teachers' characteristics (e.g., focus on progress vs. focus on performance). Contrastive studies in particular, such as one by Ryser, Beeler, and

McKenzie (1995), are largely lacking with regard to academic self-concept and its potential differential role in various learning environments.

3.2.2 Self-efficacy

Similar to self-concept, self-efficacy refers to an individual evaluation of capabilities to learn or perform certain behaviors (Bandura, 1997, 2013). However, and in contrast to the self-concept, the reference of the capability lies rather in the action than in the personal ability (Bong & Skaalvik, 2003). Whether a person thinks that he or she can accomplish a certain task is hence more important than the individual evaluation of his or her own abilities. Self-efficacy can thus be considered as a success expectation or a conviction in successful outcomes. Bandura (1986) provided the example of the expectation that one can high-jump 6 ft. This would be a self-efficacy evaluation because it does not necessarily relate to a person's general high-jump capabilities; the frame of reference is rather the momentary circumstance. Furthermore, self-efficacy is embedded in social cognitive theory and highlights human agency (Usher & Schunk, 2018). With this agency, individuals are thought to be persistent, follow and reach their goals, and regulate their behavior accordingly (Bandura, 1997; Zimmerman et al., 2017). In contrast, individuals who are not self-efficacious give up more easily and follow less ambitious goals (Usher, Li, Butz, & Rojas, 2019).

While the academic self-concept is highly framed by comparing one's self against different reference criteria, self-efficacy beliefs originate from four major sources (Bandura, 1997, 2013): 1) enactive mastery experience, 2) vicarious experience (e.g., performance of people who are considered similar to oneself), 3) verbal persuasion, and 4) physiological reactions (e.g., pain, fatigue, and mood).

As with the academic self-concept, self-efficacy has been shown to be associated with numerous outcomes (Honicke & Broadbent, 2016), such as achievement (Hoigaard, Kovac,

Overby, & Haugen, 2015; Kitsantas & Zimmerman, 2008; Schnell, Ringeisen, Raufelder, & Rohrmann, 2015; Skaalvik, Federici, & Klassen, 2015), persistence and effort (Schnell et al., 2015), and self-regulation (Kitsantas & Zimmerman, 2008), and it has negative associations with test anxiety (Ringeisen & Raufelder, 2015).

Lorsbach and Jinks (1999) have criticized that a vast majority of self-efficacy research focuses on the responsibilities of the teacher instead of facilitating the establishment of variable learning environments. Yet, it is questionable whether this demand has been translated to educational practice or to educational research. Studies contrasting learning environments (e.g., Afari, Aldridge, Fraser, & Khine, 2012) seem to remain the exception rather than the rule.

3.3 Achievement Emotions

Achievement emotions are typically defined as a multifaceted phenomenon that consists of affective, cognitive, physiological, motivational, and expressive components (Shuman & Scherer, 2014), which indicate how those emotions manifest themselves in the individual's thoughts or behavior. For example, individuals can experience nervousness as a feeling of unease (affective dimension), but they can also experience it as an increased heart beat (affective dimension). Moreover, this nervousness can lead the individual to evade a situation (motivational dimension) or worry about failing a test (cognitive dimension), and it can be externalized, witnessed by others in the individual's facial expressions or as shivering (expressive dimension; Boekaerts & Pekrun, 2016).

The learning environment, with certain class climates, continuous assessment situations, and interactions with significant others, makes the classroom a particularly prominent place for the emergence of emotions. Within the taxonomy of academic achievement emotions (Pekrun, 2006), emotions are categorized according to their valence,

their degree of activation, and their object focus. Achievement emotions are typically distinguished from epistemic emotions, topic emotions, and social emotions (Boekaerts & Pekrun, 2016). In terms of their object focus, they can relate either to achievement activities (e.g., studying) or to achievement outcomes (e.g., success). Moreover, with regard to their valence, achievement emotions can either be positive or negative. Lastly, the degree of activation refers to initiating behavior, while deactivation refers to impeding it. Enjoyment can consequently be characterized as a positive activating activity emotion, whereas sadness would be a negative deactivating outcome emotion.

Goetz, Hall, Frenzel, and Pekrun (2006) have demonstrated that emotions, such as enjoyment, might be affected by different contexts. Similar to the differentiations of the academic self-concept (Marsh & Shavelson, 1985), they hypothesized that an individual trait emotional experience could be distinguished depending on the context. Specifically, they posited that the recollection of emotional states is either activity-specific, situation-specific, context-specific, or related to enjoyment of life (from most specific levels to the most general) and that reciprocal effects between the four levels can be assumed. In their model, context-specific experiences relate to individuals' dispositions to react with certain emotional responses to their immediate context, such as their school, their parents, or their peers. In turn, situation-specific experiences relate to individuals' predispositions to react to aspects of their environment that are not particularly stable, such as instruction by their teachers, learning processes, or exams. In other words, certain learning environments (context-specificity) may influence the emotional experience of students, with potential consequences for motivation, learning strategies, and general academic performance.

Considering the present study, the SCL environment based on competency matrices would be a context-specific representation because those matrices are a fixed method of

instruction within such schools. In contrast, typical instruction as used in TDL is rather situation-specific as it depends on the teacher.

3.4 Approaches to Learning

Approaches to learning are usually referred to with a dichotomization of the ways in which students approach their learning material: Marton and Säljö (1997)) distinguished between students who used a) surface strategies with the intention to reproduce learning material and those who employed b) deep learning strategies with the intention to understand the learning material.

Research on the use of approaches to learning is mainly situated within the theoretical framework of self-regulated learning (Schunk, 2008; Schunk & Zimmerman, 2009; Zimmerman & Cleary, 2009). Given the focus on metacognitive and cognitive processes in this research framework, the component of control becomes an additional integral part, which relates to how well students plan, monitor, and, if necessary, adapt their learning process. While deep processing and self-regulation in general can be regarded as main educational goals themselves (León, Núñez, & Liew, 2015), deep processing has also found substantial evidence in the relation to academic achievement (Richardson, Abraham, & Bond, 2012; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Vansteenkiste, Zhou, Lens, & Soenens, 2005).

Studies on the relationship between learning environments and approaches to learning have yielded ambiguous results (Baeten, Kyndt, Struyven, & Dochy, 2010), some indicating that SCL environments induce deep approaches and lead to less surface approaches, while other studies have found the complete opposite. Baeten et al. (2010) have criticized that many studies lacked comparability and that all learning environments in question differed considerably in terms of teaching methods, assessment, feedback, and task requirements,

among other things. Therefore, the questions regarding if and under which conditions SCL environments do contribute to the adoption of deep approaches to learning remain open.

3.5 Summary

The previous subchapter discussed that noncognitive learner characteristics have been shown to be of great importance for the quality of learning and achievement, future aspirations, and well-being. However, a clear research gap exists regarding the consideration of the effects of the learning environment on these factors and their interrelations. The theoretical frameworks of the constructs usually refer to this as the educational context. Yet, it remains unclear what contributes to this context. Many empirical studies seem to grasp the educational context as a function of class composition in terms of gender, socioeconomic status, and context and climate variables (Marsh, Lüdtke, et al., 2012). However, this function omits a variety of important aspects of teaching and learning processes in schools—the learning environment. Moreover, differences in statistical parameter estimates are usually treated as statistical noise as the assumption is that in all classrooms, the process of teaching and learning is basically identical. Nonetheless, such studies have greatly contributed to our understanding of what plays a part in successful learning and established favorable preconditions. However, alternative and innovative learning environments are rarely evaluated through those lenses.

4 Desideratum and Hypotheses

Based on the previously mentioned theoretical and empirical rationales, the central research question of this dissertation is as follows:

- How adolescent students differ in their self, emotions, motivation, and learning behavior in TDL and SCL classes?

Particular attention is thus drawn to potential mediators, which relate to a more immediate way of intervening in favor of promoting adaptive educational practice and enabling educational outcomes.

From the perspective of evaluating the learning environment, practical consequences are derived from these results. These consequences lead to the following research questions:

- Is a learning environment based on competence matrices beneficial for students?
- What are potential starting points to promote the further development of individualized educational practices?

5 General Design and Methodology of the Present Thesis

5.1 Participants and Procedure

The present study was conceptualized as a quantitative survey study. The first round of data collection took place in the winter term 2015 of the German school year. In this first round, 1,153 adolescent students (M_{age} = 13.97, SD = 1.37) from six secondary schools in the federal states of Berlin, Mecklenburg-West Pomerania, Northrine-Westphalia, and Schleswig-Holstein were asked to complete the survey instruments. Half a year apart, the second round of data collection took place in the summer term 2016, wherein 775 adolescent (M_{age} = 14.27, SD = 1.25) students from the original sample were surveyed again. The drop-out rate between both points of measurement was 22.8%.

Three schools were purposely chosen that have an individualized learning environment with competence matrices at their core. In the pool of potential schools, we only considered those that met the following criteria:

- The use of competence matrices as the main instructional practice has been present in the school for so long that study participants have only been exposed to this learning environment in their secondary school lives.
- Competence matrices are used in all major subjects (German, Maths, Second Language).
- Apart from specific teacher interventions, students can generally decide for themselves which subjects they want to work on.

Based on these criteria, only three schools were eligible: urban low-track and mixed-track schools. As no rural and no high-track schools were present in this sample, for the comparison group—the TDL group—a restricted random sample was chosen; this also excluded rural and low-track schools to achieve comparability. These schools have a traditional TDL environment at the core of their instructional practices.

To comply with school and privacy laws, as well as with ethical standards (American Psychological Association, 2002), a strict procedure was adhered to. First, permission was obtained from the educational administrations. Second, the schools were approached. Third, letters were distributed to students and teachers, explaining the goals of the study, the voluntary nature of participation, and the assurance of anonymity. On the day of data collection, two research assistants were present throughout the survey. They repeated the goals, the voluntary nature of participation, and the data protection to the students, and they then explained how to use the questionnaire, particularly the use of the Likert scales. Moreover, if necessary, they answered any questions about the nature of the questions or explained any ambiguous items.

5.2 Statistical Analyses

Data analyses were conducted using *IBM SPSS Statistics 23* and *24*, *Mplus 7.4* and *8.1* (Muthén & Muthén, 1998-2017), and *R 3.5.0* (R Core Team, 2018) with the *psych-package* (v1.9.12; Revelle, 2019). IBM SPSS Statistics and psych were used to prepare the dataset, recode reversed items, and compute Cronbach's α and descriptive statistics (scale means, kurtosis, and skewness). All subsequent analyses were conducted with *Mplus 7.4* and *8.1* (Muthén & Muthén, 1998-2017). With the help of this software package, structural equation modeling was performed with three different approaches. All three studies that this dissertation is comprised of were based on multi-group models, which require the establishment of measurement invariance across all constructs used in the studies (Brown, 2015). Based on that, latent mean comparisons (Study I, II, and III) were performed. Moreover, in Study II, mediation analyses were conducted in a four-group statistical model, whereas Study I and Study III made use of the two-group cross-lagged panel design, controlling for age. All models were computed using maximum-likelihood estimation with robust standard errors. Moreover, the type-is-complex approach was used (Study II and III) to adjust standard errors for the nested structure of the present dataset (students nested in classes; Asparouhov, 2005). In contrast, Study I accounted for the nested data structure by utilizing the multilevel framework. Finally, missing data were compensated for using full information maximum likelihood.

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6 Study I: How Autonomy Mediates the Relationship between Self-Efficacy and Learning Strategies

6.1 Abstract

The significant interplay between self-efficacy, perceived autonomy support and approaches to learning in adolescent students is widely recognized. However, less is known about whether substantial differences exist between students from schools with different environments (student-centered vs. teacher-centered learning). To close this research gap, this study used latent mean comparison and multigroup multilevel mediation modelling with questionnaire data from a sample of German adolescent students (N = 1153; M_{AgeT1} = 13.97, SD = 1.37; M_{AgeT2} = 14.27, SD = 1.25) in two waves. Multigroup multilevel mediation modelling reveals that perceived autonomy support functions as a mediator in the association between self-efficacy and approaches to learning only for students from schools with a student-centered learning environment based on competency matrices in contrast to a teacher-directed learning environment. More specifically, adolescents' approaches to learning can be enhanced through autonomy-supportive learning independently of their self-efficacy.

Keywords: autonomy, student-centered learning, teacher-directed learning, approaches to learning, self-efficacy

6.2 Introduction

Research has thoroughly documented the significant interplay between self-efficacy, autonomy, and approaches to learning (Baeten, Kyndt, Struyven, & Dochy, 2010); in particular, self-efficacy directs learners toward a proactive autonomous role in their learning process (Bandura, 1997, 2013) and achievement (Schunk & Pajares, 2005, 2009). However, research has also indicated that adolescence is a vulnerable time that is associated with a decline in students' self-efficacy (Bandura, 1997; Harter, 1996; Schunk, Meece, & Pintrich, 2014; Schunk & Pajares, 2002). Furthermore, in traditional teacher-directed learning (TDL), the proactive role that students are assumed to take is often compromised by external requirements such as consequent summative assessments and curricular expectations (Niemiec & Ryan, 2009; Reeve & Assor, 2011). It is therefore necessary to have learning environments that support students' proactive role through the enhancement of self-efficacy and autonomy to lead students to use beneficial approaches to learning such as control and elaboration.

Since theory indicates that the interplay of self-efficacy, autonomy support, and approaches to learning may depend on the learning environment (Kaplan & Patrick, 2016; Meece, 1997; Schunk & Pajares, 2002; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004; Yeager, Lee, & Dahl, 2017), student-centered learning (SCL) environments are expected to overcome the detrimental effects of traditional TDL environments. Specifically, SCL environments based on competency matrices follow the recommendations made by self-efficacy and self-determination research (Bandura, 1997; Niemiec & Ryan, 2009), which include the overall avoidance of lock-step sequences and the general provision of choice in the learning process. While such practices are also present in many TDL classrooms, these classrooms rely entirely on the teachers and, for instance, their application of autonomy-supportive behavior (Ryan & Deci, 2016) and their provision of differentiated instruction,

which is a major limitation on developing high self-efficacy (Schunk, 1995; Schunk & DiBenedetto, 2016). Conversely, the SCL environment makes those rather necessary. However, empirical research on different learning environments is scant but highly necessary (Brackett & Rivers, 2014; Hagenauer & Hascher, 2011; Meyer, 2014). This is equally true for SCL environments (Krille, 2016; Saldern, 2011).

To closes this research gap, this study is intended to investigate whether educational contexts affect the interplay of self-efficacy, perceived autonomy support, and approaches to learning. In particular, perceived autonomy support is expected to function as a mediator only in educational contexts that enable autonomous decision-making. For this purpose, this study contrasts students from classes with a conventional TDL environment with those from classes with an SCL environment based on competency matrices.

6.2.1 Self-efficacy and learning strategies

Self-efficacy as theorized by Bandura refers to students' individual evaluation of their own capabilities to learn and perform expected behaviors (Bandura, 1997, 2013). In terms of learning processes in school, expected behavior can refer to the learning approach that students adopt (Baeten et al., 2010). These learning approaches relate to the students' intended use of strategies to approach certain tasks (Biggs, 2001; Entwistle, 1991; Marton & Säljö, 1997). Using strategy to succeed in learning is a complex, dynamic process that involves cognitive, metacognitive, motivational, affective, and behavioral components (Weinstein, Acee, & Jung, 2011; Weinstein et al., 2015).

The metacognitive component refers to the control of the learning process following a self-regulated approach, particularly evaluating one's own learning process in terms of monitoring and potential behavioral adaption (Bandura, 2013; Usher & Schunk, 2018; Zimmerman & Cleary, 2009; Zimmerman, Schunk, & DiBenedetto, 2017). The cognitive

domain relates to a taxonomy of processing information (Schwartz & Goldstone, 2016; Weinstein et al., 2015). In that sense, memorization relates to surface-level approaches with the aim of rehearsal and reproduction of learning material and therefore builds the basis for deep understanding and competence development (Baeten et al., 2010). In turn, elaboration refers to these deep learning processes and intends to build upon previous knowledge and connect new content and skills with those that have already been learned. The intention of this approach is an understanding of content to foster application to new areas (Baeten et al., 2010).

Empirical evidence suggests that depending on the increasing levels of students' self-efficacy, they are more inclined to adopt a deep approach and less likely to choose a surface-level approach (Cassidy & Eachus, 2000; Geitz, Brinke, & Kirschner, 2016; Harris, 2003; Papinczak, 2009; Shen, Lee, Tsai, & Chang, 2016) and prefer to control their own learning process (Bath & Smith, 2009; Papinczak, 2009). These results become crucial due to a typical decline in students' self-efficacy during their time at school, especially with the onset of adolescence (Eccles & Midgley, 1989; Eccles, Midgley, & Adler, 1984; Harter, 1996; Schunk et al., 2014).

Particularly in schools, teachers and the accompanying learning environment play a crucial role in shaping this relationship. Student-centered learning environments have a tendency to encourage a deep approach, whereas TDL environments induce a surface-level approach to learning (Baeten et al., 2010).

6.2.2 Autonomy support as a potential mediator

As stated in social cognitive theory (Bandura, 1989), students with high self-efficacy are inclined to be proactive and autonomous in their behavior and constantly strive to gain control of their own lives (Schunk & DiBenedetto, 2016). In schools, the individual

perception of autonomy depends on the provision of choice and freedom with regard to one's own study activities (Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009). Empirical research has yielded proof of the association between self-efficacy and autonomy, although many researchers treat autonomy as an antecedent (Alivernini & Lucidi, 2011; Garcia & Pintrich, 1996) rather than a desirable outcome. Niemiec and Ryan (2009) have noted that the direction of this relation posits a distinctive difference between self-efficacy and self-determination theory. In this sense, the assumption is that the moment students experience self-efficacy, they need autonomy, and therefore autonomy support, in their learning processes in school.

However, summative evaluations and restrictions made due to imposed external goals, as are common in TDL environments, largely prevent autonomy in schools (Niemiec & Ryan, 2009; Ryan & Deci, 2017). This is particularly problematic because these increasingly restrictive TDL environments are established during a time when students constantly strive for more autonomy in their lives due to the onset of adolescence (Eccles & Midgley, 1989; Eccles et al., 1993).

The provision of autonomy is an essential factor if schools want students to strive for a deep level of understanding (Mazlum, Cheraghi, & Dasta, 2015; Reeve, Jang, Carrell, Jeon, & Barch, 2004; Ryan & Deci, 2000, 2017; Sierens et al., 2009). Although educators cannot convey an experience of autonomy, they must establish a framework in which autonomy is fostered. Studies have indicated that the support of autonomy fosters students' adoption of deep learning approaches such as elaboration, whereas a lack of autonomy induces surface-level approaches (Harris, 2003; Nijhuis, Segers, & Gijselaers, 2008). Contrary to the common notion that autonomy support as a classroom climate variable depends on the class context (Marsh et al., 2012), multiple studies have demonstrated that only small proportions of autonomy support can be attributed to the classroom context (Diseth, Danielsen, & Samdal,

2012; Diseth & Samdal, 2014). Therefore, it seems that autonomy support is perceived quite differently among students.

Ryan and Deci (2000) have already promoted the idea that autonomy-supportive learning environments (e.g., SCL) play a crucial role in improving learning. However, there is not yet any research that has examined the interplay of self-efficacy, autonomy support, and approaches to learning in different learning contexts, namely traditional TDL and innovative SCL environments.

6.2.3 Student-centered learning with competency matrices

Instruction in SCL classrooms is centered on the work with competency matrices. These matrices are subject-specific and divide the skills and contents of a subject into distinctive competence areas (e.g., "dialogic speaking") and respective competence levels (e.g., "I can understand the message of a conversation," "I can distinguish different types of conversations," "I can appropriately communicate depending on the addressee and the situation") (Landesinstitut für Schulentwicklung, 2016). The resulting goal of a specific competence is thereby provided with descriptors such as "I can" statements. Certain competence levels are related to the educational standards established in Germany (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, 2004). Moreover, these levels lead the students to the material necessary to develop that respective competence completely independent of their teacher's input.

Before learning processes are initiated, the students' initial competence levels are evaluated through self- and external assessment. Thus, the initial individual position on a certain competence level is supposed to be the most adaptive to the students' previous knowledge. The individual proximal learning goals for each individual student may be determined with the help of these competency matrices. In turn, these matrices are supposed

to enhance self-efficacy since the students' performances are continually and visibly reflected as progress in the matrices (Schunk, 1995; Schunk & DiBenedetto, 2016).

Consequently, the autonomy in the learning process becomes one of the distinctive features of the SCL environment. The significance of autonomy for learning processes has prompted researchers to identify several behaviors of autonomy-supportive educators (Reeve, 2009; Reeve & Halusic, 2009; Reeve & Jang, 2006), such as patience to allow time for self-paced learning, the use of informational language in contrast to controlling language, the acceptance of students' negative affect, and generally adopting students' perspectives. Teachers are enabled to continually provide performance and attributional feedback to enhance students' self-efficacy (Bandura, 1997; DiBenedetto & Schunk, 2018; Schunk, 1995; Usher & Weidner, 2018). With regard to the use of learning strategies, the competency matrices moreover make competence-oriented goals transparent and enable a stepwise approach to them. It is apparent that early stages of competency development (e.g., memorization) are only a threshold for more cognitively demanding stages (e.g., elaboration).

6.2.4 Current study and hypotheses

This study aims to examine whether substantial differences exist in the interplay between self-efficacy, the perception of autonomy, and approaches to learning in students from SCL environments and students from TDL environments in terms of potential classroom effects.

In particular, the following hypotheses were tested based on the theoretical review: (H1) students differ in their perception of self-efficacy, perceived autonomy support, memorization, elaboration, and control. Specifically, it is assumed (H1a) that students from the SCL environment report higher self-efficacy because the competency matrices provide mastery experiences (Bandura, 1997). Moreover, it is expected (H1b) that students from SCL

classrooms perceive higher autonomy support since SCL enables constant independent decision-making (Niemiec & Ryan, 2009). Finally, it assumed (H1c) that students from SCL environments exhibit higher values of elaboration and control but lower values of memorization since SCL environments tend to induce deep approaches to learning (Baeten et al., 2010).

(H2) Perceived autonomy support may function as a mediator in the association between self-efficacy and approaches to learning (Baeten et al., 2010; Bandura, 1997; Ryan & Deci, 2017); hence, potential learning environment (H2a) (Eccles & Midgley, 1989; Ryan & Deci, 2017) and classroom (H2b) (Eccles & Midgley, 1989; Eccles et al., 1984; Eccles et al., 1993; Harter, 1996) differences are expected. Specifically, (H2a) perceived autonomy support is presumed to be a stronger mediator for students from schools with an SCL environment compared to students from schools with a TDL environment, because SCL better supports students' autonomy perception (Reeve, 2009; Reeve & Halusic, 2009; Reeve & Jang, 2006). Furthermore, (H2b) since previous research has demonstrated that perceived autonomy support considerably varies between students (Diseth et al., 2012; Diseth & Samdal, 2014), this interplay is assumed to be present on the student level rather than the classroom level.

6.3 Method

6.3.1 Participants and procedures

The sample includes 1,153 students ages 12 to 18 years from grades 7 to 10 (M_{age} = 13.97; *SD* = 1.37, 49% girls) at Time 1 (T1) and 775 (M_{age} = 14.27, *SD* = 1.25, 49% girls) from the initial sample at Time 2 (T2) (0.5 years later) from six secondary schools in Germany in which all 57 classes were surveyed. Three of these schools were randomly selected from those schools that structure their learning environments based on SCL

principles ($N_{classes}$ = 36). This subsample includes 772 students (M_{age} = 13.85, SD = 1.32, 49% girls) at T1. The other three schools were also randomly selected from those schools that structure their learning environments based on TDL principles ($N_{classes}$ = 21). This subsample consists of 381 students (M_{age} = 14.22; SD = 1.42; 52% girls) at T1. Socioeconomic status and parents' educational level could not be determined due to German privacy law restrictions that prohibit asking students for information about their parents. Likewise, ethnic background could not be determined due to small proportions of ethnic minorities, particularly in Mecklenburg-Vorpommern (4.3%).

Students from both groups had only learned within their respective instructional design aside from some occasional changes of schools. Before approaching the students, we had to follow a strict procedure to comply with German privacy and educational laws as well as the Ethical Principles of Psychologists and Code of Conduct (American Psychological Association, 2002). First, we obtained permission from the Ministry of Education, Science and Culture of the federal state of Mecklenburg-Vorpommern, the Senate Administration for Education, Youth, and Family of the federal state of Berlin, the Ministry of Education and Science of the federal state of Schleswig-Holstein, and the Ministry of Schools and Education of the federal states of North Rhine-Westphalia. Second, we approached the schools with our study and informed them and the parents of the purpose of the data collection. After obtaining all necessary permission (from the schools, parents, and students), we conducted our study in the mid-winter term of 2015 (T1) and the mid-summer term of 2016 (T2). Two research assistants who were present throughout the process informed the students about the purpose of the study and its instruments, the voluntary nature of participation, and the anonymity of the data collection. These research assistants distributed the questionnaires to the students and explained the proper use of the Likert scales.

6.3.2 Measures

Table 1 exhibits the psychometric characteristics of the study's scales.

Table 1

Psychometric Quality of the Scales

	N_{items}	Cronbach's Alpha (α)		congeneric reliability (ω)	
		SCL	TDL	SCL	TDL
self-efficacy	10	.84	.85	.85	.85
perceived autonomy support	5	.80	.78	.81	.79
memorization	4	.74	.78	.77	.77
elaboration	4	.75	.78	.76	.76
control	4	.75	.77	.75	.65

Independent variable: self-efficacy. For this measure, we utilized the German version of the general self-efficacy scale (Jerusalem & Schwarzer, 1999). This scale consists of 10 items (e.g., “I can find a solution for every problem”) with answers ranging from 1 (“not true”) to 4 (“exactly true”) on a four-point Likert-scale.

Mediator variable: perceived autonomy support. Perceived autonomy support was measured with a subscale of the “Support of Basic Needs Scales for Adolescent Students” (Müller & Thomas, 2011). The subscale consists of five items (e.g., “My teacher likes it when I find my own way of problem solving”). Answers were rated on a four-point Likert scale ranging from 1 (“not true”) to 4 (“exactly true”).

Dependent variables: approaches to learning. Approaches to learning were assessed with three subscales from the German “Program for International Student Assessment” questionnaire regarding memorization strategies, elaboration strategies, and control strategies

(Artelt, Baumert, Julius-McElvany, & Peschar, 2004). The students were asked to rate the statements on a four-point Likert scale from 1 (“not true”) to 4 (“exactly true”). Memorization was measured with four items (e.g., “When I study, I memorize all new material so that I can recite it”). Elaboration was also measured with four items (e.g., “When I study, I try to relate new material to things I have learned in other subjects”). The subscale control consists of five items (e.g., ”When I study, I force myself to check to see if I remember what I have learned”).

Covariates. Since previous research has suggested that approaches to learning may vary across student ages (Baumert, 1993), age was included as a covariate. Similarly, gender was included since prior studies have indicated that the interplay of the variables may differ between male and female students (Baeten et al., 2010).

6.3.3 Statistical analyses

All analyses were conducted using Mplus 8.1 (Muthén & Muthén, 1998–2012) via the robust maximum likelihood estimator (MLR). Since the data were hierarchical in nature (i.e., 1,153 students/57 classes/6 schools), we used a multilevel approach (Hox, Moerbeek, & Schoot, 2018; Raudenbush & Bryk, 2002; Snijders & Bosker, 2012).

Of the 1,153 cases used in the study, 392 (34%) were affected by missing data. Across the 29 observed variables, missingness varied between 0.52% and 32.78%. Full information maximum likelihood (FIML) estimation was used under the missing at random assumption (MAR; Rubin, 1987). Full information maximum likelihood estimation is a state-of-the-art technique for dealing with missing data (Schafer & Graham, 2002) and is said to outperform multiple imputation in the multilevel context (Larsen, 2011).

We evaluated the fit of our models based on five primary fit indices as suggested by Hu and Bentler (1999): $\chi 2$ test of model fit, root mean square error of approximation

(RMSEA) with its respective confidence intervals, standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker-Lewis index (TLI).

Initially, we performed a series of confirmatory factor analyses (CFAs) to establish measurement models and measurement invariance with the “type is complex approach” (Asparouhov, 2005). This way, measurement error can be explicitly modeled and separated from the latent constructs (Brown, 2015). The establishment of measurement invariance was compulsory for our research, because we had to ensure that the latent constructs remained invariant across both groups to test differences in the latent means (Hypothesis 1). Thus, we performed the CFA on all latent constructs and added constraints in a stepwise manner: first, all constructs were freely estimated for both groups individually (Model 1: configural measurement invariance). Second, both groups were merged (Model 2: factorial measurement invariance). Third, factor loadings were equated (Model 3: weak factorial measurement invariance). Finally, the factor intercepts were also equated (Model 4: strong factorial invariance). Reaching the level of strong factorial invariance was necessary to conduct latent mean comparisons between the two groups (Brown, 2015). The evaluations of measurement invariance were based on Chen's (2007) recommendations. Thus, for studies with $N > 300$, weak factorial invariance is established if there are decreases in CFI < .010, increases in RMSEA < .015, and increases in SRMR < .030. For strong factorial invariance, measurement invariance is established if there are decreases in CFI < .010, increases in RMSEA < .015, and increases in SRMR < .010.

Secondly, we conceptualized a multigroup, multilevel mediation model that examined the role of autonomy support on the student level (Preacher, Zyphur, & Zhang, 2010), thereby controlling for potential classroom effects. Following Lüdtke, Marsh, Robitzsch, and Trautwein (2011), we used a manifest measurement/latent aggregation approach. For this approach, item scores were averaged for the L1 construct and then aggregated for the

respective L2 construct, thereby correcting for sampling error. Lüdtke et al. (2011) have shown that such a partial correction approach may even outperform doubly latent models when there is only limited information about the L2 constructs (i.e., a small number of classes or a small number of individuals within classes).

At both levels, the mediation model (e.g., perceived autonomy support mediates the association between self-efficacy and approaches to learning) was specified. To evaluate the hypothesized differences in the interplay, two forms of the model were conceptualized: a less restricted model that freely estimated regression and covariance coefficients between all groups and a more restricted model assuming equated regression and covariance coefficients. The significance of the indirect effect was determined using symmetric confidence intervals (MacKinnon, 2008).

6.4 Results

6.4.1 Descriptive statistics and intercorrelations

Descriptive statistics (range, means, standard deviation, skewness, and kurtosis) as well as all intercorrelations between the variables of interest are presented in Table 2 separately for each subsample.

6.4.2 Confirmatory factor analyses: Latent mean comparison

Before conducting a multigroup, multilevel mediation analysis, CFAs were performed to produce an initial measurement model and confirm measurement invariance across both groups. Strong factorial measurement invariance was reached (Chen, 2007). In sum, the measured constructs remained stable across both groups, allowing us to continue the investigation of the associations between the variables of interest with latent mean comparisons and multigroup, multilevel modeling.

Table 2

Intercorrelations between self-efficacy, autonomy (T1) and memorization, elaboration and control (T2) and their range, means, standard deviations, kurtosis and skewness for students following student-centered learning and teacher-directed learning separately

	2	3	4	5	6	7	M	Range	SD	Skewness	Kurtosis	ICC(1)	ICC(2)
Student-centered Learning													
1 self-efficacy T1	.42***	.14**	.26***	28***	-.08	.08	2.74	1–4	0.52	−.13 (.09)	.06 (.18)	.05	.54
2 autonomy T1		.23***	.25***	.35***	-.20***	-.04	2.68	1–4	0.67	−.21 (.09)	−.26 (.18)	.07	.60
3 memorization T2			.39***	.56***	-.02	-.06	2.57	1–4	0.67	−.34 (.11)	−.09 (.22)	.03	.43
4 elaboration T2				.50***	-.06	.04	2.54	1–4	0.68	−.17 (.11)	−.14 (.22)	.08	.65
5 control T2					-.08	-.10*	2.86	1–4	0.66	−.55 (.11)	.30 (.22)	.06	.56
6 age						.08	13.85	11–18	1.32	.33 (.09)	−.71 (.18)		
7 gender (0=girls, 1=boys)							0.51	0–1	.50	−.06 (09)	−2.00 (.18)		
Teacher-directed Learning													
1 self-efficacy T1	.27***	.13	.20**	.20	.13	.20***	2.49	1–4	0.50	.42 (.13)	.42 (.25)	.08	.61
2 autonomy T1		.15*	.11	.27***	-.09	.03	2.38	1–4	0.61	.17 (.13)	−.25 (.25)	.16	.78
3 memorization T2			.17*	.60***	.04	-.12	2.83	1–4	0.63	−.12 (.15)	−.28 (.30)	.13	.72
4 elaboration T2				.36***	-.02	.08	2.46	1–4	0.61	.10 (.15)	–.11 (.30)	.06	.55
5 control T2					.01	-.14**	2.83	1–4	0.53	−.29 (.15)	.75 (.30)	.04	.40
6 age						.00	14.22	11–18	1.42	.21 (13)	−.49 (.25)		
7 gender (0=girls, 1=boys)							0.48	0–1	0.50	.06 (.13)	− 2.01 (.25)		

Note. T1 = Time 1; T2 = Time 2. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3

Model fit indices of the stepwise CFA procedure to proof measurement invariance

Model	df	χ2	*p*	CFI	RMSEA	90%CI	SRMR	ΔCFI	ΔRMSEA	ΔSRMR
Model 1a	340	712.57	< .001	.930	.038	.034–.042	.050			
Model 1b	340	519.12	< .001	.923	.037	.013–.043	.063			
Model 2	680	1231.33	< .001	.928	.038	.034–.041	.055			
Model 3	703	1258.37	< .001	.928	.037	.034–.040	.057	.000	-.001	.002
Model 4	726	1364.68	< .001	.917	.039	.036–.042	.058	-.011	.002	.001

Note. Model 1a–b = measurement model for SCL, TDL separately (configural invariance); Model 2 = merged measurement model with all parameters free (form invariance); Model 3 = equality of factor loadings (weak factorial invariance); Model 4 = equality of factor intercepts (strong factorial invariance).

Using the group of SCL students as a reference group, mean comparisons revealed that students in TDL environments reported significantly less self-efficacy at T1 (β = -0.55, $p < .001$) and perceived autonomy support at T1 (β = -0.46, $p < .001$) but indicated higher memorization values at T2 (β = 0.51, $p < .001$). The latent means of elaboration at T2 (β = -0.12, $p = .32$) and control at T2 (β = -0.01, $p = .97$) did not differ significantly.

6.4.3 Multigroup multilevel modelling

The intercorrelations (see Table 2) already indicate that the interplay of the variables may vary across all groups. Consequently, we produced our hypothesized model in which perceived autonomy support mediates the association between self-efficacy and approaches to learning (i.e., memorization, elaboration, and control). First, a less restricted model that freely estimated regression and covariance coefficients was tested ($\chi2(2) = 3.395$, $p(\chi2) = .18$, CFI = .998, RMSEA = .035, $SRMR_{within} = .009$, $SRMR_{between} = .011$). Therefore, we included direct effects of self-efficacy on perceived autonomy support and on all three approaches to learning (i.e., memorization, elaboration, and control). We also added direct effects of

perceived autonomy support on the approaches to learning. The approaches were allowed to covary. Second, a more restricted model was tested ($\chi2(16) = 42.671$, $p(\chi2) < .001$, CFI = .969, RMSEA = .054, $SRMR_{within} = .015$, $SRMR_{between} = .078$), which additionally constrained the regression and covariance coefficients, implying no group differences. According to Chen (2007), the decreases in the fit indices ($\Delta CFI = -.029$, $\Delta RMSEA = .19$, $\Delta SRMR_{within} = .006$, $\Delta SRMR_{between} = .067$) lead to a significant deterioration of model fit. Consequently, we accepted the less restricted model as our final model. In accordance with our hypotheses, this model implies that there are differences between the variables of interest patterns of the students in the two different learning environments.

Patterns for SCL. Table 4 presents the model results of the final model for the SCL group. Figure 1 depicts the central effects.

Direct effects. At the student level, students reported that self-efficacy was positively associated with perceived autonomy support at T1 ($B = 0.54$, $\beta = 0.42$, $SE = 0.05$, $p < .001$), with elaboration at T2 ($B = 0.23$, $\beta = 0.18$, $SE = 0.07$, $p < .001$), and with control at T2 ($B = 0.21$, $\beta = 0.17$, $SE = 0.07$, $p < .01$). Moreover, the perceived autonomy support at T1 reported by the students was associated with their reported memorization at T2 ($B = 0.21$, $\beta = 0.21$, $SE = 0.07$, $p < .01$), elaboration at T2 ($B = 0.18$, $\beta = .18$, $SE = .05$, $p < .01$), and control at T2 ($B = 0.27$, $\beta = 0.27$, $SE = 0.06$, $p < .001$). At the classroom level, only reported self-efficacy at T1 significantly predicted reported elaboration at T2 ($B = 1.54$, $\beta = 0.95$, $SE = 0.53$, $p < .01$).

Table 4

Results of the Multigroup Multilevel Analyses for Student-centered Learning

	Mediator: perceived autonomy support T1				Dependent variable: memorization T2				Dependent variable: elaboration T2				Dependent variable: control T2			
predictors	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*
Within-Ebene																
self-efficacy T1	**.54**	**.42**	**.05**	**< .001**	.08	.06	.06	= .21	**.23**	**.18**	**.07**	**<. 001**	**.21**	**.17**	**.07**	**< .01**
autonomy T1					**.21**	**.21**	**.07**	**< .01**	**.18**	**.18**	**.05**	**< .01**	**.27**	**.27**	**.06**	**< .001**
age					.01	.02	.03	= .71	–.01	–.01	.03	= .84	–.01	–.02	.03	=.79
gender					–.07	–.05	.06	= .24	.05	.04	.06	= .43	**–.14**	**–.11**	**.06**	**< .05**
R^2		**.18**	**.03**	**< .001**		.06	.03	= .05		**.09**	**.03**	**< .01**		**.15**	**.03**	**< .001**
Between-Ebene																
self-efficacy T1	.58	.41	.34	= .09	.74	.75	.62	= .24	**1.54**	**.95**	**.53**	**< .01**	.93	.72	.58	= .11
autonomy T1					–.23	–.33	.25	= .35	– .04	–.04	.28	= .88	.25	.27	.23	= .29
R^2		.17	.18	= .35		.47	.72	= .51		**.87**	**.38**	**< .05**		.75	.42	= .07

Note. Significant effects are printed in bold at $p <. 05$.

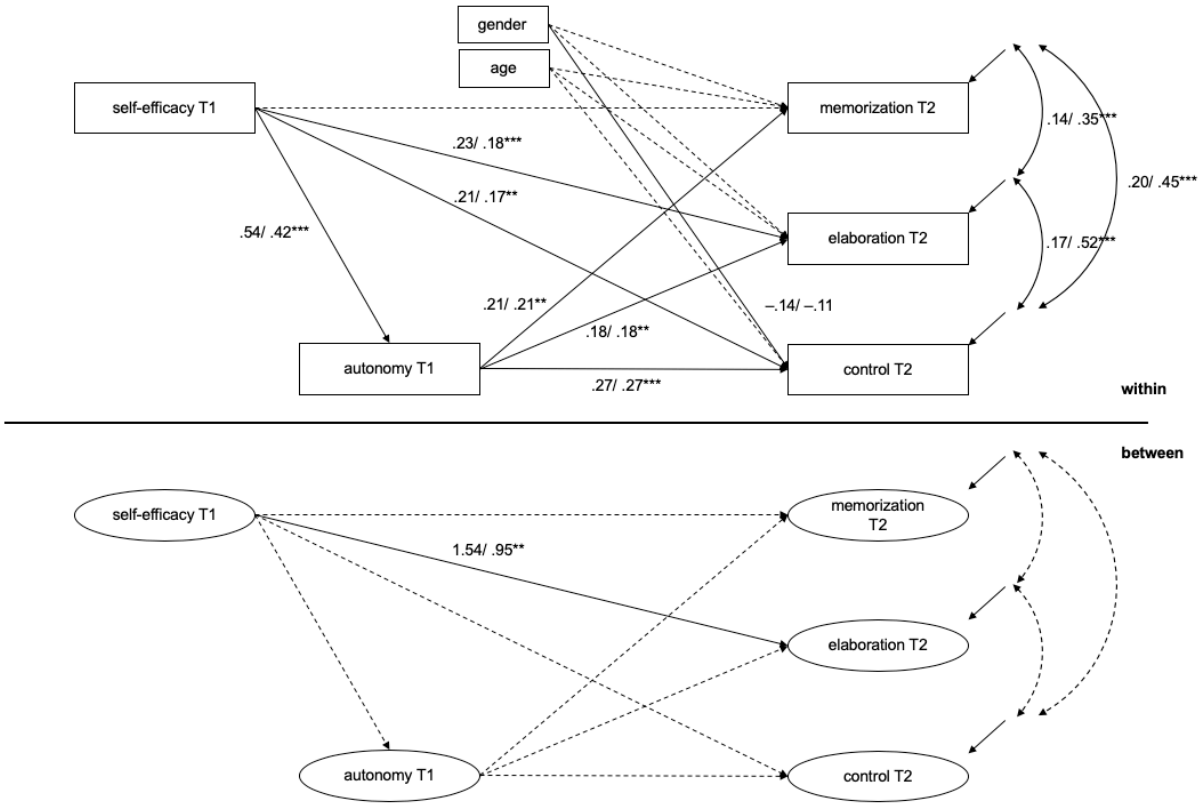

Figure 1. Final model for students following student-centered learning. Only significant estimates are displayed with unstandardized estimate first, and standardized estimate second; * $p < .05$, ** $p < .01$, *** $p < .001$.

Indirect effects. At the student level, all three indirect effects were significant in the SCL group. Perceived autonomy support fully mediated the association between reported self-efficacy at T1 and reported memorization at T2 ($B = 0.11$, $SE = 0.04$, 95% CI [0.04–0.18]). Furthermore, perceived autonomy support partially mediated the association between reported self-efficacy at T1 and reported elaboration at T2 ($B = 10$, $SE = 0.03$, 95% CI [0.04–0.15]) and between reported self-efficacy at T1 and reported control at T2 ($B = 0.14$, $SE = 0.03$, 95% CI [0.08–0.21]). No significant indirect effects were found on the classroom level.

Covariances. The residual covariances of memorization and elaboration were found to be positively associated ($r = .14$, $p < .001$), as were the residual covariances of memorization and control ($r = .20$, $p < .001$) and control and elaboration ($r = .17$, $p < .001$). Moreover, gender was significantly associated with perceived autonomy support at T1 ($r = -.02$, $p < .05$), and student age was significantly associated with perceived autonomy support at T1 ($r = -.02$, $p < .05$).

Patterns for TDL. Table 5 presents the results of the final model for the TDL group. Figure 2 depicts the model's central effects.

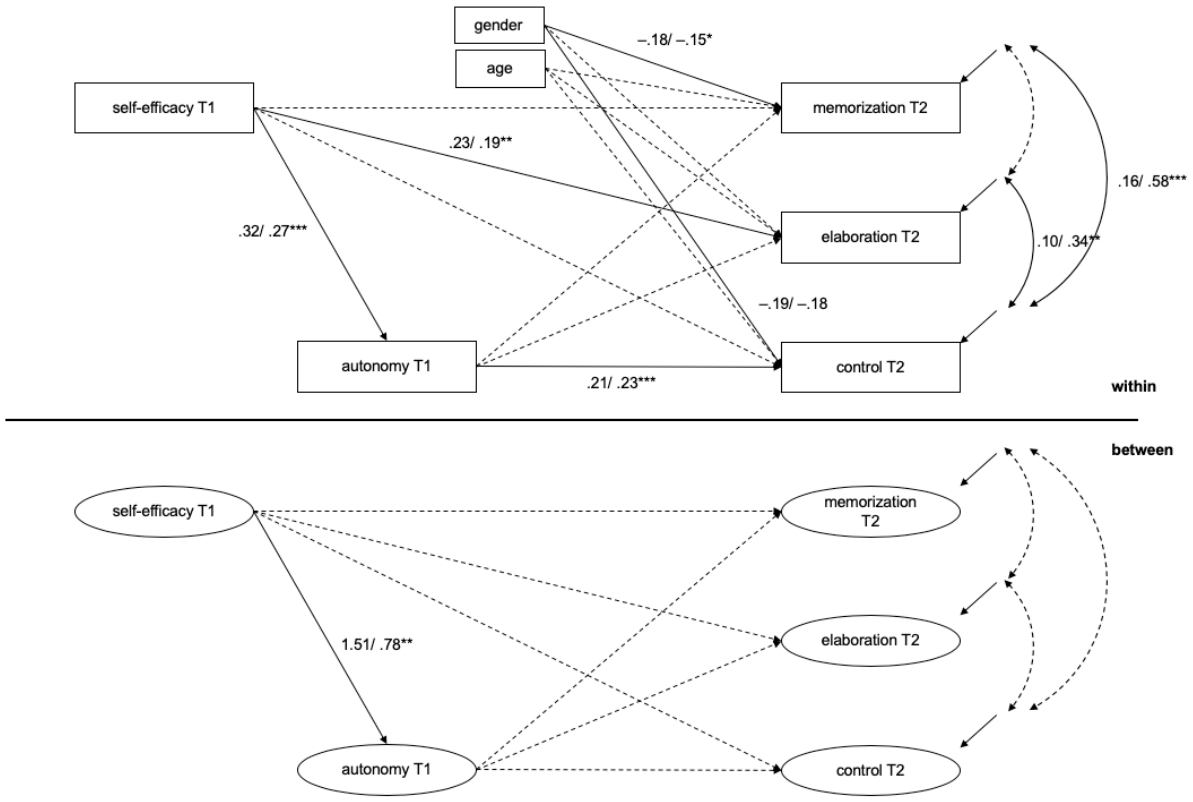

Figure 2. Final model for students following teacher-directed learning. Only significant estimates are displayed with unstandardized estimate first, and standardized estimate second; * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5

Results of the Multigroup Multilevel Analyses for Teacher-directed Learning

	Mediator: perceived autonomy support T1				Dependent variable: memorization T2				Dependent variable: elaboration T2				Dependent variable: control T2			
predictors	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*
Within-Ebene																
self-efficacy T1	**.32**	**.27**	**.07**	**< .001**	.14	.12	.13	= .25	**.23**	**.19**	**.09**	**< .01**	.19	.18	.13	= .14
autonomy T1					.13	.12	.08	= .12	.06	.06	.07	= .40	**.21**	**.23**	**.08**	**< .01**
age					.01	.03	.04	= .70	–.02	–.04	.04	= .69	.03	.01	.02	=. 91
gender					**–.18**	**–.15**	**.08**	**< .05**	.05	.04	.07	= .49	**–.19**	**–.18**	**.05**	**< .001**
R^2		**.07**	**.03**	**< .05**		.05	.03	= .06		.05	.03	= .06		**.12**	**.04**	**< .001**
Between-Ebene																
self-efficacy T1	**1.51**	**.78**	**.55**	**< .01**	2.28	1.28	1.34	= .09	1.24	.96	1.26	= .32	.69	.90	1.06	= .51
autonomy T1					–.31	–.82	.52	= .56	–.31	–.46	.52	= .56	–.36	–.91	.49	= .47
R^2		**.61**	**.29**	**< .05**		.67	.99	= .50		.44	.83	= .59		.36	.93	= .70

Note. Significant effects are printed in bold at $p <$. 05.

Direct effects. At the student level, five effects were significant in the TDL group. Reported self-efficacy at T1 positively predicted perceived autonomy support at T1 (B = 0.32, β = 0.27, SE = 0.07, p < .001) and reported elaboration at T2 (B = 0.23, β = 0.19, SE = .09, p < .01). Moreover, perceived autonomy support at T1 predicted reported control at T2 (B = 0.21, β = 0.23, SE = 0.08, p < .01). Gender effects applied since gender negatively predicted reported memorization at T2 (B = -0.18, β = -0.15, SE = 0.08, p < .05) and reported control at T2 (B = -0.19, β = -0.18, SE = .05, p < .001).

Indirect effects. Contrary to the SCL group where all associations were mediated by perceived autonomy support at T1, in the TDL group, perceived autonomy support at T1 only mediated the association between reported self-efficacy at T1 and reported control at T2 (B = 0.07, SE = 0.03, 95% CI [0.02–0.12]).

Covariances. In the TDL group, reported control was also associated with both reported memorization (r = .16, p < .001) and reported elaboration *(*r = .10, p < .01). Moreover, gender was associated with self-efficacy at T1 (r = .05, p < .001), meaning that boys reported higher values of self-efficacy.

6.5 Discussion

The aim of this study was to clarify the substantial differences between adolescent students from classrooms with an SCL environment and students from classrooms with a TDL environment in terms of the interplay of self-efficacy, perceived autonomy support, and approaches to learning. Specifically, this study examined whether these two student groups differ in their mean values of these variables and whether perceived autonomy support

functions as a mediator between self-efficacy and approaches to learning in the same manner for both groups considering potential classroom effects through a multilevel approach.

Hypothesis 1 was partly confirmed: with regard to Hypothesis 1a, reported self-efficacy was indeed significantly higher for students in SCL environments, which aligns with Bandura's (1997) posited sources of self-efficacy. The competency matrices orchestrate instruction to a large degree; hence, teachers are enabled to continually provide formative feedback and thereby use verbal persuasion. Moreover, mastery experiences are supposed to be the strongest source of self-efficacy. The continuous adaptation of individual competence level and the setting of new proximal learning goals allow for these experiences. Thus, the competency matrices follow Vygotsky's zone of proximal development (Vygotsky, 1981).

Furthermore, as hypothesized in Hypothesis 1b, perceived autonomy support was lower for students in TDL classrooms, which aligns with recent school evaluations (Sächsisches Bildungsinstitut, 2013). Reeve and Halusic (2009) have suggested that allowing students to work at their own pace is a major determinant of autonomy support. In SCL, the respective tasks of competency matrices make this particularly easy, whereas a teacher instructing a class collectively will likely experience difficulty in coordinating instructional activities. Discussions abound regarding the restrictions that confront schools in terms of providing an autonomy-supportive environment (Niemiec & Ryan, 2009). The SCL environment seems to circumvent some of these problems.

The students in TDL environments reported significantly more memorization than the students in SCL environments, which supports Hypothesis 1c; on the one hand, this result is aligned with the educational reports of various federal states in Germany (Institut für Qualitätsentwicklung, 2012; Sächsisches Bildungsinstitut, 2013), but on the other hand, it supports the idea that SCL environments induce fewer surface-level approaches (Baeten et al., 2010). This result could indicate a problem regarding the extent to which assessment is

still based on memorization rather than elaboration (Morgan, 2016), but it could also denote a stronger focus on those approaches within instruction (Trigwell, Prosser, & Waterhouse, 1999). However, both reasons question whether schools sufficiently address competence development as demanded by educational standards.

In contrast to Hypothesis 1c, students in SCL environments did not report higher values of elaboration and control. A possible explanation for this result might be the age of the participating students; for instance, Baumert (1993) has argued that students in early and middle adolescence do not have a very differentiated set of cognitive strategies and that these cognitive strategies continue to develop until late adolescence. An extensive body of research indicates a correlation of age and deep approaches to learning and a negative correlation between age and surface-level approaches to learning (Chamorro-Premuzic & Furnham, 2009; Furnham, Christopher, Garwood, & Neil Martin, 2007). Accordingly, future studies with older participants are warranted. With regard to control, the multilevel analysis revealed that boys tended to report lower values. This result is in line with the examination of gender differences by Duckworth and Seligman (2006) but contradicts more recent findings by Zimmerman and Kitsantas (2014), who have found no association between gender and metacognitive control strategies. Moreover, there were no significant associations between control and age. This result aligns with past research that found that general self-regulatory skills develop at the age of 10 (Smith, Borkowski, & Whitman, 2008) and are henceforth subject to inter-individual differences rather than developmental differences (De Corte, Mason, Depaepe, & Verschaffel, 2011).

Hypothesis 2 was also partly confirmed. In line with H2a, significant differences in the interplay between the self-efficacy, perceived autonomy support, and approaches of students from different learning environments (i.e., SCL vs. TDL) were identified. In the SCL environment, perceived autonomy support operated as a full mediator in the association

between reported self-efficacy and reported memorization and as a partial mediator in the association between self-efficacy and reported control and between self-efficacy and reported elaboration. Since perceived autonomy support reduces the associations between self-efficacy and approaches to learning to zero (full mediation) or at least minimizes the effect (partial mediation), students with low levels of self-efficacy can be prevented from demonstrating fewer surface-level approaches, fewer deep approaches, and fewer metacognitive approaches in SCL environments through the perception of high levels of autonomy support. Thus, in-class autonomy support can protect students' approaches to learning independent of their self-efficacy. These results highly align with the theoretical foundation (Bandura, 1997; Ryan & Deci, 2017) of self-determination theory, which posits that given the presence of more self-determined conditions, an internalization can be expected in which socially endorsed practices and ideals such as certain educational expectations are integrated into one's own value system (Deci & Ryan, 1991; Ryan, Connell, & Deci, 1985; Ryan & Deci, 2017). In both SCL and TDL environments, students may not find many educational objectives interesting, and such educational objectives could be interpreted as a controlling factor. However, in SCL, students are offered incentives for internalizing a personal value of these objectives, such as more self-determined learning conditions paired with continuous depictions of the goals of students' learning tasks with "can-do" statements (Moeller, Theiler, & Wu, 2012). Moreover, Sierens et al. (2009) have underscored that autonomy only develops its full potential if students perceive their educational setting as structured. The competency matrices provide such a continuous structure. In accordance with H2b, classroom effects generally did not apply, meaning that the interplay of self-efficacy, perceived autonomy support, and approaches to learning are dependent on the individual rather than the classroom. However, at the class level, self-efficacy predicted elaboration, indicating that

classes with high average self-efficacy result in higher average elaboration strategy use values.

By contrast, only one mediating effect could be determined for students in TDL environments. Specifically, perceived autonomy support mediated the association between self-efficacy and control. These results effectively coincide with the intercorrelations, which exhibit some significant but weak associations and predominantly non-significant associations. Similar effects have also been identified in studies that compared the associations between autonomy and achievement (Ng, Kenney-Benson, & Pomerantz, 2004) and motivation (Lazarides & Raufelder, 2017). A possible explanation for the lack of associations might lay in the nature of the classroom context (Lazarides & Raufelder, 2017; Sierens et al., 2009). More specifically, Sierens et al. (2009) have suggested that at least moderate autonomy conditions have to be fulfilled to allow other perceived classroom variables such as perceived structure to have significant associations with approaches to learning. Patall, Sylvester, and Han (2014) have reported similar interaction effects. In this research context, this finding engenders the assumption that associations of perceived autonomy support can only be investigated if the proper contexts that allow for autonomy exist, making SCL environments preferable to TDL environments. In the TDL group, H2b was also confirmed. The interplay did not replicate at the classroom level, meaning that the interplay between self-efficacy, perceived autonomy support, and approaches to learning is determined by the individual student rather than his or her class.

6.5.1 Practical implications

These results are promising since they indicate that structured autonomy-supportive learning environments can be established to foster deep learning approaches. Many schools still attempt to group students according to ability, because this method helps teachers satisfy

their students' instructional needs (Chorzempa & Graham, 2006). However, recent research has indicated that heterogeneity in classrooms can even be beneficial if students perceive a cognitively activating and supportive classroom climate (Decristan, Fauth, Kunter, Büttner, & Klieme, 2017). The concept of teachers as facilitators is frequently the focus of discourses about student-centered environments (Goodyear & Dudley, 2015; Hmelo-Silver & Barrows, 2006; OECD, 2015). Nevertheless, the challenge for teachers is seemingly a desire to achieve the balance of reaching educational standards while simultaneously providing for a classroom climate that sufficiently addresses all of the learners' individual needs. Consequently, this scenario constantly requires instructional innovations (OECD, 2017), thus enabling the teachers to provide cognitive activation and a supportive classroom climate for individual students.

Student-centered learning environments with competency matrices apparently enable this approach in various ways. First, SCL primarily shifts the responsibility of the instruction to the students, which can develop their competences with the aid of the matrices. Therefore, the students' heterogeneity is acknowledged and adequately addressed. Additionally, teachers can focus on individual students, offer adequate formative feedback, and provide an adequately supportive classroom climate overall.

6.5.2 Strengths, limitations, and future directions

Although the current study offers important insights into how the relations of self-efficacy, perceived autonomy support, and approaches to learning differ between students from two learning environments, it is nonetheless subject to various limitations. First, this study exclusively utilized self-reported data. The use of questionnaires is regularly subject to uncertainty-related problems such as social desirability and common method variance (Brannick, Chan, Conway, Lance, & Spector, 2010). These problems are not exclusive to

self-reported data (Chan, 2009; Spector, 2006), but it could certainly enrich the significance of our research to in future include additional measurements from external sources such as family members, teachers, and peers. Moreover, future studies should also include other student and classroom characteristics in addition to age and gender, such as socioeconomic status and teacher qualifications. Thereby, a more thorough analysis of employment of the classroom principles could be achieved to specifically see how consequent the teachers apply the SCL principles and which potentially alternative approaches of instruction teachers in TDL environments use. This kind of fidelity check would greatly improve the validity of the study and its inferences (Gitlin & Parisi, 2016). After considering the advantages and disadvantages of using these self-reported measures, we decided to use them for the following reasons: (1) the focus of our research was the students' perception of the learning environment, and (2) adolescents were considered thoughtful enough to evaluate their internal states. Moreover, we tried to counteract potential bias by controlling for potential confounders. Second, our study only utilized two time points of measurement, which hindered the derivation of causal relations from our data and was additionally affected by a dropout rate of approximately 33%. However, future studies could employ more waves to increasingly differentiate between various developmental timespans. This aspect especially accounts for the learning approaches of students in late adolescence (Baumert, 1993). Third, our study was not domain-specific in its evaluation of self-efficacy and approaches to learning. However, previous research (Baumert, 1993; Garner, 2016) has indicated that all constructs are potentially dependent upon and vary across certain domains. Thus, future studies should take different school subjects into account.

Despite these limitations, this study demonstrates some important strengths. First, hardly any studies have investigated the central antecedents of academic performance from the perspective of distinctive learning environments. Second, the complex statistical analyses

were based on a large sample of adolescent students and allow for detailed analysis of the interplay of student perceptions in the classroom, which largely contributes to a general demand for innovative ideas in scholastic education (OECD, 2017). Third, the multilevel approach revealed that the interplay of self-efficacy, perceived autonomy support, and approaches to learning is an individual rather than classroom issue.

Additionally, future studies should focus more strongly on identifying the underlying mechanisms involved in individualized learning environments such as SCL. In particular, the underlying socio-motivational mechanisms and self-regulatory processes at hand should be of significant research interest because such research could better guide schools in shifting toward more autonomy-supportive learning environments. For example, Lazarides and Raufelder (2017) have emphasized the necessity of creating learning environments that enhance students' perception of motivational needs. Moreover, this prerequisite involves questions about how social comparison processes such as the "big fish, little pond" effect can be prevented if students learn under individualized and autonomous conditions (Hoferichter, Lätsch, Lazarides, & Raufelder, 2018). Finally, future studies should include competence assessment to determine actual student performance. This approach could be especially beneficial for ensuring comparable achievement results across distinct learning environments.

6.6 References

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7 Study II: Academic Self-concept and Achievement Motivation among Adolescent Students in Different Learning Environments – Does Competence-Support Matter?

7.1 Abstract

The present study tests the following: a) whether perceived competence support functions as a mediator in the associations between academic self-concept and achievement motivation and b) how various learning environments shape these associations. A teacher-directed learning environment (TDL) and a student-centered approach, namely competence-based learning (CBL), were contrasted using latent mean comparison and multi-group structural equation modeling with indirect effects. This study is based on a sample of German students in early and middle adolescence (N = 1,153; M_{AgeT1} = 13.97, SD = 1.37; M_{AgeT2} = 14.27, SD = 1.25) in two waves (T1 = Autumn 2015 and T2 = Spring 2016). The results of the latent mean comparison indicate that students from schools with CBL perceive a higher level of academic self-concept compared to students from TDL environments. Moreover, multigroup structural equation modeling demonstrates that perceived competence support functions as a mediator in the association between academic self-concept and achievement motivation primarily for students from schools with CBL. Findings suggest that mostly students with a low level of academic self-concept benefit from CBL because this student-centered learning environment reduces the association between academic self-concept and achievement motivation through a high level of perceived competence support.

Keywords: competence support, student-centered learning, teacher-directed learning, achievement motivation, self-concept, adolescence

7.2 Introduction

Adolescence is a particularly sensitive period in students' educational development. Students at an early age are expected to learn as effectively and efficiently as possible. These high expectations are paired with the pressures of highly competitive societies in which lifelong learning has become the key goal for a secure future. However, these demands are associated with declines in adolescents' academic self-concept (Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991) and motivation (Anderman & Midgley, 1997; Eccles, Wigfield, & Schiefele, 1998; Harter, 1996; Watt, 2004; Zusho & Pintrich, 2001). Accordingly, research has attempted to identify both the variables and learning environments that tend to compensate for these declines. Following stage-environment fit theory, a major contribution to these declines in motivation and self-concept in adolescence is attributed to a misfit of individual developmental needs and the provided educational environment (Eccles & Midgley, 1989). Therefore, to effectively support adolescents in their scholastic education, it is imperative to examine learning environments and their characteristics that support the positive motivational development of adolescent students (Lazarides & Raufelder, 2017).

An increasing number of schools have changed their instructional practices from teacher- to student-directed approaches to address the above-mentioned misfit effectively (OECD, 2017). Competence support thus plays a key role because perceived competence assumes a central function in students' performance, behavior, and motivation (Ryan & Moller, 2017). One student-directed approach that is gaining growing attention among German schools is a learning environment based on competency matrices. This competency-based learning (CBL) environment uses competency matrices as a basis of instruction and thereby enables teachers to provide more in-depth and formative feedback on students' progress in their learning processes. However, less is known about the issue of whether students in CBL environments perceive higher levels of competence support, academic self-

concept, and achievement motivation compared to students in traditional teacher-directed learning environments. Furthermore, an understanding of the interplay of these particular variables in different learning environments is needed to identify best practices for preventing declines in achievement motivation.

Academic self-concept is a multidimensional construct that refers to an individual evaluation of personal cognitive abilities in academic achievement contexts (Harter, 1999, 2012). In the formation of academic self-concept, age is deemed to have a major contribution, with the period until middle adolescence being particularly vulnerable to declines (Marsh & Hocevar, 1985; Wigfield et al., 1991). Two major influencing factors during this period are the transition from elementary to secondary schools and shifts in educational contexts (Wigfield & Eccles, 2002; Wigfield et al., 2015). Between middle and late adolescence, academic self-concept then becomes more stable and less prone to changes (Marsh, 1989).

The theoretical framework of academic self-concept highlights the importance of the social environment (Marsh & Martin, 2011; Marsh, Xu, & Martin, 2012). In this domain, current research is focused on social contexts, such as the big-fish-little-pond effect, which play a key role in the formation of academic self-concept (Hoferichter, Lätsch, Lazarides, & Raufelder, 2018; Marsh, 1984; Marsh & Parker, 1984; Marsh, Trautwein, Lüdtke, Baumert, & Köller, 2016; Stäbler, Dumont, Becker, & Baumert, 2017). However, few studies have investigated the role of the learning environment itself, despite some promising results of certain intervention programs targeting academic self-concept (O'Mara, Marsh, Craven, & Debus, 2006).

Numerous studies have indicated that academic self-concept is closely associated with academic performance (Marsh, Hau, Artelt, Baumert, & Peschar, 2006) and motivational outcomes (Denissen, Zarrett, & Eccles, 2007; Simpkins, Davis-Kean, & Eccles, 2006), particularly achievement motivation (Wigfield et al., 2015), which conceptualizes domain-

unspecific competences such as persistence and effort, focus, and accuracy (Holz-Ebeling, 2010). Achievement motivation relates to a behavioral dimension of motivation (Eccles & Wigfield, 1995) insofar as it is distinct from cognitive dimensions, such as students' goals and goal orientations, and from affective dimensions, such as enjoyment of tasks (Eccles & Wigfield, 2002). In classroom settings, this behavioral dimension is mostly observable when facing task-related difficulties (Lazarides & Raufelder, 2017), such as individual persistence in pursuing learning activities (persistence and effort) and the intensity of students' engagement (focus, accuracy) to organize learning processes and adapt to specific content and situations (Wigfield et al., 2015).

In spite of the reciprocal effect model, which states that self-concept and achievement constantly reinforce each other (Marsh, 1990; Marsh & Craven, 2006; Marsh & Martin, 2011), Garn and Shen (2014) demonstrated that the associations between academic self-concept and motivational variables were rather mono- than bidirectional. In fact, self-concept predicted perceived competence support but not vice versa. They have thus hypothesized that self-concept might be more stable in nature and less prone to changes in contextual variables.

According to Deci and Ryan (1985), positive support of competence feelings is an integral determinant of students' motivation. Within self-determination theory, they define the need for competence as the feeling of effectiveness in the interaction with one's environment (Deci & Ryan, 1985; Ryan & Deci, 2000). Particularly in classrooms, this refers to the process of enabling students to experience opportunities and to express individual abilities and talents (Deci & Ryan, 1980; Ryan & Moller, 2005, 2017; White, 1959). This characteristic certainly distinguishes the need for competence from academic self-concept. The latter pertains to a rather individual cognitive evaluation of one's own capabilities (Harter, 1999, 2012), whereas the former denotes the intrinsic satisfaction of a person when effectively meeting the expectations of a challenge. Moreover, the support of academic self-

concept may require intensive interventions (O'Mara et al., 2006); by contrast, perceived competence support can be achieved through a teacher's more immediate means, such as providing differentiated learning activities that are appropriate to students' individual prerequisites (Niemiec & Ryan, 2009).

The support of competence tends to result in increasing levels of motivation, academic performance, and well-being (Deci & Ryan, 1985). Self-determination theory emphasizes the role of the context and its function in the satisfaction of one's needs (Deci & Ryan, 2000a, 2000b), indicating that some environments are likely to be more need supportive than others (Mouratidis, Vansteenkiste, Sideridis, & Lens, 2011). Schools can certainly foster optimal conditions in which students' basic needs for competence can be satisfied, and teachers typically play a crucial role in this context (Katz & Assor, 2006; Niemiec & Ryan, 2009). On the one hand, those conditions refer to tasks and activities that enable students to extend their abilities. On the other hand, they refer to the type of feedback that students obtain. Deci and Ryan (1985, 2011) distinguish between controlling and informational elements. Especially in schools, providing feedback with reference to normative performance standards increases the presence of controlling elements (Ryan & Moller, 2017). In contrast, informational feedback contains information about students' effectivity with higher levels of specificity and shorter temporal distances to the students' challenges (Ryan & Moller, 2017).

Eccles and Midgley (1989) argue that, in particular, the transition from primary to secondary schools is a highly sensitive period in which discrepancies occur between students' individual needs and the contextual conditions; this is because the development into adolescence is coupled with disruptive changes in the educational setting. Moreover, Wang and Eccles (2012) suggest that the misfit increases throughout adolescence. These discrepancies are largely the results of ability grouping, summative assessment, lack of

autonomy in one's own learning process, and whole-class instruction (Eccles & Midgley, 1989). Eccles and Midgley (1989) stage-environment fit theory assumes that more facilitative educational environments can have positive effects. The idea of facilitative environments is also often taken up by self-determination theory (Ryan & Deci, 2017) and respective empirical research (Lazarides & Raufelder, 2017), indicating that the relations among variables may differ across different educational contexts. Instruction and differential treatment may especially have substantial effects on motivation and achievement (Eccles & Roeser, 2011). Learning environments are consequently, and more importantly, necessary for achieving a congruence of individual needs and contextual conditions.

A student-centered learning environment has gained popularity among German schools in recent years. The aim of this learning environment is to attain a high degree of differentiated instruction and hence provide an initial position of learning that is most adaptive to students' prior knowledge. In contrast to a conventional teacher-directed learning (TDL) environment with whole-class instruction, the responsibility in the learning process is mainly shifted to the students (Schweder, Raufelder, Kulakow, & Wulff, 2019). Students are enabled to coordinate learning processes with the help of an instructional instrument, namely a competency matrix (also often referred to as rubrics or competence grids). Competency matrices direct students with a task-based learning approach toward the attainment of educational standards, which have been developed for different subjects and age groups in Germany for the last decade (e.g., Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, 2004). The matrices separate a subject's different goals on a vertical axis and differentiate them into competence levels on a horizontal axis (Stevens, Levi, & Walvoord, 2013). The result is a complex matrix that allows for the determination of a specific individual competence level as the initial learning position. Based on this competence level, students can subsequently access learning material to advance in

that competence field. As teachers are not responsible for instruction in this learning environment, they can focus on individual problems, offer continuous formative feedback, and generally provide a positive learning atmosphere.

Competency matrices particularly allow for consistent academic advancement. Students are given tasks and learning material, which follow Vygotsky's demand of structuring new content to the zone of proximal development (Vygotsky, 1981). The approximate fit of prior knowledge and new content should hence convey to students a continuous sense of capability and indirectly allow for constant success in actual performance—both factors contribute to an increase in the level of academic self-concept (O'Mara et al., 2006; Reeve & Halusic, 2009). Students are similarly supposed to be provided with a high degree of perceived competence support, as they obtain feedback on their competence development on a continuous basis. The mastery of a certain competence level should consequently address the specificity of feedback and provide prompt informational feedback on the student's progress.

Studies on competency matrices have primarily examined their potential in providing effective feedback and the validity of assessments based on those matrices (Jonsson & Svingby, 2007). However, no studies have examined competence matrices as the predominant basis of instruction on a broad range of subjects and across grades in secondary education.

7.2.1 Current study and hypotheses

This study aims to fill the above-mentioned gap by examining whether substantial differences emerge in the interplay between academic self-concept, perceived competence support, and achievement motivation in students from both CBL and TDL environments, considering the potential age-specific effects between early and middle adolescence. By doing so, this study combines aspects of self-determination theory (Deci & Ryan, 1985),

stage-environment fit theory (Eccles & Midgley, 1989), and expectancy value theory (Eccles & Wigfield, 1995) with the aim of deepening our understanding of CBL environments, in which motivational processes are fostered through perceived competence support independent of students' academic self-concept. Accordingly, this study particularly tests whether perceived competence support mediates the relationship between academic self-concept and achievement motivation. Following the method recommended by Baron and Kenny (1986), the current study fulfills all the preconditions of a mediation analysis. As previously mentioned, the existing empirical research has revealed that the predictor variable (academic self-concept) is significantly related to the outcome variable, namely, achievement motivation (Wigfield et al., 2015), whereas the mediating variable (perceived competence support) is significantly related to both the outcome (Deci & Ryan, 1985; Ryan & Deci, 2017) and the predictor variable, which is academic self-concept (Garn & Shen, 2014).

The following hypotheses were tested based on the theoretical review. Hypothesis 1: Students from (a) TDL and (b) CBL environments differ in their perceptions of academic self-concept, perceived competence support, and achievement motivation (persistence and effort, focus, and accuracy). Based on stage-environment fit theory (Eccles & Midgley, 1989), it is assumed that CBL is a more flexible and facilitative environment, in which differentiated instruction is enabled through competence matrices. These competence matrices in turn allow teachers to focus more on the provision of formative feedback, resulting in higher scores of academic self-concept (Hypothesis 1a) and perceived competence support (Hypothesis 1b). As students with higher levels of academic self-concept and perceived competence support tend to demonstrate greater achievement motivation (Areepattamannil, 2012), we also assume higher values in persistence and effort, focus, and accuracy (Hypothesis 1c).

Perceived competence support may function as a mediator in the associations between academic self-concept and achievement motivation (Hypothesis 2). Therefore, potential learning environment and age-specific (Hypothesis 2a) differences could be expected (Eccles & Midgley, 1989).

7.3 Method

7.3.1 Participants and procedures

The data for this study were collected during the winter term (Time 1: T1) and summer term (Time 2: T2) of the German school year 2015–2016. The sample consists of 1,153 students aged 12–18 from the 7th to 10th grades (M_{age} = 13.97; SD = 1.37, 49% girls) at T1 and 775 (M_{age} = 14.27, SD = 1.25, 49% girls) from the initial sample at T2 from six secondary schools in Germany. All six urban mixed- and lower-track schools included in this study were selected from the federal states of Mecklenburg-Western Pomerania, Berlin, Schleswig-Holstein, and North Rhine-Westphalia. Three of these schools ($N_{classes}$ = 36) base their instruction on competence matrices and thus follow a student-centered learning approach in their curricula. First, schools were researched online on the basis of available school profiles, with an emphasis on individualized learning with competence matrices. Second, schools were only incorporated into the pool of potential schools under the condition that all major subjects (German, Maths, and English) were taught exclusively on that basis. Since this approach is newly emerging, only three schools could be identified in which all 7th to 10th grade students have only experienced this learning environment in their secondary school days. Other potential schools have only just begun implementing it with the first classes. The other three ($N_{classes}$ = 21) follow the traditional TDL approach with whole-class instruction as the main instructional practice. Because the identified CBL were exclusively

low-track and mixed-track schools ("Oberschule"), the reference group also included these two school forms.

In Germany, school grades 7 and 8 ("Unterstufe") roughly correspond to early adolescence (ages 10–14) and grades 9 and 10 ("Mittelstufe") to middle adolescence (ages 15–17) (Lerner, 2002). To examine developmental differences in the interplay between the variables of interest (Eccles & Midgley, 1989), we merged the aforementioned grades into the respective groups. We consequently formed the CBL7/8 group from students from the 7th and 8th grade (N = 478, M_{age} = 13.04, SD = 0.81, 49% girls) and the CBL9/10 group from students from the 9th and 10th grade (N = 294, M_{age} = 15.16; SD = 0.87; 48% girls). Accordingly, the TDL sample comprised the TDL7/8 group (N = 211, M_{age} = 13.35; SD = 0.97; 55% girls) and the TDL9/10 group (N = 160, M_{age} = 15.40; SD = 1.05; 47% girls).

Data on ethnicity and socioeconomic status could not be gathered, because of German privacy laws, which prohibit asking somebody for information about another person, including ethnicity and parental income. After the educational authorities approved the conduct of the study, we informed schools, parents, and students about the purpose of the research, along with the anonymity of data collection and voluntary nature of participation. Two trained research assistants distributed the questionnaires to students and explained to them the use of Likert scales. These research assistants were also present throughout the data collection process.

7.3.2 Measures

Independent variable: Academic self-concept. This measure was assessed by a subscale of Skalen zur Erfassung des schulischen Selbstkonzepts (Scales to assess school self-concept) by Schöne, Dickhäuser, Spinath, and Stiensmeier-Pelster (2012). The subscale, consisting of five items, demonstrated good reliability in the present sample (total sample: α

= .84, CBL7/8: α = .86, CBL9/10: α = .82, TDL7/8: α = .83, TDL9/10: α = .83). Items were measured with reference to normative performance criteria (Heckhausen & Heckhausen, 2008) (e.g., “When I look at what we are supposed to know in school, I think that I am not intelligent / very intelligent”) on a five-point Likert scale. This scale is based on self-concept theory (Marsh & Martin, 2011).

Mediator variable: Perceived competence support. Perceived competence support was addressed using a subscale from Support of Basic Needs Scales for Adolescent Students by Müller and Thomas (2011). The subscale consisted of five items on a four-point Likert scale ranging from 1 (almost never) to 4 (almost always). It exhibited good reliability in the present sample (total sample: α = .87, CBL7/8: α = .87, CBL9/10: α = .88, TDL7/8: α = .86, TDL9/10: α = .89). The subscale assessed students’ perceived competence support from their teachers (e.g., “My teacher helps me when I am stuck with a problem”) based on self-determination theory, which states that competence support is a central antecedent of motivation (Deci & Ryan, 1985).

Dependent variables: Achievement motivation. Achievement motivation was addressed using the scales developed by Petermann and Petermann (2014), which associate achievement motivation – according to expectancy value theory – with its behavioral components (Eccles & Wigfield, 1995; Petermann & Petermann, 2014; Rheinberg, 2004). All three of the utilized subscales were measured on a four-point Likert scale ranging from 1 (never) to 4 (often) with the help of four items each. The subscale focus measures the extent to which students can follow tasks assigned to them (e.g., “I am very attentive in class to understand everything”), and it achieved good reliability in the present sample (total sample: α = .81, CBL7/8: α = .81, CBL9/10: α = .81, TDL7/8: α = .82, TDL9/10: α = .81). The

subscale accuracy measures the extent to which students organize their work material to be effectively prepared for learning (e.g., “I sort my worksheets, so that I can find them easily”); it achieved good reliability in the present sample (total sample: α = .82, CBL7/8: α = .83, CBL9/10: α = .84, TDL7/8: α = .76, TDL9/10: α = .80). Finally, the subscale persistence and effort assesses students’ ability to work for a longer period of time and deal with more difficult tasks (e.g., “I am patient when I do my tasks”). It achieved good reliability in the present sample (total sample: α = .83, CBL7/8: α = .83, CBL9/10: α = .80, TDL7/8: α = .86, TDL9/10: α = .85).

7.3.3 Statistical analyses

To test the hypotheses, we conducted latent mean comparison and multigroup structural equation modeling (MGSEM) with indirect effects using Mplus 8.1 (Muthén & Muthén, 1998-2017). All the models were estimated with the maximum likelihood estimator with robust standard errors and Asparouhov’s type-is-complex approach, which corrects standard error biases that emerge as a consequence of the hierarchical nature of our data (students nested in classes) (Asparouhov, 2005). Missing data were considered using the full-information-maximum-likelihood estimation.

Both latent mean comparison and MGSEM require the establishment of measurement invariance across all four groups. We subsequently performed confirmatory factor analyses (CFAs) on all latent constructs and continually added equality constraints to the models’ parameters. First, all the models were estimated freely and separately (model 1: configural measurement invariance). Second, all the groups were merged into one common model (model 2: factorial measurement invariance). Third, equality constraints were set on the factor loadings of all the latent constructs (model 3: weak factorial invariance). Finally, the equality constraints were extended to the factor intercepts (model 4: strong factorial

invariance). In testing our hypotheses, reaching the level of at least partial strong factorial invariance was crucial for both latent mean comparison and MGSEM (Brown, 2015).

To test Hypothesis 2 concerning whether perceived competence support mediates the association between academic self-concept and achievement motivation (focus, accuracy, and persistence and effort) across all four groups, MGSEM with indirect effects was used. The estimates of the indirect effects were calculated using the delta method with symmetric confidence intervals (MacKinnon, 2008). We conceptualized three MGSEM approaches. The first, less restrictive MGSEM assumed measurement invariance (equal factor loadings or intercepts) but freely estimated regression and residual covariance coefficients. Second, a more restrictive model was estimated that assumed differences between both learning environments but equated regression and residual covariance coefficients between both age groups. Lastly, the third MGSEM assumed measurement invariance and additionally equated regression and covariance coefficients across all four groups.

The evaluation of the best fitting model was determined using the recommendations of Hu and Bentler (1999): $\chi 2$ test of model fit, root mean square error of approximation (RMSEA) with its respective confidence intervals, standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker-Lewis index (TLI). Model comparisons of the nested models, such as the invariance test and the test for group differences, were conducted through the $\chi 2$ difference test, which is based on log likelihood values and scaling correction factors, and through examining differences in CFI, TLI, RMSEA, and SRMR (Chen, 2007; Satorra & Bentler, 2001).

7.4 Results

7.4.1 Descriptive statistics and intercorrelations

The descriptive statistics (means, standard deviations, range, skewness and kurtosis with their respective standard errors) along with the intercorrelations of all the latent variables for each group are presented in Table 6.

Table 6

Intercorrelations between the academic self-concept, competence support (T1) and focus, accuracy and persistence (T2) and their range, means, standard deviations, kurtosis and skewness for 7th/8th and 9th/10th grade students following CBL or TDL

	1	2	3	4	5	M	Range	SD	Skewness (SE)	Kurtosis (SE)
CBL – grade 7/8										
1 self-concept_t1		.20**	.42***	.32***	.43***	3.52	1–5	0.68	−.23 (.11)	.07 (.22)
2 competence support_t1			.42***	.38***	.38***	2.90	1–4	0.69	−.52 (.11)	−.24 (.22)
3 focus_t2				.85***	.91***	3.08	1–4	0.65	−.77 (.12)	.99 (.24)
4 accuracy_t2					.74***	3.02	1–4	0.75	−.74 (.12)	.13 (.24)
5 persistence_t2						2.94	1–4	0.66	−.84 (.12)	1.02 (.24)
CBL – grade 9/10										
1 self-concept_t1		.39***	.43**	.39***	.41***	3.42	1–5	0.66	−.30 (.14)	−.21 (.28)
2 competence support_t1			.41***	.38***	.37**	2.73	1–4	0.74	−.33 (.14)	−.25 (.28)
3 focus_t2				.60***	.83***	3.21	1–4	0.55	−.70 (.23)	.57 (.45)
4 accuracy_t2					.53***	3.26	1–4	0.75	−1.20 (.23)	.89 (.45)
5 persistence_t2						3.03	1–4	0.62	−.56 (.23)	.02 (.45)
TDL – grade 7/8										
1 self-concept_t1		.31***	.54***	.21*	.44***	3.17	1–5	0.63	−.44 (.16)	.94 (.33)
2 competence support_t1			.37***	.23**	.35***	2.74	1–4	0.65	−.10 (.16)	−.46 (.33)
3 focus_t2				.60***	.86***	3.05	1–4	0.59	−.45 (.18)	.02 (.36)
4 accuracy_t2					.48***	3.21	1–4	0.60	−.74 (.18)	.35 (.36)
5 persistence_t2						2.88	1–4	0.67	−.47 (.18)	.23 (.36)
TDL – grade 9/10										
1 self-concept_t1		.25***	.24	.09	.33*	3.44	1–5	0.59	.22 (.19)	−.39 (.38)
2 competence support_t1			.17	.13	.13	2.69	1–4	0.73	−.17 (.19)	−.04 (.38)
3 focus_t2				.81***	.74***	3.14	1–4	0.60	−.54 (.27)	.87 (.53)
4 accuracy_t2					.59**	3.24	1–4	0.66	−1.11 (.27)	1.75 (.53)
5 persistence_t2						3.01	1-4	0.66	−.45 (.27)	.25 (.53)

Note. Self-concept_t1 = academic self-concept time 1, competence support_t1 = competence support time 1, focus_t2 = focus time 2, accuracy_t2 = accuracy time 2, persistence_t2 = persistence and effort time 2; * $p < .05$, ** $p < .01$, *** $p < .001$.

7.4.2 Latent mean comparison

To test Hypothesis 1, we conducted CFA on all the latent constructs to compare the latent means across all four groups and establish an initial measurement model for the mediation analysis (Hypothesis 2).

The CFA for measurement invariance confirmed the level of partial strong factorial invariance. The respective model fit indices and the results of the χ^2 difference test are presented in Table 7 According to Brown (2015), a free estimation of certain factor parameters is justified and does not prohibit the comparison of latent means. Precisely, we freed one indicator of the accuracy scale in the CBL 7/8 group and one indicator of the academic self-concept scale in group TDL 7/8 and TDL 9/10. Thus, the preliminary analyses allowed for investigating both latent means and MGSEM.

Table 7

Model fit indices of the stepwise CFA procedure to proof measurement invariance

Model	df	χ2	*p*	CFI	TLI	RMSEA	90%CI	SRMR	Δ_{χ}^2	Δdf	*p*
Invariance testing across groups											
Model 1a	199	352.671	< .001	.96	.95	.04	.03–.05	.04			
Model 1b	199	349.779	< .001	.92	.91	.05	.04–.06	.06			
Model 1c	199	262.206	< .001	.96	.96	.04	.02–.05	.05			
Model 1d	199	374.215	< .001	.89	.87	.07	.06–.09	.08			
Model 2	796	1330.089	< .001	.94	.93	.05	.04–.05	.06			
Model 3*	847	1386.907	< .001	.94	.94	.05	.04–.05	.07	57.68	51	.24
Model 4a*	898	1482.594	< .001	.94	.94	.05	.04–.05	.07	96.65	51	<.001
Model 4b**	895	1451.652	< .001	.94	.94	.05	.04–.05	.07	63.90	48	.06

Note. Model 1a–d = measurement models for CBL 7/8, CBL 9/10, TDL 7/8, TDL 9/10 separately (configural invariance); Model 2 = merged measurement model with all parameters free (form invariance); Model 3 = equality of factor loadings (metric invariance); Model 4a = equality of factor intercepts (scalar invariance); Model 4b = equality of several factor incepts (partial scalar invariance) *result of the χ2-difference test between the two subsequent models; **result of the χ2-difference test between Model 4b (partial invariance) with Model 3 (metric invariance).

Comparison of CBL vs. TDL. Using students from CBL 7/8 as a reference group, students from TDL 7/8 exhibited significantly lower values concerning the academic self-concept at T1 (β = -0.55, $p < .001$), but students in TDL 7/8 reported greater values in accuracy at T2 (accuracy time 2: β = 0.35, $p < .05$). However, both groups did not differ in perceived competence-support at T1 (β = -0.25, $p = .06$), focus at T2 (β = -0.02, $p = .86$), and persistence and effort at T2 (β = -0.06, $p = .62$). Results of the comparison between students from CBL 9/10 and students from TDL 9/10 indicated no significant differences between the groups: perceived competence-support at T1 (β = -0.04, $p = .82$), academic self-concept at T1 (β = -0.07, $p = .60$), accuracy at T2 (β = 0.01, $p = .13$), focus at T2 (β = 0.10, $p = .67$), and persistence and effort at T2 (β = -0.06, $p = .80$) did not differ significantly.

Comparison of latent means across time. The developmental perspective within CBL demonstrated that the middle adolescent students in CBL 9/10 reported significantly less perceived competence-support at T1 (β = -0.25, $p < .05$) but more accuracy at T2 (β = 0.29, $p < .05$). Academic self-concept at T1 (β = -0.16, $p = .10$), focus at T2 (β = 0.23, $p = .14$), and persistence and effort at T2 (β = 0.18, $p = .28$) did not differ between the two groups.

In the TDL environment, middle adolescent students reported significantly higher values of academic self-concept at T1 (β = .46, $p < .001$). All other latent constructs did not change over time: perceived competence-support at T1 (β = -.09, $p = .64$), accuracy at T2 (β = .05, $p = .82$), focus at T2 (β = .15, $p = .44$), and persistence and effort at T2 (β = .17, $p = .33$).

7.4.3 Multigroup structural equation modelling

Based on the intercorrelations in Table 1, the interplay of the variables of interest was assumed to differ across all four groups. Thus, we developed our conceptualized model. In this model, perceived competence-support mediates the association between academic self-concept (independent variable) and achievement motivation (dependent variables of focus, accuracy, and persistence and effort).

First, we produced the less-restrictive model (model 1), which included the invariance assumptions of CFA, but freely estimated regression and residual covariance coefficients. Therefore, the direct effects from the academic self-concept on perceived competence-support and on the achievement motivation variables (focus, accuracy, and persistence and effort) were added, implying the hypothesis that group differences in the interplay exist. Moreover, the residuals of the dependent variables were allowed to covary with each other. This model produced a good fit: $\chi^2(898) = 1482.593$, $p(\chi^2) < .001$, CFI = .94, TLI = .94, RMSEA (90% *CI*) = .05 [.04,.05], SRMR = .07.

Second, a more restrictive model (model 2) was computed that assumed differences in terms of the learning environment, but did not assume differences in terms of age. Consequently, regression and residual covariance coefficients were equated between the age groups within both learning environments. This model also produced good fit indices

($\chi^2(918) = 1518.387$, $p(\chi^2) < .001$, CFI = .94, TLI = .94, RMSEA (90% *CI*) = .05 [.04,.05], SRMR = .09).

Last, a model with more restrictions (model 3) was tested, which additionally placed equality constraints on all the direct effects and residual covariance coefficients across all four groups, implying the non-existence of group differences, both in terms of the learning environment and the age of the students. This model produced a good fit as well: $\chi^2(928) = 1537.416$, $p(\chi^2) < .001$, CFI = .93, TLI = .93, RMSEA (90% *CI*) = .05 [.04,.05], SRMR = .10.

Finally, the models were compared in a step-wise procedure. The comparisons of model 1 and model 2 ($\Delta\chi^2 = 36.27$, $\Delta df = 20$; $p < .001$; ΔCFI = .00; ΔTLI = .00; ΔRMSEA = .00; ΔSRMR = .02), and the comparisons of model 2 and model 3 ($\Delta\chi^2 = 18.94$, $\Delta df = 10$; $p < .001$; ΔCFI = .01; ΔTLI = .01; ΔRMSEA = .00; ΔSRMR = .01) indicated a slight, but significant decreases in model fit when introducing the equality constraints. Consequently, significant differences in the patterns between the variables of interest among the four groups were assumed based on the final least restrictive model (model 1).

Patterns for CBL in early adolescence. Figure 3 illustrates the final model for the CBL 7/8 group. Academic self-concept at T1 is significantly associated with perceived competence-support at T1 ($B = 0.21$, $\beta = 0.21$, $SE = 0.06$, $p < .01$), with focus at T2 ($B = 0.34$, $\beta = 0.35$, $SE = 0.05$, $p < .001$), with accuracy at T2 ($B = 0.29$, $\beta = 0.26$, $SE = 0.06$, $p < .001$), and with persistence and effort at T2 ($B = 0.35$, $\beta = 0.37$, $SE = 0.05$, $p < .001$). Moreover, perceived competence-support at T1 predicted focus at T2 ($B = 0.33$, $\beta = 0.35$, $SE = 0.05$, $p < .001$), accuracy at T2 ($B = 0.37$, $\beta = 0.32$, $SE = 0.06$, $p < .001$), and persistence and effort at T2 ($B = 0.28$, $\beta = 0.30$, $SE = 0.04$, $p < .001$).

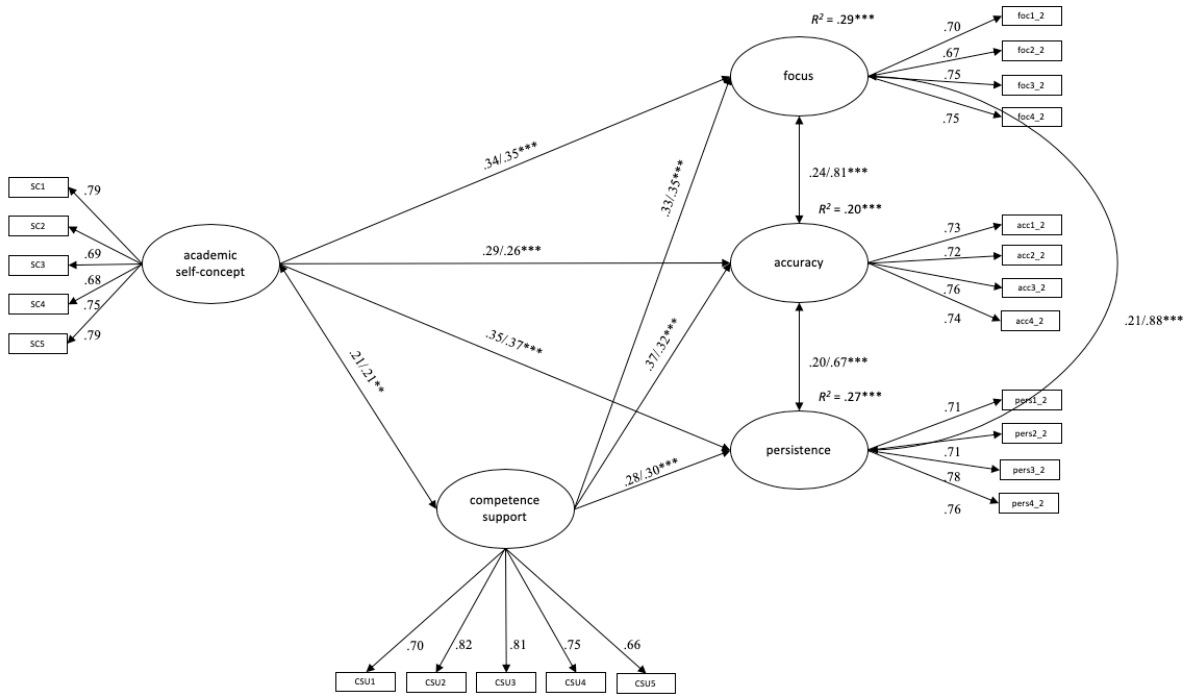

Figure 3. Final model for the 7th/ 8th grade students following CBL. * $p < .05$, ** $p < .01$, *** $p < .001$; in contrast to this depiction, the calculation of the confidence intervals suggests insignificant indirect effects.

All the associations between academic self-concept and the three achievement motivation variables were found to be positively mediated by perceived competence-support. Perceived competence-support at T1 partially mediated the association between academic self-concept at T1 and focus at T2 ($B = 0.07$, $\beta = 0.07$, $SE = 0.02$, 95% CI [0.03, 0.11]), and accuracy at T2 ($B = 0.08$, $\beta = 0.07$, $SE = 0.03$, 95% CI [0.02, 0.13]), and persistence and effort at T2 ($B = 0.06$, $\beta = 0.06$, $SE = .02$, 95% CI [0.02, 0.09]).

The residual covariance of focus at T2 and accuracy at T2 was positively associated ($r = .81$, $p < .001$), as were the residual covariances between focus at T2 and persistence and effort at T2 ($r = .88$, $p < .001$), and accuracy at T2 and persistence and effort at T2 ($r = .67$, $p < .001$). Overall, this model accounted for 29.2% of the variation of focus at T2 ($R^2 = .292$, p

< .001), 20.3% of accuracy at T2 (R^2 = .203, p < .001), and 26.9% of persistence and effort at T2 (R^2 = .269, p < .001).

Patterns for CBL in middle adolescence. Figure 4 depicts the final model for the CBL 9/10 group. In the CBL 9/10 group, we have identified five significant direct effects: academic self-concept at T1 is associated with perceived competence-support at T1 (B = 0.47, β = 0.41, SE = 0.10, p < .001), with focus at T2 (B = 0.29, β = 0.33, SE = 0.12, p < .05), with accuracy at T2 (B = 0.33, β = 0.27, SE = 0.10, p < .01), and with persistence and effort at T2 (B = 0.30, β = 0.32, SE = 0.12, p < .05). Moreover, perceived competence-support at T1 is positively associated with accuracy at T2 (B = 0.28, β = 0.27, SE = 0.08, p < .001).

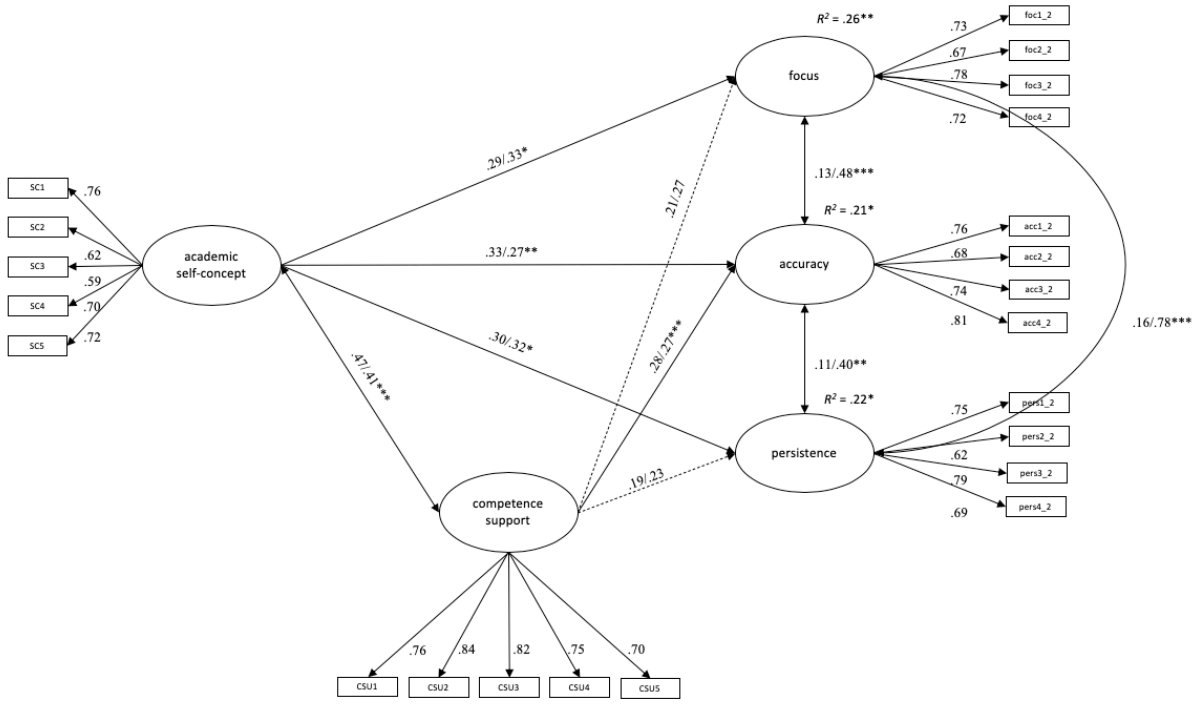

Figure 4. Final model for the 9th/ 10th grade students following CBL. * p < .05, ** p < .01, *** p < .001; in contrast to this depiction, the calculation of the confidence intervals suggest insignificant indirect effects.

In the middle adolescent CBL 9/10 group, perceived competence-support at T1 positively mediated the association between academic self-concept at T1 and accuracy at T2 (B = 0.13, β = 0.11, SE = 0.05, 95% CI [0.04, 0.23]). However, the competence support did not mediate the association between academic self-concept at T1 and focus at T2 (B = 0.10, β = 0.11, SE = 0.07, 95% CI [-0.03–0.23]) and between academic self-concept at T1 and persistence and effort at T2 (B = 0.09, β = 0.10, SE = 0.05, 95% CI [-0.01–0.19]).

The residuals of all three dependent variables were positively associated: focus at T2 with accuracy at T2 (r = .48, p < .001), focus at T2 with persistence and effort at T2 (r = .78, p < .001), and accuracy at T2 with persistence and effort at T2 (r = .40, p < .01).

Overall, this model explained 25.6% of the variation of focus at T2 (R^2 = .256, p < 01), 20.6% of accuracy at T2 (R^2 = .206, p < .05), and 22.2% of persistence and effort at T2 (R^2 = .222, p < .05).

Patterns for TDL in early adolescence. Figure 5 presents the final model for the TDL 7/8 group. In the TDL 7/8 group, six of the seven direct effects were found to be significantly associated. Academic self-concept at T1 was positively associated with perceived competence-support at T1 (B = 0.32, β = 0.31, SE = 0.09, p < .001), with focus at T2 (B = 0.44, β = 0.47, SE = 0.08, p < .001), and with persistence and effort at T2 (B = 0.38, β = 0.36, SE = 0.12, p < .01). Moreover, perceived competence-support at T1 was associated with focus at T2 (B = 0.21, β = 0.22, SE = 0.09, p < .05), with accuracy at T2 (B = 0.17, β = 0.18, SE = 0.08, p < .05), and with persistence and effort at T2 (B = 0.24, β = 0.24, SE = 0.10, p < .05).

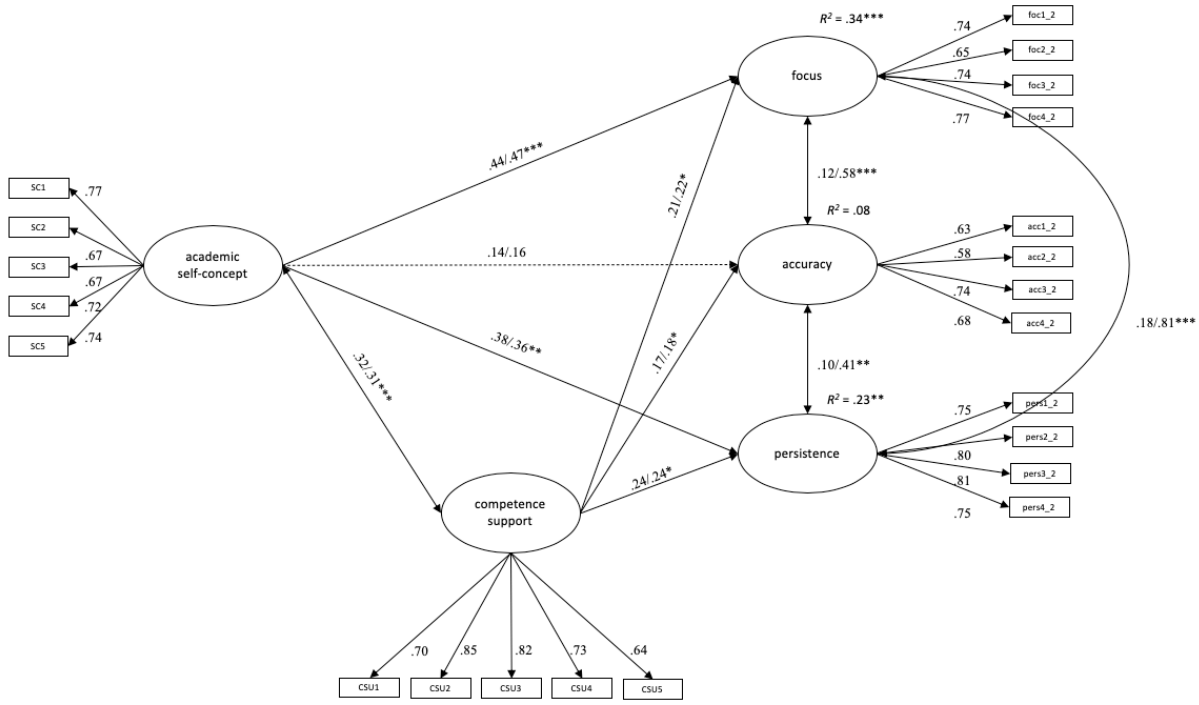

Figure 5. Final model for the 7th/ 8th grade students following TDL. * $p < .05$, ** $p < .01$, *** $p < .001$.

No significant indirect effect could be identified for the TDL 7/8 group. Perceived competence-support at T1 did not mediate the association between academic self-concept at T1 and focus at T2 ($B = 0.07$, $\beta = 0.07$, $SE = 0.03$, 95% CI [-0.001, 0.13]), and accuracy at T2 ($B = 0.05$, $\beta = 0.06$, $SE = 0.03$, 95% CI [-0.001, 0.11]), and persistence and effort at T2 ($B = 0.08$, $\beta = 0.07$, $SE = 0.04$, 95% CI [-0.001, 0.16]).

The residuals of all the dependent variables were positively associated in the TDL 7/8 group: focus at T2 with accuracy at T2 ($r = .58$, $p < .001$), focus at T2 with persistence and effort at T2 ($r = .81$, $p < .001$), and accuracy at T2 with persistence and effort at T2 ($r = .41$, $p < .001$).

The final model of TDL 7/8 explained 33.8% of variation of focus at T2 ($R^2 = .338$, $p < .001$) and 24.3% of persistence and effort at T2 ($R^2 = .243$, $p < .01$). The coefficient of determination was insignificant for accuracy at T2 ($R^2 = .075$, $p = .08$).

Patterns for TDL in middle adolescence. Figure 6 illustrates the final model for the TDL 9/10 group. In the TDL9/10 group, two of the seven effects were found to be significantly associated: academic self-concept at T1 predicted perceived competence support at T1 (B = 0.32, β = 0.25, SE = 0.08, p < .001) and persistence and effort at T2 (B = 0.35, β = 0.32, SE = 0.13, p < .01).

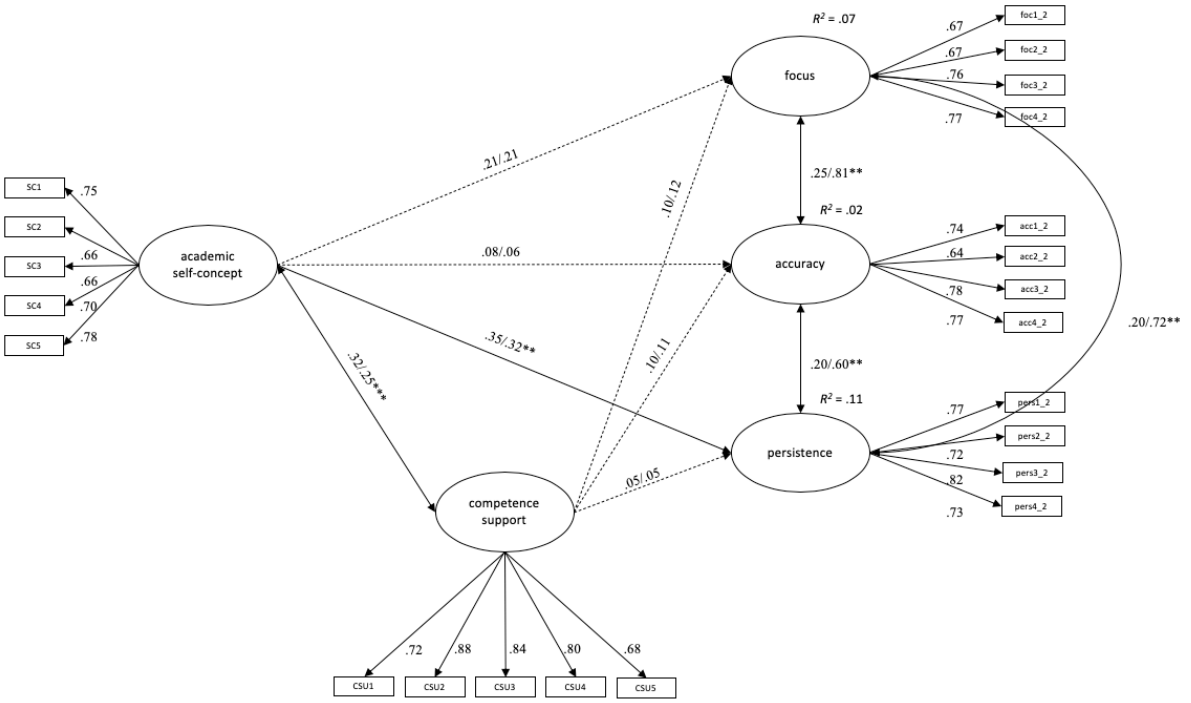

Figure 6. Final model for the 9th/ 10th grade students following TDL. * p < .05, ** p < .01, *** p < .001.

Significant indirect effects for the TDL9/10 group were lacking, and perceived competence support at T1 consequently did not mediate the association between academic self-concept at T1 and focus at T2 (B = 0.03, β = 0.03, SE = 0.02, 95% CI [-0.02, 0.08]), accuracy at T2 (B = 0.03, β = 0.03, SE = 0.03, 95% CI [-0.03, 0.10]), and persistence and effort at T2 (B = 0.01, β = 0.01, SE = 0.03, 95% CI [-0.05, 0.08]).

In the CBL9/10 group, the residuals of all dependent variables were significantly associated at T2: focus and accuracy ($r = .81$, $p < .001$), focus and persistence and effort ($r = .72$, $p < .001$), accuracy and persistence and effort ($r = .60$, $p < .001$).

This final model did not explain any variation in the dependent variables: focus at T2 ($R^2 = .070$, $p = .50$), accuracy at T2 ($R^2 = .019$, $p = .52$), and persistence and effort at T2 ($R^2 = .112$, $p = .23$).

7.5 Discussion

This study investigated the role of perceived competence support in the association between academic self-concept and achievement motivation among early and middle adolescent students in different learning environments (CBL vs. TDL). It specifically examined whether students in early adolescence and middle adolescence from classes following CBL vs. TDL differ in the variables' mean values and whether perceived competence support equally functions as a mediator between academic self-concept and achievement motivation for each group.

Hypothesis 1a was only partially confirmed: students following CBL reported significantly greater values in academic self-concept than students from TDL environments. This result aligns well with O'Mara et al. (2006) meta-analysis, which indicates that intervention characteristics, such as individual counseling and feedback, have significant effect sizes on academic self-concept. The reduced responsibility of teachers to instruct the students creates additional capacities for them to provide individual feedback. In addition, competence matrices enable students to continuously experience progress in their learning processes and to have this progress visibly reflected to them, which might even enrich the personal feedback of teachers. Furthermore, the effects of social comparison on academic self-concept (Hoferichter et al., 2018) can be reduced because of students' ability to

simultaneously work on different competence fields. However, this difference did not replicate at T2. In summary, this supports the notion that age might be an important factor for self-concept interventions (O'Mara et al., 2006).

Contrary to Hypothesis 1b, students from CBL vs. TDL environments did not significantly differ in their perceived competence support, neither in early adolescent nor in middle adolescent students. This result might have occurred because of the scale that was used in this study: the perceived competence support scale solely focuses on the provision of competence by the person of the teacher (e.g., “My teacher helps me when I am stuck with a problem”) (Müller & Thomas, 2011) rather than by the entity of the learning environment. Considering a study on the importance of social relations in scholastic education (Raufelder, Jagenow, Drury, & Hoferichter, 2013), we determine that teachers are only partly perceived as motivational resources, whereas the need for competence may also be satisfied by various other influences. This aspect may well apply to the TDL environment in which teachers assume a central role in the classroom; by contrast, teachers in CBL classrooms have a relatively distal role in the instructional process, and the students themselves enhance their competence independently.

The results of achievement motivation contradicted Hypothesis 1c. While a) persistence and effort and b) focus did not differ between the groups, a mean difference in accuracy at T1 was identified in favor of the TDL environment. Nevertheless, this difference might more strongly reflect classroom demands within the two learning environments. Teacher-directed learning environments are more dependent on accuracy as teachers cannot properly adapt to previous content if students inadequately prepare their material. By contrast, the necessary accuracy in CBL environments might be more flexible because of individual needs and demands.

With regard to Hypothesis 2a, significant differences occurred in the associations between the academic self-concept, perceived competence support, and achievement motivation (persistence and effort, accuracy, and focus) of early and middle adolescent students from both learning environments (CBL vs. TDL). Specifically, for early adolescent CBL students, perceived competence support partially mediated all the associations between academic self-concept and achievement motivation (persistence and effort, accuracy, and focus). For middle adolescent students in CBL environments, only the association between academic self-concept and accuracy was partially mediated by perceived competence support. However, while the confidence intervals indicated insignificant indirect effects for the middle adolescent group, parameter estimates were in fact higher in this group which may indicate insufficient statistical power to detect the significance of the effect. As perceived competence support reduces the associations (partial mediation) between academic self-concept and achievement motivation, students' motivation can be better fostered through high perceived competence support in CBL independent of their academic self-concept, compared to students in TDL. In other words, perceived competence support in class can protect achievement motivation. An open question, however, remains whether the mediator actually loses relevance in middle adolescence or whether it is only the power that failed to detect the effects. This may contribute to a more proper understanding of stage-environment fit (Eccles & Midgley, 1989), namely whether appropriate adjustments in learning environments are necessary throughout adolescence.

On the contrary, the statistically significant mediating effects of perceived competence support between academic self-concept and achievement motivation could not be identified for students in TDL environments, neither for early nor middle adolescent students. However, similarly to the middle adolescent CBL group, the early adolescent TDL sample exhibited comparable parameter estimates to the early and middle adolescent CBL sample.

However, in the TDL case, sample size might have led to the rejection of the alternative hypothesis. Achievement motivation of students in TDL seems to be more strongly associated with relatively stable factors such as academic self-concept, and external factors such as perceived competence support cannot dissolve this relationship. This inflexible relationship might be because achievement motivation in such a learning environment could be much more strongly dependent on the teachers and their central position in this classroom context. This aspect is particularly problematic as it indicates that students' achievement motivation is rather attached to a person who will eventually disappear from their academic life. This dependency relates to raising and educating students without the premise of becoming independent in their learning processes. Furthermore, the expected differences of stage-environment fit theory (Eccles & Midgley, 1989) between TDL7/8 and TDL9/10 were present, even though they were negative. Although TDL7/8 lacked indirect effects, academic self-concept and competence support significantly contributed to achievement motivation in terms of direct effects. The majority of these effects was not present in the middle adolescent TDL9/10 group. This lack of effects is linked particularly to the predictor, namely, perceived competence support. Ryan and Moller (2017) consider perceived competence support to be an insufficient condition for achievement motivation. Instead, perceived competence support depends on the presence of autonomy. However, TDL environments frequently fail to provide autonomy support (Reeve, 2009; Reeve, Jang, Carrell, Jeon, & Barch, 2004). In contrast, the development of students from early adolescence to middle adolescence is accompanied by an increasing need for autonomy (Eccles et al., 1991). The gap between the needs' satisfaction of the environment and the actual needs consequently broadens. This assumption could also be made, if we consider that the lack of indirect effects in the TDL7/8 sample was only caused by insufficient statistical power. In that case, it could be argued that the associations between academic self-concept, perceived competence-support, and achievement motivation

are not moderated by the learning environment. However and in support of stage-environment fit theory (Eccles & Midgley, 1989), distinctive differences are evident if we consider the middle adolescent TDL group.

The coefficients of determination are alarming for the TDL9/10 group, although they must be considered carefully because of the relatively small subsample. The final model for this group could not explain any significant variation in the dependent variables, indicating that neither academic self-concept nor perceived competence support play an important role in students' achievement motivation, contrary to predominant educational theory. We can consequently assume that restrictive and controlling learning environments may even suppress the relations among the variables. Ryan and Deci (2017) argue that schools often tend to fail to capitalize on establishing learning environments that support the diversity of their students, such as their interests and capacities. Instead, "grades, awards, and social comparisons are commonplace" (p. 351).

7.5.1 Theoretical implications

These results align well with both the theoretical background within both self-determination theory (Ryan & Deci, 2000) and stage-environment fit theory (Eccles & Midgley, 1989). Based on self-determination theory, Ryan and Moller (2017) refer to the need for competence as an essential but insufficient condition for motivation. According to the theory, this condition may be attributable not only to the provision of autonomy as a basic need within the learning environment but also to the environment itself (Ryan & Deci, 2017), which provides either optimal conditions for satisfying a person's needs or conditions that thwart them. To utilize the needs, learning activities should be adaptive to varying levels of challenge (Ryan & Moller, 2017). If the learning environment is somewhat controlling und externally regulated, then competence need satisfaction becomes rather redundant, and

minimal performance outputs are to be expected (Taylor et al., 2014). Comparable results were also indicated by Raufelder, Regner, Drury, and Eid (2015), who found considerable inter-individual differences in the role of perceived competence support depending on the socio-motivational type of students. Self-determination theory argues that the satisfaction of the need for competence depends to a large degree on teaching style and teacher feedback (Niemiec & Ryan, 2009), similarly to academic self-concept (Usher, 2016).

In summary, TDL is assumed to be a relatively controlling environment in which perceived competence support is incapable of dissolving the relationship between academic self-concept and achievement motivation, particularly in middle adolescence. This assumption provides further evidence for the dependency of perceived competence support on contextual conditions. In contrast, students following the CBL approach are widely autonomous in engaging in learning activities with the help of competence matrices. This flexibility in the context conditions enables the integration of perceived competence support to foster achievement motivation.

Drawing on stage-environment fit theory (Eccles & Midgley, 1989), we assume that the CBL environment is more favorable than the conventional TDL environment. According to the theory, educational contexts may facilitate or thwart the motivational development of students. The learning environment in CBL enables more flexible associations between the variables of interest and possibly easier intervention possibilities. Furthermore, the possible sources of a better context fit might lie in less teacher control coupled with more opportunities for decision-making and autonomy, better teacher–student relationships, and less social comparison and competition (Roeser, Eccles, & Sameroff, 1998; Wang, 2009). To a certain extent, these factors are addressed in the CBL environment, and if Reeve and Halusic (2009's) recommendations for autonomous teaching practices are considered, then

this learning environment's incorporation of a number of those factors without depending on the teacher becomes apparent.

7.5.2 Practical implications

From an instructional viewpoint, students in CBL face an environment in which they have the opportunity to learn at their own pace and expand their skills and prior knowledge. In traditional classroom contexts (TDL), however, teachers prefer relatively homogeneous learning groups because such structures help them to address their students' instructional needs (Chorzempa & Graham, 2006). In the past decade, awareness has grown not only in the divergent instructional needs but also in other variable motivational requirements that significantly affect learning. Furthermore, learning environments should be more adaptive to these needs and provide a broader range of possible arrangements than pure whole-class instruction. In addition to highlighting the instructional viewpoint, the CBL environment enables teachers to individually focus on students. This focus refers to individual help if students are unable to cope with the instruction based on the competence matrices or with task difficulty. Moreover, whole-class instruction in TDL frequently denotes that high-ability students are restrained from progressing in certain competence fields or vice versa; at the same time, low-ability students are left behind because they either need more time to deal with certain contents or lack the prior knowledge to appropriately connect it with new skills and knowledge. The major concern with perceived competence support in TDL classrooms might lie in the fact that students cannot suitably address the feedback issued by teachers, as these teachers will continue with instruction to meet the needs of other students who will otherwise become bored. The responsibility of catching up to the instructional level of the class is thus placed outside of the classroom. In contrast, students in CBL classrooms do not depend on their teachers' instruction and are able to effectively address prior feedback within

their time at school. In that sense, CBL represents a learning environment that unties the dependency on the teacher and shifts the responsibility for achievement motivation and learning to the student. In such autonomy in learning, the support of competence bolsters achievement motivation.

7.5.3 Strengths, limitations and future directions

This study has some limitations that must be addressed. First, it used solely questionnaires and therefore self-report data. However, our singular focus was on investigating the internal states of participants rather than their actual performance behavior. Moreover, the study participants were adolescent students, and in contrast to younger children, adolescent students do not tend to have difficulty in expressing their internal states. We consequently believe in the appropriateness of self-report data. Second, the four age groups were not equally distributed; and significant effects may also be caused by greater statistical power. This poses a problem as many of the indirect effects barely failed to reach the significance level of .05, which mostly affected the CBL9/10 which even showed higher parameter estimates in contrast to the significant estimates of the CBL7/8 group.

Therefore, replication studies are warranted to confirm or refute these findings. Third, the issue of partial invariance is problematic. Brown (2015) criticizes this procedure as it is a post-hoc procedure without theoretical rationales. On the other hand, however, the large sample size of this study has sufficient power to detect even marginal differences in these parameter estimates. An attempt was made to minimize the potential for misleading results of the latent mean comparisons by freeing only the minimum number of factor intercepts. Moreover, future studies might test self-concept as a potential mediator in the relationship between perceived competence support and achievement motivation, as both predictor and mediator were assessed at the same timepoint in our study. Therefore, the regressions in the

SEM are assumed to be conceptual relations rather than causal relations. Furthermore, we could not include demographic control variables such as socioeconomic status and ethnicity, which are prohibited by the educational administration resulting from German privacy laws. Finally, generalizability is limited to a certain degree because of the non-random sample of the CBL group, in which no high-tracking and schools from rural areas were incorporated. This selectiveness also leads to a restricted random sample of the TDL group, which then had to exclude rural and high-tracking schools as well to achieve comparability. If the CBL learning environment continues to gain popularity in the school system, future studies should aim to incorporate schools with those features to achieve representativeness of the sample.

This study also offers several strengths. First, it compares students' academic self-concept, achievement motivation, and perceived competence support in different instructional learning environments. It specifically considers and identifies the essential differences between students from schools with traditional teacher-directed learning (TDL) environments and those from a newly emerging student-centered learning environment (CBL), which empirically supports stage-environment fit theory. Future longitudinal studies are required to confirm these findings and investigate how different learning environments contribute to motivational development in scholastic education. This is particularly necessary as the indirect effects were rather small. Because of the theoretical similarities between self-concept and perceived competence-support, an additional empirically driven analysis was conducted in which both constructs were specified as predictors. The results of that analysis can be found in the online supplement (Appendix A).

Moreover, the present study was conducted on the basis of stage-environment-fit theory (Eccles & Midgley, 1989). With that theoretical background and the subsequent division of the sample in two age groups, multilevel analyses were not feasible anymore. Even with manifest measurement and manifest aggregation approach (Lüdtke, Marsh,

Robitzsch, & Trautwein, 2011), which would introduce other bias to the model, the number of L2 units (e.g., classes) and L3 (e.g., schools) was too small. Future studies should focus on sampling a high number of classes and schools to capture the hierarchical nature of the data and perform multilevel analyses. These analyses could further increase the reliability and validity of the findings and verify/ falsify the findings of the present study.

Furthermore, the study reveals that perceived competence support in CBL environments can decrease the influence of academic self-concept on students' motivation. This factor is particularly important for the enhancement of students with a low level of academic self-concept and who are more often at risk for a downward tendency of their motivation during adolescence (Bakadorova & Raufelder, 2016; Hay, Ashman, & van Kraayenoord, 1998).

7.6 Appendix A

As the indirect effects were weak, an alternative model was conceptualized in which perceived competence support and academic self-concept predicted achievement motivation (model 1). This model produced a good fit: $\chi2(898) = 1482.594$, $p(\chi2) < .001$, CFI = .94, TLI = .94, RMSEA (90% CI) = .05 [.04,.05], SRMR = .07. Second, a more restrictive model (model 2) was computed that assumed differences in terms of the learning environment, but did not assume differences in terms of age. Consequently, regression and residual covariance coefficients were equated between the age groups within both learning environments. This model also produced good fit indices ($\chi2(918) = 1515.023$, $p(\chi2) < .001$, CFI = .94, TLI = .94, RMSEA (90% CI) = .05 [.04,.05], SRMR = .09).

Last, a model with more restrictions (model 3) was tested, which additionally placed equality constraints on all the direct effects and residual covariance coefficients across all four groups, implying the non-existence of group differences, both in terms of the learning environment and the age of the students. This model produced a good fit as well: $\chi2(928) = 1534.198$, $p(\chi2) < .001$, CFI = .94, TLI = .94, RMSEA (90% CI) = .05 [.04,.05], SRMR = .10.

Finally, the models were compared in a step-wise procedure. The comparisons of model 1 and model 2 ($\Delta\chi2 = 32.34$, $\Delta df = 20$; $p < .05$; ΔCFI = .00; ΔTLI = .00; ΔRMSEA = .00; ΔSRMR = .01), and the comparisons of model 2 and model 3 ($\Delta\chi2 = 19.06$, $\Delta df = 10$; $p < .05$; ΔCFI = .00; ΔTLI = .00; ΔRMSEA = .00; ΔSRMR = .01) indicated a slight, but significant decreases in model fit when introducing the equality constraints. Consequently, significant differences in the patterns between the variables of interest among the four groups were assumed based on the final least restrictive model (model 1).

Table A1

Results of the Alternative Model

	focus_t2				persistence_t2				accuracy_t2			
Predictors	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*	*B*	β	*SE*	*p*
CBL7/8												
academic self-concept_t1	**0.34**	**0.35**	**0.05**	**< .001**	**0.35**	**0.37**	**0.05**	**< .001**	**0.29**	**0.26**	**0.06**	**< .001**
perceived competence support_t1	**0.33**	**0.35**	**0.05**	**< .001**	**0.28**	**0.30**	**0.04**	**< .001**	**0.37**	**0.32**	**0.06**	**< .001**
CBL9/10												
academic self-concept_t1	**0.29**	**0.33**	**0.12**	**< .05**	**0.30**	**0.32**	**0.12**	**< .05**	**0.33**	**0.27**	**0.10**	**< .01**
perceived competence support_t1	0.21	0.27	0.12	= .09	0.19	0.23	0.10	= .06	**0.28**	**0.27**	**0.08**	**< .001**
TDL7/8												
academic self-concept_t1	**0.44**	**0.47**	**0.08**	**< .001**	**0.38**	**0.36**	**0.12**	**< .01**	0.14	0.16	0.09	= .10
perceived competence support_t1	**0.21**	**0.22**	**0.09**	**< .05**	**0.24**	**0.24**	**0.10**	**< .05**	**.017**	**0.18**	**0.08**	**< .05**
TDL9/10												
academic self-concept_t1	0.21	0.21	0.19	= .26	**0.35**	**0.32**	**0.13**	**< .01**	0.08	0.06	0.16	= .63
perceived competence support_t1	0.10	0.12	0.08	= .24	0.05	0.05	0.11	= .68	0.10	0.11	0.11	= .35

Note. Self-concept_t1 = academic self-concept time 1, competence support_t1 = competence support time 1, focus_t2 = focus time 2, accuracy_t2 = accuracy time 2, persistence_t2 = persistence time 2; significant paths are displayed in bold at $p < .05$ level.

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8 Study III: Enjoyment Benefits Adolescents' Self-Determined Motivation in Student-Centered Learning

8.1 Abstract

This study examines the interplay of enjoyment and self-determined motivation by contrasting students from a traditional teacher-directed learning and a student-centered learning environment based on competency matrices. Using two-wave questionnaire data from 1,153 (M_{age} = 13.97, SD = 1.37, 49% girls) 7th–10th grade German students, this study conducts latent mean comparisons and multigroup cross-lagged panel analyses. Latent mean comparisons did not indicate significant differences between both learning environments. However, the cross-lagged panel models revealed that enjoyment is not only concurrently but also longitudinally associated with self-determined motivation in the student-centered learning environment. The results further imply that the associations between enjoyment and self-determined motivation are monodirectional rather than bidirectional.

Keywords: self-determination; motivation; enjoyment; adolescence; learning environments

8.2 Introduction

Students' perception of their learning environment is an important determinant of successful learning processes. Emotions can reflect this perception (Meyer, 2014). However, many studies emphasize negative achievement emotions (e.g., anxiety) even though positive achievement emotions (e.g., enjoyment) are important starting points for teaching practices. The necessity to examine such starting points is of particular interest in adolescence as research has continuously indicated a decline in students' motivation (Gillet, Vallerand, & Lafrenière, 2011; Gnambs & Hanfstingl, 2015; Harter, 1981; Lepper, Corpus, & Iyengar, 2005; Otis, Grouzet, & Pelletier, 2005). More specifically, the more self-determined forms of motivation (i.e., intrinsic motivation and identified regulation) tend to rapidly decrease with the onset of adolescence (see Raufelder, 2018). Hence, providing learning environments for students, which foster positive achievement emotions, may in turn counteract those declines.

Students' achievement emotions are closely associated with their performance, motivation, and self-regulation (Linnenbrink & Pintrich, 2002; Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Pekrun, Goetz, Titz, & Perry, 2002; Zeidner, 2014). Despite the many similarities between motivational constructs (e.g., self-determined motivation) and achievement emotions (e.g., enjoyment), empirical research on their associations is scant (Pekrun, Elliot, & Mayer, 2009). This research gap is even broader if we consider the influence of different learning environments. Most studies are based on teacher-directed learning (TDL) environments, which have dominated traditional classes in schools for decades. Nevertheless, interest in school practice on student-centered learning (SCL) environments is growing due to the heterogeneity of students and the consideration of these interindividual differences in educational processes (Decristan, Fauth, Kunter, Büttner, & Klieme, 2017). The present study aims to provide deeper insights into the interplay between enjoyment and self-determined motivation by

investigating this (reciprocal) association in adolescent students from schools with SCL and TDL environments and thus conveys implications for teaching practices in schools.

8.2.1 Enjoyment and self-determined motivation

Within self-determination theory (SDT), Deci and Ryan (1985) have defined intrinsic motivation as the inherent feature of human nature to expand competencies and capacities affecting cognitive and emotional development, quality of performance, and psychological wellbeing. Identified regulation – a more self-determined form of extrinsic motivation – refers to the personal valuing of (external) behavioral goals and regulations that are deemed personally important. Hence, the goals and regulations become congruent with other personal values and needs and thus share many similarities with intrinsic motivation (Ryan & Deci, 2000, 2017). Self-determined motivation is essential not only for persistence and reduced school dropout rates (Hardre & Reeve, 2003; Otis et al., 2005; Vallerand, Fortier, & Guay, 1997), achievement (Guay, Ratelle, Roy, & Litalien, 2010; Ratelle, Guay, Vallerand, Larose, & Senécal, 2007; Taylor et al., 2014), and negative associations with stress (Raufelder, Lazarides, & Lätsch, 2018) but also for the emotional perception of learning processes in class. On the other hand, enjoyment as conceptualized via the three-dimensional taxonomy of achievement emotions (Pekrun, 2006; Pekrun, Goetz, Titz, & Perry, 2002) is defined as a positive activating achievement emotion with a focus on an activity. In relation to scholastic education, the perception of this emotion indicates that students perceive the active process of learning as enjoyable. Studies reveal that enjoyment has moderate correlations with performance (Pekrun et al., 2011; Pekrun et al., 2002). Some indices denote that positive emotions such as enjoyment can foster self-regulation, which negative emotions can thwart (Linnenbrink & Pintrich, 2002; Pekrun et al., 2010; Pekrun et al., 2011; Pekrun et al., 2002). Consequently, intrinsic motivation and enjoyment in particular share some common

properties; however, they differ fundamentally in certain aspects. Particularly with regard to the object focus, the nature of intrinsic motivation refers to expanding individual capabilities whereas enjoyment focus on an activity by itself. Moreover, Pekrun et al. (2009) have asserted that enjoyment originates from being able to control and value an activity, such as feeling competent to master an activity while simultaneously perceiving it as interesting. Therefore, enjoyment depends on the presented learning material or activity, whereas intrinsic motivation refers to the goal of the activity.

Empirical research on the interrelation between enjoyment and self-determined motivation has yielded more detailed results concerning the degree of activation. Overall, studies indicate a positive relationship between positive achievement emotions and intrinsic motivation and even less self-determined motivation such as extrinsic motivation (Bieg, Rickelman, Jones, & Mittag, 2013; Pekrun et al., 2011; Pekrun et al., 2002; Zeidner, 1998, 2014). However, in the distinction between activating and deactivating positive emotions, Pekrun et al. (2010) argue that activating positive emotions (e.g., enjoyment) supports motivation, whereas deactivating positive emotions (e.g., relaxation) hinders it.

8.2.2 Reciprocity or unidirectionality

Most of the scant empirical research is of a correlational nature without assuming the directionality of the relationship between achievement emotions and motivation. Meyer and Turner (2002) have asserted that motivational theories have broadly neglected the complex synergistic relationships between emotion and motivation, viewing emotions separately as an external source rather than integrative as an inherent component of motivational patterns (Ford, 1992). As learning unfolds over time, classroom practices that are constantly associated with emotional support appear to become part of the learning environment (Meyer, 2014); these emotions consequently affect motivation and vice versa (Ahmed, Minnaert, van

der Werf, & Kuyper, 2010; Pekrun & Perry, 2014). Learning environments and classroom practices that may foster positive emotions and self-determined motivation should be identified accordingly.

While SDT does not make predictive assumptions about emotions and rather argues that they represent sources of information that help to address need satisfaction more appropriately (Deci & Ryan, 2017), control-value theory (CVT; Pekrun, 2006; Pekrun & Perry, 2014) offers rather strong causal predictions. CVT posits that achievement emotions (e.g., enjoyment) depend on the presence of appraisals, such as subjective control (i.e., control over achievement activities and their outcomes), and subjective value (i.e., value of these activities and outcomes). In other words, if students face achievement situations, their emotional reaction will depend on whether they can control their own achievement outcome (e.g., be successful in a test) and whether they subjectively value it (e.g., acknowledge the usefulness of the subject matter). Consequently, positive activating achievement emotions, such as enjoyment, can foster students' motivation, while negative deactivating achievement emotions can thwart it (Pekrun, 2006). Moreover, emotions are assumed to be in reciprocal associations with the environment, the appraisals, and educational outcomes, such as self-determined motivation (Pekrun, 2006; Pekrun & Perry, 2014).

8.2.3 Role of the learning environment

Both CVT and SDT highlight the importance of appraisals or basic needs and therefore attribute a major responsibility to schools' learning environments. According to SDT, contexts may either promote or thwart students' development in schools (Deci & Ryan, 2017). Thus, contexts may either facilitate self-determined motivation by providing contexts that support the basic need or thwart self-determined motivation by imposing restrictions on these needs. Particularly in schools, the presence of external pressures is usually strong due to

curricula and constant testing and grading (Niemiec & Ryan, 2009; Reeve & Assor, 2011; Ryan & Deci, 2000a). These pressures are risk factors not only for students' self-determined motivation but also for their perception of enjoyment. Such systemic demands often hinder an autonomy-supportive teaching style (Guay et al., 2008; Reeve & Halusic, 2009).

Similarly, with regard to CVT (Pekrun & Perry, 2014), emotions and achievement values are strongly influenced by parents, teachers, and peers through direct and indirect messages. In Pekrun's and Perry's (2014) definition, indirect messages refer to meeting both the students' individual needs and the teachers' enthusiasm, which may facilitate the adoption of achievement values and related emotions (Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009).

However, both SDT and CVT are relatively vague about the definition of the learning environment. Generally, the underlying assumption is that these theories are based on a traditional setting (i.e., TDL) in which a head teacher instructs a group of students with preselected materials (Meyer, 2014; Ryan & Deci, 2017). Moreover, the teacher assumes a central position in this theorizing, because the highlighted features (Guay et al., 2008) depend on the person rather than the context. A question therefore arises: how might the context itself play a certain role in the interplay between enjoyment and self-determined motivation?

8.2.4 Student-centered learning with competence matrices versus teacher-directed learning

TDL environments have dominated classes in schools for decades. They are characterized by the predominance of the teacher, who provides instruction in a sequential manner. Although commonly associated terms such as whole-class lecture method (Hänze & Berger, 2007; Mergendoller, Maxwell, & Bellisimo, 2006) undoubtedly have a decreasing

dominance in modern classrooms, the paradigm holds that teachers are responsible for providing instruction and coordinating instructional activities.

Recent discussions about standards in education (Cizek & Bunch, 2007; Frey & Hartig, 2009) and the process of addressing student heterogeneity in terms of individual needs (Decristan et al., 2017) have prompted schools to start developing SCL around the work with competence matrices. Competence matrices divide a subject's different subdomains on a vertical axis and the increasing demands of a certain subdomain on a horizontal axis (Stevens, Levi, & Walvoord, 2013), thereby generating multiple elements that comprise educational goals. Each element assigns students appropriate material to develop each specific goal. This environment subsequently allows students to learn independent of their teacher's instruction and simultaneously about different subjects, subdomains of those subjects, and levels of those subdomains. From an instructive viewpoint, this learning environment follows the demands of the zone of proximal development insofar as the material is highly adaptive to students' prior knowledge (Vygotskij, 1978). Students can access learning material and independently check their tasks and can consequently progress to higher levels in a subdomain or pursue different subjects and respective subdomains. Previous research has exhibited differences of autonomy and competence support between SCL and TDL environments (Kulakow, 2020a, 2020b), which may imply differences in the emotional perception of the learning environment.

8.2.5 Research aims

This study intends to evaluate any associations in the interplay between enjoyment and self-determined motivation. According to SDT (Ryan & Deci, 2017) and CVT (Pekrun, 2006; Pekrun & Perry, 2014), emotions are reciprocally associated with self-determined motivation. Motivation – especially the more self-determined forms thereof – has been shown

to decline multiple times throughout adolescence (Gillet et al., 2011; Gnambs & Hanfstingl, 2015; Harter, 1981; Lepper et al., 2005; Otis et al., 2005), which highlights the necessity of finding adequate starting points to counteract this decline, such as the design of the learning environment. Therefore, the current study examines the interplay between enjoyment and self-determined motivation in two different learning environments — a traditional TDL environment and an SCL environment based on competence matrices— since contexts affect the interplay of the variables (Pekrun & Perry, 2014; Ryan & Deci, 2017). Based on the theoretical and empirical outline, the following hypotheses are tested:

Hypothesis H1. Students who learn in a traditional TDL environment differ in their perception of enjoyment and self-determined motivation (i.e., intrinsic motivation and identified regulation) compared to students in an SCL environment. Specifically, based on the theoretical rationale that the support of individual needs fosters both positive emotions and self-determined motivation (Baudoin & Galand, 2017; Guay et al., 2008; Pekrun & Perry, 2014; Ryan & Deci, 2000b), students who attend an SCL environment are expected to report higher values of enjoyment, intrinsic motivation, and identified regulation.

Hypothesis H2. Since CVT assumes reciprocal associations between emotions and motivation (Pekrun, 2006; Pekrun & Perry, 2014), the expectation (Hypothesis H2a) is that enjoyment and self-determined motivation (i.e., intrinsic motivation, identified regulation) are concurrently and longitudinally associated with each other. As we could only identify prior research that provided correlational evidence of these associations (Bieg, Rickelman, Jones, & Mittag, 2013; Pekrun et al., 2011; Pekrun et al., 2002; Zeidner, 1998, 2014), this hypothesis tests whether the reciprocity assumption of CVT in the interplay between

enjoyment and self-determined motivation holds as it has for the association between emotions and achievement (Pekrun et al., 2017).

Furthermore, research has indicated that the perception of emotions and self-determined motivation may not only be concurrently associated with each other in the current lesson but also in the expectance of similar situations in future lessons (Ahmed et al., 2010; Pekrun et al., 2017). Thus, autoregressive associations in the variables of interest are assumed (Hypothesis H2b). Both SDT and CVT conditionally depend on the context (Pekrun & Perry, 2014; Ryan & Deci, 2017). As prior research on CVT has already indicated that different learning environments affect the interplay of emotions with other educational outcomes (Butz et al., 2016), the expectation (Hypothesis H2c) is that there are substantial differences in the interplay of enjoyment and self-determined motivation (e.g., intrinsic regulation and identified regulation) between students from TDL and SCL environments.

8.3 Method

8.3.1 Participants and procedure

The data of the present study were collected during the winter term (T1) and the summer term (T2) of the German school year 2015–2016. Overall, the sample consisted of 1,153 students aged 12–18 from grades 7–10 (M_{age} = 13.97, SD = 1.37, 49% girls) at T1 and 775 students (M_{age} = 14.27, SD = 1.25, 49% girls) at T2. Data were collected from six secondary schools in Germany from the federal states of Berlin, Mecklenburg-Western Pomerania, North Rhine-Westphalia, and Schleswig-Holstein.

Among the six schools, three base their learning environment on a student-centered approach with competence matrices, whereas three follow a traditional TDL approach with whole-class instruction as the main instructional practice. We consequently formed the SCL

group (N_{T1} = 772, M_{age} = 13.85, *SD* = 1.32, 49% girls; N_{T2} = 515) and the TDL group (N_{T1} = 381, M_{age} = 14.22, *SD* = 1.42, 52% girls, N_{T2} = 260).

To conduct our study in accordance with ethical standards, we followed a step-wise procedure (American Psychological Association, 2002). First, we obtained permission to conduct our study from the relevant federal authorities. Second, we approached the schools and informed the parents of the aims and procedure of our study. Third, two trained research assistants approached the students and informed them about the voluntary nature of the study and the anonymity of data collection. They explained the use of Likert scales and answered any question during data collection.

8.3.2 Measures

Intrinsic motivation and academic self-regulation were measured using two subscales of the adapted version of the Academic Self-Regulation Questionnaire (Ryan & Connell, 1989), which was developed and validated by Müller, Hanfstingl, and Andreitz (2007). All the items were measured on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The subscale *intrinsic motivation* refers to students' inherent enjoyment in learning (e.g., "I work and learn in class because it is enjoyable"). The scale exhibited a good internal reliability (T1: overall sample: α = .85, SCL: α = .86, TDL: α = .79; T2: overall sample: α = .86, SCL: α = .87, TDL: α = .85). The subscale *identified regulation* pertains to an appreciation for the contents and goals of subjects because they are considered personally important (e.g., "I work and learn in class because it will provide me with future job opportunities"). This scale demonstrated good internal reliabilities (T1: overall sample: α = .82, SCL: α = .83, TDL: α = .80; T2: overall sample: α = .82, SCL: α = .84, TDL: α = .76).

The positive achievement emotion *enjoyment* was assessed using a subscale by Prenzel, Kristen, Dengler, Ettle, and Beer (1996). All six items were measured on a four-point

Likert scale ranging from 1 (“almost never”) to 4 (“almost always”). The subscale refers to the evaluation of students’ experience in class as being enjoyable and interesting (e.g., “I experience my lessons as exciting”). The subscale achieved good internal reliability (T1: overall sample: α = .79, SCL: α = .82, TDL: α = .71; T2: overall sample: α = .82, SCL: α = .84, TDL: α = .76).

As the previous studies have indicated that intrinsic motivation is steadily declining through adolescence (e.g., Gnambs & Hanfstingl, 2015), age was included as a covariate. Moreover, students’ achievement was included as a scale score of self-reported grades of the main subjects German and Math on students’ last certificates. German grades range from 1–6 with “1” being the best possible result and “6” being the worst possible result.

8.3.3 Statistical analyses

Latent mean comparisons and multigroup latent cross-lagged panel analyses were conducted to test the hypotheses. Multigroup latent cross-lagged panel analysis allows for exploring within and over time the associations between intrinsic motivation, identified regulation, and achievement emotions. This statistical method examines the stability and relationships between the variables of interest between and over time to enhance the understanding of how they influence each other (Geiser, 2011; Kearney, 2017). These models incorporate regression effects from a construct at one point of measurement on the same construct at a later point of measurement (i.e., autoregressive effect) and simultaneously on another construct (i.e., cross-lagged effect). Thus, we are able to estimate the effect of one construct on another while controlling for prior states of those constructs.

As both latent mean comparison and multigroup latent cross-lagged panel analysis compare the two different groups in our study, the establishment of measurement invariance was compulsory. We followed Brown’s step-up procedure to identify the possible violations

of measurement invariance (Brown, 2015). This procedure involves performing a confirmatory factor analysis (CFA) and continually adding parameter constraints across groups and time (Little, 2013). First, a baseline model was conceptualized to freely estimate factor loadings and intercepts across both groups and both time points (model 0: configural measurement invariance). Second, equality constraints were set on all factor loadings across groups (model 1a: weak factorial invariance across groups). Third, these equality constraints were extended to the second time point (model 1b: weak factorial invariance across groups and time). Fourth, the factor intercepts were equally equated across groups while keeping the previous constraints (model 3a: strong factorial invariance across groups). Finally, the constraints were also extended to the second time point of measurement (model 3b: strong factorial invariance across groups and time). All the subsequent models were compared using the differences in comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation (Chen, 2007). For the analyses, reaching the level of at least partial strong factorial invariance was essential (Brown, 2015).

Two multigroup cross-lagged panel models were conceptualized to test the hypothesis on whether differences exist between the two groups in terms of the interplay of intrinsic motivation, identified regulation, and enjoyment. The first semi-restrictive model assumed measurement invariance (i.e., equal factor loadings, equal intercepts), but it freely estimated covariance and regression coefficients. By contrast, the second more restrictive model assumed measurement invariance and additionally set equality constraints on the covariance and regression coefficients across the two groups. Both models were also compared using the $\chi 2$ difference test (Kline, 2016; Satorra & Bentler, 2001).

As large numbers of items (i.e., overall 32 items) negatively affect model fit (Ding, Velicer, & Harlow, 1995; Wang & Wang, 2012), we decided to use parceling. Contrary to using item-level data, parceling shows several advantages for both psychometric

characteristics of the scales used and model fit indices. Specifically, parcels demonstrate higher reliability, a reduced number of parameter estimates, a higher ratio of common-to-unique factor variance, a lower likelihood of correlated residuals, a lower likelihood of distributional violations, and generally reduced sources of sampling error (Little, Cunningham, Shahar, & Widaman, 2002; Little, Rhemtulla, Gibson, & Schoemann, 2013; Nasser & Wisenbaker, 2003). The parcels were built randomly. This technique is frequently used in psychological research (Nasser & Wisenbaker, 2003) because it ensures that all measurement information is included in the analyses.

All the analyses were performed using Mplus version 8.1 (Muthén & Muthén, 1998-2017) and robust maximum likelihood estimation with robust standard errors. To account for the nested structure of the data, we applied the "type is complex" approach (Asparouhov, 2005). Missing data were compensated for using full-information maximum likelihood (FIML) estimation. As highlighted in the theoretical background, the students' age and achievement might play a considerable role in the associations, so they were included in the final models as covariates to rule out spurious correlations. To evaluate the best fitting models, we considered the following model fit indices as proposed by (Hu & Bentler, 1999): RMSEA, SRMR, CFI, and TLI.

8.4 Results

8.4.1 Descriptive statistics and bivariate correlations

The observed bivariate correlations and descriptive statistics (i.e., range, means, standard deviation, skewness, kurtosis with their standard errors) are provided for all the latent variables and for each group separately in Table 8.

Table 8

Descriptive Statistics and Intercorrelations for SCL and TDL

	2	*3*	*4*	*5*	*6*	*7*	*8*	Range	*M*	*SD*	Skewness (SE)	Kurtosis (SE)
Student-centered Learning												
1 InMot T1	.66***	.56***	.31***	.78***	.52***	–.08	–.20***	1–5	2.87	0.89	−0.03 (0.09)	−0.32 (0.18)
2 InMot T2		.33***	.57***	.59***	.82***	.07	–.15**	1–5	2.81	0.91	−0.13 (0.09)	−0.36 (0.18)
3 IdReg T1			.57***	.41***	.26***	–.07	–.26***	1–5	3.78	0.90	−0.65 (0.09)	0.06 (0.18)
4 IdReg T2				.33***	.39***	.08	–.19**	1–5	3.64	0.98	−0.65 (0.09)	0.01 (0.18)
5 PoEm T1					.63***	–.08	–.21***	1–4	2.09	0.61	0.39 (0.09)	−0.03 (0.18)
6 PoEm T2						.10	–.16**	1–4	2.04	0.64	0.46 (0.09)	−0.05 (0.18)
7 age T1							.29***	11–18	13.85	1.32	0.32 (0.09)	−0.71 (0.18)
8 achievement T1								1–6	2.73	0.82	0.40 (0.09)	0.14 (0.18)
Teacher-directed Learning												
1 InMot T1	.65***	.48***	.24**	.69***	.56***	–.06	–.27***	1–5	2.71	0.76	−0.03 (0.13)	0.19 (0.25)
2 InMot T2		.32***	.34***	.51***	.75***	–.16	–.15***	1–5	2.73	0.76	−0.08 (0.13)	0.10 (0.25)
3 IdReg T1			.53***	.24**	.26***	.12	–.29***	1–5	3.80	0.81	−0.56 (0.13)	0.31 (0.25)
4 IdReg T2				.08	.30***	.08	–.22*	1–5	3.87	0.76	−0.41 (0.13)	−0.44 (0.25)
5 PoEm T1					.63***	–.11	–.14*	1–4	2.06	0.47	0.41 (0.13)	0.55 (0.25)
6 PoEm T2						–.07	–.09	1–4	2.04	0.49	0.39 (0.13)	0.54 (0.25)
7 age T1							.06	11–18	14.22	1.42	0.21 (0.13)	−0.49 (0.25)
8 achievement T1								1–6	2.92	0.80	0.36 (0.13)	–0.01 (0.25)

Note. All measures are standardized; *$p < 0.05$. **$p < 0.01$ ***$p < 0.001$; InMot = intrinsic motivation, IdReg = identified regulation, PoEm = positive emotions, T1 = time 1 (winter term 2015), T2 = time 2 (summer term 2016).

8.4.2 Measurement invariance

To examine our hypotheses, we first conducted CFAs on all the latent constructs to ensure measurement invariance for the latent mean comparisons (Hypothesis 1) and establish an initial model for the multigroup cross-lagged panel analyses (Hypothesis 2).

According to Chen (2007), weak factorial invariance is warranted, if differences in CFI < –.010, RMSEA < .015, and SRMR < .030. Accordingly, strong factorial invariances are warranted, if differences in CFI ≤–.010, supplemented by differences of RMSEA < .015, and SRMR < .010. All model fit indices of the subsequent models (see Table 9) were consistently below these thresholds. Consequently, strong factorial invariance could be

assumed, meaning that the instruments used measured the same underlying constructs at both time points and in both groups. These results subsequently allow for the application of latent mean comparisons and the latent cross-lagged panel design.

Table 9

Measurement Invariance

Model	χ^2	df	*p*	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI	ΔCFI	ΔSRMR	ΔRMSEA
Model 0	463.232	124	< .001	.947	.922	.045	.069	.062–.076			
Model 1a*	424.923	132	< .001	.954	.937	.049	.062	.055–.069	.007	.004	–.007
Model 1b*	434.632	136	< .001	.953	.937	.050	.062	.055–.068	–.001	.001	.000
Model 2a*	457.470	144	< .001	.951	.938	.052	.061	.055–.068	–.002	.002	–.001
Model 2b *	481.523	151	< .001	.948	.938	.055	.062	.055–.068	–.003	.003	.001

Note. Model 0 = measurement model with all parameters free (form invariance), Model 1a = equality of factor loadings across groups (weak invariance), Model 1b = equality of factor loadings across groups and time (weak invariance), Model 2a = equality of factor intercepts across groups (strong invariance), Model 2b = equality of factor intercepts across groups and time (strong invariance); *differences in CFI, TLI, and SRMR between the two subsequent models.

8.4.3 Latent mean comparisons

Using students from SCL as a reference group, we did not find any significant mean differences between both groups of students at the .05 significance level. Intrinsic motivation did however exhibit a tendency in favor of the SCL group (T1: β = –.21, *p* = .06; T2: β = –.18, *p* = .12). The means of identified regulation were consistently beyond the .10 significance level (T1: β = .04, *p* = .68; T2: β = .19, *p* = .10), as were the differences of enjoyment (T1: β = –.03, *p* = .80; T2: β = –.07, *p* = .54).

8.4.4 Cross-lagged panel design

To ensure that differences actually exist between the two groups, we conceptualized two models. The first semi-restricted model assumed measurement invariance and freely estimated covariance and regression coefficients between the two groups, presuming that differences exist between these groups. This model exhibited a good fit ($\chi^2(176) = 565.45$, $p(\chi^2) < 0.001$; CFI = 0.942, TLI = 0.921, RMSEA = 0.062 (0.056–0.068), SRMR = 0.048). The second more restricted model additionally equated covariance and regression coefficients, assuming the lack of any differences between the two groups. This model likewise exhibited an adequate fit ($\chi^2(203) = 640.85$, $p(\chi^2) < 0.001$; CFI = 0.935, TLI = 0.923, RMSEA = 0.061 (0.056–0.067), SRMR = 0.102), although deteriorations in the χ^2 value, CFI, and SRMR are present. The χ^2 difference test based on scaled values ($\Delta\chi^2 = 76.78$, $\Delta df = 27$, $p < 0.001$) and the differences in the other fit indices (ΔCFI = -0.007, ΔTLI = 0.002, ΔRMSEA = –0.001, ΔSRMR = .054) indicated that the more restricted model caused a distinctive deterioration in model fit. We consequently selected the semi-restricted model as our final model for examining our hypotheses. In this final model, standardized factor loadings ranged between $.64 \leq \lambda \leq .90$ for the SCL group and between $.54 \leq \lambda \leq .91$ for the TDL group.

8.4.5 Associations in student-centered learning

Within-time associations. In the SCL group, the covariance between all the latent constructs was found to be significant at both points of measurement: intrinsic motivation and identified regulation (T1: $r = 0.37/ 0.55$, $p < .001$; T2: $r = 0.27/ 0.61$, $p < .001$); intrinsic motivation and enjoyment (T1: $r = 0.38/ 0.78$, $p < .001$; T2: $r = 0.22/ 0.74$, $p < .001$; identified regulation and enjoyment (T1: $r = 0.20/ 0.41$, $p < .001$; T2: $r = 0.09/ 0.27$, $p < .001$). Age was not significantly correlated with any of the variables at T1. However,

achievement was significantly associated with intrinsic motivation at T1 (r = –0.14/ –0.20, p < .001), with identified regulation at T1 (r = –0.17/ –0.26, p < .001), and with enjoyment at T1 (r = –0.10/ –0.21, p < .001).

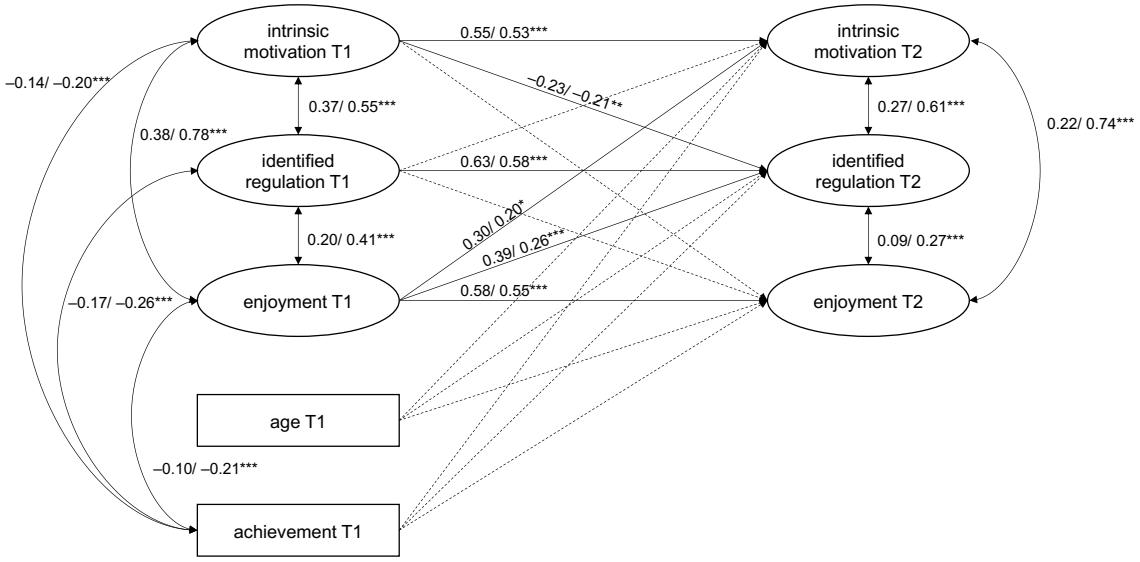

Figure 9. Cross-lagged Panel Model for the Students Following SCL. T1 = time 1, T2 = time 2 (0.5 years later). Significant effects are shown as unstandardized coefficients (B) in the first position and standardized coefficients (β) in the second position; continuous pathways are significant at *p < 0.05, **p < 0.01, ***p < 0.001, dashed pathways are not significant. Only significant covariance/ correlations are shown for clarity.

Over-time associations: Direct effects. All the direct effects from one latent construct at T1 to the same construct at T2 were found to be positively significant in the SCL group: intrinsic motivation at T1 positively predicted intrinsic motivation at T2 (B = 0.55, β = 0.53, SE = 0.09, p < .001), and identified regulation at T1 positively predicted identified regulation at T2 (B = 0.63, β = 0.58, SE = 0.08, p < 0.001). Furthermore, enjoyment (B = 0.58, β = 0.55, SE = 0.12, p < .001) at T1 predicted the subsequent perception of the same construct at T2.

Over-time associations: Cross-lagged effects. For the SCL group, three significant cross-lagged effects were identified: enjoyment at T1 positively predicted intrinsic motivation at T2 (B = 0.30, β = 0.20, SE = 0.13, $p < .05$) and identified regulation at T2 (B = 0.39, β = 0.26, SE = 0.12, $p < .001$). Moreover, intrinsic motivation at T1 negatively predicted identified regulation at T2 (B = -0.23, β = -0.21, SE = 0.08, $p < .01$).

8.4.6 Associations in teacher-directed learning

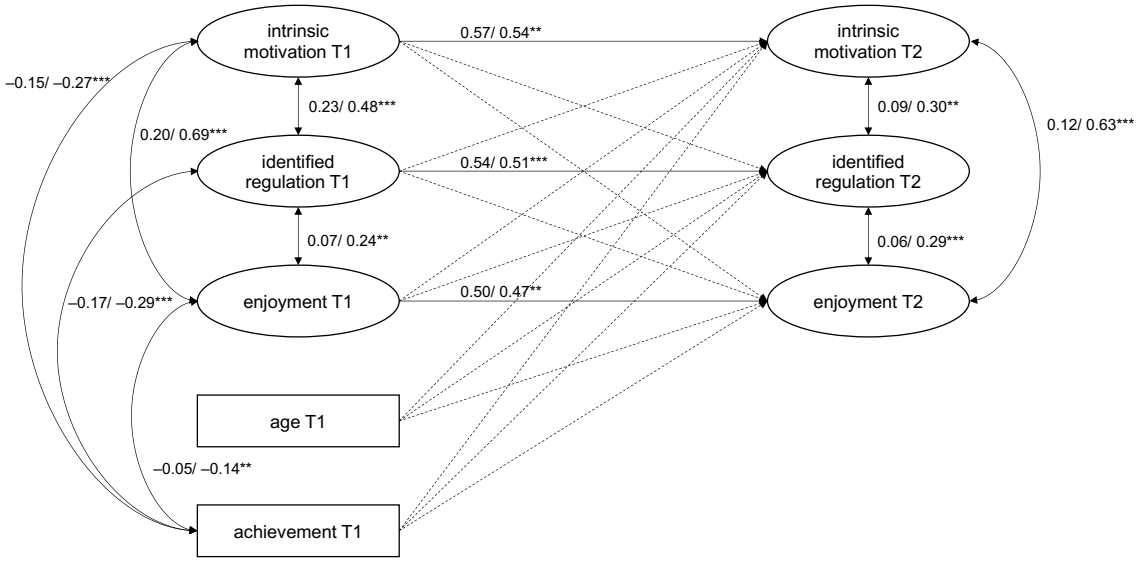

Figure 10. Cross-lagged Panel Model for the Students Following TDL. T1 = time 1, T2 = time 2 (0.5 years later). Significant effects are shown as unstandardized coefficients (B) in the first position and standardized coefficients (β) in the second position; continuous pathways are significant at *p < 0.05, **p < 0.01, ***p < 0.001, dashed pathways are not significant. Only significant covariance/ correlations are shown for clarity.

Within-time associations. In the TDL group, the covariance between all the latent constructs was found to be significant at both points of measurement: intrinsic motivation and

identified regulation (T1: $r = 0.23/ 0.48$, $p < .001$; T2: $r = 0.09/ 0.30$, $p < .01$); intrinsic motivation and enjoyment (T1: $r = 0.20/ 0.69$, $p < .001$; T2: $r = 0.12/ 0.63$, $p < .001$; identified regulation and enjoyment (T1: $r = 0.07/ 0.24$, $p < .01$; T2: $r = 0.06/ 0.29$, $p < .001$). Age was not significantly correlated with any of the variables at T1. However, achievement was significantly associated with intrinsic motivation at T1 ($r = –0.15/ –0.27$, $p < .001$), with identified regulation at T1 ($r = –0.17/ –0.29$, $p < .001$), and with enjoyment at T1 ($r = –0.05/ –0.14$, $p < .05$).

Over-time associations: Direct effects. In the TDL group, all the latent constructs at T1 positively predicted the respective constructs at T2; thus, all the constructs remained stable over time: intrinsic motivation at T1 positively predicted intrinsic motivation at T2 ($B = 0.57$, $\beta = 0.54$, $SE = 0.17$, $p < .01$) and identified regulation at T1 positively predicted identified regulation at T2 ($B = 0.54$, $\beta = 0.51$, $SE = 0.13$, $p < .001$). Furthermore, enjoyment at T1 ($B = 0.50$, $\beta = 0.47$, $SE = 0.16$, $p < .01$) positively predicted the same construct 0.5 years later (T2).

Over-time associations: Cross-lagged effects. No cross-lagged effects were found to be significant in the TDL group.

8.5 Discussion

Both SDT and CVT seem to be relatively vague about the definition of the learning environment, and previous research has mostly focused on the teacher rather than the learning environment. Hence, this study aims to shed light on the question of whether there are substantial differences in the interplay between enjoyment and self-determined motivation of students from TDL and SCL environments independent of specific teacher-related

influences (e.g., teacher enthusiasm). This issue is becoming particularly important since TDL is being replaced with modern SCL environments in schools without fundamental research accompanying this transformation process. This study was conceptualized to close this research gap. Using multigroup cross-lagged panel analyses and latent mean comparisons on a dataset with two waves, this study contrasted students from TDL and SDL classes in terms of the interplay between enjoyment and self-determined motivation. The results help identify the contextual conditions that may counteract the motivational decline during adolescence.

Hypothesis H1 was not confirmed. None of the latent mean comparisons yielded significant differences. While there was a tendency of intrinsic motivation in favor of the SCL environment at T1, this tendency could not be replicated at T2. Research on both SDT and CVT has indicated that the support of positive emotions and self-determined motivation may additionally depend on teachers' enthusiasm (Frenzel et al., 2009; Pekrun & Perry, 2014) and involvement (Guay et al., 2008). These two factors strongly focus on the interaction with the teacher. In the TDL environment, the central position of the teacher for coordinating different phases of instruction and practice could lead to less involvement, as teachers cannot continuously deal with individual students and offer individual feedback, because they take responsibility for whole-class instruction. In spite of the less prominent position of the teacher in SCL environment, a similar point can be made for this learning environment. While the competency matrices coordinate the learning activities, teachers are enabled to provide more individual feedback. However, one can assume that these free resources are primarily shifted to deal with students who face difficulty with the activities or with working independently. Consequently, particular high-achieving students might barely interact with their teachers which in turn might suppress higher perception of self-determined motivation or enjoyment in the learning process. Accordingly, the results of a recent study indicate that

individual teacher support might be of equal importance, independently of the learning environment (Schweder & Raufelder, 2019). According to Guay et al. (2008), research on teacher involvement is scant compared to studies about parental involvement. Future studies might also assess students' perception of teachers (Raufelder et al., 2016) and the support they provide (Kulakow, 2020a). However, it also seems plausible that the systemic demands of Western educational systems, that equally apply to both learning environments (e.g., standardized curricula and summative testing), restrict the facilitation of enjoyment and self-determined motivation on the level of the learning environment. This particularly applies to SDT. If we consider its basic assumption, that self-determined motivation depends primarily on the provision of autonomy (Deci & Ryan, 2017; Ryan & Moller, 2017), one can easily see how these systemic restrictions prevent real autonomy and consequent individual decision-making to a large degree. An individualized learning environment, such as SCL, might provide more adequate competence development and more flexible interaction structures. However, the provision of individualized learning processes might perhaps not be equated with consequent better emotional and motivational support of individual students.

Hypothesis H2 could only be partially confirmed. Significant differences were identified between the two learning environments (H2c), which involved not only variances in the magnitude of the associations but also diverse cross-lagged effects. This result consequently supported the assumption of contextual differences in CVT (Pekrun & Perry, 2014) and SDT (Ryan & Deci, 2017). In contrast to most other studies (e.g., Guay et al., 2008), the context of the current research was defined by the instructional learning environment rather than by class-level differences based on classroom and teacher characteristics.

In the SCL group, enjoyment and self-determined motivation were positively associated both concurrently and longitudinally, supporting Hypothesis H2a. Both intrinsic

motivation and identified regulation were positively correlated with enjoyment at both measurement time points. The association between enjoyment and intrinsic motivation was thereby distinctively higher, indicating a stronger link between the two constructs. Pekrun et al. (2011) also identified the respective effects in their investigation of this association among university students. Meanwhile, Meyer (2014) indicated that the perception of emotions is drawn not only from the past and the present but also from the anticipation of future experiences. The individualized SCL environment allows for a more precise anticipation of future classroom situations due to the consistent structure (Guay et al., 2008), hence building the basis for these effects.

Despite the positive correlations between intrinsic motivation and identified regulation at both points of measurement, we established a negative over-time association between the two variables. This result indicates that students with a high intrinsic motivation at the beginning of the school year exhibited less identified regulation toward the end of the school year. However, this relationship might also signify a suppression effect (Paulhus, Robins, Trzesniewski, & Tracy, 2004) or vertical multicollinearity problems that could emerge due to correlated predictors (Kock & Lynn, 2012). Appendix A provides further analyses of this effect. These analyses suggest the emergence of a statistical artifact rather than a theoretically sound effect.

Hypothesis H2a could only be partially confirmed for the SCL environment. Positive concurrent associations emerged between enjoyment and self-determined motivation in the TDL group, but these associations did not replicate longitudinally. Since students in traditional learning environments are usually not in control of their learning process, they depend on their teachers to instruct and guide them. In contrast to the longitudinal effects of enjoyment in the SCL group, students in TDL may not adequately anticipate their emotions due to this lack of control in the learning process. Research on SDT has regularly criticized

educational systems for preventing autonomous motivational styles with intrinsic motivation at the forefront (Niemiec & Ryan, 2009; Ryan & Deci, 2017). In particular, identified regulation is presumably a regulatory style that many schools find appealing because of the more stringent association between what is taught and what is expected of the students. However, particularly when considering the missing differences with regard to the latent means, it also becomes imperative for the learning material in SCL to be adequate for students in terms of control and value.

For both learning environments, however, the reciprocity assumption of CVT (Pekrun & Perry, 2014) that emotions and self-determined motivation reciprocally reinforce each other is not supported in our dataset for either the individualized SCL or the TDL environment. The associations were essentially monodirectional rather than bidirectional. The claim of a constant reciprocal association might be too universal for the wide span of motivational constructs (e.g., self-determination, self-efficacy, achievement emotions). Ryan and Moller (2017) argue that SDT differs considerably from other motivational theories in its conception of autonomously initiated behavior. In that theorizing, increasingly external demands that inevitably accompany schools, such as continuous assessment and external goals, might longitudinally suppress the emergence of positive emotions, although these constructs are concurrently associated with each other.

The constructs remained relatively stable during the 0.5 year, confirming Hypothesis H2b. Moreover, in line with Hypothesis H2c, differences between the learning environments emerged. Only marginal differences were identified for intrinsic motivation and enjoyment; however, the stability of identified regulation was distinctly higher for students from SCL environments. Identified regulation represents a conscious valuing of goals and regulations such that these goals and regulations are deemed personally important (Ryan & Deci, 2000b). In TDL classrooms, this self-determined motivational style may be more dependent on the

integration of teachers' messages about the personal benefits of the learning material. In contrast, the personal examination of materials is in direct correspondence to the individual beliefs and values that, however, bear the risk for students with low identified regulation. Moreover, time might be an important factor in integrating these benefits into one's own value system. Since students in SCL do not depend on teachers' instruction, they have more time to think about the benefits of certain material. In contrast, students in TDL have a limited period for integrating the value of certain material and skills before teachers continue to other subdomains or levels and thus may interrupt the integration process.

In addition to our actual hypotheses, the interplay of variables was controlled for the age and prior achievement of the students, because studies have indicated a consistent motivational decline throughout adolescence (Gillet et al., 2011; Gnambs & Hanfstingl, 2015; Harter, 1981; Lepper et al., 2005; Otis et al., 2005, Sansone & Morgan, 1992). These tendencies were not present in either of the two groups, contradicting prior research on these motivational and emotional declines. However, the missing tendencies may also be due to the restricted sample, which excluded students from high-track schools, which have particularly indicated decreases in motivational beliefs (Eccles et al., 1993).

8.5.1 Strengths, limitations, and future directions

Although this study provides important insights into the differences in the interplay of enjoyment and self-determined motivation, it also underscores some methodological aspects that need to be addressed because they potentially affect the generalizability and validity of the results. First, students from both learning environments (i.e., traditional TDL and individualized SCL) are not equally distributed in the present sample. This unequal distribution might result in the lack of significant effects in the TDL group due to limited statistical power. Therefore, future studies are necessary for replicating these findings in

evenly distributed samples. Second, this study uses entirely self-reported data. Despite its poor reputation (Chan, 2009), questionnaire data was considered appropriate for the hypotheses that focus on students' internal states rather than their actual performance. Another point that needs to be addressed is the use of approximately three parcels for each latent variable (Matsunaga, 2008). While this recommendation was applied to enjoyment, it was not feasible for intrinsic motivation and for identified regulation, because of the number of items that scales consist of (i.e., four items).

Notwithstanding these limitations, this study exhibits some important strengths because it examines the role of the learning environment in the interplay of enjoyment and self-determined motivation. Therefore, this study identifies and evaluates essential differences between students from traditional TDL environments and students from SCL environments based on competence matrices. Both SDT and CVT seem to be relatively vague about the definition of the learning environment, and previous studies have mostly focused on the teacher rather than the learning context. Hence, this research empirically supports and expands both theoretical assumptions, demonstrating that the context itself moderates the interplay of emotions and self-determined motivation. However, because this research merely emphasizes value appraisal in terms of CVT, future studies are warranted and should also consider the potential role of control appraisals.

Overall, this study provides important insights into the association of enjoyment and self-determined motivations, thereby contributing to fundamental research on SCL processes in school classes in contrast with traditional TDL environments.

8.6 Appendix A

As the significant negative regression coefficient from intrinsic motivation at T1 to identified regulation at T2 (B = -0.23, β = -0.22, SE = 0.08, $p < 0.01$) was contrary to theory

(Ryan & Deci, 2017), a subsequent analysis was performed to rule out a potential regression artefact that might emerge due to multicollinearity (Kock & Lynn, 2012). Accordingly, we conducted another less complex cross-lagged-panel model with only intrinsic motivation and identified regulation. This model exhibited a good fit ($\chi^2(52) = 222.436$, $p(\chi^2) < 0.001$; CFI = 0.95, TLI = 0.94, RMSEA = 0.08 (0.07–0.09), SRMR = 0.06). In the SCL group, both constructs were significantly associated with each other at both time points (T1: $r = 0.36/ 0.57$, $p < 0.001$; T2: $r = 0.27/ 0.62$, $p < 0.001$). In the TDL group, intrinsic motivation and identified regulation were positively associated with each other, too (T1: $r = 0.23/ 0.48$, $p < 0.001$; T2: $r = 0.09/ 0.29$, $p < 0.01$). Table A1 shows the regression coefficients of that model.

Table A2

Regression Coefficients of the Cross-lagged Panel Model of Intrinsic Motivation and Identified Regulation

	outcome variables					
	intrinsic motivation (T2)			identified regulation (T2)		
predictor variables	*B*	β	*p*	*B*	β	*p*
SCL						
intrinsic motivation T1	**0.71**	**0.68**	< 0.001	0.01	0.01	= 0.85
identified regulation T1	-0.06	-0.05	= 0.45	**0.61**	**0.56**	< 0.001
TDL						
intrinsic motivation T1	**0.65**	**0.61**	< 0.001	0.01	0.01	= 0.92
identified regulation T1	0.04	0.04	= 0.66	**0.44**	**0.49**	< 0.001

8.7 References

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9 General Discussion

The main objective of this Ph.D. thesis was to evaluate how the learning environment affects adolescent students' self, achievement emotions, motivation, and learning behavior. This dissertation specifically contrasted adolescent students from a traditional teacher-directed learning (TDL) environment with those from a student-centered learning (SCL) environment. The three studies used for this thesis aimed at exploring the research question from three angles. First, Study I focused on the question of whether perceived autonomy support mediates the association between general self-efficacy and approaches to learning. Second, Study II investigated the role of perceived competence support as a potential mediator in the association between academic self-concept and achievement motivation. Lastly, Study III investigated the reciprocal nature of positive emotions and self-determined motivation.

9.1 Review of the Main Findings

The aim of Study I was to examine the interplay between self-efficacy and approaches to learning. The study specifically tested whether perceived autonomy support mediates this association for students from TDL and SCL equally. The hypothesis was that general self-efficacy, perceived autonomy support, memorization, elaboration, and control differ across both learning environments (H1). The assumptions were that (H1a) general self-efficacy and (H1b) perceived autonomy support are higher for students from SCL environments. With regard to approaches to learning, the assumption was that students from TDL report (H1c) higher memorization, but lower elaboration and control. Moreover, the study hypothesized that (H2a) perceived autonomy support is a stronger mediator for students from SCL. Lastly, Hypothesis 2b assumed no effects on the classroom level.

To address these hypotheses, a series of multi-group confirmatory factor analyses (MGCFAs) was first conducted to investigate potential mean differences across both student populations. Second, multi-group multilevel structural equation modeling (MGMSEM) was used to examine the role of perceived autonomy support as a potential mediator in the association between general self-efficacy and approaches to learning (memorization, elaboration, and control).

The latent mean comparisons (H1) partly confirmed our hypotheses: Students from SCL indeed reported higher values of general self-efficacy (H1a), higher perceived autonomy support (H1b), and lower values of memorization (H1c). However, the results did not support differences in elaboration (H1c) and control (H1c).

Hypothesis 2 was confirmed: The MGMSEM showed significant differences in the postulated associations between students from both learning environments (H2a). For the SCL environment, perceived autonomy support acted as a partial mediator for all three associations. In contrast, in the TDL group, only the association between general self-efficacy and control was mediated by perceived autonomy support. With regard to Hypothesis 2b, the postulated interplay did not replicate at the classroom level.

Overall, the first study demonstrates that in SCL environments, perceived autonomy support does indeed enhance the adoption of learning strategies, independent of students' general self-efficacy. Moreover, while the motivational variables had higher values, this did not apply to elaboration and control, a result that contradicts existing research on SCL (Schweder, Raufelder, Kulakow, & Wulff, 2019). Particularly the lack of differences in elaboration may call into question the task-based design of classroom instruction generally. Perhaps alternative educational settings, such as self-directed learning, are needed to achieve that goal, as a recent study by Schweder (2019) has indicated. This more natural learning setting may also explain missing differences in control—in contrast to self-directed learning

(Schweder, 2018)—as it is questionable how students should make independent decisions when their learning paths are predefined.

Study II sought to shed light on the questions of whether perceived competence support acts as a mediator in the association between academic self-concept and achievement motivation and whether the learning environment affects this interplay. In particular, the study hypothesized that (H1) students from SCL and TDL differ in their perceptions of academic self-concept, perceived competence support, and achievement motivation (persistence and effort, focus, and accuracy). Moreover, it was assumed that (H2) competence support mediates the association between academic self-concept and achievement motivation. Potential learning environment and age-specific differences were thus expected.

In contrast to Study I, this study examined the differences between students from both learning environments with a four-group design. Based on stage-environment fit theory (Eccles & Midgley, 1989), the sample was divided into an early adolescent group (grade 7–8) and a middle adolescent group (grade 9–10). Thus, MGCFAs and multi-group structural equation modeling (MGSEM) with indirect effects were used to investigate the postulated hypotheses.

Hypothesis 1 could only be partly confirmed: In the early adolescent SCL group, students reported significantly higher values of academic self-concept. However, students in TDL reported higher values of accuracy. In contrast to H1, students did not report any differences in terms of perceived competence support, focus, and persistence and effort. At T2, the latent means did not differ significantly at all.

Hypothesis 2 was partly confirmed as well. The comparison of a series of MGSEMs suggested differences in the interplay between academic self-concept, perceived competence support, and achievement motivation (focus, accuracy, and persistence and effort), which confirmed Hypothesis 2a. Particularly for early adolescent SCL students, perceived

competence support partially mediated all associations between academic self-concept and achievement motivation. In the middle adolescent SCL group, only the association between academic self-concept and accuracy was partially mediated by perceived competence support. In contrast to Hypothesis 2, no significant indirect effects were observed in the TDL group—neither in the early nor in the middle adolescent group. Perceived competence support thus acted as a mediator only in the SCL environment.

Overall, the results of Study II align well with the theoretical assumptions made by self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2017) and stage-environment fit theory (Eccles & Midgley, 1989; Eccles & Roeser, 2011): Ryan and Moller (2017) referred to competence support as a necessary, yet insufficient condition. They assumed that competence support only fulfills its potential under autonomous conditions. These autonomous conditions seem to be present in the SCL environment in this study. However, while the indirect effects were all significant in the early adolescent sample, there was only one significant indirect effect in the middle adolescent subsample. This effect could further imply that continuous changes in the learning environment are necessary and that learning environments need to adapt to the developmental needs of students (Eccles & Midgley, 1989). One could hence assume that the SCL environment based on competency matrices is more suitable to early adolescents.

The final study of this Ph.D. thesis examined the interplay between emotions and self-determined motivation across students from both learning environments. As in Study I and Study II, the assumption here was also that the interplay is moderated by the learning environment. Self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2017) assumes that self-determined students tend to experience enjoyment in class. Moreover, prior research on emotions has demonstrated that positive achievement emotions are associated with motivation. Therefore, this study hypothesized that (H1) students from SCL and TDL differ

in their self-determined motivation (e.g., intrinsic regulation or identified regulation) and that students from SCL report higher values of positive achievement emotions (e.g., enjoyment). Moreover, it was assumed that (H2a) the interplay between enjoyment and self-determined motivation is reciprocal, that (H2b) the perception is stable across time, and that (H2c) the learning environment moderates the interplay between the variables.

Similarly to the previous studies, Study III was conducted in a multi-group design contrasting both learning environments. Therefore, a series of MGCFAs was conducted to establish longitudinal and cross-group measurement invariance and to conduct latent mean comparisons (H1). Two multi-group cross-lagged panel models (MGCLPMs) were subsequently specified to examine the interplay between the variables of interest.

The comparison of latent means (H1) did not lead to the identification of differences with regard to intrinsic regulation, identified regulation, and enjoyment. Hypothesis I was thus not confirmed. Two MGCLPMs were specified with different restrictions and subsequently compared. The model that assumed differences in the interplay between self-determined motivation and enjoyment was supported by the data, which consequently confirmed Hypothesis 2c. In contrast, Hypothesis 2a was only partly confirmed: In the SCL group, enjoyment was concurrently and longitudinally associated with self-determined motivation, but only monodirectionally and not reciprocally. Furthermore, Hypothesis 2b was confirmed in both groups: All autoregressive paths remained stable across the school year.

In summary, the results of Study III support the assumption that the learning environment might be a distinguishing factor for emotional and motivational perceptions. This equally accounts for SDT (Deci & Ryan, 1985; Ryan & Deci, 2017) and control-value theory (Pekrun, 2006). However, the question that remains pertains to how context-specific factors (e.g., learning environment) amplify or suppress theoretical associations.

9.2 Practical and Theoretical Implications

9.2.1 Theoretical and methodological implications

To generalize the results of Study I–III, the present Ph.D. thesis potentially offers some important theoretical contributions:

A major limitation of the theoretical foundations within self-concept research (Marsh, Xu, & Martin, 2012), SDT (Deci & Ryan, 1985; Ryan & Deci, 2017), control-value theory (Pekrun, 2006), and stage-environment fit theory (Eccles & Midgley, 1989) is that they are all quite vague when it comes to the learning environment as a distinctive factor, which the authors seem well aware of. For example, Pekrun (2006, p. 331) highlights the problem that "it is quite unclear whether the results [...] can be transferred to real-life, context-bound [...] achievement emotions experienced by students in academic settings." Moreover, Ryan and Deci (2017) refer to only the satisfaction of the basic needs within SDT. However, as Study I has demonstrated, even under level 2 control of autonomy support, the learning environments still differed from each other. Therefore, two major questions arise:

1. What constitutes the learning environment?
2. How do we measure these constituents?

With regard to the first question, this thesis has found that, apart from numerous other factors, the learning environment (TDL vs. SCL) might be an important factor by itself. The question that arises is whether these results originate from the learning environment factor or from the lack of construct validity of the used measurement instruments. For instance, if we consider the *Support of Basic Needs Scales for Adolescent Students* (Müller & Thomas, 2011), then it becomes clear that the majority of items used have the referent of the teacher. This fact is problematic because we hypothesized that the competency matrices are a major source of competence support (Study II). Consequently, the teacher becomes automatically only one of many potential sources of basic need support.

The second question is also rather open and depends upon the first—thus, are there gaps in the theoretical frameworks, or is it a methodological problem of construct validity of the instruments?

This blind spot of educational research has potential consequences for several theoretical frameworks. As all three studies within this thesis have indicated, the educational environment not only affects baseline differences (e.g., latent mean comparisons), but also potentially moderates the associations (e.g., interaction of learning environment and construct). This result questions and possibly extends, for instance, the hierarchical model of enjoyment (Goetz, Pekrun, Hall, & Haag, 2006). Goetz et al. (2006) hypothesized that, similar to the multifaceted nature of the academic self-concept (Shavelson & Marsh, 1986), L1 (activity-specific enjoyment), L2 (situation-specific enjoyment), L3 (context-specific enjoyment), and L4 (enjoyment of life) reciprocally affect one another.

Extended by this research, a point could be made that context-specific enjoyment (L3) affects not only the baseline level of situation-specific enjoyment (L2), but also the hypothetical association between situation-specific enjoyment and situation-specific achievement. This moderation effect could possibly also explain both the varying strengths of effects and the lack of effects, which were supposed to be present from a theoretical point of view. For instance, the studies by León, Núñez, and Liew (2015) and Diseth (2011) presented lacking associations between deep approaches to learning and achievement. The authors suggested that this lack could be explained by more domain-specific instruments. However, the possibility also exists that distinctive features of the learning environment were not controlled for.

Moreover, the present studies contribute to existing research in various ways. First, with regard to SDT (Deci & Ryan, 1985; Ryan & Deci, 2017), the studies indicate that autonomy support can mediate the association between general self-efficacy and learning

strategies in the SCL environment. Sierens, Vansteenkiste, Goossens, Soenens, and Dochy (2009) emphasize that autonomy may depend on structure. Particularly the latter might be given by the competency matrices. Study II also adds empirical results that support the notion that competence support depends on autonomous conditions to unfold its full potential (Ryan & Moller, 2017).

Finally, Study III indicates that the perception of positive emotions is an antecedent of self-determined motivation rather than a consequence. It thus contradicts the reciprocal effects assumption within control-value theory (Pekrun, 2006) and respective empirical research (Pekrun, Lichtenfeld, Marsh, Murayama, & Goetz, 2017).

With regard to self-concept research, Study II indicates that under certain conditions (e.g., SCL), the stable nature of the academic self-concept can be dissolved by perceived competence support. This corroborates the notion that the academic self-concept becomes stable and less prone to changes in the transition from middle to late adolescence (Marsh, 1989). This notion can be reinforced by the fact that perceived competence support mediated the association between academic self-concept and achievement motivation. In contrast, it also indicates that in conventional TDL classrooms, the academic self-concept is already less prone to intervention.

Lastly, Study II substantiates the claims of stage-environment fit theory (Eccles & Midgley, 1989). It indicates that early adolescence is an especially developmental period in which self-conceptions are rather flexible and prone to intervention, which changes in middle adolescence.

9.2.2 Practical implications

This Ph.D. thesis set out to examine whether the SCL environment is beneficial for students' development. In particular, it aimed to identify potential starting points for targeting

students' decline in motivation throughout adolescence and to support them in the use of deep-level learning and strategies. While the results are ambiguous (Tab. 10), some practical implications can be derived from them.

Table 10

Summary of Latent Mean Comparisons

Theoretical Background	**Variable**	**In SCL compared to TDL**	**Hypothesis**
motivation	autonomy support	higher	confirmed
	competence support	same	rejected
	intrinsic regulation	same	rejected
	identified regulation	same	rejected
self	academic self-concept	higher	confirmed
	general self-efficacy	higher	confirmed
emotion	enjoyment	same	rejected
learning behavior	control strategies	same	rejected
	memorization	lower	confirmed
	elaboration	same	rejected
	focus	same	rejected
	accuracy	lower	rejected
	persistence	same	rejected

Although the constituents of the SCL learning environment that contribute to certain learner dispositions remain rather speculative, the studies basically referred to three central aspects:

1. the use of competency matrices for instruction;

2. the use of competency matrices for feedback;
3. additional resources for teachers, since competency matrices orchestrate instruction.

Considering the academic self-concept (Study II), a consistent finding in prior research is the enhancing role of feedback in general and attributional feedback, goal feedback, and contingent praise in particular (Craven, Marsh, & Burnett, 2003; O'Mara, Marsh, Craven, & Debus, 2006). The competency matrices enable these types of feedback because goal attainment and progress are visually reflected in the matrices. In these matrices, students continuously see what their individual competence level is in a certain subject domain and whether they can progress to a subsequent level or shift towards other domains. Moreover, as teachers are not permanently occupied with instruction, they can focus on providing individual feedback on a more regular basis than in conventional TDL classrooms. Moreover, according to the reciprocal effect model (Marsh & Craven, 2006), achievement and academic self-concept reciprocally affect each other. As the SCL environment enables individualization to a high degree, students work on their individual learning goals. A more consistent sense of achievement is hence enabled, which should in turn enhance the academic self-concept.

Self-efficacy (Study I) is meant to be strengthened by four major sources: enactive mastery, verbal persuasion, vicarious experience, and physiological arousal (Bandura, 1997). Similarly to the academic self-concept, enactive mastery can be better supported by adequate learning goals that are fitted to students' individual competence levels because they demand neither too little nor too much from the students. A consistent sense of achievement should consequently also enhance self-efficacy. Another major contribution to verbal persuasion lies within providing contingent feedback (Schunk, 1983; Schunk & Swartz, 1993; Wright,

O'Halloran, & Stukas, 2016), which can be more adequately provided when teachers can focus individually on their students.

Moreover, particularly considering Study I and II, it could be demonstrated that teachers can—in accordance with SDT—play an important role in students' learning behavior. While most differences were not significant (Tab. 1), the effects of the mediational analyses suggest that students who perceive their autonomy and competence support as high also display higher values in the behavioral variables (e.g., elaboration). This underlines that although students in SCL classes may work relatively independently, they still need support from teachers. SCL does not mean that teachers do not play a role; rather, their role is different than in TDL because students work individually on their own learning goals instead of being taught collectively in class (Bolhuis & Voeten, 2001, 2004; Goodyear & Dudley, 2015; Vogt & Rogalla, 2009). For example, Kramarski (2018) highlights the role of guiding students to set goals, allocate time to specific tasks, select strategies that best fit the lesson topic, and reflect on and evaluate progress. These tasks, however, seem incompatible with a collectively taught TDL class, which may be a reason why many teachers experience difficulties in applying such self-regulated teaching practices (Kramarski & Michalsky, 2009a, 2009b; Perry, Phillips, & Hutchinson, 2006). In contrast, the SCL environment makes such practices imperative.

Furthermore, even though the adaptivity of the learning environment was not the focus of the studies, the learning environment provides clear guidelines for how teachers can adapt their instruction to students' individual needs and prior knowledge. Considering the study on heterogeneity in classrooms by Decristan, Fauth, Kunter, Büttner, and Klieme (2017), the authors have demonstrated that high heterogeneity in class has positive effects on individual achievement under the condition that the learning environment is cognitively activating and has a supportive climate. Conversely, their results also suggest that

heterogeneity in class impairs individual achievement if classrooms are not cognitively activating and supportive. However, many teachers prefer within-class ability grouping because it helps them to address their students' needs (Chorzempa & Graham, 2006). The SCL environment may provide such a structure and may further overcome teachers' predispositions about heterogeneity.

Considering the three teaching quality dimensions (namely, cognitive activation, supportive climate, and classroom management; Klieme, Pauli, & Reusser, 2009; Praetorius, Klieme, Herbert, & Pinger, 2018), the results of the studies indicate that the SCL environment may particularly support the dimensions of cognitive activation and supportive climate. While results such as increased autonomy support (Study III) directly relate to the supportive climate in class, the mediational analyses (Study I and Study II) suggest that certain preconditions in the environment must be present to foster student outcomes (e.g., elaboration and achievement motivation). In contrast, in the TDL environment, teachers' autonomy and competence support did not mediate the associations, indicating that the supportive climate was unrelated to student outcomes. Moreover, the increased self-efficacy and academic self-concept (Study I and II) might also relate to the dimension of cognitive activation, although this fact remains rather speculative, as cognitive activation was not truly measured.

9.3 Limitations and Future Directions

This thesis has a limited scope about the SCL environment based on competency matrices. It specifically investigated the associations between motivational constructs (e.g., basic needs and achievement motivation), aspects of the self (academic self-concept and self-efficacy), behavioral constructs (e.g., approaches to learning), and emotions (e.g., enjoyment). The scope is limited because the studies within this thesis do not refer to a magnitude of other learner characteristics. Future studies should therefore extend the existing

research by focusing on, for instance, achievement and competence development, the negative aspects of scholastic education (e.g., stress and test anxiety), social development (e.g., self-claim, conflict resolution, and cooperative learning), and social interactions (e.g., student-student or teacher-student relationships).

9.3.1 Instruments used

One potential limitation can also be seen in the instruments that have been used in this study. This limitation affects Study I and Study II. In both studies, I used general instruments that aimed at capturing students' self-efficacy, their self-concepts, and the learning strategies they adopt when approaching tasks. However, there has been an ongoing debate about the validity of such general instruments: With regard to learning strategies, in spite of theoretical justifications, multiple studies have failed to find correlational evidence between deep-processing learning strategies and academic achievement (Diseth, 2011; Garner, 2016; León et al., 2015). Dinsmore and Alexander (2012) have pointed out that such inconsistencies may stem from a lack of domain specificity of the instruments used.

This criticism equally applies to the academic self-concept. While the subscale of the criterial self-concept is conceptualized as a subdomain of the academic self-concept within SESSKO (Schöne, Dickhäuser, Spinath, & Stiensmeier-Pelster, 2012), this division could be further extended to more domain-specific aspects, such as the math academic self-concept, which could be even further dissolved into the math self-concept and the physical science self-concept, among others (Marsh & Shavelson, 1985). Similarly to the reasoning within the multifaceted nature of the academic self-concept, self-efficacy may also be prone to vary across different domains (Shelton, 1990).

Another potential criticism might relate to the manner of data collection as well as the instrument that was used to assess positive achievement emotions (e.g., enjoyment) in Study

III. One might claim that there was no assessment of emotions in that study, but rather an assessment of mood, which some researchers categorically distinguish (Rosenberg, 1998). Following Pekrun and Linnenbrink-Garcia (2014), in contrast to emotions, moods lack the intensity and a specific referent. Considering the sample items (see Study III), one could fairly consider the assessed construct as a mood. Instruments such as the *Achievement Emotion Questionnaire* (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011) would have been more accurate, since they distinguish enjoyment in temporal relation (e.g., before, during, or after) and with reference to specific occasions (e.g., attending class, studying, or taking tests).

Therefore, future studies should be more precise in their choice of instruments, particularly in relation to their theoretical foundations and the research questions that arise.

9.3.2 Lack of instruments

While empirical studies must balance parsimonious models and theoretically and plausibly sound models, the present study failed to include some potentially important constructs: First, the studies did not include the socioeconomic status (SES) of the students. In spite of some disagreement on what SES is actually comprised of, researchers share the view that parental income, parental education, and parental occupation are central components (Sirin, 2005). This variable becomes of particular importance in Germany as the PISA studies have regularly pointed out that social disparities cause differences in academic achievement (Reiss, Weis, Klieme, & Köller, 2019). Likewise, immigrant generational status, which has also been found to be a distinctive influencing factor in students' academic performance, was not assessed (Reiss et al., 2019). However, the assessment of those two factors in particular is often problematic due to German school and privacy laws and generally because of tendencies to refuse to answer respective questions (Ensminger et al., 2016; May, 2016).

9.3.3 Statistical models

With the exception of Study I, all of the statistical models that were specified in this dissertation were used with Aspahourov's *type-is-complex* feature within Mplus, which adds sampling weights to the parameters obtained, thereby affecting standard errors and hence the *p*-values of the parameter estimates (Asparouhov, 2005). However, considering the general multilevel framework (see Hox, Moerbeek, & Schoot, 2018), and ignoring the nested nature of the data, the influence of classroom and/or school structure may potentially impair parameter estimates. Strictly speaking, even with the *type-is-complex* approach, the magnitude of the estimates is computed under the assumption that each student is in a different class—an assumption that does not hold in reality.

The resulting conflation of within and between effects has been particularly shown with regard to the cross-lagged panel model (CLPM; Hamaker, Kuiper, & Grasman, 2015). The specified model in Study III is thus especially prone to this problem. In this study, this multilevel framework does not only apply to potential classroom and school effects, but to within-person variation (intraindividual changes of constructs in time) and between-person variation (interindividual changes of constructs in time). The conventional CLPM used in our study assumes that all students vary around the same mean. This, however, implies that there are no intraindividual differences, only interindividual differences. Hamaker et al. (2015) demonstrated that this problem can be addressed by including a random intercept into the model, which models the individual trait-like stability; this should be done in future research. However, in the case of this study, the random intercept CLPM approach is not feasible because of the limited measurement points (e.g., two). One would need at least three points of measurement to statistically identify the model and distinguish state- and trait-like stability.

9.3.4 Missing data

As most studies in educational contexts, this study is impacted by missing data. Reasons for this missing data are diverse, ranging from students' deliberate decision to refuse to answer certain items, an occasional lack of focus, and deliberate or random dropout from the second measurement time (e.g., because of field trips). This presents a challenge to the studies that this thesis is comprised of.

Traditional methods for handling missing data usually tend to exclude these cases with pairwise or listwise deletion. However, research related to missing data has suggested that full maximum likelihood (FIML) and the multiple imputation (MI) approach are almost always more advantageous than traditional approaches (Schafer & Graham, 2002). Nevertheless, a theoretical problem exists with both of these approaches, namely the *missing-at-random* (MAR) assumption (Rubin, 1987). The problem with the MAR assumption is that one cannot prove it; one can only make its application more plausible.

All three studies within this Ph.D. thesis made use of FIML and thus assumed that the missing data emerged systematically at random (e.g., low-achieving students who refuse to do achievement tests) and completely randomly (e.g., student stops the survey because of nausea).

However, no attempts were made to make the MAR assumption more plausible. Future studies should focus on analyzing missing data patterns (e.g., identifying variables that are predictive of missing data) and making them available in research articles (e.g., in the form of an online appendix). From an empirical point of view, particularly with regard to FIML, future studies should make use of the saturated correlates approach (Graham, 2003), which adds auxiliary variables to the model, thereby counteracting bias and thus making MAR more plausible. With that approach, FIML estimation becomes even more similar to MI because the imputed datasets in MI are also constructed based on auxiliary variables.

9.3.5 Variable-oriented vs. person-oriented approaches

It may be seen cynical to address heterogeneity and individualized learning in the classroom context with a variable-oriented approach. The distinction between the two approaches basically resembles the one of "idiographic information and nomothetic observation" (Raufelder, Jagenow, Drury, & Hoferichter, 2013, p. 79). While variable-centered studies examine associations between variables, person-centered approaches examine patterns and/or profiles of individuals and groups of individuals. Therefore, the statistical analyses in variable-centered approaches use variables as the analytic unit in which the individual person is interchangeable, whereas in person-oriented approaches, the individual person or group is the focus of the research (Bogat, von Eye, & Bergman, 2016).

While the present studies distinguish between two groups of students—namely those who learn under conventional circumstances (TDL) and those who learn in a more individualized setting (SCL), prior research has found that within student populations, various subclasses exist, for example in terms of socio-motivational dependency (Raufelder et al., 2013), motivational beliefs (Lazarides, Dicke, Rubach, & Eccles, 2019), and engagement and burnout (Salmela-Aro, Moeller, Schneider, Spicer, & Lavonen, 2016). The comparison of subgroups might thus reveal even further differences across different learning environments and should be the focus of future research on learning environments.

9.3.6 Assessing adaptivity of learning environments

One further aspect that needs to be addressed is the actual adaptivity of individualized learning environments—a factor that this dissertation takes as a given. All constructs assessed in the present study approach the constructs from a trait-like perspective. However, more recent methods could potentially capture the state-like nature of certain constructs. This is of particular importance considering the adaptivity of learning environments. In this sense,

adaptivity refers not only to an approximate fit between the learner and learning material (Vygotsky, 1978), but also to the fit of learners' intra-individually varying needs—their intra- and inter-individual motivational heterogeneity, so to speak. This becomes of utmost importance as cognitive and motivational processes underlying learning are reciprocal in nature and cannot be considered separately (Zimmerman, 1990). Modern statistical methods that include intensive longitudinal panel data and experience sampling methods could be suitable to achieve that goal (Bolger & Laurenceau, 2013; Csikszentmihalyi & Larson, 1987).

9.3.7 Individualized learning environments

There has been a long tradition, both nationally and internationally, of establishing schools that base their pedagogy and instruction on alternative methods. Montessori education, the Dalton Plan, and Jenaplan schools are some examples of concepts that have gained wide recognition in the educational system of Western countries. All of these concepts have in common that they aim to address the individuality of students. As a consequence, many of their methods have in part been incorporated into public school systems—either because of individual teachers' interest in them or because of their achievement of variability in the use of instructional methods. Project-based learning and self-directed learning are hence continually gaining popularity because they assumingly manage to bridge the gap between an individual learner's prerequisites and the learning material more easily than conventional TDL environments.

However, research on different learning environments is still scant. In part, the problem lies in the comparability of the settings (Baeten, Kyndt, Struyven, & Dochy, 2010). More recent publications on a self-directed learning environment (Schweder, 2018, 2019; Schweder & Raufelder, 2019) seem to be the exemption rather than the rule, when research aims at capturing the breadth of learning environments. This study aimed to empirically

contribute to this “young” research field by identifying substantial differences in adolescent students’ motivation, self, emotions, and learning behavior, depending on attendance in SCL or TDL classroom environments.

9.4 References

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