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STUDENTS' AFFECT AND MOTIVATION: ASSESSMENT, STRUCTURE, AND DEVELOPMENT

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Summary

Students' affect and motivation are key determinants of academic effort, academic choices, and academic success. The present dissertation scrutinizes students' affect and motivation with respect to (a) possibilities of economic assessment, (b) structure, and (c) development. To this end, the present dissertation focusses on three central affective-motivational constructs that have a long tradition in educational science and are not only important with respect to students' learning, but are also considered to be vital learning outcomes themselves: academic self-concept, academic interest and academic anxiety. This dissertation includes three studies that are based on large-scale data sets.

In the first study, we examined the feasibility of short scales to assess affective-motivational constructs. This is an important research question, as testing time in educational research is typically scarce, which makes the use of long scales problematic. Specifically, we developed three-item and single-item scales for general and subject-specific (i.e., mathematics, German, French) academic anxieties and academic self-concepts and evaluated their psychometric properties by systematic comparison with corresponding long scales. Our results showed that (1) all three-item scales showed satisfactory reliabilities and substantial correlations with long scales, (2) the reliabilities and correlations of single-item measures were somewhat lower. Importantly, however, (3) the correlational patterns of the three-item as well as single-item scales with important students' characteristics (e.g., gender, school satisfaction, achievement) were similar to those obtained with the corresponding long scales. We concluded therefore that when a study design requires short measures, three-item scales and perhaps even single items may be used as reasonable alternatives for assessing academic anxiety and academic self-concept.

The second study tackled the question of structural models of students' affect and motivation. With regard to academic self-concept, much research has been devoted to the

structural conceptualization of this construct. Current structural models consider academic self-concept to be not only subject-specific by nature but also hierarchically organized with general academic self-concept operating at the apex of the hierarchy. Although theoretical considerations and consistent correlational patterns of academic interest and academic anxiety measures indicate that these constructs show similar structural characteristics to academic self-concept, structural models that can account for and test these characteristics are missing. Therefore, first, we specified and examined structural models of academic self-concept, academic interest, and academic anxiety, separately. Our results underscored empirically the structural similarities between the constructs. Furthermore, theoretical predictions and empirical results indicate interrelations between the different affective-motivational constructs. In order to properly examine the constructs' interrelations, the multidimensional and hierarchical organization of the constructs needs to be taken into account. Therefore, in the next step, we developed an integrative model which provides a comprehensive formal psychometric representation to capture and analyze the complex interplay of general and subject-specific (i.e., mathematics, French, and German) components across academic self-concept, academic interest, and academic anxiety. Finally, we validated the integrative model with respect to indicators of students' achievement.

In the third study we investigated the developmental dynamics of students' affect and motivation from Grade 7 to 9. Importantly, in previous developmental research the multidimensional and hierarchical organization of the constructs was rarely taken into account. Consequently, little is known about the manifold developmental dynamics of general and subject-specific components of academic self-concept, academic interest, and academic anxiety. Therefore, we applied longitudinal models that capture the hierarchical and subject-specific structure of these constructs to contribute to a fuller and more nuanced understanding of their developmental processes. The investigated constructs showed moderate differential stabilities at the general and subject-specific levels. Further, the development of academic self-

concept, academic interest, and academic anxiety seems to be characterized neither by top-down nor bottom-up developmental processes. Rather, general and subject-specific components of the constructs in Grade 9 were shown to be primarily a function of the corresponding components in Grade 7. However, there proved to be several negative ipsative developmental processes across different school subjects.

Zusammenfassung

Affekt und Motivation von SchülerInnen stellen Schlüsselfaktoren der Dauer und Intensität von Lernbemühungen, akademischen Entscheidungen und des schulischen Erfolgs dar. Die vorliegende Dissertation beschäftigt sich mit Affekt und Motivation von SchülerInnen in Bezug auf (a) Möglichkeiten einer ökonomischen Messung, (b) Struktur, und (c) Entwicklung. Zu diesem Zweck, liegt der Fokus dieser Dissertation auf drei zentralen affektiv-motivationalen Konstrukten, die in der Bildungsforschung eine lange Tradition haben und nicht nur in Bezug auf das Lernen der SchülerInnen von Bedeutung sind, sondern auch als wesentliche Lernergebnisse an sich betrachtet werden: schulisches Selbstkonzept, Schulinteresse und -Angst. Die Arbeit besteht aus drei Studien, für die Datensätze aus zwei Large-Scale-Erhebungen genutzt wurden.

In der ersten Studie untersuchten wir, ob es zulässig ist, affektiv-motivationale Konstrukte mit Kurzskalen zu erfassen. Dies ist eine wichtige Fragestellung, da in bildungswissenschaftlichen Studien die Zeit für Testungen oft eingeschränkt ist, was das Erfassen von Konstrukten mit langen Skalen problematisch oder sogar unmöglich machen kann. Daher haben wir Drei-Item- und Single-Item-Skalen für fachübergreifende und fachspezifische (d.h., Mathematik, Deutsch, Französisch) schulische Selbstkonzepte und Schulängste entwickelt und ihre psychometrischen Eigenschaften durch systematischen Vergleich mit langen Skalen überprüft. Die Ergebnisse zeigten, dass alle Drei-Item-Skalen zufriedenstellende Reliabilitäten und substanzielle Korrelationen mit langen Skalen aufwiesen, während die Reliabilitäten und Korrelationen der Single-Item-Skalen niedriger waren. Weiterhin konnten sowohl für die Drei-Item- als auch für die Einzel-Item-Skalen ähnliche Korrelationsmuster mit anderen wichtigen Schülermerkmalen (z.B. Geschlecht, Schulzufriedenheit, Leistung) wie für die dazugehörigen langen Skalen festgestellt werden. Die Ergebnisse zeigen, dass, sollte der Einsatz von langen Skalen auf Grund des Studiendesigns

nicht möglich sein, Drei-Item- und Single-Item-Skalen als verlässliche Alternativen für die Messung von schulischen Selbstkonzept und Schulangst herangezogen werden können.

Die zweite Studie befasste sich mit Strukturmodellen von affektiv-motivationalen Konstrukten. Im Hinblick auf das schulische Selbstkonzept wurde der Frage nach der Struktur dieses Konstrukts viel Forschung gewidmet. Aktuelle Strukturmodelle betrachten akademisches Selbstkonzept nicht nur als fachspezifisch, sondern auch als hierarchisch organisiert, mit einem fachübergreifenden schulischen Selbstkonzept an der Spitze der Hierarchie. Obwohl theoretische Überlegungen und Korrelationsmuster von Schulinteresse und -Angst zeigen, dass diese Konstrukte im Vergleich zum akademischen Selbstkonzept ähnliche strukturelle Merkmale aufweisen, fehlen bisher hierzu entsprechende Untersuchungen. Darüber hinaus, weisen theoretische Überlegungen und Ergebnisse empirischer Studien auf Zusammenhänge zwischen den verschiedenen affektiv-motivationalen Konstrukten hin. Allerdings, um eine genauere Untersuchung der Zusammenhänge zwischen den Konstrukten vorzunehmen, sollte die multidimensionale und hierarchische Organisation der Konstrukte berücksichtigt werden. Vor diesem Hintergrund haben wir in Studie 2 zuerst für jedes Konstrukt einzeln Strukturmodelle spezifiziert und untersucht. Die Ergebnisse stützten empirisch die strukturellen Ähnlichkeiten zwischen schulischem Selbstkonzept, Schulinteresse und Schulangst. Zweitens, entwickelten wir ein integratives Modell, das eine umfangreiche formale Erfassung und Analyse des komplexen Zusammenspiels von fachübergreifenden und fachspezifischen Komponenten (d.h., Mathematik, Französisch und Deutsch) über verschiedene affektiv-motivationale Konstrukte hinweg ermöglicht. Das integrative Modell wurde in Bezug auf Indikatoren der Schülerleistung validiert.

In der dritten Studie wurden die Entwicklungsdynamiken von schulischem Selbstkonzept, Schulangst und Schulinteresse zwischen Klasse 7 bis 9 untersucht. In der bisherigen Entwicklungsforschung von affektiv-motivationalen Konstrukten fand die multidimensionale und hierarchische Organisation der Konstrukte nur selten Berücksichtigung.

Bislang gibt es daher nur eingeschränktes empirisches Wissen bezüglich der vielfältigen Entwicklungsdynamiken zwischen fachübergreifenden und fachspezifischen Komponenten der Konstrukte. Um diese Lücke zu füllen, haben wir längsschnittliche Modelle definiert, die die hierarchische und fachspezifische Struktur von akademischem Selbstkonzept, Schulinteresse, und -Angst erfassen und dadurch zu einem differenzierteren Verständnis der Entwicklungsdynamiken beitragen. Die untersuchten affektiv-motivationalen Konstrukte zeigten mittelmäßige differentielle Stabilität, sowohl auf der fachübergreifenden als auch auf der fachspezifischen Ebene. Darüber hinaus, sind die fachübergreifenden und fachspezifischen Konstruktkomponenten in Klasse 9 in erster Linie als eine Funktion der entsprechenden Komponenten in Klasse 7 zu sehen. Die Entwicklung der Konstrukte scheint weder durch Top-Down- noch Bottom-Up-Entwicklungsprozesse zwischen den Hierarchieebenen charakterisiert zu sein. Es waren aber mehrere negative ipsative Entwicklungsprozesse zwischen den unterschiedlichen Schulfächern für die jeweiligen Konstrukte festzustellen.

Chapter I – General Introduction

Students' learning-related affect and motivation energize and direct students' school-related behavior, and are, therefore, key determinants of their academic effort, academic choices, and academic success (Pintrich, 2003; Schiefele, 1991; Schunk, Pintrich, & Meece, 2009). Thus, the enhancement of students' affect and motivation is one of the major goals of education worldwide (see Marsh & Hau, 2003; Snow, 1996). Given their importance for students' learning and educational careers, students' affect and motivation have become an important objective of educational research. An extensive amount of research has led to the development of many different explanatory constructs (e.g., competence and control beliefs, interest, intrinsic motivation, values, emotions, goals, and goal orientations) and motivational theories that integrate numerous affective-motivational constructs and their relations. In the present dissertation, I focused exemplarily on three core affective-motivational student characteristics with a long and well-established tradition in educational research: academic self-concept, academic interest, and academic anxiety. In spite of the great amount of research devoted to these constructs, there are still open questions that need to be addressed, for example, (1) How well can these constructs be assessed with short scales, (2) Are these constructs general or rather specific to different school subjects? (3) What are the relations between these affective-motivational constructs at different levels of generality? And (4) What are the developmental dynamics at and across the different levels of generality? In the following sections, first, I will present (a) the definition and relevance (Chapter 1.1.) of academic self-concept, academic interest, and academic anxiety. Second, I will describe in more detail (b) aspects of assessment (Chapter 1.2.), (c) structural models (including structural relations between measures and constructs as well as between-construct relations; Chapter 1.3.), and (d) development (Chapter 1.4.), as well as corresponding research gaps, which the present dissertation was designed to fill.

1.1. Exemplary central constructs of students' learning-related affect and motivation

1.1.1. Academic self-concept

Academic self-concept is defined as mental representations of a person's abilities in academic school subjects (Brunner et al., 2010; Marsh & Craven, 1997) and is one of the oldest and extensively studied constructs in educational research (Marsh, Xu, & Martin, 2012). Already in work by William James (1890/1983, as cited in Marsh et al., 2012), who is often referred to as the originator of self-concept research (Marsh et al., 2012), one's self-concept of one's own abilities is mentioned as a part of the spiritual self. Although much literature has been devoted to self-concept since then, the critical step was Shavelson, Hubner, and Stanton's work (1976) which initiated a rapid development of theory, measurement instruments, and methodology in (academic) self-concept research (Marsh et al., 2012; Marsh & Craven, 1997).

It is important to note that academic self-concept has been shown to predict coursework selection and other educational choices (Marsh & Yeung, 1997b; Nagy, Trautwein, Baumert, Köller, & Garrett, 2006; Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014; Parker et al., 2012) as well as to positively influence academic achievements, academic effort and persistence, as well as long-term educational attainment (Chen, Yeh, Hwang, & Lin, 2013; Guay, Larose, & Boivin, 2004; Guay, Marsh, & Boivin, 2003; Huang, 2011; Marsh & O'Mara, 2008; Marsh & Yeung, 1997a; Parker et al., 2014; Pinxten, Fraine, Van Damme, & D'Haenens, 2010; Trautwein, Lüdtke, Schnyder, & Niggli, 2006; Valentine, DuBois, & Cooper, 2004).

1.1.2. Academic interest

The concept of academic interest was mentioned as early as the beginning of the 19th century in work by the German philosopher Herbart, who expressed the view that fostering interest in school would promote learning (e.g., Herbart, 1806/1965, as cited in Schiefele, 1991; see Schunk et al., 2009, and Schiefele, 1991 for a detailed review of the history of work on the

interest construct). Although interest was a neglected research topic in the behaviorism-dominated research phase in psychology and also in the period that followed, it experienced a revival through Schiefele's (1978) work and the research that followed (e.g., Hidi, 1990; Krapp, 1992; Renninger & Wozniak, 1985; Todt & Schreiber, 1998).

The modern theories on interest differentiate between individual (personal) and situational interest (see Schiefele, 2009). Individual interest refers to a relatively stable personal preference for certain subjects or topics, whereas situational interest represents temporal attention or a state of being interested that is aroused by a specific topic or task (Krapp, 1999; Renninger, 2000; Schiefele, 2001). In the present dissertation, I focus on the individual interest of adolescents in school.

Many researchers conceive of individual interest as comprising feelings of personal valence and emotional value (Hidi & Renninger, 2006; Krapp, 2002; Renninger, 2000; Schiefele, 1991). The expectancy-value model by Eccles (Parsons) and colleagues (1983) accounts for this differentiation with the two distinct constructs of intrinsic value (defined as enjoyment) and attainment value (defined as personal importance). Further, the concept of academic interest is closely related to the concept of intrinsic motivation (Deci, 1975), especially with its more recent conceptualization as enjoyment, interest, and liking (e.g., Gottfried, 1985; see Lepper, Corpus, & Iyenger, 2005).

It is important to note that academic interest has been shown to be vitally relevant to academic choices (e.g., Köller, Baumert, & Schnabel, 2001; Nagy et al., 2006; Wigfield & Eccles, 2000). Moreover, academic interest has been shown to be positively associated with academic effort, quality of learning, and level of achievement (e.g. Denissen, Zarrett, & Eccles, 2007; Schiefele, 1996; Schiefele, Krapp, & Winteler, 1992; Trautwein et al., 2015; Wigfield & Eccles, 2000).

1.1.3. Academic anxiety

Anxiety is an elementary human emotion induced by perceived threat (Zeidner, 1998).

In the educational context, the concept of anxiety has been an objective of extensive research since the early 1950s in its specific form: test anxiety, initiated by Sarason and Mandler (1952; see Zeidner, 1998, for a review of the history of research on the test anxiety construct). Moreover, in the course of research on this construct, a need to consider situations other than only test situations has been expressed with regard to academic anxiety (Tobias, 1980; Wine, 1980). In the school context, researchers found it useful to study anxiety within specific school subjects (Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Gottfried, 1982; Marsh, 1988), especially in mathematics (Frenzel, Thrash, Pekrun, & Goetz, 2007; Hembree, 1990; Ma, 1999; Meece, Wigfield, & Eccles, 1990; Wigfield & Meece, 1988; Richardson & Woolfolk, 1980).

Two components of academic anxiety are usually distinguished in the literature: thoughts of worry (i.e., a cognitive component) and physical arousal (i.e., an emotional component; Liebert & Morris, 1967; Wigfield & Meece, 1988; Zeidner, 1998). Furthermore, academic anxiety may refer to a dispositional trait level or to a momentary state of anxiety (cf. Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013; Zeidner, 1998). In the present dissertation I focused on trait-level academic anxiety. It is important to note that there is strong empirical evidence for negative associations between academic anxiety and academic performance (Hembree, 1988; 1990; Ma, 1999; Seipp, 1991).

1.2. Assessment of academic self-concept, academic interest, and academic anxiety

Academic self-concept, interest, and anxiety are not directly observable but rather constitute (latent) constructs. A variety of methods can be used to construct measures that students' levels of affect and motivation can be inferred from (e.g., self-reports, ratings by others, behavioral observations; see Schunk et al., 2009). Self-reports are the predominant method for assessing students' affective-motivational constructs (Fulmer & Frijters, 2009). Although self-reports have often been criticized as an assessment method (e.g., Dunning, Heath,

& Suls, 2005; Nisbett, & Wilson, 1977), asking a person may even be the only choice when her or his experiential states and thinking are of interest (Baumeister, Vohs, & Funder, 2007). An application of long scales to reliably measure all facets of a construct, as recommended by text books (e.g., Nunally, 1978), can be problematic or even impossible if multiple constructs need to be measured in assessment settings where testing time is very scarce or there is restricted space on a questionnaire. In previous studies, thus, short scales (e.g., three items) and single-item measures were sometimes used to assess, for example, academic self-concept and academic anxiety (e.g., PISA study 2000; Goetz, Frenzel, Stoeger, & Hall, 2010; Gottfried, 1982; Nett, Goetz, & Hall, 2011; Preckel and Brüll, 2008; Stipek & Mason, 1987; Trautwein, Lüdtke, Marsh, Köller, & Baumert, 2006). However, short scales and especially single-item measures are presumed to have psychometric disadvantages. Although many empirical studies from different domains of psychological research have shown that even single items can have acceptable psychometric properties (e.g., to measure job satisfaction [Nagy, 2002], personality traits [e.g., Gosling, Rentfrow, & Swann, 2003], well-being and life satisfaction [Diener, 1984]), and self-esteem [Robins, Hendin, & Trzesniewski, 2001]), there still exists little empirical evidence for the psychometric qualities of short scales and, in particular, single items for assessing affective-motivational constructs in comparison with longer scales in the educational context.

1.3. Structure of academic self-concept, academic interest, and academic anxiety

1.3.1. Structural relations within constructs

Researchers have commonly stressed the multidimensional nature of academic self-concept, academic interest, and academic anxiety with respect to school subjects because the subject-specific measures of these constructs have been found to be weakly correlated across different school subjects (e.g., Bong, 2001; Brunner et al., 2010; Frenzel, Goetz, Pekrun, &

Watt, 2010; Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010; Goetz et al., 2007; Gottfried, 1982; Marsh, 1990; Shavelson et al., 1976; Watt, 2000). Alternatively, especially in earlier research on academic affect and motivation, many researchers have often focused on the general level of academic anxiety (e.g., Zeidner, 1998) and academic self-concept (e.g., Byrne, 1986)—the parts that are not tied to any specific school subject. Even with regard to academic interest, which is conceived as strongly subject-specific (e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 1991), some scholars argue that it can also be defined as a general individual interest in learning or at the level of the entire school curriculum (e.g., Ainley, Hidi, & Berndorff, 2002; Krapp, 2005). Similarly, intrinsic motivation, a construct that is conceptually close to academic interest, is usually conceptualized in self-determination theory as a general construct that is not tied to any particular subject (e.g., Otis, Grouzet, & Pelletier, 2005; Vallerand et al., 1992, 1993). These conceptualizations of these affective-motivational constructs at different levels of generality may imply hierarchical relations between the general and subject-specific levels.

Much research has been devoted to the structural conceptualization of academic self-concept, and structural models have been developed to formally represent and test its subject-specific and hierarchical organization at the same time (e.g., Brunner et al., 2010; Brunner, Keller, Hornung, Reichert, & Martin, 2009; Marsh, 1990; Marsh, Byrne, & Shavelson, 1988; Marsh & Shavelson, 1985; Marsh, Smith, & Barnes, 1985). For academic interest and academic anxiety, however, general and subject-specific conceptualizations appear to coexist in the literature, and these have not been related to each other previously. It is important to note that structural models that could account for both the subject-specific and the potentially hierarchical structure of these constructs are still lacking but may be warranted given the theoretical considerations and consistent correlational patterns of their measures. Crucially, such models are an essential pre-requisite to investigate any between-construct relations, instruction effects, or developmental dynamics of achievement motivation.

1.3.2. Structural relations between constructs

Although usually investigated in isolation, academic self-concept, interest, and anxiety are theoretically conceived as mutually related. Specifically, these constructs are part of Eccles et al.'s (1983) comprehensive expectancy-value theory, which has generated most of the research on academic achievement in a classroom setting (Schunk et al., 2009). This theory differentiates between two broad sets of beliefs that influence students' achievement behaviour: students' expectations of success and the value that students attach to an activity. Whereas academic self-concept is a key component of the expectancy beliefs, both academic interest (as a combination of intrinsic and attainment values) and academic anxiety (as related to negative emotional costs when engaging in an academic activity) belong to the value belief system (Wigfield & Eccles, 2002). Eccles et al.' expectancy-value theory makes predictions concerning the interplay between the expectancy and value components. Specifically, perceptions of a person's competences are supposed to predict his/her value beliefs. Thus, academic self-concept is anticipated to be related to academic interest and academic anxiety. Further, academic interest and academic anxiety represent value components, and this implies their association. In line with these predictions, a few empirical studies have shown interrelations between academic self-concept, academic interest, and academic anxiety (e.g., Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Ferla, Valcke, & Cai, 2009; Fredricks & Eccles, 2002; Goetz et al., 2010; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Lee, 2009; Marsh, Köller, Trautwein, Lüdtke, & Baumert, 2005).

It is important to note that a thorough examination of empirical relations between theoretical constructs requires the multidimensionality and the hierarchical structure of the constructs to be taken into account. As Law, Wong, and Mobley (1998) stated, "Only when the interrelations between a multidimensional construct and its dimensions are specified can we derive overall and parsimonious conclusions about the role of the multidimensional construct in its nomological network." (p. 749). However, relations across the different affective-

motivational constructs have not been previously investigated at different levels of constructs' hierarchy simultaneously. To this end, a comprehensive structural model that captures the complex interplay across the general and subject-specific components of different affective-motivational constructs is needed. Crucially, such a model would allow the fragmented findings to be integrated and would provide a more comprehensive picture of the different affective-motivational constructs, their interrelations, and their relations to other constructs in their nomological network. Moreover, it would enable a parsimonious and comprehensive investigation to be conducted, for example, on intervention effects or on the developmental dynamics of students' affect and motivation.

1.4. Development of academic self-concept, academic interest, and academic anxiety

Given the significance of students' affect and motivation, much research has been devoted to the development of affective-motivational constructs. The question of the differential stability is central in developmental research. Differential stability refers to stability in the rank order of individuals across time (Bashkov & Finney, 2013) and is typically assessed by the correlation between a construct and itself measured at different points in time (i.e., autocorrelation).

Results from previous studies have indicated moderate to relatively high stability coefficients in adolescent students for academic self-concept (e.g., Eccles et al., 1989; Frenzel, Pekrun, & Zimmer, 2006; Marsh et al., 2005; Möller, Retelsdorf, Köller, & Marsh, 2011; Musu-Gillette, Wigfield, Harring, & Eccles, 2015; Parker, Marsh, Morin, Seaton, & Van Zanden, 2015; Pinxten, Marsh, De Fraine, Van Den Noortgate, & Van Damme, 2014; Shavelson & Bolus, 1982), academic interest (e.g., Frenzel et al., 2006, 2010; Köller et al., 2001; Marsh et al., 2005; Musu-Gillette et al., 2015; Watt, 2000), and academic anxiety (e.g., Ahmed et al., 2012; Frenzel et al., 2006; Selkirk, Bouchey, & Eccles, 2011) in mathematics or verbal school

subjects. However, little is known about the differential stability of the general components as well as the subject-specific components of the affective-motivational constructs that are not confounded with the stabilities of the general level of the constructs. With regard to academic self-concept, theory predicts decreasing stability from the apex of the hierarchy (Shavelson et al., 1976) to the lower hierarchical levels, suggesting that general academic self-concept should be more stable than subject-specific self-concepts. However, the few previous studies that simultaneously examined the development of the general and subject-specific components of academic self-concept, found little support for increases in stability when approaching the apex of the hierarchy (Marsh & Yeung, 1998; Shavelson & Bolus, 1982). Similarly, little knowledge has been obtained regarding the developmental dynamics across and at different levels of generality. The scarce empirical research has provided little evidence for longitudinal developmental processes across different levels of the academic self-concept hierarchy (Marsh & Yeung, 1998). With regard to developmental dynamics across different school subjects, the dimensional comparison theory of academic self-concepts (Möller & Marsh, 2013) implies that a person's self-concept in one subject (e.g., mathematics) will have a negative effect on change in that person's self-concept in other subjects (e.g., English; see Parker et al., 2015). The few empirical studies in this area have found some support for such negative effects (Möller et al., 2011; Niepel, Brunner, & Preckel, 2014). However, in the previous developmental research on academic self-concept, adequate structural models have not been applied to combine the research questions regarding the developmental processes across the different hierarchical levels and across different school subjects. Moreover, with regard to academic interest and academic anxiety, such research questions have not been addressed at all, as general and subject-specific conceptualizations of the constructs have not been linked to each other in previous research. Thus, the application of structural models that can capture relations between general and subject-specific components of academic self-concept, academic interest, and academic anxiety, respectively, is needed to gain fuller and more differentiated picture of their

developmental dynamics.

1.5. Objectives of the present dissertation

The present dissertation consists of three separate studies that were designed to address the research gaps identified above and, thus, it scrutinizes three key aspects of students' affect and motivation, namely, (a) possibilities for economic assessment (Chapter 2), (b) structure (Chapter 3), and (c) development (Chapter 4). To this end, the present dissertation exploits data sets that were collected while conducting the national school assessment program Épreuves Standardisées (EpStan) and the national extensions of the Programme for International Student Assessment (PISA) 2009 in Luxembourg. Both EpStan (in annual cycles) and PISA (in triennial cycles) represent large-scale student assessment programs that scrutinize the manifold relations between students' competencies (cognitive and affective-motivational action resources) on the one hand and school-related learning environments on the other. The affective-motivational constructs that were the focus of the present dissertation (i.e., academic self-concept, academic interest, and academic anxiety) were measured at two different levels of generality, namely, a school-subject-specific level involving mathematics, French, and German (e.g., German anxiety) and a general level that was not tied to specific school subjects (e.g., general academic anxiety). Academic self-concept, interest, and anxiety are not directly observable but rather constitute (latent) constructs. Therefore, all studies in the present dissertation made use of the latent variable framework. Specifically, in Study 1, factor models were applied to study the reliability of the short versions of the academic self-concept and academic anxiety scales. In Studies 2 and 3, recent psychometric advances in confirmatory factor analysis (Eid, Lischetzke, Nussbeck, & Trierweiler, 2003) were capitalized on in order to capture the structure and developmental dynamics of academic self-concept, interest, and anxiety. In the next sections, the specific aims and methods of each study are presented in more detail.

1.5.1. Study I: "My questionnaire is too long!" The assessments of motivational-affective constructs with three-item and single-item measures.

Given the practical problems associated with the application of long scales in educational research and the lack of empirical evidence on the psychometric qualities of short scales (and single items in particular) for assessing affective-motivational constructs in comparison with longer scales, the goal of this study was to evaluate the psychometric properties of three-item and single-item scales for measuring general and subject-specific (i.e., mathematics, French, and German) academic self-concept and academic anxiety. The data for this study stemmed from ninth graders (N = 3.879) who took part in the 2011 cycle of the EpStan. Specifically, the following research questions were addressed: (a) How reliably do the short and single-item scales measure the respective construct captured by the longer scales? (b) How much overlapping variance do the short and single-item scales have with the corresponding long scales? (c) How well do the short and single-item scales capture the relations of longer scales with other important student' characteristics?

1.5.2. Study II: Affect and motivation within and between school subjects: Development and validation of an integrative model

Research on academic self-concept, academic interest, and academic anxiety seems fragmented. First, these constructs are often investigated in isolation although some scholars have proposed comprehensive theoretical frameworks that cover motivational and affective constructs as well as their interrelations (e.g., the expectancy-value theory by Eccles et al., 1983). Second, research on the structural conceptualization of academic self-concept has resulted in structural models that relate general and subject-specific components of academic self-concept to their corresponding manifest measures and account for the hierarchical and subject-specific structure of the construct. Conversely, with regard to academic interest and anxiety there is a dearth of knowledge about the relations between their general and subject-specific components. Structural models that are able to capture and test the structural

organization of academic interest and academic anxiety are lacking. Consequently, the relations between the constructs are usually analyzed at one level of construct generality, predominantly within a specific school subject without accounting for the relations between the general and subject-specific components. The aim of the Study 2 was, therefore, to formally integrate and extend the diverse research on academic self-concept, interest and anxiety in order to obtain a more comprehensive and more differentiated picture of affective-motivational constructs and their relations. To this end, by capitalizing on methodological approaches in confirmatory factor analysis (Eid et al., 2003; Gustafsson & Balke, 1993) and the nested Marsh/Shavelson model of academic self-concept (Brunner et al., 2010), Study 2 was conducted to examine the hierarchical structure of academic self-concept, interest, and anxiety, and contributes to the development and validation of an integrative model that can be used to capture and analyze the complex interplay between the general and subject-specific components of academic self-concept, academic interest, and academic anxiety. All analyses were conducted with four large-scale samples of ninth graders in Luxembourg (total N = 14,620). Specifically, data sets from the 2010 and 2011 EpStan cycles and two national extensions of the PISA 2009 study in Luxembourg were used.

1.5.3. Study III: Developmental dynamics of general and school-subject-specific components of academic self-concept, academic interest, and academic anxiety

Previous research on the development of affective-motivational constructs has primarily focused on either their general or subject-specific level but has rarely taken the multidimensional and hierarchical organization of the constructs into account. Thus, there is a dearth of empirical knowledge about the manifold developmental dynamics of the general and subject-specific components of affective-motivational constructs. The purpose of Study 3 was to fill this research gap. Specifically, the differential stabilities of the general and subject-specific components (i.e., mathematics, French, and German) of academic self-concept, academic interest, and academic anxiety were examined. Moreover, the following questions

about the direction of the developmental processes across the constructs' hierarchies were addressed: Are they top-down (e.g., Does general academic interest affect the development of interest in German?) or bottom-up (e.g., Does interest in mathematics affect the development of general academic interest?)? Finally, ipsative developmental processes across different school subjects (e.g., Does interest in mathematics affect the development of interest in verbal subjects?) were analyzed. To address these research questions, nested-factor models of the constructs were applied to two representative, longitudinal large-scale data sets of students in Grades 7 and 9 in Luxembourg: the 2010 and 2012 waves as well as the 2011 and 2013 waves of ÉpStan (total N = 7361).

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Chapter II – Assessment

‘‘My Questionnaire is Too Long!’’ The assessments of motivational-affective constructs with three-item and single-item measures

Gogol, K., Brunner, M., Goetz, T., Martin, R., Ugen, S., Keller, U., Fischbach, A., & Preckel, F. (2014). “My Questionnaire is Too Long!” The assessments of motivational-affective constructs with three-item and single-item measures. *Contemporary Educational Psychology*, 39(3), 188-205.

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Chapter III – Structure

Affect and Motivation Within and Between School Subjects: Development and Validation of an Integrative Model.

Note: This is the first author's version of a work that has been submitted for publication.

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*The first two authors contributed equally to this work.

Abstract

Research on students' affect and motivation is strongly fragmented as most previous studies have analyzed either different constructs within one school subject (within-subject approach) or a certain construct across different school subjects (including the hierarchical structure of constructs; between-subject approach). We developed and validated a new integrative model that combines insights from both approaches. Such a comprehensive model is necessary for disentangling the variance of subject-specific measures into components that are (a) construct-specific and generalize across different subjects, (b) subject-specific and common to different constructs, and (c) specific to a construct in a certain subject. Thereby the integrative model yields new insights concerning the generality and specificity of affective-motivational constructs. Such insights are useful for correctly interpreting corresponding measures. We used data from four large-scale samples of ninth-graders (N = 866 to 6,146) to apply the integrative model to examine three core affective-motivational constructs in educational research (academic self-concept, interest, and anxiety) in three subjects (Mathematics, French, and German). Our results consistently underscored the importance of the components at the more global level: The major part of reliable individual differences in subject-specific measures of affective-motivational constructs and their relations to achievement indicators (grades and standardized test scores) was explained by the general components at the top of the hierarchy and the global affective-motivational appraisals of specific subjects rather than by the construct-and-subject-specific components. To conclude, the integrative model has an open, empirically supported structural architecture that can be applied to simultaneously analyze complex within- and between-subject relations of affective-motivational constructs.

Keywords: academic self-concept, academic interest, academic anxiety, nested-factor model

3.1. Introduction

Motivation and affect are important determinants of students' academic effort, choices, and success (Linnenbrink & Pintrich, 2000; Pintrich, 2003; Schunk, Pintrich, & Meece, 2009). Empirical research on students' motivation and affect, however, appears to be diverse and fragmented: First, research on motivation and research on affect have remained relatively independent in educational science. Yet, for several reasons, an integrative approach seems highly warranted. (a) Some constructs simultaneously target objects in research on affect and in research on motivation. For example, students' academic interests[1] have been researched within both research traditions. (b) Some scholars have proposed comprehensive theoretical frameworks that cover motivational and affective constructs as well as their interrelations, for example the expectancy-value theory (EVT) by Eccles and her colleagues (1983). (c) There is conceptual overlap between constructs. For example, anxiety and interest both belong to the value beliefs in the EVT. (d) A few empirical studies have shown strong relations between motivational and affective constructs (e.g., Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010; Green, Martin, & Marsh, 2007).

Second, an important issue in investigations of academic affect or motivation has been the hierarchical level of construct definitions. Earlier research on academic affect and motivation focused on general constructs (at the top of the hierarchy; e.g., Byrne, 1986) with items such as "I am good at most school subjects." Contemporary educational research on affective and motivational constructs, however, has stressed the importance of differentiating between different subjects[2] (with a focus on the lower levels of the construct hierarchy; e.g., Bong, 2001; Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Marsh 1990). The focus on either

[1] In the present study, we refer to academic interest as an individual interest (i.e., a relatively enduring disposition to prefer a certain subject) and not as a situational interest (i.e., a current situationally triggered engagement; see Schiefele, 1991).

[2] The term "subject" is used throughout this study instead of the more precise term "school subject" for the clarity of the presentation.

general or subject-specific affective-motivational constructs, however, implies that hierarchical relations between general and subject-specific components were not analyzed in most empirical studies.

In sum, it is an important research endeavor to simultaneously investigate relations between affective-motivational constructs and the hierarchical relations between the general and subject-specific components of these constructs with the aim of better integrating the diverse and fragmented findings on these key constructs in educational psychology. Such an integrative approach, which can simultaneously capture different perspectives, is essential for helping researchers to understand students' affective-motivational experiences at school.

3.1.1. The present study

The present study focuses on students' affective-motivational characteristics that have a long tradition in educational science: academic self-concept, academic interest, and academic anxiety—constructs that are not only relevant to students' learning but are also considered to be vital learning outcomes themselves (e.g., Goetz et al., 2010; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Marsh & O'Mara, 2008; Marsh & Yeung, 1997a; Zeidner, 1998). *Academic self-concepts* are mental representations of a person's abilities in academic subjects (Brunner et al., 2010) entailing aspects of both self-description and self-evaluation (Brunner, Keller, Hornung, Reichert, & Martin, 2009; Marsh & Craven, 1997). *Academic interest* comprises feelings of personal importance and emotional value (Krapp, 2002; Renninger, 2000; Schiefele, 1991). *Academic anxiety* refers to feelings of worry as well as nervousness and uneasiness in achievement-related situations in the school context (Goetz, Preckel, Zeidner, & Schleyer, 2008; Liebert & Morris, 1967; Zeidner, 2007). The choice of these constructs is also important from the integrative perspective of our study: Whereas academic self-concept can be seen as a central construct in motivational research, academic anxiety is an important construct in research on academic affect; interest cannot be uniquely assigned to either of these two research traditions and can be seen as a point of intersection as it includes both motivational

and affective characteristics (see above).

To systematize the diverse research endeavors that have investigated the relations of the general and subject-specific components of these constructs, we distinguish between three research approaches (see Figure 3.1). (a) The *within-subject approach* focuses on relations across different affective-motivational constructs within a specific subject (or at the general level of the constructs[3]; see Figure 3.1a). (b) The *between-subject approach* targets relations between different subject-specific components as well as relations between general[4] and subject-specific components of a certain construct (see Figure 3.1b). This approach addresses questions about the multidimensionality and hierarchical structure of a certain construct. (c) The *integrative approach* (see Figure 3.1c) combines the first two approaches and allows for the simultaneous investigation of within- and between-subject relations.

The overall goal of the present four-part study was to significantly further the integration of the diverse perspectives and fragmented findings on three key affective-motivational constructs in educational psychology. We began our integrative endeavor by focusing on the *within-subject approach.* In Part 1, we investigated relations between academic self-concept, academic interest, and academic anxiety in three core subjects—mathematics, French, and German, respectively. These subjects are central parts of the curriculum of schools in Luxembourg where the data for the present study were collected. We also analyzed the mutual relations between these constructs when measured at the general level.

[3] Although the relations between different constructs at the general level do not belong to the strict interpretation of the within-subject approach, we assigned these relations to this approach to preserve the clarity of the structure of the manuscript.

[4] The issue of the hierarchical structure of a certain construct (in terms of relations between the general and subject-specific components of the construct) can be considered a facet of the between-subject approach. Please note that in the present study, we measured the general component of each construct directly with corresponding items (e.g., "I am good at most school subjects"; see Table A3.1 in the Appendix A). In doing so, our approach diverges somewhat from other research that has applied a between-subject approach where the general level of a construct was inferred from aggregating the subject-specific measures (see, e.g., Figure 1C in Bong, 2001).

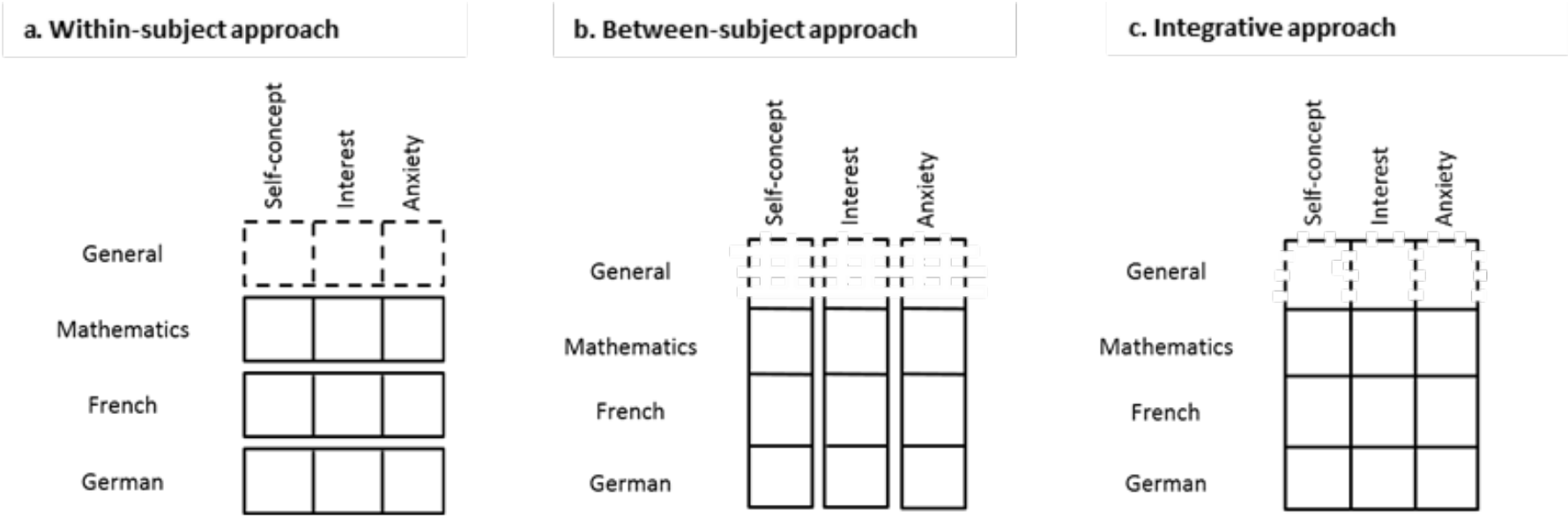

Figure 3.1. Schematic representation of three approaches used in research on affective-motivational personality constructs: (a) the within-subject approach, (b) the between-subject approach, and (c) the integrative approach. The dashed lines indicate that the general level of the constructs is usually rarely addressed in the between-subject, within-subject, and integrative approaches.

In Part 2, we focused on the *between-subject approach.* To this end, we took advantage of recent structural models of academic self-concept (Brunner et al., 2010) to investigate the interplay of the general and subject-specific components of academic self-concept, academic interest, and academic anxiety, separately. In doing so, our aim was to examine (a) the multidimensionality and (b) hierarchical structure of each construct.

In Part 3 of the present study, we combined the *within-subject approach* with the *between-subject approach*. In particular, by synthesizing the insights gained from applying the two approaches separately, we developed a new integrative model that could simultaneously capture the complex interplay of general and subject-specific academic self-concepts, interests, and anxieties. Thus, this model depicts the *within-subject* and *between-subject relations* simultaneously in a parsimonious way and consequently helps to integrate and extend the fragmented and diverse research on students' affect and motivation in school.

Finally, in Part 4 of our study, we validated the general and subject-specific components of affective-motivational constructs (as defined in the integrative model) by studying their relations to students' grades and performance on standardized achievement tests. In doing so, we were able to empirically underscore how the integrative perspective on students' affect and motivation can help us better understand the well-documented relations between students' achievement and affective-motivational measures in as much as these relations are attributable to different constructs, different subjects, or the specifics of a certain subject-specific construct.

Importantly, following the methodological advice given by Cumming (2014) and Bonett (2012) for carrying out replication studies, we conducted our analyses separately on four independent samples with representative data from a total of 14,620 ninth-graders from Luxembourg. By doing so, we were able to scrutinize the robustness of the results and to judge the generalizability of our findings.

3.2. Part 1: Within-Subject Approach

In the following we describe theoretical considerations and empirical findings from the *within-subject approach* (see Figure 3.1a) that targets relations across different affective-motivational constructs for a certain subject (or at the general level).

Although academic self-concept, academic interest, and academic anxiety are often investigated in isolation, they are theoretically supposed to be mutually related. The broad theoretical framework of the EVT (Eccles et al., 1983; Wigfield & Eccles, 2000) predicts relations between different affective-motivational constructs: academic self-concept is a key component of expectancy beliefs, whereas interest and anxiety are vital parts of the value belief system. Importantly, the theory predicts that the perceptions of one's competence are related to the value beliefs (i.e., interest and anxiety). And further, as both interest and anxiety are value components, they should also be interrelated.

In line with these theoretical predictions, empirical results from previous studies have indicated interrelations between these constructs within specific subjects. In general, academic self-concepts have been found to be positively related to academic interests (e.g., Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Marsh et al., 2005) and negatively related to academic anxieties (e.g., Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Goetz et al., 2010; Lee, 2009). Research on other conceptually close constructs of academic interest (e.g., enjoyment or intrinsic motivation) has shown positive relations with academic self-concept and negative relations with anxiety (e.g., Goetz et al., 2007, 2010; Gottfried, 1982). However, divergent findings can also be found in the literature, showing close to zero correlations between anxiety and constructs that are conceptually close to academic interest (e.g., Marsh & Yeung, 1996; Pintrich & de Groot, 1990).

3.2.1. Research objectives

We investigated the relations between academic self-concept, interest, and anxiety in

three core subjects (i.e., mathematics, French, and German) separately as well as at the general level. To this end, for each subject (or at the general level), we defined a model with correlated first-order factors representing the respective constructs (see Figure 3.2).

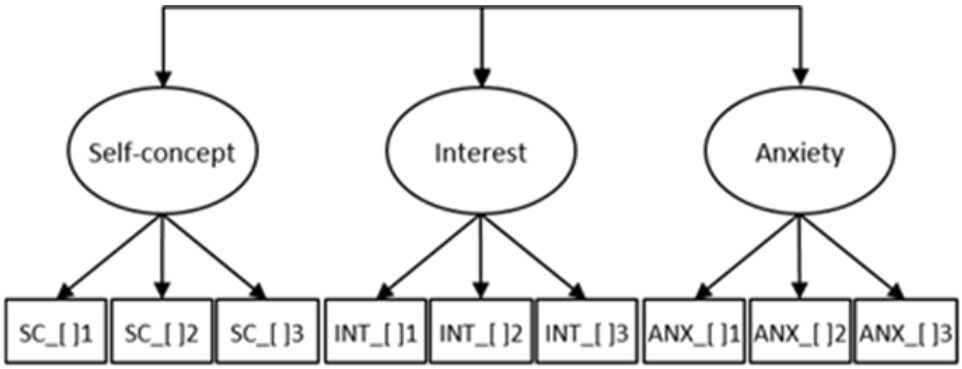

Figure 3.2. Schematic diagram of the conception of the structure of the within-subject relations that was applied in the present study for a certain subject (i.e., mathematics, French, and German) as well as the general level. Residuals are not depicted in the model to ensure the clarity of the figure. The brackets [ ] in the item label are to be replaced by A, M, F, and G in models representing the general level, mathematics, French, and German, respectively.

3.2.2. Method

3.2.2.1. Samples

Our study drew on four large-scale assessments in Luxembourg; the samples consisted of students in the ninth grade. Specifically, data were obtained from two samples of students who participated in the 2011 cycle (Sample 1 [S1]) and the 2010 cycle (Sample 2 [S2]) of the Luxembourg school-monitoring program Épreuves Standardisées (ÉpStan; Martin & Brunner, 2012). The main aim of the ÉpStan is to evaluate the key educational outcomes (e.g., subject-specific achievement and students' affective-motivational characteristics) across all state schools in Luxembourg. Data were also obtained from two national extensions of the Luxembourgish PISA year 2009 cycle: Sample 3 (S3) consisted of a random subsample of

students who worked on the tests for cross-national comparisons and then completed a questionnaire on achievement motivation; Sample 4 (S4) consisted of students who did not take the tests for cross-national comparisons but completed a questionnaire on achievement motivation and several achievement measures. Except for S4 for which the schools decided whether they wanted to participate or not, participation in S1 to S3 was obligatory for schools in Luxembourg.

In the Luxembourg school system, after the sixth grade, students are assigned to different secondary tracks according to achievement-based selection. These secondary tracks differ in their mean achievement levels as well as in the subjects taught. On the administrative level, two main secondary strands can be distinguished in Luxembourg: the lower and upper academic tracks. Table 3.1 presents the students' gender and track ratios and the mean age of the four samples. The samples showed high comparability regarding school form and gender ratios with S4 diverging slightly from the remaining samples. Further, whereas students in S1 and S2 were similar and most representative in terms of their age distributions (i.e., all ninth-graders in Luxembourg), students in S3 and S4 differed on the age variable: S3 consisted of only ninth-grade students around the age of 15 years, and S4 consisted mostly of ninth-graders who were younger or older than the S3 students.

In the present study, we excluded students who had more than two missing values on any of the general and subject-specific academic self-concept, interest, and anxiety scales to assure valid measurement of the general and subject-specific constructs. Table 3.1 presents the initial and final sample sizes, after excluding students with missing values. The large number of excluded students in S2 resulted from technical problems in the computer-based assessment, which caused randomly missing values.

Table 3.1

Summary of Sample-Specific Characteristics

Sample	Initial *N*	Final *N*	Age (years)		% Girls	% Upper track
			Mean	*SD*		
S1	6,577	6,146	14.95	0.92	49.5	30.3
S2	6,488	5,500	14.97	0.91	50.1	30.8
S3	953	866	15.86	0.28	51.2	34.8
S4	1,766	1,748	15.65	0.96	54.2	39

Note. *N* = sample size; *SD* = standard deviation.

3.2.2.2. Measures

The measures of academic self-concept, interest, and anxiety administered in all four samples covered three core subjects (i.e., mathematics, French, and German) as well as general academic self-concept, general academic interest, and general academic anxiety. Each scale consists of three items that were extensively pilot tested. The wording of the self-concept, anxiety, and interest items and corresponding scale formats used in the four studies is presented in Table A3.1 in the Appendix A. Please note that the items differed slightly between the studies. In the samples from the Luxembourg school monitoring program (S1 and S2), the questionnaires were computer-administered.

Tables B3.1, B3.2, B3.3, and B3.4 in the Appendix B in the online supplemental material present descriptive statistics, reliabilities, and intercorrelations of the scale scores that were obtained for S1, S2, S3, and S4, respectively. All scales showed satisfactory levels of reliability with values for the model-based reliability coefficient ω (see Brunner, Nagy, & Wilhelm, 2012) ranging from .77 to .91 in S1, .77 to .92 in S2, .80 to .94 in S3, and .79 to .94 in S4.

Academic self-concept measures. The academic self-concept instruments consisted of items taken from the Self-Description Questionnaire (SDQ; e.g., Marsh & O'Neill, 1984),

which is considered to be one of the best self-concept instruments available (e.g., Byrne, 1996), and were adapted to the respective subjects according to the instructions provided by Marsh (1990).

Academic interest measures. The academic interest instruments consisted of three items for general and each subject-specific interest. The items were developed according to the corresponding construct definitions (Krapp, 2002; Renninger, 2000; Schiefele, 1991); that is, one item assessed the feelings of personal importance and one item the emotional value. In addition, one global item was constructed with the aim of directly and maximally representing the essence of the definition of academic interest (e.g., "I am interested in French" for the subject of French or "I am interested in most school subjects" for the general level).

Academic anxiety measures. The academic anxiety instruments consisted of three items for general and each subject-specific anxiety. The items were developed according to the corresponding construct definitions (Liebert & Morris, 1967; Zeidner, 2007); that is, one item assessed the worry component and one the emotionality component of academic anxiety. In addition, one global item was constructed with the aim of directly and maximally representing the essence of the definition of academic anxiety (e.g., "I am afraid of mathematics class").

3.2.2.3. Statistical analyses

Missing data are unavoidable in any large-scale assessment. The highest sample-specific percentages of missing data were 2.4% in S1 for both item SC_G2, which assessed German self-concept, and item INT_M1, which assessed mathematics interest; 2.1% in S2 also for item SC_G2; 2.3% in S3 for item ANX_D1, which assessed anxiety in German; and finally, 2.2% in S4 for item ANX_M3, which assessed anxiety in mathematics. We used the full information maximum likelihood procedure (FIML) implemented in Mplus to account for the pattern of missing data as observed in the present study. The "complex" option in Mplus was used to obtain standard errors and fit statistics that were corrected for the nonindependence of observations given that the students were not independently sampled but rather nested within

classes and schools. The model parameters were estimated by the MLR estimator, which is an appropriate variant of the maximum likelihood estimator (ML) for data with nonindependence of observations (see Muthen & Muthen, 1998 – 2012). The statistical analyses were conducted separately for each sample to scrutinize the robustness of the results.

To investigate the relations between academic self-concept, interest, and anxiety in each specific subject and at the general level, four factor models were estimated for each sample (see Figure 3.2). Each of these models contained three first-order factors that represented academic self-concept, interest, and anxiety in the respective subject (or at the general level). The factors were allowed to correlate freely to account for the potential overlap between the constructs. Latent variables in all models were identified by fixing the variance of each latent variable to 1.

The model fit of each model was examined with global fit indices as recommended by Hu and Bentler (1998) and commonly used in studies applying structural equation models: the chi-square test of overall model fit, the Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). SRMR values below .08, RMSEA values below .05, and CFI values greater than .95 are considered to indicate good model fit (Hu & Bentler, 1998). RMSEA values between .05 and .08 indicate moderate fit (Browne & Cudeck, 1993).

3.2.3. Results and discussion

Although the *p*-values for the χ^2 statistics for the subject-specific models and the model at the general level were below $p < .01$ in all samples, indicating statistically significant discrepancies between the hypothesized models and the observed data, the fit of these models was considered good in all samples because the descriptive fit statistics met the recommended benchmark values for a good model fit (see Table 3.2). Moreover, the factor loadings of all items on the corresponding factors were large (see Tables B3.5, B3.6, B3.7, and B3.8 in the Appendix B in the online supplemental material for the factor loadings obtained for the general,

mathematics, French, and German models, respectively), showing that all the first-order factors were well defined.

The correlations between the academic self-concept, interest, and anxiety factors in the specific-subject models were modest to strong with the highest positive correlations between the academic self-concept and interest factors and the lowest and negative correlations between the interest and anxiety factors (see Table 3.3), indicating substantial overlap between the constructs. Finally, the academic self-concept, interest, and anxiety factors at the general level had somewhat lower correlations on the whole than the models for the subject-specific factors (only the correlations between general academic self-concept and interest were substantial; see Table 3.3), indicating the distinctiveness of the constructs at the general level. Specifically, the general academic self-concept factor was positively correlated with the general interest factor and negatively correlated with the general anxiety factor. Interestingly, the general interest factor was slightly positively correlated (but was near zero) with the general anxiety factor (see General Discussion for a discussion of this finding).

Table 3.2

Fit Statistics for Structural Models of Affective-Motivational Students' Characteristics

Construct	*N*	χ^2	*df*	CFI	RMSEA	SRMR
General-level model						
S1	6,146	140.65	24	.99	.03	.02
S2	5,500	136.96	24	.99	.03	.02
S3	866	60.87	24	.98	.04	.03
S4	1,748	85.84	24	.98	.04	.03
Mathematics model						
S1	6,146	812.84	24	.96	.07	.04
S2	5,500	611.84	24	.97	.07	.04
S3	866	69.74	24	.99	.05	.03
S4	1,748	211.03	24	.98	.07	.04
French model						
S1	6,146	586.96	24	.98	.06	.06
S2	5,500	447.24	24	.98	.06	.06
S3	866	72.74	24	.99	.05	.03
S4	1,748	243.67	24	.97	.07	.03
German model						
S1	6,146	306.85	24	.99	.04	.03
S2	5,500	282.75	24	.99	.04	.03
S3	866	83.53	24	.98	.05	.03
S4	1,748	99.84	24	.98	.04	.03
Academic self-concept model						
S1	6,146	208.04	27[a]	.99	.03	.02
S2	5,500	253.10	27[a]	.99	.04	.02
S3	866	52.00	27[a]	1.00	.04	.02
S4	1,748	56.80	30[a]	1.00	.02	.02
Academic interest model						
S1	6,146	228.31	24	.99	.04	.02
S2	5,500	197.36	24	.99	.04	.02
S3	866	46.71	24	1.00	.03	.02
S4	1,748	131.22	24	.99	.05	.02
Academic anxiety model						
S1	6,146	235.05	24	.99	.04	.02
S2	5,500	318.32	24	.99	.05	.02
S3	866	100.13	24	.98	.06	.03
S4	1,748	136.21	24	.98	.05	.03
Integrative model						
S1	6,146	624.96	39	.98	.05	.05
S2	5,500	557.18	39	.98	.05	.04
S3	866	68.81	39	.99	.03	.03
S4	1,748	178.73	40[b]	.99	.05	.03

Note. N = sample size; *df* = degrees of freedom; CFI = Comparative Fit Index; RMSEA= Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual. All χ^2 goodness-of-fit tests were statistically significant at $p < .001$.

[a] Different numbers for the degrees of freedom in the academic self-concept models across the samples were the result of different numbers of items with parallel wording whose residuals were allowed to correlate freely. [b] The residual variance of the mathematics self-concept scale score was constrained to 0, which resulted in an additional degree of freedom in the model.

Table 3.3

Correlations between Factors Obtained for the General-Level Model and Subject-Specific Models (S1/S2/S3/S4)

General-level model			
	ASC	AINT	AANX
AINT	.60/.67/.39/.54	-	
AANX	-.13/-.10/-.38/-.33	.16/.15/-.05/.02	-
Mathematics model			
	MSC	MINT	MANX
MINT	.84/.85/.66/.85	-	
MANX	-.51/-.49/-.56/-.65	-.30/-.29/-.35/-.45	-
French model			
	FSC	FINT	FANX
FINT	.81/.82/.68/.81	-	
FANX	-.33/-.34/-.60/-.67	-.14/-.17/-.34/-.45	-
German model			
	GSC	GINT	GANX
GINT	.76/.79/.55/.74	-	
GANX	-.39/-.38/-.57/-.61	-.14/-.12/-.26/-.30	-

Note. ASC = general academic self-concept; AINT = general academic interest; AANX = general academic anxiety; MSC = mathematics self-concept; MINT = mathematics interest; MANX = mathematics anxiety; FSC = French self-concept; FINT = French interest; FANX = French anxiety; GSC = German self-concept; GINT = German interest; GANX = German anxiety.

3.3. Part 2: Between-Subject Approach

In the following we describe the theoretical considerations and empirical findings from the *between-subject approach* (see Figure 3.1b) that targets the relations between the general and subject-specific components separately for each motivational and affective construct under investigation.

3.3.1. Academic self-concept

Much research has been devoted to the structural conceptualization of academic self-

concept (e.g., Brunner et al., 2009, 2010; Marsh, 1990; Marsh, Byrne, & Shavelson, 1988; Marsh & Shavelson, 1985; Marsh, Smith, & Barnes, 1985). Current academic self-concept models (see Brunner et al., 2010; Marsh, 1990) conceive of academic self-concept as a construct that is both (a) multidimensional in nature and (b) hierarchically structured. Many studies have found strong empirical support for the multidimensionality of self-concept with regard to specific subjects (e.g., Brunner et al., 2010; Marsh, 1990, 1993; Marsh et al., 1988; Möller & Köller, 2001). Regarding the hierarchical organization of academic self-concept, general academic self-concept was originally conceived as operating at the apex of the hierarchy (Brunner et al., 2009, 2010; Shavelson, Hubner, & Stanton, 1976), but earlier research failed to confirm this theoretical prediction (e.g., Marsh, 1990). Nevertheless, there is a replicated finding that general academic self-concept is positively correlated with subject-specific self-concepts (e.g., Marsh 1990; Marsh et al., 1988; Marsh et al., 1985), a finding that supports the idea that general academic self-concept is at the highest hierarchical level. The Nested Marsh/Shavelson model (Brunner et al., 2010; Brunner, Lüdtke, & Trautwein, 2008) as depicted in Figure 3.3 was developed to formally represent and test the hierarchical structure of academic self-concept (e.g., for different cultures; Brunner et al., 2009). Specifically, this model includes a latent variable that represents general academic self-concept (gASC) as the model's most general construct, which directly influences the general and subject-specific measures of academic self-concept. This is consistent with the idea that gASC operates at the apex of the hierarchy of academic self-concepts. Further, latent variables that represent academic self-concepts specific to different subjects (e.g., specific mathematics self-concept [spMSC], specific French self-concept [spFSC], and specific German self-concept [spGSC]) influence corresponding measures of subject-specific self-concepts independently of gASC. Note that the factors representing subject-specific self-concepts are nested within the general factor representing gASC. Such a structural model is therefore often referred to as a nested-factor model (Gustafsson & Balke, 1993).

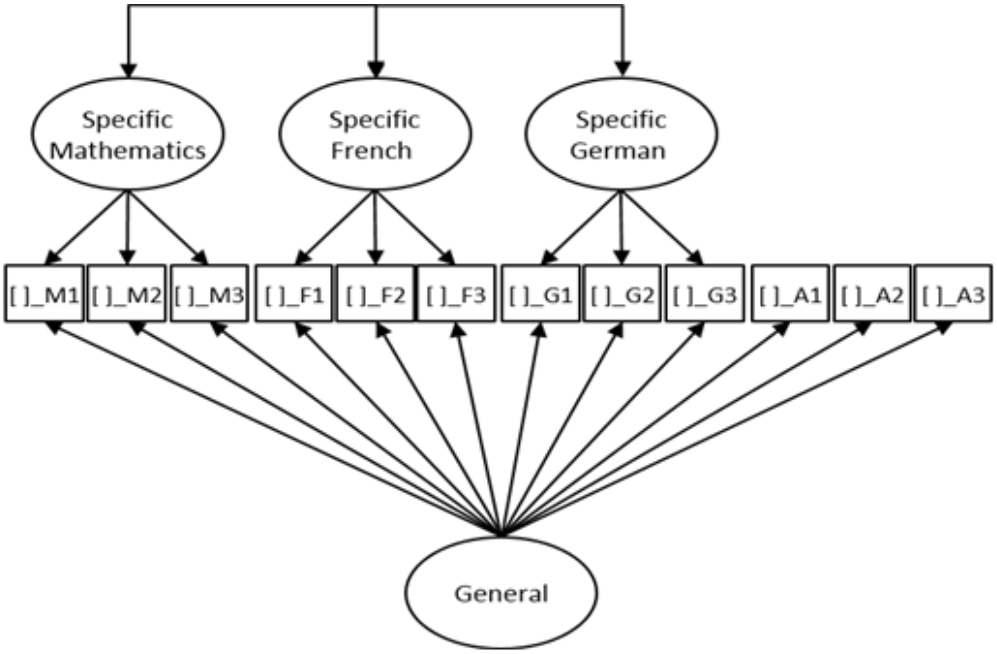

Figure 3.3. Schematic diagram of the conception of the structure of the between-subject relations in the form of nested-factor models (based on the nested Marsh/Shavelson model; Brunner et al., 2010) as applied in the present study for academic self-concept, academic interest, and academic anxiety. Residuals as well as the correlations between the residuals of items with parallel wording are not depicted in the model to ensure the clarity of the figure. The brackets [ ] in the item labels are to be replaced by SC, INT, and ANX in the academic self-concept, interest, and anxiety models, respectively.

To better understand the properties of the nested-factor model, it is useful to describe the close link between this model and students' academic self-concept profiles. Specifically, the gASC indicates the mean level of students' academic self-concepts across different subjects, whereas spMSC, spFSC, and spGSC form its particular subject-specific profile (see Brunner et al., 2009). Although orthogonal to gASC, subject-specific self-concepts can be correlated with each other. Thus, findings showing negative correlations between specific mathematics self-concept and subject-specific self-concepts from the verbal domain indicate that perceived strengths in mathematics are associated with perceived weaknesses in subjects from the verbal domain (Brunner et al., 2009, 2010). This finding has also been interpreted as indicating a strong separation of self-concepts across subjects (Marsh & Hau, 2004).

3.3.2. Academic interest

Regarding academic interest, general and subject-specific conceptualizations seem to coexist. Several scholars see academic interest as strongly subject-specific (e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 1991). Some researchers even claim that there is no such thing as general student interest (e.g., Frenzel, Goetz, Pekrun, Watt, 2010, p. 509). Their view is supported by empirical findings showing that measures of academic interest and closely related constructs such as the value construct (Wigfield & Eccles, 2000), academic enjoyment (Goetz et al., 2007), or intrinsic motivation (Ryan & Deci, 2002) are weakly correlated across subjects (e.g., Bong, 2001; Goetz et al., 2007, 2010; Gottfried, 1985; Guay et al., 2010). However, other scholars have conceptualized interest in academic activities as a general construct that is not tied to a particular subject (e.g., as intrinsic motivation in self-determination theory; Otis, Grouzet, & Pelletier, 2005; Vallerand et al., 1992, 1993). Similarly, Ainley, Hidi, and Berndorff (2002) argued that besides defining interest in terms of specific subjects, students may have a general individual interest in learning. Importantly, given the distinct research strands that conceptualize academic interest as either a general or a subject-specific construct, it comes as no surprise that structural models that capture the interplay between general and subject-specific components of academic interest are missing.

3.3.3. Academic anxiety

Early research on academic anxiety conceived of it as a broad general construct (e.g., Zeidner, 1998). However, in more recent educational research (dating back across the last 10-15 years), academic anxiety has been considered to be highly specific to subjects (Goetz et al., 2007). Whereas some empirical studies have shown weak between-subject relations for academic anxiety (e.g., Goetz et al., 2007), other studies have suggested that academic anxiety is more general across different subjects (e.g., Green et al., 2007). Yet, to the best of our knowledge, structural models capturing the interplay between general and subject-specific components of academic anxiety are missing.

3.3.4. Research objectives

Relative to academic self-concepts, there has been little research on the hierarchical characteristics of academic interest and academic anxiety. Given the theoretical considerations and consistent correlational patterns of the measures, there are some indications that academic interest and academic anxiety are structurally similar to academic self-concept (i.e., multidimensional with respect to different subjects and hierarchically organized with a general component of these constructs at the apex of the hierarchy). Yet, structural models that can account for and test these characteristics of academic interest and academic anxiety are still lacking. The purpose of Part 2 of the present study was, therefore, to fill this research gap on the structure of academic interest and anxiety by simultaneously examining their (a) potential multidimensional nature and (b) hierarchical organization. To this end, we drew on knowledge about the structure of academic self-concept (Brunner et al., 2010) and modern methodological approaches in confirmatory factor analysis (Eid, Lischetzke, Nussbeck, & Trierweiler ,2003; Gustafsson & Balke, 1993) to develop and test new structural models for academic interest and academic anxiety (see Figure 3.3). We also aimed to replicate the findings on the nested Marsh/Shavelson model of academic self-concept (Brunner et al., 2010) in several independent samples. To sum up, we applied nested-factor models to systematically investigate the between-subject relations of academic self-concept, academic interest, and academic anxiety. By doing so, we could compare the structural similarities and differences across constructs concerning (a) the relations of the subject-specific components after accounting for the general level of a construct and (b) the strength of the general factors (i.e., degree of generality across different subjects).

3.3.5. Method

Part 2 of our study drew on the same four samples and measures as presented in Part 1. All statistical analyses and model evaluations in Part 2 were analogous to Part 1 as the data were the same. Similar to Part 1, the statistical analyses were applied separately for each sample

to scrutinize the robustness of the results.

To investigate the structural models representing the between-subject relations and hierarchical nature of academic self-concept, academic interest, and academic anxiety, we specified a nested-factor model for each construct (see Figure 3.3). In these models a general latent factor represents the general component of the respective construct, and subject-specific factors represent the subject-specific components of the respective construct. Latent variables were measured by the items (as described above) that assessed the corresponding general or subject-specific constructs. To obtain a unique mathematical solution for each model (i.e., to identify the model), no specific latent variable influenced the measures of the general component in addition to the general latent factor (see Eid et al., 2003). Further, as no restrictions were imposed on the pattern of intercorrelations between the subject-specific factors, the nested-factor model was particularly useful for addressing questions about the relations of the subject-specific components after accounting for the general level of a certain construct. Latent variables in all models were identified by fixing the variance of each latent variable to 1. Factor loadings and residual variances were freely estimated. Correlations between the residuals of items with parallel wording were included in the model to obtain accurate parameter estimates (Marsh, Roche, Pajares, & Miller, 1997).

In addition, we investigated the relative strengths of the general factors for each construct in comparison with the subject-specific factors in terms of the explained common variance index (ECV; see Reise, Scheines, Widaman, & Haviland, 2013). The ECV represents the proportion of variance in subject-specific measures that is explained by the general factor to the total common variance of the subject-specific measures. The latter variance is computed as the sum of the common variance explained by the general factor and the variance explained by the subject-specific factors. The ECV is particularly helpful for comparing the strength of the general construct across different affective-motivational constructs.

3.3.6. Results and discussion

Despite significant χ^2 goodness-of-fit statistics[5], the fit of the nested-factor academic self-concept, interest, and anxiety models could be considered acceptable in all samples as the descriptive measures of fit matched the benchmark values (see Table 3.2). These results show that the nested-factor models were capable of capturing the interplay between the general and subject-specific components for academic self-concept, academic interest, and academic anxiety in four independent samples.

The results from the nested-factor models empirically underscore structural similarities between academic self-concept, academic interest, and academic anxiety. First, all factor loadings on the general factors (i.e., gASC, gINT, gANX, respectively) were substantial in all samples, thus supporting the assumption that general academic self-concept, general academic interest, and general academic anxiety operate at the apex of each hierarchy, respectively (see Tables B3.9, B3.10, and B3.11 in the Appendix B in the online supplemental material). These general constructs accounted for a substantial amount of variance in both the corresponding general measures and subject-specific measures. Second, the factor loadings for the subject-specific factors were also large, thus demonstrating the multidimensional nature of the constructs with respect to specific subjects (see Tables B3.9, B3.10, and B3.11). Third, the subject-specific components for each construct were negatively related across the different subjects in all models (see Table 3.4). For example, these results indicated that after controlling for the overall level of academic self-concept, a higher self-concept in German went along with a relatively lower self-concept in French. This separation was also found between mathematics and the subjects from the verbal domain. Such negative correlations between subject-specific self-concepts reflect the notion that students think of themselves, for example, as being good in

[5] Please note that the estimation of all models in S3 and S4 resulted in a warning message issued by Mplus indicating that there were more parameters than independent pieces of observation. However, simulation studies seem to suggest that this message can usually be ignored without affecting the results (Bengt O. Muthen, 2013).

mathematics but not in German, good in mathematics but not in French, or good in German but not in French (see also Marsh & Hau, 2004, p. 57). The interpretation of the negative correlations between the subject-specific components of academic interest or academic anxiety is analogous.

Despite these structural similarities, the investigated constructs also showed some differences: The strength of the general factor was found to differ across academic self-concept, interest, and anxiety. The analysis of the patterns of factor loadings and the explained common variance index (ECV) for each construct (see Table 3.4) showed that academic anxiety had the strongest general factor, whereas academic self-concept had a relatively weak general factor. This result indicates that, of the constructs we investigated, academic anxiety is most general in its nature, followed by academic interest and academic self-concept.

Table 3.4

Correlations between the Factors and the Indices Indicating the Strength of the General Factors (ECV) Obtained for the Academic Self-Concept, Academic Interest, and Academic Anxiety Models (S1/S2/S3/S4)

Academic self-concept model				
	gASC	spMSC	spFSC	spGSC
spMSC	0	-		
spFSC	0	-.21/-.21/-.16/-.13	-	
spGSC	0	-.24/-.25/-.17/-.35	-.49/-.52/-.42/-.43	-
ECV	.15/.17/.15/.14	-	-	-
Academic interest model				
	gAINT	spMINT	spFINT	spGINT
spMINT	0	-		
spFINT	0	-.11/-.14/-.08/-.06	-	
spGINT	0	-.12/-.08/-.10/-.25	-.30/-.30/-.21/-.27	-
ECV	.27/.28/.21/.24	-	-	-
Academic anxiety model				
	gAANX	spMANX	spFANX	spGANX
spMANX	0	-		
spFANX	0	-.15/-.16/-.20/-.17	-	
spGANX	0	-.33/-.36/-.13/-.30	-.37/-.39/-.40/-.37	-
ECV	.57/.57/.40/.41	-	-	-

Note. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept; gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest; gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety; ECV = explained common variance index – as the ECV is usually definded for the general factor only (see Reise et al., 2013), we did not calculate ECVs for subject-specific factors.

3.4. Part 3: Integrative Approach

Interestingly, there has been little research that has combined the within-subject approach with the between-subject approach in an integrative approach (see Figure 3.1c). The few empirical findings that exist and our results from Part 2 suggest that some constructs (e.g., academic anxiety) are likely more general than others (e.g., academic self-concept or interest;

Goetz, Pekrun, Hall, & Haag, 2006; Green et al., 2007). Moreover, the relations between measures of different constructs within the same subject (within-subject relations) have been found to be stronger than relations between measures of the same construct in different subjects (between-subject relations; Goetz et al., 2007; Gottfried, 1990). In line with this finding, Marsh and Yeung (1996) found more support for subject-specific factors that generalize across different affective constructs than for construct-specific factors that generalize across different subjects. However, none of the studies followed the integrative approach precisely as defined in the present study (see Figure 3.1c) and simultaneously investigated relations across different affective-motivational constructs while accounting for the multidimensional and hierarchical structure of the constructs.

3.4.1. Research objectives

On the basis of the structural models for the specific constructs and specific subjects from the first and second parts of our study, we followed the integrative approach (see Figure 3.1c) to propose a new structural model that could be used to investigate within- and between-subject relations simultaneously. To this end, we created the so-called *integrative model*—depicted in Figure 3.4—to combine the findings from the within-subject and between-subject approaches. Specifically, the model accounts for the multidimensional and hierarchical structure of the constructs as well as for the substantial correlational overlap between different constructs in the same subject and the distinctions between the constructs at the general level. In other words, we developed this model to parsimoniously depict the complex interplay of general and subject-specific components across different affective-motivational constructs. Hence, the integrative model contains subject-specific mathematics (cM), French (cF), and German (cG) factors that account for the subject-specific variance that is common to all three affective-motivational constructs under investigation. Academic self-concept, academic interest, and academic anxiety measures that are related to the same subject were considered to be indicators of an underlying common subject-specific factor that could be interpreted as

students' global affective-motivational appraisal of a certain subject. Moreover, we allowed the common subject-specific factors correlate to account for the potentially strong separation of affective-motivational constructs across subjects. Finally, as the correlational pattern of affective-motivational constructs at the general level in Part 1 did not support the conceptualization of a common factor of affective-motivational constructs at the general level, we set the integrative model up to contain three factors to represent students' general levels of academic self-concept, academic interest, and academic anxiety, respectively.

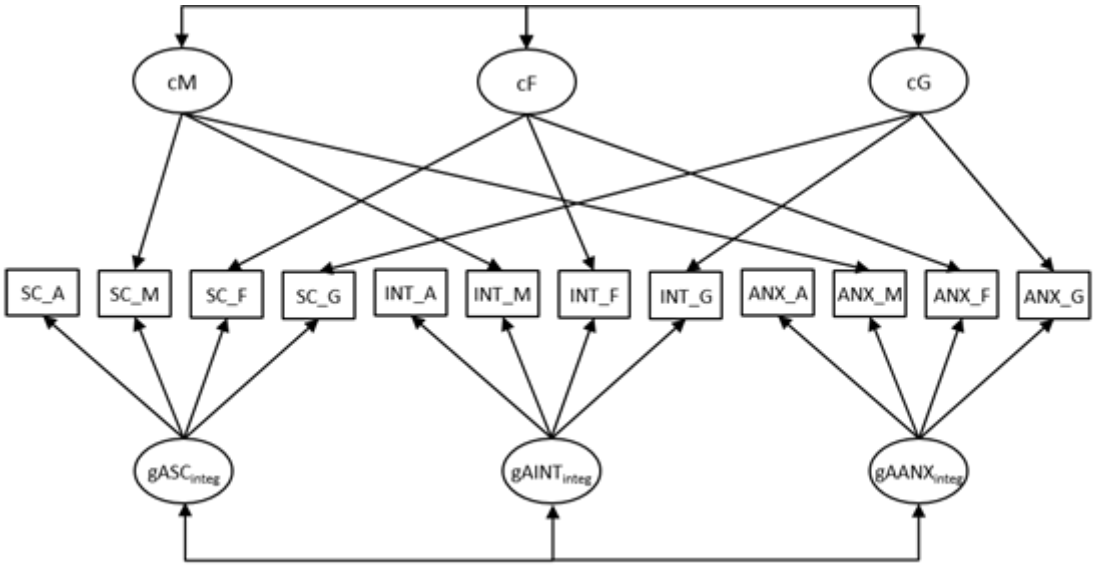

Figure 3.4. Schematic diagram of the integrative nested-factor model. Residuals are not depicted in the model to ensure the clarity of the figure. gASCInteg = general academic self-concept; gAINTInteg = general academic interest; gAANXInteg = general academic anxiety; cM = common mathematics factor; cF = common French factor; cG = common German factor; SC_A = academic self-concept; SC_M = mathematics self-concept; SC_F = French self-concept; SC_G = German self-concept; INT_A = academic interest; INT_M = mathematics interest; INT_F = French interest; INT_G = German interest; ANX_A = academic anxiety; ANX_M = mathematics anxiety; ANX_F = French anxiety; ANX_G = German anxiety; ACH_A = academic achievement; ACH_M = mathematics achievement; ACH_F = French achievement; ACH_G = German achievement.

Importantly, our new integrative model contributes to a fuller and more nuanced understanding of students' affective-motivational experience because it can be used to tackle

research questions that cannot be addressed by the within-subject or between-subject approaches alone. First, the model integrates and extends fragmented research on different affective-motivational constructs because it represents both within-subject and (hierarchical) between-subject relations for key affective-motivational constructs as measured for several core subjects and different levels of generality. In doing so, the integrative model may provide information on relations between subject-specific components that are shared by different affective-motivational constructs (e.g., the strong separation across subjects that was observed for academic self-concept, interest, and anxiety, respectively). Second, the integrative model provides a more differentiated picture of the relations between the subject-specific self-concepts, interests, and anxieties because it accounts for the general level of each construct in the subject-specific measures (and thus controls for this source of variance). Third, the integrative model can help answer questions about the generality and specificity of affective-motivational constructs. In particular, the model can be used to estimate the variance in subject-specific measures of academic self-concept, interest, and anxiety that (a) generalizes across different subjects for a specific construct (i.e., construct-specific variance), (b) is common to different affective-motivational constructs within a specific subject (i.e., subject-specific variance), and (c) is specific to a particular construct in a particular subject (i.e., construct-and-subject-specific variance). In other words, the integrative model can help to answer questions such as how much of the observed heterogeneity in measures of affective-motivational constructs in the student body is common to a certain affective-motivational construct across subjects, is shared by different subjects across constructs, or can be attributed to a specific construct in a specific subject.

3.4.2. Method

Part 3 of our study drew on the same four samples and measures as presented in Part 1. All statistical analyses and model evaluations in Part 3 were analogous to Part 1 as the data were the same. Similar to Part 1, the statistical analyses were conducted for each sample

separately to scrutinize the robustness of the results.

In line with the aggregation strategy recommended by Bagozzi and Edwards (1998), we used the sum scores for each subscale as indicators of the general and subject-specific academic self-concepts, interests, and anxieties in order to better capture the latent constructs in the integrative model. Like parcel scores, scale scores are less prone to distributional violations and show higher reliability than individual item scores (see Little, Cunningham, Shahar, & Widaman, 2002). Further, models that are based on scale scores have estimation advantages; for example, the models are more parsimonious and the indicator-to-subject ratio is lower (Little et al., 2002). In our study, for each general and subject-specific measure of academic self-concept, interest, and anxiety, a scale score containing the respective three items was created to measure the respective construct (i.e., 12 scale scores altogether).

All latent variables in the integrative model were identified by fixing their variance to 1. The factor loadings and residual variances were freely estimated.

On the basis of the factor-loading and residual-variance estimates from the integrative model as well as the scale score reliabilities for the subject-specific academic self-concepts, academic interests, and academic anxieties (as presented in Tables B3.1, B3.2, B3.3, and B3.4), we decomposed the reliable variance of each subject-specific scale score into variance that (a) could be attributed to the general component, (b) was common to other constructs in a specific subject, and (c) was specific to a particular construct in a particular subject.

3.4.3. Results and discussion

In all four samples, the model showed good fit to the empirical data according to the descriptive fit statistics[6] (see Table 3.2). The factor loadings on all common subject-specific factors were substantial, demonstrating that common variance exists between different subject-

[6] The residual variance of the mathematics self-concept scale score was estimated to be slightly negative (-0.008) in S4 and thus out of the range of admissible parameter estimates. To overcome this problem, we constrained this residual variance to 0 in S4. The model fit of the constrained model was good (see Table 3.2 for model fit statistics).

specific components of affective-motivational constructs and indicating the commonality of the subject-specific components across the affective-motivational constructs (see Table 3.5). This finding corroborates the interpretation that common subject-specific factors represent global affective-motivational appraisals of specific subjects. Notably, the absolute values of the factor loadings showed a consistent pattern for all common subject-specific factors in almost all of the samples: The self-concept scales loaded most strongly on the subject-specific factors, whereas the factor loadings of the anxiety scales on the subject-specific factors were lowest. (The only exception to this pattern was the cG factor in S3, on which academic interest and anxiety loaded almost to the same degree). Taken together, this finding points to the central importance of academic self-concept for the common subject-specific components. The negative relations between these factors demonstrate a strong separation of the subject-specific components. Analogous to results from the specific academic self-concept, interest, and anxiety models (see Part 2), the highest negative relation was found between factors representing the French and German components (see Table 3.5 for the pattern of correlations between the factors across all samples). Moreover, the integrative model captured the hierarchical structure of the affective-motivational constructs as well as the mutual relations of the general components. In line with our results from Part 1, the correlational patterns between the general construct factors demonstrate the distinctiveness of the constructs (see Table 3.5).[7] Please note that the correlations between the general construct factors in the integrative model differed only slightly from the correlations between the constructs in the general-level model (see Part 1), thus pointing to the high degree of similarity between the corresponding factors (e.g., $gASC_{Integ}$ and ASC may be interpreted analogously).

[7] We also specified an integrative model with a second-order general factor influencing the general self-concept, interest, and anxiety factors. This model did not converge in any of the samples, thus indicating the distinctiveness of the general self-concept, interest, and anxiety factors.

Table 3.5

Standardized Factor Loadings and Correlations between Factors Obtained for the Integrative Model (S1/S2/S3/S4)

	$gASC_{Integ}$	$gAINT_{Integ}$	$gAANX_{Integ}$	gM	gF	gG
Standardized factor loadings						
SC_A	.84/.83/.83/.84					
INT _A		.84/.84/.84/.88				
ANX_A			.92/.91/.93/.93			
SC_M	.43/.46/.45/.38			.88/.86/.77/.92		
INT _M		.52/.55/.48/.44		.67/.65/.67/.73		
ANX_M			.71/.71/.61/.61	-.44/-.44/-.50/-.57		
SC_F	.36/.38/.42/.42				.88/.86/.81/.88	
INT _F		.51/.53/.50/.53			.69/.68/.65/.68	
ANX_F			.66/.66/.60/.59		-.46/-.47/-.57/.-.64	
SC_G	.39/.41/.40/.40					.86/.87/.78/.89
INT _G		.55/.55/.51/.49				.61/.62/.54/.62
ANX_G			.66/.66/.58/.60			-.36/-.37/-.55/-.55
Correlations between factors						
$gAINT_{Integ}$	.64/.70 /.45/.61	-				
$gAANX_{Integ}$	-.11/-.07/-.42/-.29	.21/.21/ .04 /.07	-			
gM	0	0	0	-		
gF	0	0	0	-.23/-.25/-.27 /-.18	-	
gG	0	0	0	-.26/-.25/-.28 /-.37	-.54/-.56/-.58/-.46	-

Note. SC_A = academic self-concept; SC_M = mathematics self-concept; SC_F = French self-concept; SC_G = German self-concept; INT_A = academic interest; INT_M = mathematics interest; INT_F = French interest; INT_G = German interest; ANX_A = academic anxiety; ANX_M = mathematics anxiety; ANX_F = French anxiety; ANX_G = German anxiety; ACH_A = academic achievement; ACH_M = mathematics achievement; ACH_F = French achievement; ACH_G = German achievement; $gASC_{Integ}$ = general academic self-concept; $gAINT_{Integ}$ = general academic interest; $gAANX_{Integ}$ = general academic anxiety; cM = common mathematics factor; cF = common French factor; cG = common German factor. All factor loadings were statistically significantly different from zero at $p < .05$.

Finally, Figure 3.5 presents the proportions of the reliable variance of the subject-specific scale scores that can be attributed to (a) a particular general component for a certain construct, (b) a subject-specific component common to different constructs, and (c) variance that is specific to a particular construct in a particular subject. In line with recommendations from generalizability theory, negative variance estimates were set to zero (Shavelson & Webb, 1991). First, for the decomposition of the variance, the academic anxiety scales had the highest generality, followed by academic interest and academic self-concept (also see Part 2). Second, the amount of reliable variance remaining after accounting for the variance of the general constructs and the subject-specific variance common to the affective-motivational constructs depended on the construct: Almost no variance was left in the self-concept scales, whereas there was a substantial amount of variance that was specific to a particular construct in a particular subject for most of the subject-specific academic anxiety and interest scale scores.

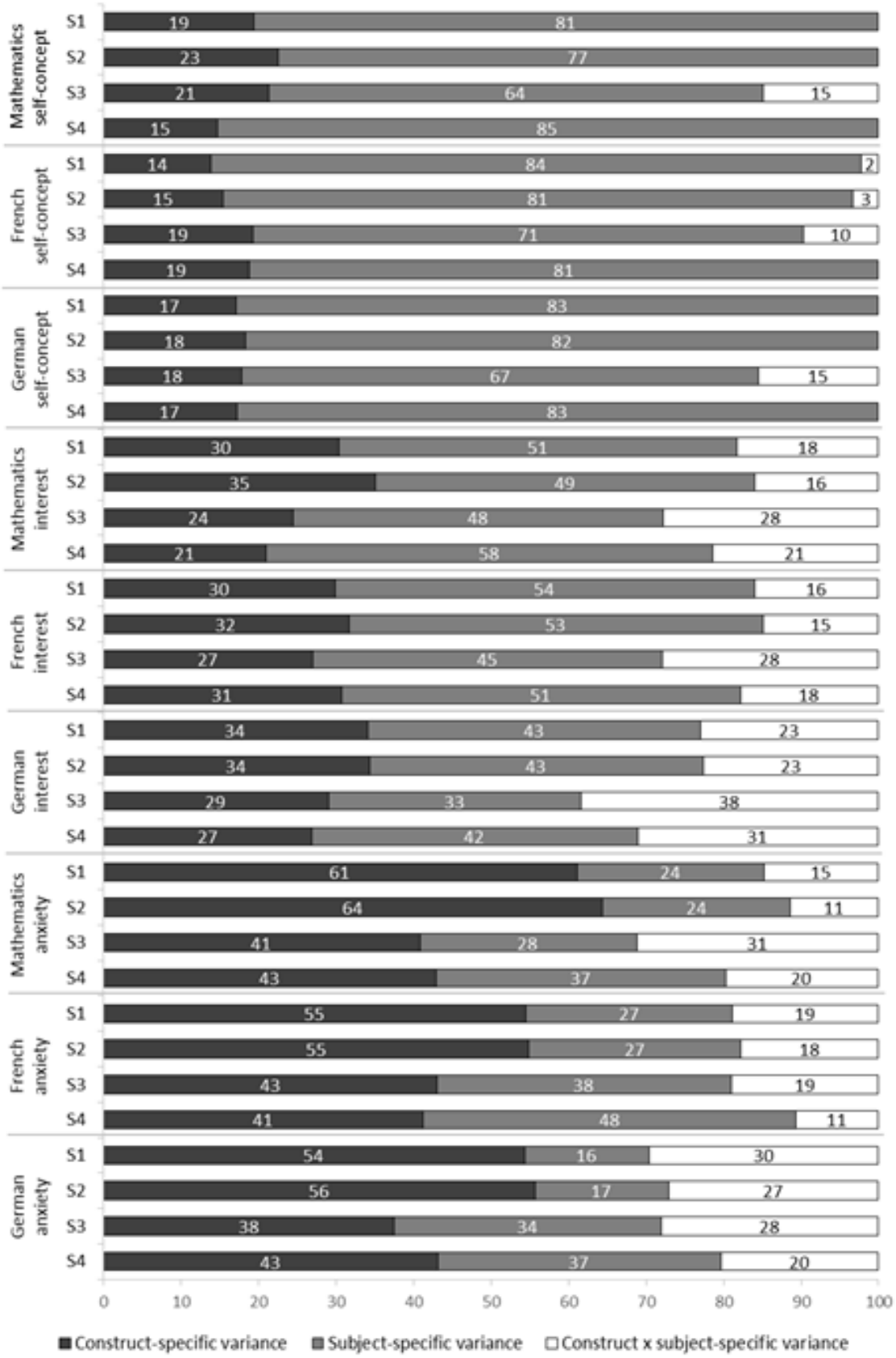

Figure 3.5. Proportions of reliable variance in the subject-specific scale scores that can be attributed to a particular general construct (i.e., construct-specific variance), a subject-specific component common to different constructs (i.e., subject-specific variance), and variance that is specific to a particular construct in a particular subject (construct x subject-specific variance).

3.5. Part 4: Validation of the Integrative Model in Relation to Student Achievement

The integrative nested-factor model established in Part 3 of our study can be described as a psychometric model that can be used to statistically decompose the variances of the affective-motivational constructs into (a) proportions of general variance for certain constructs and (b) proportions of subject-specific variance. The common subject-specific factors as defined in this model can be understood as students' global affective-motivational appraisals of specific subjects (see General Discussion); however, these appraisals are difficult to interpret from a substantive point of view. Therefore, we investigated the validity of the model-specified general and subject-specific factors with respect to their relations to two types of highly relevant school achievement measures: school grades and standardized test scores.

3.5.1. Relations of the academic self-concepts, interests, and anxieties with students' achievement

On the basis of theoretical considerations (e.g., expectancy-value theory; Eccles et al., 1983), substantial correlations could be expected for the academic self-concepts, academic interests, and academic anxieties with both school grades and standardized test scores. The academic self-concepts should be positively related to academic achievement as they represent students' descriptions and evaluations of their academic abilities. In the EVT, previous achievement-related experiences indirectly affect the corresponding interests, anxieties, and other subjective task values. Subsequently, the subjective task values influence students' choices and task investments that are important for academic achievement. This implies bidirectional relations between academic interest and academic anxiety on one side with achievement on the other.

The existing body of empirical knowledge suggests that the relations of the academic self-concepts, academic interests, and anxieties with student achievement are moderated by the

correspondence of the subjects and level of generality. That is, correlations are usually higher when achievement and the respective construct refer to the same subject and when they are matched on level of generality (e.g., math grades and academic self-concept in math are more highly correlated than math grades and general academic self-concept). Self-concept and interest are usually positively, and academic anxiety negatively, related to academic achievement. The correlations between academic self-concepts, interests, and anxieties with academic achievement (e.g., grades, standardized achievement tests) as typically found in empirical studies are presented in Table 3.6 (based on meta-analyses and selected studies with representative student samples from large-scale assessment studies).

It also has to be noted that empirical knowledge about the relations between academic self-concepts, interests, and anxieties with academic achievement measures has been acquired primarily from studies that have applied unidimensional measurement models. When the nested-factor model, which accounts for a substantial amount of the general variance in subject-specific measures of academic self-concepts, has been used, lower correlations between subject-specific self-concepts and academic achievement measures have resulted (see Brunner et al., 2009, in Table 3.6). Consequently, a more differentiated picture of the relations between subject-specific self-concepts and measures of academic achievement has emerged. Specifically, when the general variance was partialled out from the subject-specific academic self-concept measures, their correlations with general academic achievement and achievement in noncorresponding subjects were close to zero (see Brunner et al., 2009, in Table 3.6).

Finally, it has been posited and empirically confirmed that as grades represent a more salient source of individual feedback to students, academic self-concepts and interests show stronger associations with school grades than they do with standardized achievement tests (see Marsh et al., 2005; Möller, Pohlmann, Köller, & Marsh, 2009). By contrast, Hembree's (1990) meta-analysis indicates that the two achievement indicators show similar relations with academic anxiety.

Table 3.6

Mean Correlations between Student Achievement and Academic Self-Concepts, Interests, and Anxieties as Obtained in Meta-Analyses and Large-Scale Assessment Studies with Representative Student Samples

	General academic achievement	Mathematics achievement	Verbal achievement
Academic self-concept			
General academic self-concept	r = .29/.29 (L; N = 106,680)[a]	r = .24/.24 (L; N = 106,680)[a]	r = .28/.28 (L; N = 106,680)[a]
	r = .34 (M; N = 46,482)[b]		
Mathematics self-concept	r = .21/.05 (L; N = 106,680)[a]	r = .26/.15 (L; N = 106,680)[a]	r = .13/-.04 (L; N = 106,680)[a]
		r = .20 (M; N = 30,317)[b]	r = .14 (M; N = 125,308)[c]
		r = .43 (M; N = 125,308)[c]	
Verbal self-concept	r = .19/.03 (L; N = 106,680)[a]	r = .10/-.05 (L; N = 106,680)[a]	r = .24/.11 (L; N = 106,680)[a]
		r = .12 (M; N = 125,308)[c]	r = .20 (M; N = 3,669)[b]
			r = .35 (M; N = 125,308)[c]
Academic interest			
General academic interest			
Mathematics interest		r = .32 (M; N not reported)[d]	
Verbal interest			r = .17 (M; N not reported)[d]
Academic anxiety			
General academic test anxiety	r = -.29 (M; N = 6,390)[e]	r = -.22 (M; N = 6,534)[e]	r = -.24 (M; N = 10,761)[e]
	r = -.23 (M; N = 28,424)[f]		
Mathematics anxiety		r = -.34/-.30 (M; N = 5,555)[g]	r = -.06 (M; N = 1,941)[g]
		r = -.27 (M; N = 18,279)[h]	

Note. M = meta-analysis; L = large-scale assessment study. The number in parentheses indicates the sample size on which the correlation estimate was based.

[a] Brunner et al., 2009. The first number reflects the correlation obtained with the unidimensional model, whereas the second one reflects the correlation obtained when the general variance was accounted for in measures of school-subject-specific self-concepts. [b] Hansford & Hattie, 1982. [c] Möller, Pohlmann, Köller, & Marsh, 2009. [d] Schiefele, Krapp, & Wintler, 1992. [e] Hembree, 1988. [f] Seipp, 1991. [g] Hembree, 1990. [h] Ma, 1999.

3.5.2. Research objectives

External validity criteria are essential for examining the meaning and substantive interpretation of the factors in the integrative model. Therefore, the aim of the fourth part of our study was to validate the factors in the integrative model representing general and subject-specific components of affective-motivational constructs by studying their relations to two key achievement measures: school grades and standardized test scores. By doing so, this model can help us better understand the well-documented relations between students' achievement and affective-motivational measures in as much as these relations are attributable to different constructs, different subjects, or the specifics of a certain subject-specific construct.

3.5.3. Method

3.5.3.1. Sample

Part 4 of our study drew on the same four samples as described in Part 1.

3.5.3.2. Measures

Measures of academic self-concept, interest, and anxiety. The measures of general and subject-specific academic self-concepts, academic interests, and academic anxieties were identical to those used in Part 1.

Student achievement. To obtain comprehensive validation evidence, we used two alternative key indicators of students' achievement: grades and standardized competency tests. Tables B3.1, B3.2, B3.3, and B3.4 in the Appendix B in the online supplemental material present descriptive statistics, reliabilities (for the standardized competency tests), and intercorrelations of the student achievement measures and the academic self-concept, academic interest, and academic anxiety scale scores as obtained for S1, S2, S3, and S4, respectively.

***Competency tests*.** Students who participated in the Epstan (S1 and S2) were administered competency tests in mathematics and French and German reading comprehension. These competency tests were developed by experts on the basis of extensive pilot studies. The difficulty of the competency tests was tied to the achievement levels of each academic track.

Item scores were scaled using a unidimensional Rasch model with the ConQuest software (Wu, Adams, Wilson, & Haldane, 2007), which allowed us to compare student performance across different tracks. In addition to subject-specific achievements, general academic achievement was calculated as the mean of the mathematics, French, and German achievement scores.

Grades. Students in S3 and S4 were asked to report the grades they received on their last report card in mathematics, French, and German. In the Luxembourgish school system, grades can range from 0 to 60 (higher grades indicate better achievement).[8] In addition to subject-specific grades, general academic achievement was calculated as the means of the grades in mathematics, French, and German achievement in order to examine the general and subject-specific relations.

3.5.3.3. Statistical analyses

The highest percentages of missing data were 6.1% (S1) and 6.4% (S2) for German competency tests, 11.3% (S3) for French grades, and 8.3% (S4) for mathematics grades. All statistical analyses in Part 3 were analogous to Parts 1 and 2. Similarly, the statistical analyses were conducted for each sample separately to scrutinize the robustness of the results. The students' achievement variables were represented as manifest variables in the analyses.

In the integrative model, relations between students' achievement and affective-motivational measures can be decomposed into relations that are attributable to different constructs, different subjects, or the specifics of a certain subject-specific construct. First, the relations between students' achievement and the general and common subject-specific factors as conceptualized in the integrative nested-factor model were analyzed in separate runs for each achievement variable. When interpreting the correlations with the achievement measures, it is

[8] Although it has been documented in meta-analytic research (with the majority of studies coming from English-speaking countries) that self-reported grades can be positively biased to a certain extent (Kuncel, Credé, & Thomas, 2005), some recent research from German-speaking countries has demonstrated that self-reported school grades are not subject to systematic reporting bias (Dickhäuser & Plenter, 2005). Moreover, even if self-reported grades might show some response bias, self-reported grades demonstrate convergent validity as they generally predict educational outcomes as well as actual grades do (Kuncel et al., 2005).

important to remember that the general factors are uncorrelated with the subject-specific factors. That is, the correlations between the common subject-specific factors and achievement are the correlations over and above the general factor correlations and vice versa (i.e., semipartial correlations). Second, we also ran additional analyses to determine whether some of the relations between the achievement indicators on one side and the affective-motivational construct scale scores on the other could be attributed to the reliable construct-and-subject-specific variance components of these measures. Notably, these variance components are contained in the residual terms of the manifest variables in the integrative model. Thus, to examine the correlations between the residual variances of the subject-specific indicators and the measures of academic achievement, we studied the modification indices and the expected parameter change (E.P.C.) as provided by Mplus. Specifically, the E.P.C. for the proposed model modifications provides an approximate estimation of the relation between the construct-and-subject-specific variance and academic achievement because, according to classical test theory, the part of the residual variance that is comprised of random error is assumed to be uncorrelated with other constructs or any other random errors.

3.5.4. Results and discussion

The relations between students' achievement and affective-motivational measures that could be attributed to different constructs and different subjects are presented in Table 3.7. Meaningful relations emerged for all factors defined in the integrative model. Moreover, the expected correlations of the residuals of the subject-specific scale scores in a certain subject with academic achievement are presented in Table B3.12 in the Appendix B in the online supplemental material supplement along with the modification indices for improving the model fit to allow for the respective correlations.

Table 3.7

Correlations between Students' Achievement and Academic Self-Concepts, Academic Interests, and Academic Anxieties as Obtained for the Integrative Model

	$gASC_{Integ}$	$gAINT_{Integ}$	$gAANX_{Integ}$	cM	cF	cG
			Standardized achievement scores (S1/S2)			
General	.25/.23	.01/.00	-.21/-.19	-.01/.03	-.05/-.09	.05/.05
Mathematics	.20/.20	-.02/-.02	-.19/-.16	.16/.18	-.17/-.17	.05/.03
French	.20/.18	.02/.02	-.15/-.12	-.09/-.10	.24/.25	-.14/-.15
German	.22/.20	.01/-.01	-.19/-.16	-.09/-.08	-.21/-.23	.24/.25
			Grades (S3/S4)			
General	.51/.57	.25/.23	-.18/-.23	.08/.17	.03/.11	-.06/-.11
Mathematics	.42/.41	.16/.15	-.16/-.15	.45/.56	-.12/-.11	-.22/-.30
French	.40/.43	.20/.17	-.16/-.19	-.19/-.11	.40/.58	-.26/-.32
German	.35/.40	.20/.14	-.13/-.17	-.14/-.18	-.23/-.21	.37/.44

Note. $gASC_{Integ}$ = general academic self-concept; $gAINT_{Integ}$ = general academic interest; $gAANX_{Integ}$ = general academic anxiety; cM = common mathematics factor; cF = common French factor; cG = common German factor.

General factors for affective-motivational constructs. The general academic self-concept and general anxiety factors showed psychologically meaningful relations as they were positively correlated (for self-concept) and negatively correlated (for anxiety) with general academic achievement. Moreover, in line with results from previous studies (see Table 3.6), these factors were also substantially, however slightly less, correlated with achievement in the specific subjects. Similar correlational patterns were found for general interest and students' grades (S3 and S4).

The general interest factor showed near-zero correlations with the standardized achievement tests (S1 and S2). Overall, the general self-concept factor showed higher correlations with student achievement than the general anxiety and general interest factors.

3.5.4.1. Common subject-specific factors

The subject-specific factors representing the common variance of the subject-specific

components of the academic self-concepts, interests, and anxieties were substantially correlated with achievement in the corresponding subject and were negatively or not correlated with achievement in noncorresponding subjects. These results indicate the psychological meaningfulness of these factors.

3.5.4.2. Grades versus standardized tests

Regarding general academic interest, the results appeared to depend on the achievement measures used: Whereas general academic interest showed close to zero correlations with scores from the standardized achievement tests for each subject and the aggregated score across all subjects, the relation to grades were positive.

Moreover, as expected, the relations of the general constructs and the subject-specific components of the constructs seemed to be by and large higher for grades than standardized achievement tests. The only exception was the general anxiety factor, which had similarly strong correlations with both indicators of student achievement. However, direct comparison of the correlations was not possible because for each sample data were available on either school grades or standardized competency tests but not both.

3.5.4.3. Construct-and-subject-specific components

Figure 3.6 juxtaposes (a) correlations between subject-specific scale scores and academic achievement indicators and (b) the corresponding correlations as estimated for the residuals of the subject-specific scale scores (in terms of the E.P.C.). As can be seen in Figure 3.6, most of the correlations for the residuals were centered around zero. This pattern of results was consistent across all constructs and subjects in all samples and suggests that almost all relations of the subject-specific scale scores with the achievement indicators could be accounted for by the general construct components and the subject-specific components that were common to the different affective-motivational constructs. In other words: at most, very small portions of these relations could be attributed to variance that was specific to a certain construct in a certain subject (i.e., the construct-and-subject-specific component).

To sum up, the results provide strong evidence for the empirical validity of the components for certain constructs but also for the common subject-specific components that were specified in the integrative model. The general and the common subject-specific factors in the model are psychologically meaningful as they showed significant and meaningful relations to students' achievement.

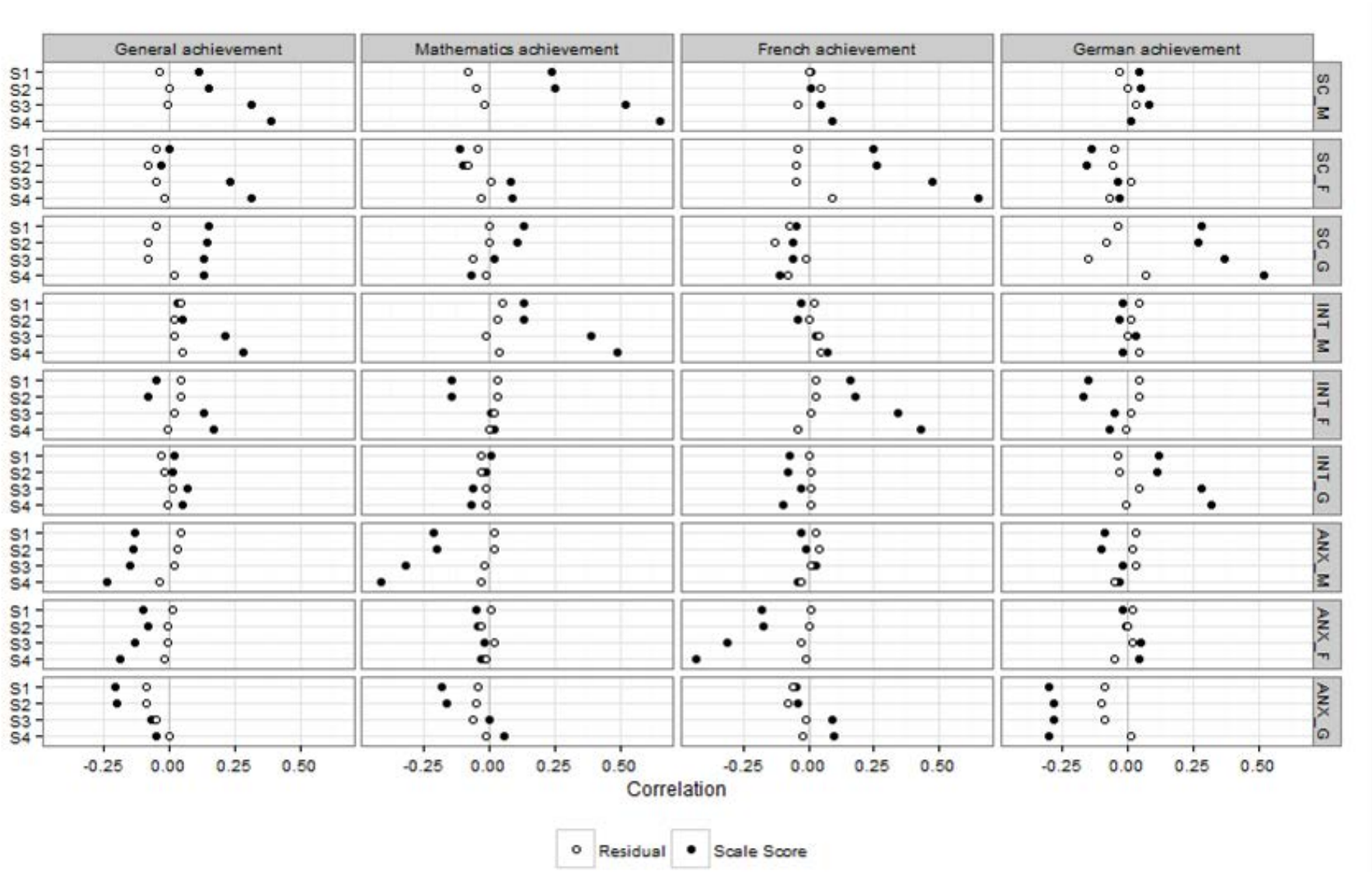

Figure 3.6. Correlations between subject-specific scale scores and their residuals obtained for the integrative model (i.e., correlation estimates of the construct-and-subject-specific components), on the one hand, and measures of academic achievement, on the other.

3.6. General Discussion

The main objective of the present study was to integrate and extend the fragmented and diverse body of research on relations between the general and subject-specific components of three affective and motivational constructs (i.e., academic self-concept, interest, and anxiety). Through the sequential integration of distinct theoretical approaches and by providing a validated proposal of a comprehensive formal psychometric representation of theoretical and empirical relations across these constructs from Eccles et al.'s (1983) expectancy-value framework, the present study makes a substantial contribution to a fuller and more nuanced understanding of academic affect and motivation.

3.6.1. Within-subject approach

In the first part of our study, we focused on the within-subject approach and examined relations between academic self-concept, interest, and anxiety within a specific subject and at the general level by employing first-order factor models. In line with previous research (e.g., Bong, 2001; Goetz et al., 2007, 2009), the constructs showed a substantial correlational overlap within specific subjects. However, the overlap across the constructs at the general level was somewhat weaker, indicating the distinctiveness of the general components across the affective-motivational constructs. Whereas a higher general level of academic self-concept corresponded as expected with higher levels of general academic interest and lower general anxiety in school, interestingly, the general level of academic anxiety was weakly positively correlated (S1 and S2) or correlated near zero (S3 and S4) with general academic interest. This result was unexpected. One tentative explanation is that general interest represents the general importance that students assign to the subjects so that students who acknowledge that subjects are important to them tend to worry more and feel more anxious about the outcomes. It may also be possible that the positive correlation between general interest and anxiety is an expression of emotional intensity in both constructs (Cohen, Cohen, West, & Aiken, 2003).

3.6.2. Between-subject approach

In the second part of our study, we followed the between-subject approach and analyzed the nested-factor models for academic self-concept, anxiety, and interest, separately. Notably, the multidimensional and hierarchical structure of academic self-concept has been empirically supported by research on the nested Marsh/Shavelson model (Brunner et al., 2010; Brunner et al. 2008, 2009). Regarding the generality and subject-specificity of academic interest and academic anxiety, however, the general and subject-specific conceptualizations of these constructs have not been explored simultaneously in previous research. Specifically, whereas some scholars have conceived of academic interest as strongly subject-specific (e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 1991), other have expressed the idea that students may also have a general individual interest in learning (Ainley, Hidi, & Berndorff, 2002). Similarly, in contemporary educational research, the subject-specific character of academic anxiety has been emphasized (Goetz et al., 2007), whereas earlier research focused on the general nature of academic anxiety (Zeidner, 1998). A vital contribution of the present study was that we integrated the subject-specific and general approaches of academic interest and academic anxiety (and, of course, academic self-concept) by applying nested-factor models to represent the hierarchical relations between the general and subject-specific construct components. Our results showed that all these constructs indeed share very similar structural characteristics: (a) a multidimensional nature with respect to different subjects, (2) a hierarchical structure of each construct with general academic self-concept, interest, or anxiety at the apex of the hierarchy, and (3) a strong separation of the subject-specific components of each construct. In other words, academic self-concept, academic interest, and academic anxiety seem to be simultaneously organized in a subject-specific way (i.e., part of the variance of subject-specific measures is specific to subjects) and generalize across different subjects (i.e., part of the variance of subject-specific measures is common to different subjects). Notably, however, academic self-concept, interest, and anxiety differ with respect to their generality

across different subjects; our results suggest that academic anxiety is the most general construct of the investigated ones, followed by academic interest and academic self-concept. This result is in line with previous studies (e.g., Green et al., 2007) and may reflect the different nature of the constructs: Whereas academic anxiety seems to have the characteristics of a general trait and is hence characterized by a general disposition to experience anxiety in different subjects (see Sarason & Sarason, 1990; Zeidner, 1998), academic self-concept seems to be more dependent on specific experiences and feedback (see Shavelson et al., 1976). Regarding academic interest, although the dispositional character of the construct is usually distinguished (e.g., Krapp, 1999; Schiefele, 1996; Todt & Schreiber, 1998), a strong object-relatedness is also emphasized (e.g., a group of similar subjects or a specific subject or topic) so that the idea that interest might generalize across different subjects is usually rejected. However, our results revealed some common variance in interest across distinct subjects (e.g., mathematics and German). This general interest in many subjects may be an expression of a more global trait like curiosity or another construct from the framework of intellect (see Mussel, 2013), and it would reveal itself in a general tendency to enjoy learning and collecting new information independent of content.

3.6.3. Integrative approach

In the third and fourth parts of our study, we followed the integrative approach, which combines the within- and between-subject approaches. Specifically, first, we combined the insights gained from the models investigated in Parts 1 and 2 into a comprehensive structural model that could parsimoniously capture the complex interplay of within-subject and between-subject relations and integrate the structural similarities of different affective-motivational constructs (Part 3). Second, we validated the general and subject-specific components of this integrative model with respect to two key indicators of students' achievement: grades and standardized test scores (Part 4). By replicating the key results in four large heterogeneous student samples, our study provides strong empirical support for the integrative model of

affective-motivational constructs in the school context.

Our findings suggest that the diverse theoretical perspectives on affective-motivational constructs from the within-subject and between-subject approaches can be integrated under one coherent structural model. Apart from integrating fragmented research on academic affect and motivation, the integrative model provides new insights into and a more nuanced understanding of students' affect and motivation. Specifically, in line with results from the models in Part 1, the integrative model points to subject-specific components of different affective-motivational constructs as sharing common variance and thus to global affective-motivational appraisals that expresses the affective-motivational experiences of the students in a specific subject. Importantly, however, the overlap between subject-specific academic self-concepts, interests, and anxieties depends on the way the subject-specific constructs are conceptualized. Whereas the integrative nested-factor model disentangles the general variance from the subject-specific variance in the subject-specific scale scores, in the models using the within-subject approach (Part 1), the subject-specific factors reflect a mixture of a certain construct's general and subject-specific variance. The overlap of subject-specific academic self-concepts, interests, and anxieties was higher in the integrative model than in the within-subject approach's subject-specific models that did not account for the general variance in the subject-specific scale scores. This difference is due to the relative distinctiveness of the general components of the affective-motivational constructs so that the correlations across the subject-specific factors in the subject-specific models (following the within-subject approach) are "pulled" toward the corresponding correlations of the general components.

Further, the common subject-specific factors that represent the variance that is common to the different affective motivational constructs in specific subjects were most strongly associated with the respective subject-specific components of academic self-concepts. This result points to the central role of academic self-concept in the common subject-specific components, and it is consistent with the notion from Eccles et al.'s (1983) expectancy-value

theory that an individual's perceptions of his/her competences in specific subjects predict how much value is placed on these subjects among others in terms of perceived interest and anxiety. This result may reflect the great importance of performance and performance evaluation in educational systems, both of which are internalized by the students, and it stresses the central role of ability beliefs in the formation of affective-motivational appraisals of subjects.

Moreover, our results consistently underscored the importance of components at a more global level. Specifically, the general construct factors and the common subject-specific factors, rather than components that are specific to a construct in a certain subject, accounted for the major part of the reliable variance in the subject-specific scale scores of the affective-motivational constructs and their relations to academic achievement. Especially the subject-specific variance in measures of self-concept seems to be almost completely shared with other affective-motivational constructs and is not unique to self-concept. That is, students do not seem to show any individual differences in their subject-specific perceptions of competence that would not be explained by their general beliefs about their competence in most subjects or their affective-motivational appraisal of the subject. Moreover, the relations between the affective-motivational scale scores and indicators of students' achievement could be almost completely accounted for by the general construct and the common subject-specific factors in the integrative model.

Notably, our results from the integrative nested-factor model also point toward possible redundancies across the subject-specific constructs. Specifically, on the one hand, the finding that the variance in the subject-specific academic self-concept scale scores was almost completely explained by the general academic self-concept factor and the common subject-specific factors could be interpreted as calling into question the usefulness of subject-specific self-concepts (see Marsh & Yeung, 1996). On the other hand, however, the highest factor loadings for the common subject-specific factors on the self-concept scale scores in the corresponding subjects indicated the importance and usefulness of subject-specific self-

concepts when the global affective-motivational appraisal of a specific subject is of interest.

3.6.4. Comparability of the results across samples

Importantly, our study showed that a similar pattern of results could be replicated across the four independent samples, thus indicating the broad generalizability and robustness of our findings. Although the pattern of results of the model solutions seemed in general to be more similar between S1 and S2 (both Epstan samples) and between S3 and S4 (both samples assessed in the national extensions of the Luxembourgish PISA year 2009 cycle) than between the samples from the different assessment contexts, the interpretation and implications of the models were by and large similar across all samples. Despite these similarities, however, there were also some sample-specific results. The largest discrepancies emerged in the correlations between the general self-concept, interest, and anxiety factors (both in the general-level model and the integrative model): Whereas the corresponding correlations had the same direction in all samples (apart from the general-level model's interest-anxiety correlation, which was slightly negative in S3 and positive in the remaining samples), the strengths of the relations varied somewhat across the samples. It seems that the assessment context and sample-specificity may have influenced the results, as the correlations from S1 and S2 were more similar to each other, and these samples were both obtained from the Luxembourg school-monitoring program, which follows a rigorous standardized study protocol each year. Moreover, the slight differences in the result patterns of S3 and S4 may have been the result of the fact that S3 was a representative samples and S4 was a convenience sample, as well as the restrictions in the age ranges in these samples.

3.6.5. Limitations

Certain limitations should be considered when interpreting the results of our study. First, the generalizability of the results from this study may be limited by the fact that the data were obtained only from samples of adolescents in Luxembourg in the ninth grade. For example, there are indications that the relations between the language-specific self-concepts may depend

on the role of the languages in the various curricula and societies. In Luxembourg, both German and French play important roles in school and society. Our results are congruent with results from other studies that have investigated self-concepts in languages of high importance (Marsh & Yeung, 2001; Marsh, Kong, & Hau, 2001; Brunner et al., 2010). However, results from studies in which one language was clearly more dominant (Goetz et al. 2010; Möller, Streblow, Pohlmann, & Köller, 2006) indicate positive correlations between the self-concepts (but also see Xu et al., 2013). Therefore, further research is needed to investigate the integrative model in different contexts.

With regard to the students' age, further research should also investigate changes in the structural relations of the affective-motivational constructs depending on age. The differential distinctiveness hypothesis (DDH; Marsh & Ayotte, 2003) predicts that (a) academic self-concepts that are weakly associated in young children become even more differentiated with age, and (b) academic self-concepts that are highly correlated in young children, on the other hand, remain highly correlated when children grow older. Previous research has supported these self-concept predictions (e.g., Brunner et al., 2008, 2009; Byrne & Worth Gavin, 1996; Marsh, 1990b; Marsh & Ayotte, 2003; Marsh et al., 1988; Marsh & Shavelson, 1985) and has indicated that these predictions may also hold for academic anxiety and interest (Goetz et al., 2007, 2010). With respect to the integrative model, we would therefore expect that the influence of the general constructs on the general and subject-specific measures would remain constant across age levels. Moreover, we would also expect that the intercorrelations between the subject-specific affective-motivational constructs would be more negative for older than for younger students.

3.6.6. Implications

Concerning implications for educational research, the construct-specific nested-factor models and the integrative nested-factor model open manifold avenues for future research. Recall that the nested-factor academic self-concept model can be interpreted in terms of an

academic self-concept profile (also see Brunner et al., 2009). Likewise, the nested-factor models that we introduced for academic interest and anxiety are able to statistically decompose the profiles of academic interest and anxiety, respectively: the general anxiety factor and the general interest factor reflect the mean level of interest or anxiety across different subjects, whereas the domain-specific interests/anxieties can be seen as forming a particular profile. Consequently, the common subject-specific factors from the integrative model can be interpreted as unifying the subject-specific profiles across different constructs. The implementation of nested-factor models, therefore, allows researchers to tackle important research questions concerning students' developmental dynamics. For example, previous research (Brunner et al., 2008; Eccles, 1994; Lubinski, 2004; Marsh & Yeung, 1997b; Nagy, Trautwein, Köller, Baumert, & Garrett, 2006) indicates that students' academic achievement profiles, but also their motivational profiles, contribute to their choices of particular learning environments. Nested-factor models allow researchers to simultaneously investigate the differentiated effects of affective-motivational constructs at the general level and the profiles of the corresponding subject-specific constructs on the academic development of students.

Further, nested factor-models are potentially valuable tools in intervention research, as a construct-specific nested-factor model would allow for the estimation of whether and how an intervention affects a targeted construct at the general level (i.e., whether it affects more subjects) or whether and how an intervention affects the target construct in some specific subjects beyond the general level. And further, a nested-factor model integrating numerous constructs (e.g., like the proposed integrative model) would allow researchers to examine the effect of an intervention in a specific subject that was common to different constructs.

Moreover, nested-factor models can be useful for investigating the effects of academic achievement or other variables on affective-motivational constructs. For example, nested-factor models can be used to investigate effects from dimensional comparison theory (Möller & Marsh, 2013) as they incorporate the general component and the hierarchical structure of a

construct (see Brunner et al., 2008, for their test of the internal/external frame of reference model [I/E model] with the nested-factor academic self-concept model). As the effects of dimensional comparisons are usually investigated with respect to academic self-concept (see Marsh, 1988; Miller, 2000, and Goetz, Frenzel, Hall, & Pekrun, 2008, for exceptions), the need to examine the generalizability of the I/E model in the context of other psychosocial variables has been expressed (see Xu et al., 2013). The proposed nested-factor academic interest and anxiety models and the integrative model seem to be well suited for this research endeavor.

Finally, in the present study, we synthesized diverse research approaches with respect to three key affective-motivational constructs in Eccles et al.'s (1983) expectancy-value framework. We used the integrative model to parsimoniously represent a large amount of information on the interplay of within- and between-subject relations across these affective and motivational constructs. We hope that in the long run, this model will contribute to the development of an open structural architecture of students' affect and motivation that formally organizes the numerous constructs in these research areas under a coherent theoretical umbrella and opens many avenues for future research. It would be important to extend this model by including additional constructs from the expectancy-value theory, for example the remaining constructs from the value beliefs (e.g., utility value), as well as other affective and motivational constructs such as achievement goals, motivation types as defined by self-determination theory (Ryan & Deci, 2002), or diverse academic emotions. This endeavour would help verify the tentative conclusion from the present study in the context of more affective-motivational constructs and detect differences and similarities or even redundancies between further affective-motivational constructs. Such a theoretical integration is needed to obtain a fuller and more nuanced understanding of students' affective-motivational experiences.

3.7. References

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3.8. Appendix A to Chapter 3

Table A3.1

Items Assessing Academic Self-Concepts, Academic Interests, and Academic Anxieties

		S1	S2	S3	S4
General academic self-concept					
SC_A1-S3	I get good marks in most school subjects.			X[a]	
SC_A1-S1/2/4	I do well on tests in most school subjects.	X[a]	X[a]		X[b]
SC_A2	I learn things quickly in most school subjects.	X[a]	X[a]	X[a]	X[b]
SC_A3	I am good at most school subjects.	X[a]	X[a]	X[a]	X[b]
Subject-specific academic self-concepts					
SC_[S]1	[SUBJECT] is one of my best subjects.	X[a]	X[a]	X[a]	X[b]
SC_[S]2	I learn things quickly in [SUBJECT].	X[a]	X[a]	X[a]	X[b]
SC_[S]3-S1/2	I am good at [SUBJECT].	X[a]	X[a]		
SC_[S]3-S3/4	I get good marks in [SUBJECT].			X[a]	X[b]
General academic interest					
INTA1	I am interested in most school subjects.	X[a]	X[a]	X[b]	X[b]
INT_A2	Most school subjects are important to me personally.	X[a]	X[a]	X[b]	X[b]
INT_A3-S1/2	I enjoy most school subjects.	X[a]	X[a]		
INT_A3-S3/4	I enjoy learning about most school subjects.			X[b]	X[b]
Subject-specific academic interests					
INT_[S]1	I am interested in [SUBJECT].	X[a]	X[a]	X[b]	X[b]
INT_[S]2	[SUBJECT] is important to me personally.	X[a]	X[a]	X[b]	X[b]
INT_[S]3	I enjoy [SUBJECT].	X[a]	X[a]	X[b]	X[b]
General academic anxiety					
ANX_A1	I am afraid of most school subjects.	X[a]	X[a]	X[b]	X[b]
ANX_A2	I get very nervous before tests in most school subjects.	X[a]	X[a]	X[b]	X[b]
ANX_A3-S1/2	I am worried before tests in most school subjects.	X[a]	X[a]		
ANX_A3-S3/4	Before tests in most school subjects, I worry that I will perform poorly.			X[b]	X[b]
Subject-specific academic anxieties					
ANX_[S]1	I am afraid of [SUBJECT] class.	X[a]	X[a]	X[b]	X[b]
ANX_[S]2	I get very nervous before tests in [SUBJECT].	X[a]	X[a]	X[b]	X[b]
ANX_[S]3-S1/2	I am worried before tests in [SUBJECT].	X[a]	X[a]		
ANX_[S]3-S3/4	Before tests in [SUBJECT], I worry that I will perform poorly.			X[b]	X[b]

Note. X indicates that an item was used in a certain sample. To assess subject-specific constructs, [SUBJECT] was replaced by mathematics, French, and German, respectively.

[a] Students responded to these items on a rating scale with four categories: *disagree*, *disagree somewhat*, *agree somewhat*, and *agree*. [b] Students responded to these items on a 6-point rating scale: *disagree completely*, *disagree*, *disagree somewhat*, *agree somewhat*, *agree*, and *agree completely*.

3.9. Appendix B to Chapter 3 (Online Supplementary Material)

Table B3.1

Descriptive Statistics and Intercorrelations of the Scale Scores Assessing Academic Self-Concepts, Academic Interests, Academic Anxieties, and Academic Achievements in S1

	SC_A	SC_M	SC_F	SC_G	INT_A	INT_M	INT_F	INT_G	AX_A	AX_M	AX_F	AX_G	ACH_A	ACH_M	ACH_F	ACH_G
SC_M	.40	-														
SC_F	.26	-.03	-													
SC_G	.32	-.01	-.29	-												
INT_A	.47	.23	.21	.18	-											
INT_M	.32	.74	.02	-.01	.43	-										
INT_F	.22	.00	.72	-.23	.44	.17	-									
INT_G	.26	.02	-.14	.66	.44	.17	.06	-								
AX_A	-.12	-.11	.11	-.09	.14	.03	.21	.08	-							
AX_M	-.10	-.44	.17	.06	.10	-.25	.23	.15	.67	-						
AX_F	-.04	.06	-.34	.19	.12	.14	-.15	.23	.56	.40	-					
AX_G	-.09	.06	.31	-.35	.12	.14	.35	-.11	.63	.42	.29	-				
ACH_A	.23	.11	.00	.15	.00	.03	-.05	.02	-.20	-.13	-.10	-.21	-			
ACH_M	.20	.24	-.11	.13	-.02	.13	-.14	.01	-.20	-.21	-.05	-.18	.83	-		
ACH_F	.17	.01	.25	-.05	.01	-.03	.16	-.07	-.10	-.03	-.18	-.05	.82	.50	-	
ACH_G	.21	.04	-.14	.28	.00	-.02	-.15	.12	-.19	-.09	-.02	-.30	.86	.60	.57	-
M	2.85	2.59	2.56	2.79	2.73	2.64	2.66	2.60	2.11	2.20	2.02	1.83	0.02	0.03	0.02	0.00
SD	0.61	0.95	0.95	0.91	0.70	0.94	0.92	0.89	0.81	0.92	0.86	0.84	0.84	1	1	1
ω/Rel	.77	.90	.91	.89	.77	.88	.87	.87	.79	.81	.80	.81	.78	.82	.80	.80

Note. Scale scores for academic self-concepts, interests, and anxieties were computed as the mean of the respective item scores. Reliability estimates for these scale scores were calculated as coefficient ω (McDonald, 1999) and were based on first-order factor models. ω takes into account the fact that factor loadings and error variances may vary across the items. WLE scale scores of academic achievements were obtained from unidimensional Rasch models with the ConQuest software. ω and reliability estimates of WLE scores can be interpreted in the same way as any other reliability coefficient, with values that can range from 0 (no reliability) to 1 (perfect reliability). SC_A = academic self-concept; SC_M = mathematics self-concept; SC_F = French self-concept; SC_G = German self-concept; INT_A = academic interest; INT_M = mathematics interest; INT_F = French interest; INT_G = German interest; ANX_A = academic anxiety; ANX_M = mathematics anxiety; ANX_F = French anxiety; ANX_G = German anxiety; ACH_A = academic achievement; ACH_M = mathematics achievement; ACH_F = French achievement; ACH_G = German achievement.

Table B3.2

Descriptive Statistics and Intercorrelations of the Scale Scores Assessing Academic Self-Concepts, Academic Interests, Academic Anxieties, and Academic Achievements in S2

	SC_A	SC_M	SC_F	SC_G	INT_A	INT_M	INT_F	INT_G	AX_A	AX_M	AX_F	AX_G	ACH_A	ACH_M	ACH_F	ACH_G
SC_M	.42	-														
SC_F	.28	-.01	-													
SC_G	.32	.01	-.29	-												
INT_A	.52	.27	.25	.20	-											
INT_M	.36	.75	.03	.04	.45	-										
INT_F	.26	.02	.73	-.21	.46	.18	-									
INT_G	.28	.03	-.14	.69	.44	.21	.06	-								
AX_A	-.09	-.09	.09	-.07	.13	.04	.20	.09	-							
AX_M	-.09	-.42	.16	.08	.11	-.22	.23	.18	.67	-						
AX_F	-.04	.09	-.34	.21	.10	.17	-.17	.25	.56	.40	-					
AX_G	-.06	.07	.30	-.34	.14	.14	.34	-.09	.61	.42	.29	-				
ACH_A	.21	.15	-.03	.14	-.01	.05	-.08	.01	-.17	-.14	-.08	-.20	-			
ACH_M	.19	.25	-.10	.11	-.02	.13	-.14	-.01	-.17	-.20	-.04	-.16	.88	-		
ACH_F	.15	.01	.26	-.06	.02	-.04	.18	-.08	-.07	-.01	-.17	-.04	.73	.44	-	
ACH_G	.18	.05	-.16	.27	-.02	-.03	-.17	.11	-.16	-.10	-.01	-.28	.85	.61	.49	-
M	2.82	2.53	2.52	2.78	2.66	2.56	2.57	2.55	2.11	2.22	2.06	1.85	0.01	0.02	0.01	0.00
SD	0.61	0.93	0.95	0.92	0.69	0.91	0.90	0.89	0.77	0.88	0.84	0.81	0.95	1.43	0.91	1.09
ω/Rel	.77	.90	.92	.89	.76	.87	.87	.88	.78	.79	.79	.78	.76	.81	.80	.74

Note. Scale scores for academic self-concepts, anxieties, and interests were computed as the mean of the respective item scores. Reliability estimates for these scale scores were calculated as coefficient ω (McDonald, 1999) and were based on first-order factor models. ω takes into account the fact that factor loadings and error variances may vary across the items. WLE academic achievement scale scores were obtained from unidimensional Rasch models with the ConQuest software. ω and reliability estimates of WLE scores can be interpreted in the same way as any other reliability coefficient, with values that can range from 0 (no reliability) to 1 (perfect reliability). SC_A = academic self-concept; SC_M = mathematics self-concept; SC_F = French self-concept; SC_G = German self-concept; INT_A = academic interest; INT_M = mathematics interest; INT_F = French interest; INT_G = German interest; ANX_A = academic anxiety; ANX_M = mathematics anxiety; ANX_F = French anxiety; ANX_G = German anxiety; ACH_A = academic achievement; ACH_M = mathematics achievement; ACH_F = French achievement; ACH_G = German achievement.

Table B3.3

Descriptive Statistics and Intercorrelations of the Scale Scores Assessing Academic Self-Concepts, Academic Interests, Academic Anxieties, and Academic Achievements in S3

	SC_A	SC_M	SC_F	SC_G	INT_A	INT_M	INT_F	INT_G	AX_A	AX_M	AX_F	AX_G	ACH_A	ACH_M	ACH_F	ACH_G
SC_M	.41	-														
SC_F	.33	.03	-													
SC_G	.31	.02	-.22	-												
INT_A	.34	.19	.17	.10	-											
INT_M	.24	.63	.00	-.06	.40	-										
INT_F	.13	-.04	.62	-.23	.43	.14	-									
INT_G	.14	-.08	-.14	.50	.41	.12	.06	-								
AX_A	-.31	-.24	-.13	-.18	.00	-.04	.07	-.02	-							
AX_M	-.22	-.53	.03	-.04	.02	-.34	.15	.13	.58	-						
AX_F	-.19	-.01	-.54	.14	.04	.13	-.31	.18	.54	.27	-					
AX_G	-.15	-.02	.23	-.53	.06	.12	.29	-.25	.55	.31	.13	-				
ACH_A	.44	.31	.23	.13	.21	.21	.13	.07	-.17	-.15	-.13	-.07	-			
ACH_M	.38	.52	.08	.02	.15	.39	.01	-.06	-.15	-.32	-.02	.00	.79	-		
ACH_F	.34	.05	.47	-.06	.17	.03	.34	-.03	-.11	.03	-.31	.09	.77	.38	-	
ACH_G	.29	.08	-.04	.37	.15	.03	-.05	.28	-.13	-.02	.05	-.28	.73	.34	.39	-
M	2.87	2.56	2.47	3.00	3.45	3.35	3.36	3.17	4.15	3.65	3.85	4.63	38.29	37.69	37.16	40.02
SD	0.64	1.00	0.96	0.82	1.07	1.58	1.43	1.32	1.16	1.53	1.35	1.30	8.08	11.74	10.43	9.60
ω/Rel	.84	.94	.93	.90	.81	.94	.93	.91	.80	.90	.84	.89	-	-	-	-

Note. Scale scores for academic self-concepts, anxieties, and interests were computed as the mean of the respective item scores. Reliability estimates for these scale scores were calculated as coefficient ω (McDonald, 1999) and were based on first-order factor models. ω takes into account the fact that factor loadings and error variances may vary across the items and can be interpreted in the same way as any other reliability coefficient, with values that can range from 0 (no reliability) to 1 (perfect reliability). Academic achievement scores represent students' self-reported grades on their last report card. SC_A = academic self-concept; SC_M = mathematics self-concept; SC_F = French self-concept; SC_G = German self-concept; INT_M = mathematics interest; INT_F = French interest; INT_G = German interest; ANX_A = academic anxiety; ANX_M = mathematics anxiety; ANX_F = French anxiety; ANX_G = German anxiety; INT_A = academic interest; ACH_A = academic achievement; ACH_M = mathematics achievement; ACH_F = French achievement; ACH_G = German achievement.

Table B3.4

Descriptive Statistics and Intercorrelations of the Scale Scores Assessing Academic Self-Concepts, Academic Interests, Academic Anxieties, and Academic Achievements in S4

	SC_A	SC_M	SC_F	SC_G	INT_A	INT_M	INT_F	INT_G	AX_A	AX_M	AX_F	AX_G	ACH_A	ACH_M	ACH_F	ACH_G
SC_M	.36	-														
SC_F	.31	.02	-													
SC_G	.33	-.14	-.22	-												
INT_A	.44	.25	.22	.16	-											
INT_M	.26	.80	.04	-.12	.42	-										
INT_F	.20	.03	.73	-.17	.46	.19	-									
INT_G	.25	-.07	-.14	.67	.41	.04	.05	-								
AX_A	-.27	-.17	-.08	-.10	.06	-.04	.05	.02	-							
AX_M	-.18	-.60	.08	.12	.02	-.42	.13	.13	.59	-						
AX_F	-.12	.03	-.60	.25	.05	.08	-.39	.25	.53	.27	-					
AX_G	-.13	.13	.24	-.53	.13	.16	.28	-.26	.55	.25	.15	-				
ACH_A	.50	.39	.31	.13	.20	.28	.17	.05	-.22	-.24	-.19	-.05	-			
ACH_M	.39	.65	.09	-.07	.17	.49	.02	-.07	-.18	-.41	-.03	.06	.79	-		
ACH_F	.36	.09	.65	-.11	.15	.07	.43	-.10	-.15	-.04	-.43	.10	.73	.37	-	
ACH_G	.35	.01	-.03	.52	.11	-.02	-.07	.32	-.15	-.03	.04	-.30	.66	.27	.26	-
M	2.69	3.38	3.17	2.76	3.26	3.27	3.17	3.25	4.07	3.78	3.93	4.64	37.96	36.78	37.45	39.65
SD	0.89	1.59	1.33	1.29	1.05	1.54	1.35	1.28	1.18	1.46	1.35	1.21	7.04	10.99	9.20	8.61
ω/Rel	.85	.94	.92	.90	.81	.93	.90	.90	.79	.86	.84	.84	-	-	-	-

Note. Scale scores for academic self-concepts, anxieties, and interests were computed as the mean of the respective item scores. Reliability estimates for these scale scores were calculated as coefficient ω (McDonald, 1999) and were based on first-order factor models. ω takes into account the fact that factor loadings and error variances may vary across the items and can be interpreted in the same way as any other reliability coefficient, with values that can range from 0 (no reliability) to 1 (perfect reliability). Academic achievement scores represent students' self-reported grades on their last report card. SC_A = academic self-concept; SC_M = mathematics self-concept; SC_F = French self-concept; SC_G = German self-concept; INT_M = mathematics interest; INT_F = French interest; INT_G = German interest; ANX_A = academic anxiety; ANX_M = mathematics anxiety; ANX_F = French anxiety; ANX_G = German anxiety; INT_A = academic interest; ACH_A = academic achievement; ACH_M = mathematics achievement; ACH_F = French achievement; ACH_G = German achievement.

Table B3.5

Standardized Factor Loadings Obtained for the General-Level Model (S1/S2/S3/S4)

Item	ASC	AINT	AANX
SC_A1-S3	–/–/.66/–		
SC_A1-S1/2/4	.66/.67/–/.66		
SC_A2	.75/.72/.87/.84		
SC_A3	.78/.78/.86/.90		
INT_A1		.83/.81/.90/.85	
INT_A2		.65/.65/.66/.71	
INT_A3-S1/2		.70/.71/–/–	
INT_A3-S3/4		–/–/.74/.73	
ANX_A1			.57/.55/.64/.69
ANX_A2			.86/.86/.68/.68
ANX_A3-S1/2			.76/.74/–/–
ANX_A3-S3/4			–/–/.90/.87

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. ASC = general academic self-concept; AINT = general academic interest; AANX = general academic anxiety. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.6

Standardized Factor Loadings Obtained for the Mathematics Model (S1/S2/S3/S4)

Item	MSC	MINT	MANX
SC_M1	.87/.86/.95/.93		
SC_M2	.85/.84/.90/.90		
SC_M3-S1/2	.89/.89/–/–		
SC_M3-S3/4	–/–/.92/.92		
INT_M1		.89/.88/.95/.95	
INT_M2		.77/.74/.88/.86	
INT_M3		.85/.85/.91/.91	
ANX_M1			.60/.59/.77/.68
ANX_M2			.85/.82/.91/.85
ANX_M3-S1/2			.81/.79/–/–
ANX_M3-S3/4			–/–/.91/.89

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. MSC = mathematics self-concept; MINT = mathematics interest; MANX = mathematics anxiety. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.7

Standardized Factor Loadings Obtained for the French Model (S1/S2/S3/S4)

Item	FSC	FINT	FANX
SC_F1	.86/.87/.92/.92		
SC_F2	.87/.88/.87/.85		
SC_F3-S1/2	.91/.92/–/–		
SC_F3-S3/4	–/–/.91/.88		
INT_F1		.89/.87/.94/.90	
INT_F2		.70/.71/.81/.78	
INT_F3		.88/.87/.93/.91	
ANX_F1			.49/.50/.70/.70
ANX_F2			.86/.86/.88/.86
ANX_F3-S1/2			.84/.82/–/–
ANX_F3-S3/4			–/–/.78/.82

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. FSC = French self-concept; FINT = French interest; FANX = French anxiety. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.8

Standardized Factor Loadings Obtained for the German Model (S1/S2/S3/S4)

Item	GSC	GINT	GANX
SC_G1	.83/.82/.87/.87		
SC_G2	.85/.85/.85/.85		
SC_G3-S1/2	.89/.89/–/–		
SC_G3-S3/4	–/–/.87/.88		
INT_G1		.86/.87/.90/.88	
INT_G2		.76/.78/.87/.83	
INT_G3		.87/.87/.88/.89	
ANX_G1			.63/.63/.73/.67
ANX_G2			.79/.76/.91/.79
ANX_G3-S1/2			.84/.81/–/–
ANX_G3-S3/4			–/–/.90/.89

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. GSC = German self-concept; GINT = German interest; GANX = German anxiety. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.9

Standardized Factor Loadings Obtained for the Academic Self-Concept Model (S1/S2/S3/S4)

Item	gASC	spMSC	spFSC	spGSC
SC_A1-S3	–/–/.87/–			
SC_A1-S1/2/4	.74/.70 /–/.84			
SC_A2	.66/.68 /.67/.66			
SC_A3	.78/.79/.86/.89			
SC_M1	.37/.39/.39/.32	.78/.77/.86/.88		
SC_M2	.41/.43 /.38/.33	.72/.70/.81/.82		
SC_M3-S1/2	.44/.47/–/–	.80/.78/–/–		
SC_M3-S3/4	–/–/.43/.38	–/–/.81/.86		
SC_F1	.19/.23/.30/.25		.84/.83/.87/.89	
SC_F2	.27/.31/.33/.31		.83/.82/.80/.78	
SC_F3-S1/2	.30/.33/–/–		.86/.86/–/–	
SC_F3-S3/4	–/–/.37/.37		–/–/.84/.80	
SC_G1	.26/.28/.26/.25			.78/.78 /.82/.83
SC_G2	.36/.38/.29/.33			.77/.76 /.79/.78
SC_G3-S1/2	.38/.39/–/–			.81/.80/–/–
SC_G3-S3/4	–/–/.35/.39			–/–/.81/.80

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.10

Standardized Factor Loadings Obtained for the Academic Interest Model (S1/S2/S3/S4)

Item	gAINT	spMINT	spFINT	spGINT
INT_A1	.84/.82/.88/.83			
INT_A2	.64/.64/.69/.72			
INT_A3-S1/2	.69/.70/–/–			
INT_A3-S3/4	–/–/.73/.73			
INT_M1	.46/.47/.44/.46	.82/.81/.86/.86		
INT_M2	.44/.46/.39/.42	.64/.60/.78/.74		
INT_M3	.37/.41/.35/.41	.70/.68/.84/.79		
INT_F1	.48/.47/.45/.46		.79/.77/.83/.80	
INT_F2	.42/.44/.40/.43		.56/.56/.71/.66	
INT_F3	.38/.41/.44/.47		.76/.75/.82/.76	
INT_G1	.45/.44/.49/.49			.74/.75/.76/.76
INT_G2	.46/.48/.37/.37			.62/.64/.79/.74
INT_G3	.40/.40/.36/.37			.76/.77/.80/.80

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.11

Standardized Factor Loadings Obtained for the Academic Anxiety Model (S1/S2/S3/S4)

Item	gAANX	spMANX	spFANX	spGANX
ANX_A1	.58/.58/.67/.69			
ANX_A2	.82/.81/.76/.73			
ANX_A3-S1/2	.79/.77/–/–			
ANX_A3-S3/4	–/–/.79/.82			
ANX_M1	.46/.47/.52/.44	.39/.35/.58/.53		
ANX_M2	.66/.64/.61/.60	.53/.51/.69/.63		
ANX_M3-S1/2	.70/.68/–/–	.46/.44/–/–		
ANX_M3-S3/4	–/–/.57/.59	–/–/.70/.64		
ANX_F1	.27/.26/.46/.41		.41/.43/.54/.58	
ANX_F2	.64/.65/.58/.58		.58/.57/.71/.67	
ANX_F3-S1/2	.58/.57/–/–		.60/.58/–/–	
ANX_F3-S3/4	–/–/.43/.42		–/–/.62/.66	
ANX_G1	.44/.42/.46/.34			.41/.42/.55/.56
ANX_G2	.61/.60/.62/.57			.52/.48/.71/.58
ANX_G3-S1/2	.65/.63/–/–			.54/.53/–/–
ANX_G3-S3/4	–/–/.52/.56			–/–/.72/.67

Note. See Table A3.1 for descriptions of the individual items. Missing entries as marked with "–" resulted from using different items in different samples. gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B3.12

Modification Indices and Expected Correlations between the Residuals of the Subject-Specific Scale Scores Obtained for the Integrative Model and Measures of Academic Achievement

	Mathematics self-concept		French self-concept		German self-concept		Mathematics interest		French interest		German interest		Mathematics anxiety		French anxiety		German anxiety	
	M.I.	Stand. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C	M.I.	Std. E.P.C
									Sample 1									
ACH_A	.83	-.04	3.52	-.05	1.95	-.05	6.90	.04	6.94	.04	3.65	-.03	5.75	.04	.71	.01	37.53	-.09
ACH_M	3.72	-.08	2.19	-.04	-[a]	.00	9.99	.05	3.67	.03	2.69	-.03	2.20	.02	-[a]	.01	7.71	-.04
ACH_F	-[a]	.00	1.79	-.04	3.63	-.07	1.71	.02	2.85	.03	-[a]	.00	3.57	.03	-[a]	.01	15.89	-.06
ACH_G	.36	-.03	2.58	-.05	1.08	-.04	4.98	.04	6.66	.04	7.15	-.04	5.41	.03	1.46	.02	44.07	-.09
									Sample 2									
ACH_A	.00	.00	7.06	-.08	3.37	-.08	2.02	.02	5.88	.04	2.00	-.02	4.10	.03	.67	-.01	39.85	-.09
ACH_M	1.11	-.05	7.36	-.08	.01	.00	4.16	.03	3.19	.03	2.79	-.03	1.65	.02	3.63	-.03	10.55	-.05
ACH_F	1.59	.05	2.68	-.05	8.72	-.13	.01	.00	3.35	.03	.10	.01	5.44	.04	.00	.00	29.57	-.08
ACH_G	.00	.00	4.50	-.06	3.06	-.08	.63	.01	4.74	.04	2.99	-.03	1.70	.02	.08	.00	43.43	-.10
									Sample 3									
ACH_A	.02	-.01	.55	-.05	1.84	-.08	.29	.02	.33	.02	.06	.01	.27	.02	.10	-.01	1.85	-.05
ACH_M	.09	-.02	.01	.01	1.26	-.06	.02	-.01	.26	.02	.04	-.01	.27	-.02	.45	.02	2.26	-.06
ACH_F	.41	-.04	.71	-.05	.06	-.01	.94	.04	.02	.01	.03	.01	.11	.01	.75	-.03	.02	-.01
ACH_G	.24	.03	.02	.01	6.43	-.15	.01	.00	.10	.01	.71	.04	.59	.03	.28	.02	4.24	-.09
									Sample 4									
ACH_A	-[b]	-[b]	.13	-.02	.14	.02	6.38	.05	.23	-.01	.17	-.01	4.44	-.04	.91	-.02	.01	.00
ACH_M	-[b]	-[b]	.25	-.03	.02	-.01	3.22	.04	.04	.00	.22	-.01	1.78	-.03	.22	-.01	.44	-.01
ACH_F	-[b]	-[b]	1.59	.09	1.64	-.08	7.15	.05	3.01	-.04	.31	.01	1.72	-.03	.12	-.01	1.41	-.02
ACH_G	-[b]	-[b]	1.42	-.07	.71	.07	2.80	.04	.16	-.01	.35	-.01	6.04	-.05	3.90	-.05	.21	.01

Note. M.I. = modification index (change in the χ^2 statistic after allowing a correlation between a residual and measures of academic achievement); Std E.P.C. = standardized expected parameter change (expected correlation between a residuals and measures of academic achievement).

[a] The missing M.I.s were not computed by Mplus. The corresponding E.P.C.s therefore represent the directly calculated correlation of the respective residuals with measures of academic achievement.

[b] Missing entries as marked with "-" resulted from setting the respective residual variance to zero.

Chapter IV – Development

Developmental Dynamics of General and School-Subject-Specific Components of Academic Self-Concept, Academic Interest, and Academic Anxiety.

Note: This is the first author's version of a work that has been submitted for publication.

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Abstract

The present study investigated the developmental dynamics of general and subject-specific (i.e., mathematics, French, and German, French) components of students' academic self-concept, anxiety, and interest. To this end, the authors integrated three lines of research: (a) hierarchical and multidimensional approaches to the conceptualization of each construct, (b) longitudinal analyses of bottom-up and top-down developmental processes across hierarchical levels, and (c) ipsative developmental processes across subjects. The data stemmed from two longitudinal large-scale samples (N = 3,498 and N = 3,863) of students attending Grades 7 and 9 in Luxembourgish schools. Nested-factor models were applied to represent each construct at each grade level. The analyses demonstrated that several characteristics were shared across constructs. All constructs were multidimensional in nature with respect to the different subjects, showed a hierarchical organization with a general component at the apex of the hierarchy, and had a strong separation between the subject-specific components at both grade levels. Further, all constructs showed moderate differential stabilities at both the general ($.42 < r < .55$) and subject-specific levels ($.45 < r < .73$). Further, little evidence was found for top-down or bottom-up developmental processes. Rather, general and subject-specific components in Grade 9 proved to be primarily a function of the corresponding components in Grade 7. Finally, change in several subject-specific components could be explained by negative, ipsative effects across subjects.

Keywords: academic self-concept, academic interest, academic anxiety, development, nested-factor model

4.1. Introduction

Academic self-concept, (individual) academic interest, and academic anxiety are key affective-motivational constructs in educational research that have not only been shown to determine academic effort, choices, and success but are also considered to be vital learning outcomes themselves (e.g., Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010; Marsh & O'Mara, 2008; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Marsh & Yeung, 1997a, b; Schunk, Pintrich, & Meece, 2009; Zeidner, 1998). Given their relevance for students' learning and educational careers, it is important to understand the developmental dynamics of these constructs. To this end, this article brings together important streams of research that have rarely been integrated before. A particularly important issue for investigations of academic affect or motivation has always been the hierarchical level of construct definitions. Earlier research on academic affect and motivation focused on general constructs (at the top of the hierarchy; e.g., Byrne, 1986) with items such as "I am good at most school subjects." On the other hand, contemporary educational research has stressed the importance of differentiating between different subjects[9] (e.g., "I am good at mathematics") with a focus on the lower levels of the construct hierarchy (e.g., Bong, 2001; Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Marsh 1990). Crucially, students differ and develop in their school-related affect and motivation both in general and with respect to specific subjects. However, most research on the development of affective-motivational constructs has focused on either their general or subject-specific level but has not simultaneously accounted for the general and subject-specific components of the constructs from the perspective of a hierarchical construct definition. Thus, there is a limited amount of empirical knowledge about the manifold developmental dynamics of general and subject-specific components of affective-motivational constructs, and several questions have yet to be answered about them: (a) How stable are general and subject-specific

[9] The term "subject" is used throughout this study instead of the more precise term "school subject" for the clarity of the presentation.

components across time? (b) Is the development of affective-motivational constructs characterized by top-down (e.g., Does general academic anxiety affect the development of anxiety in mathematics?) or bottom-up processes (e.g., Does anxiety in mathematics affects the development of general academic anxiety?)? (c) Are there ipsative developmental processes across subjects (e.g., Does anxiety in mathematics affect the development of anxiety in verbal subjects?)? To address these research questions, we capitalized on two representative, large-scale data sets and contemporary measurement models to examine the developmental dynamics of general and subject-specific components (i.e., German, French, and mathematics) of academic self-concept, interest, and anxiety, respectively. By doing so, we were able to scrutinize the similarities and differences in the developmental dynamics of these constructs.

4.1.1. Structure of affective-motivational constructs

Academic self-concepts are mental representations of a person's abilities in subjects (Brunner et al., 2010) entailing aspects of both self-description and self-evaluation (Brunner, Keller, Hornung, Reichert, & Martin, 2009; Marsh & Craven, 1997). Academic interest[10] comprises feelings of personal importance and emotional value (Krapp, 2002; Renninger, 2000; Schiefele, 1991). Academic anxiety refers to feelings of worry as well as nervousness and uneasiness in achievement-related situations in the school context (Goetz, Preckel, Zeidner, & Schleyer, 2008; Liebert & Morris, 1967; Zeidner, 2007).

Previous research has strongly supported the multidimensionality of these affective-motivational constructs with respect to subjects (e.g., Bong, 2001; Brunner et al., 2010; Goetz et al., 2007; Marsh 1990; Marsh, Byrne, & Shavelson, 1988). Moreover, not only do students differentiate between different subjects when evaluating their affect and motivation in school, but they also evaluate their overall levels of affective-motivational constructs. Thus, current

[10] In the present study, we refer to academic interest as an individual interest (i.e., a relatively enduring preference for a certain subject) and not as a situational interest (i.e., a current situationally triggered engagement; see Schiefele, 1991).

structural models of academic self-concept conceive of academic self-concept as a construct that is not only subject-specific by nature but also hierarchically organized with general academic self-concept operating at the apex of the hierarchy (see Brunner et al., 2010). Figure 4.1 depicts the nested Marsh/Shavelson (NMS) model, which has been shown to nicely capture the multidimensional and hierarchical structure of academic self-concepts in representative large-scale studies (Brunner et al., 2010; Brunner et al., 2008, 2009; Gogol, Brunner, Martin, Preckel, & Goetz, 2015). In particular, this model specifies a latent variable for general academic self-concept (gASC) that directly influences the general and subject-specific measures of academic self-concept. This specification implies that gASC is the most general construct in the NMS model, an idea that, in turn, is consistent with the idea that gASC operates at the apex of the hierarchy of academic self-concept. Moreover, to represent the multidimensional nature of academic self-concept with respect to specific subjects, the model specifies latent variables that influence corresponding measures of subject-specific self-concepts over and above gASC. Thus, these latent variables represent academic self-concepts that are specific to different subjects (e.g., specific mathematics self-concept [spMSC], specific French self-concept [spFSC], and specific German self-concept [spGSC]). Crucially, as these subject-specific factors are conceptualized as uncorrelated with the general academic self-concept factor, the general academic self-concept factor controls for the general level of academic self-concept in the measures of subject-specific self-concept. The latent variables representing subject-specific self-concepts thus depict how students perceive their subject-specific strengths/weaknesses over and above their individual general level of self-concept. Moreover, the nested Marsh/Shavelson model does not specify any constraints on the correlational pattern between these subject-specific self-concepts. In previous studies, negative correlations have been found between spMSC, spFSC, and spGSC (Brunner et al., 2010; Gogol et al., 2015), indicating a strong separation of self-concepts across different subjects. Specifically, such negative correlations between subject-specific self-concepts reflect the

notion that students think of themselves, for example, as being good in mathematics but not in German, good in mathematics but not in French, or good in German but not in French (see also Marsh & Hau, 2004, p. 57).

Regarding academic interest and academic anxiety, general and subject-specific conceptualizations seem to coexist in the literature. Specifically, some scholars conceive of academic interest as a strongly subject-specific construct (e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 1991). However, it has also been argued that besides defining interest in terms of specific subjects, students may have a general individual interest in learning (Ainley, Hidi, & Berndorff, 2002). Moreover, in more recent educational research (dating back across the last 10-15 years), academic anxiety has been considered to be specific to subjects (Goetz et al., 2007). Yet, the general nature of academic anxiety was emphasized in earlier research (Zeidner, 1998).

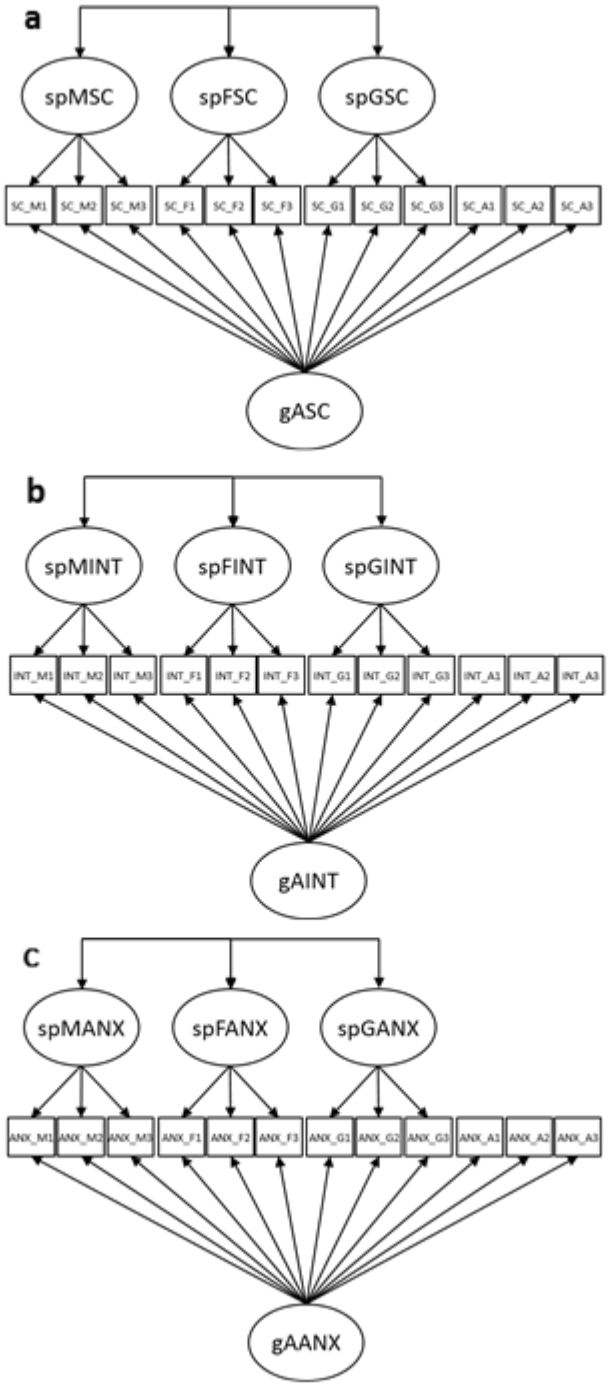

Figure 4.1. Schematic diagrams of the nested-factor models for (a) academic self-concept (nested Marsh/Shavelson model; Brunner et al., 2010), (b) academic interest, and (c) academic anxiety as applied in the present study. Residuals as well as the correlations between the residuals of items with parallel wording are not depicted in the models to ensure the clarity of the figure. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept; gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest; gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety.

The idea of conceiving of both academic anxiety and interest as both hierarchical and multidimensional constructs, however, had not been examined until recently. Specifically, Gogol et al. (2015; 2015, August) developed and tested new structural models for academic interest and academic anxiety, respectively. The models were specified as analogous to the nested Marsh/Shavelson model of academic self-concept (Brunner et al., 2010). Their results demonstrated that academic interest and anxiety were structurally similar to academic self-concept (Gogol et al., 2015; 2015, August; see Figures 4.1b and 4.1c). First, these constructs were shown to have a hierarchical structure with general academic interest (anxiety) at the apex of the hierarchy, indicating that students perceived themselves as generally more interested or less interested (more anxious or less anxious) than other students across different subjects. Second, academic interest (anxiety) was found to be multidimensional with respect to different subjects. In other words, after controlling for students' overall level of interest (anxiety), they differed across different subjects in their perceived interests (anxieties). Third, academic interest (academic anxiety) showed a strong separation between its subject-specific components, indicating that a higher interest (anxiety) in mathematics was associated with lower interests (anxieties) in subjects from the verbal domain. Similarly, a higher interest (anxiety) in French was found to be associated with a lower interest (anxiety) in German. To sum up, the study by Gogol et al. provided strong empirical support for the hierarchical and subject-specific organization of academic interest and academic anxiety, respectively.

4.1.2. Developmental dynamics of affective-motivational constructs

Two central objectives of developmental research are (a) to analyze a construct's stability and (b) to predict change (see Baltes & Nesselroade, 1979). Crucially, these key objectives have rarely been tackled by taking the multidimensional and hierarchical nature of motivational-affective constructs into account. Yet, such a broader perspective on these constructs can provide deeper and more differentiated insights into their developmental dynamics. First, it allows for simultaneous investigations of stability at different levels of the

construct hierarchy. Notably, if the stability of a construct in a specific subject is investigated without accounting for the general level of the respective construct, the resulting estimate will confound the stability of the general level of the construct with the stability of the respective subject-specific deviations from the general level. For example, high stability in the rank order of the general level of academic self-concept could mask change in the rank order of students' subject-specific strengths or weaknesses. Second, applying a hierarchical and multidimensional perspective allows for the study of developmental processes in how general construct components influence change in subject-specific components (top-down processes) and how subject-specific components influence change in general components (bottom-up process). Third, given that the influence of general construct components is accounted for in subject-specific measures, a hierarchical construct perspective can provide insights into potential ipsative effects of subject-specific components on change in other subjects (e.g., how perceptions of specific strengths in German self-concept influence change in perceptions of specific strengths or weaknesses in mathematics self-concept). What do we know from past research on affective-motivational constructs that has considered these key questions about individual development?

4.1.2.1. Differential stabilities

In developmental research, construct stability refers to the mean level of stability and differential stability in the rank ordering of individuals. Given that the present study is an investigation of individual development, we chose to focus on differential stability, which is typically analyzed in terms of the correlation of a construct measured at two different occasions (i.e., autocorrelation). Low differential stability is indicated by change in individuals' relative positions within a reference group across time. Conversely, when students retain their ranks with respect to their overall self-concept levels within a given student group, differential stability is high.

Previous studies have reported moderate to relatively high stability coefficients in

adolescent students for academic self-concept (e.g., Eccles et al., 1989; Frenzel, Pekrun, & Zimmer, 2006; Marsh et al., 2005; Möller et al., 2011; Musu-Gillette, Wigfield, Harring, & Eccles, 2015; Parker, Marsh, Morin, Seaton, & Van Zanden, 2015; Pinxten, Marsh, De Fraine, Van Den Noortgate, & Van Damme, 2014; Shavelson & Bolus, 1982), academic interest (e.g., Frenzel et al., 2006, 2010; Köller, Baumert, & Schnabel, 2001; Marsh et al., 2005; Musu-Gillette et al., 2015; Watt, 2000), intrinsic motivation (a construct that is conceptually close to academic interest; e.g., Gottfried et al., 2001), and enjoyment (the emotional component of academic interest; Pinxten et al., 2014) in mathematics or verbal subjects. For example, Frenzel et al. (2010) found 1-year stabilities in interest in mathematics ranging from .54 to .65 between Grades 6 and 9. With regard to academic anxiety, there has not been much research on differential stability in adolescents. The existing studies found stability coefficients similar to those for academic self-concept and interest (e.g., Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Frenzel et al., 2006; Selkirk et al., 2011). However, little is known about the stability of the general level of affective-motivational constructs. For example, theory predicts decreasing stability in self- concept from the apex of the hierarchy (Shavelson, Hubner, & Stanton, 1976) to the lower hierarchical levels, suggesting that general academic self-concept should be more stable than subject-specific self-concepts. Yet, the few previous studies that examined this idea found little support for increases in stability when approaching the apex of the academic self-concept hierarchy (Marsh & Yeung, 1998; Shavelson & Bolus, 1982).

4.1.2.2. Prediction of change

Regarding top-down and bottom-up processes, in 1998, Marsh and Yeung published a pioneering self-concept article that is still unique today. As Marsh and Yeung noticed, theoretical considerations of the direction of causal flow in the self-concept hierarchy have been contradictory. Specifically, the Shavelson model of self-concept (Shavelson et., 1976) and Rosenberg (1979) and Harter's (1986) theoretical considerations implied a bottom-up model in which the direction of causal influence is from the bottom to the top of the hierarchy. On the

other hand, Brown (1993) advocated for a top-down model in which the direction of the causal flow is from the apex to the base of the hierarchy. However, these theoretical predictions could not be tested without the appropriate methodology (Marsh & Yeung, 1998). Marsh and Yeung noted that the direction of causal influence could not be determined on the basis of data from only one time point. Thus, in their study, they investigated the direction of causal flow between general and subject-specific academic self-concepts in a two-wave longitudinal study. Although Marsh and Yeung found some significant top-down effects, the (horizontal) autoregressive effects were the strongest, and thus, they stated that "the most parsimonious conclusion is that the results support only the horizontal effects" (p. 525).

Regarding ipsative developmental processes, the dimensional comparison theory of academic self-concepts predicts that students compare their individual strengths and weaknesses across different academic subjects (Möller & Marsh, 2013). For example, with such (ipsative) dimensional comparison processes, positive evaluations in one academic subject may yield lower self-evaluations in other subjects (i.e., contrast effect). Such dimensional comparison processes may have important consequences for students' development, namely, that self-concept in one subject will have a negative effect on change in self-concept in other subject (see Parker et al., 2015). For example, the reciprocal internal/external frame of reference model (RI/E model; Möller et al., 2011) predicts small negative effects of academic self-concept on subsequent academic self-concept in noncorresponding subjects (Niepel et al., 2014). To the best of our knowledge, however, this prediction has been tested only a couple of times: Niepel et al. (2014) and Möller et al. (2011) found some support for such negative effects (but see also Parker et al., 2015).

Dimensional comparison theory further predicts that ipsative contrast effects may be smaller or might even become positive (i.e., assimilation effects) when dimensional comparisons are based on domains that are perceived as closely related (Marsh et al., 2014). Empirical studies that have investigated the dimensional comparison processes with subjects

other than mathematics and a verbal subject, however, have delivered mixed results. For example, some studies found negative effects between mathematics and science (Chiu, 2012), whereas other found assimilation effects between mathematics and physics (Jansen et al., 2015; Möller, Streblow, Pohlmann, & Köller, 2006). Further, within the verbal domain, some studies found negative effects between two verbal subjects (i.e., Brunner et al., 2010; Marsh, Kong, & Hau, 2001; Marsh & Yeung, 2001; Niepel et al., 2014), whereas other studies found no such effects (Xu et al., 2013) or even slightly positive effects (Marsh et al., 2014; Möller et al., 2006).

Notably, previous research on ipsative developmental processes has not taken into account the hierarchical organization of academic self-concepts. Thus, top-down effects of general academic self-concepts on subject-specific academic self-concepts were not controlled for. Consequently, previous estimates of ipsative processes may have confounded ipsative processes across subject-specific self-concepts with top-down processes of general academic self-concept. In other words, applying structural models of academic self-concept that take into account the hierarchical organization of the construct can help to disentangle (purely) ipsative processes from top-down processes.

Crucially, top-down, bottom-up, and ipsative developmental processes have never been investigated with regard to academic interest and academic anxiety. However, there is some empirical support from cross-sectional research that ipsative dimensional comparison processes can be generalized to academic interest and academic anxiety. Specifically, Schurtz, Pfost, Nagengast, and Arelt (2014) and Pohlmann (2005) found that achievement affected academic interests in the pattern that is typically found for the ipsative dimensional comparison processes. Similarly, Goetz, Frenzel, Hall, and Pekrun (2008) found support for (ipsative) dimensional comparison processes with regard to enjoyment (i.e., the emotional component of interest). Likewise, Marsh (1988) found ipsative contrast effects with regard to math and English anxieties.

4.1.3. Longitudinal measurement invariance

Measurement invariance is very important in longitudinal research. Specifically, in order to ensure that the latent constructs have the same substantive meaning over time, invariance in measurement properties is needed so that true changes in the latent constructs can be separated from changes in the operational definitions of the constructs. Crucially, the evaluation of measurement invariance concerns the question of whether or not the manifest indicators are related to their latent factors in the same way at different measurement occasions (Meredith & Horn, 2001). Different degrees of measurement invariance can be differentiated (Meredith, 1993): First, *configural invariance* requires the number of factors and the pattern of zero and nonzero factor loadings to be equal across time points. Second, *metric invariance* requires that the corresponding factor loadings are equivalent across time points. When metric invariance has been established, the rank-order stability of latent constructs (McArdle, 2009) as well as the prediction of change can be examined. Analyzing the different degrees of MI can be accomplished by employing longitudinal confirmatory factor models with increasingly more severe restrictions on parameters across time points (Little, 2013).

5.1.4. Research objectives

The overarching goal of the present study was to examine the developmental dynamics of general and subject-specific (i.e., German, French, and mathematics) components of students' academic self-concept, anxiety, and interest, respectively. Notably, in previous developmental research, the hierarchical relations between general and subject-specific components have rarely been accounted for in a combined model. A vital characteristic of the present study is therefore that we applied longitudinal nested-factor models that capture the hierarchical and subject-specific organization of the each construct. By applying these models, we were able to bring together central lines of research with the aim of making a substantial contribution to a fuller and more nuanced understanding of the developmental dynamics of three key constructs of students' learning-related affect and motivation. First, we analyzed the

differential stabilities of the general and subject-specific components. Given that nested-factor models account for the influence of the general construct components on the subject-specific measures, the estimates of the differential stabilities of the subject-specific components of the constructs are not confounded with the stabilities of the general components.

Second, we examined the prediction of change. To this end, we integrated two streams of research that have been separate until now and that have been exemplified for academic self-concepts: the direction of longitudinal causal flow in the construct hierarchy and ipsative comparison effects across different subjects. Notably, given that adequate structural models have not been applied before, these streams have not yet been combined in developmental research on academic self-concepts and have not been addressed at all in (developmental) research on academic anxiety and interest. It is important to note that by bringing these two streams together, we can study how the general components of constructs can affect change in the subject-specific components (top-down processes) and how the subject-specific components can affect change in the general components (bottom-up processes). Moreover, we can also study how subject-specific components can affect change in other subjects (ipsative processes). Given that the general components of the constructs are controlled for in the subject-specific measures, the present analyses can help to disentangle the (pure) ipsative processes occurring between subject-specific components from the top-down effects of the general components on the subject-specific components.

It is important to note that on the basis of the methodological advice given by Cumming (2014) and Bonett (2012) for carrying out replication studies, we conducted our analyses separately on two independent samples with representative longitudinal data from a total of 7,361 students attending Grades 7 and 9 in schools in Luxembourg. By doing so, we were able to scrutinize the robustness of the results and to judge the generalizability of our findings.

4.2. Method

4.2.1. Samples

The analyses applied in the present study were based on two longitudinal samples of representative data from students who participated in the Luxembourg school-monitoring program (ÉpStan; Martin & Brunner, 2012) at the beginning of the seventh grade as well as at the beginning of the ninth grade. Specifically, Sample 1 (S1) was obtained from the 2010 and 2012 waves and Sample 2 (S2) from the 2011 and 2013 waves of ÉpStan. The main aim of the ÉpStan is to evaluate the key educational outcomes (e.g., subject-specific achievement and students' affective-motivational characteristics) across all state schools in Luxembourg.

From the 4,376 students in S1 and 4,830 students in S2 who provided data at the first measurement occasion, we excluded students who had more than two missing values on any of the general and subject-specific scales of academic self-concept, interest, and anxiety to ensure valid measurement of the general and subject-specific constructs (n = 92 and n = 139 for S1 and S2, respectively). Moreover, the analyses in the present study were computed on only the seventh-grade students who also took part in the ninth grade in the respective wave of ÉpStan. As participation in ÉpStan was mandatory for the students, and given the high retention rates in Luxembourgish schools (estimated grade retention rates of 22-24% in lower secondary education, based on data available from both PISA [2009] and Eurostat [2008]; see Eurydice, 2011), it is most likely that the students who did not provide data at both waves of measurement consisted primarily of students who repeated a year after the first measurement occasion. A total of 786 students in S1 and 828 students in S2 dropped out[11]. The resulting final sample

[11] The comparisons of students who provided data at both waves of measurement with students for whom data were available in only the seventh grade revealed that, for both samples, the students who dropped out had significantly lower scores on general academic, mathematics, and German self-concept in the seventh grade (with no significant difference in French self-concept; -.02 < Cohen's d < .25). Moreover, these students experienced significantly more anxiety in the school subjects (significant results for the general academic, mathematics, French [only in S2], and German anxiety scales; -.02 < Cohen's d < -.26). Regarding interest, they scored significantly lower on the general academic, mathematics, and German interest scales in S1 as well as on the mathematics

sizes were thus N = 3,498 for S1 and N = 3,863 for S2.

4.2.2. Measures

The measures of academic self-concept, interest, and anxiety in both longitudinal samples were administered by computer. The instrument consisted of items that covered three core subjects (i.e., mathematics, French, and German) as well as general academic self-concept, general academic interest, and general academic anxiety. Each scale consisted of three items that has undergone extensive pilot testing. In line with other large-scale assessments (e.g., Programme for International Student Assessment [PISA]; OECD, 2002, 2005, 2009, 2014), students responded to each item on a rating scale with four categories: *disagree, disagree somewhat*, *agree somewhat*, and *agree* coded as 1, 2, 3, and 4, respectively. All scales showed satisfactory levels of reliability with values for the model-based reliability coefficient ω (see Brunner, Nagy, & Wilhelm, 2012) ranging from .74 to .91 in S1 and .74 to .92 in S2. The wording of the self-concept, anxiety, and interest items is presented in Table A4.1 in Appendix A. Tables A4.2 and A4.3 in Appendix A present descriptive statistics, reliabilities, correlations, and covariances of the scale scores that were obtained for both longitudinal samples, S1 and S2, respectively.

4.2.2.1. Academic self-concept measures

The academic self-concept instruments consisted of items taken from the Self-Description Questionnaire (SDQ; e.g., Marsh & O'Neill, 1984), which is considered to be one of the best self-concept instruments available (e.g., Byrne, 1996), and were adapted to the respective subjects according to the instructions provided by Marsh (1990).

4.2.2.2. Academic interest measures

The academic interest instruments consisted of items that were developed according to

interest scale in S2 (-.06 < Cohen's d < .13). This pattern of results supports the notion that students who provided data only in the seventh grade consisted primarily of students who were held back a grade between the two measurement occasions.

the corresponding construct definitions (Krapp, 2002; Renninger, 2000; Schiefele, 1991); that is, one item assessed feelings of personal importance and one item emotional value. In addition, one global item was constructed with the aim of directly and maximally representing the essence of the definition of academic interest (e.g., “I am interested in French” for the subject of French or “I am interested in most school subjects” for the general level).

4.2.2.3. Academic anxiety measures

The academic anxiety instruments consisted of items that were developed according to the corresponding construct definitions (Liebert & Morris, 1967; Zeidner, 2007); that is, one item assessed the worry component and one the emotionality component of academic anxiety. In addition, one global item was constructed with the aim of directly and maximally representing the essence of the definition of academic anxiety (e.g., “I am afraid of most school subjects”).

4.2.3. Statistical analyses

4.2.3.1. Model specification

Longitudinal confirmatory factor analyses were used to assess measurement invariance as well as the differential stability and prediction of change in the affective-motivational constructs. Specifically, in the longitudinal nested-factor models for academic self-concept, academic interest, and academic anxiety, the general factors (i.e., gASC, gINT, gANX) and the subject-specific factors (e.g., spMSC, spFSC, spGSC) were specified to be correlated with or regressed on each other across time (see Figure 4.2). All statistical analyses were computed separately for each sample so that the robustness of the results could be scrutinized.

The latent variables were measured with the items (as described above) that reflected the corresponding general or subject-specific constructs. In the configural invariance models (i.e., AS.1, AI.1, and AA.1), the latent variables were identified by fixing their variance to 1. The factor loadings and residual variances were freely estimated. Furthermore, we set the means of all latent factors to zero and freely estimated the intercepts of the manifest indicators.

To test for metric invariance (i.e., Models AS.2, AI.2, and AA.2), the variance of the factors at the first measurement occasion (Grade 7) were fixed to 1, whereas for the other measurement occasion (Grade 9), the factor variances were freely estimated (Bontempo, Grouzet, & Hofer, 2012).

The residual terms for the general and subject-specific items may capture both indicator-specific variance and random measurement error. In longitudinal studies, the residual terms are therefore often correlated over time to account for reliable indicator-specific variance in the residual terms (Cole & Maxwell, 2003; Little, 2013) because not accounting for these correlations can lead to misfit and bias in parameter estimates (e.g., the overestimation of stability coefficients; Geiser, Eid, Nussbeck, Courvoisier, & Cole, 2010). Therefore, we allowed the residual terms of all corresponding items to be correlated across time. Moreover, correlations between the residual terms of items with parallel wording were included in the models to obtain accurate parameter estimates (Marsh, Roche, Pajares, & Miller, 1997).

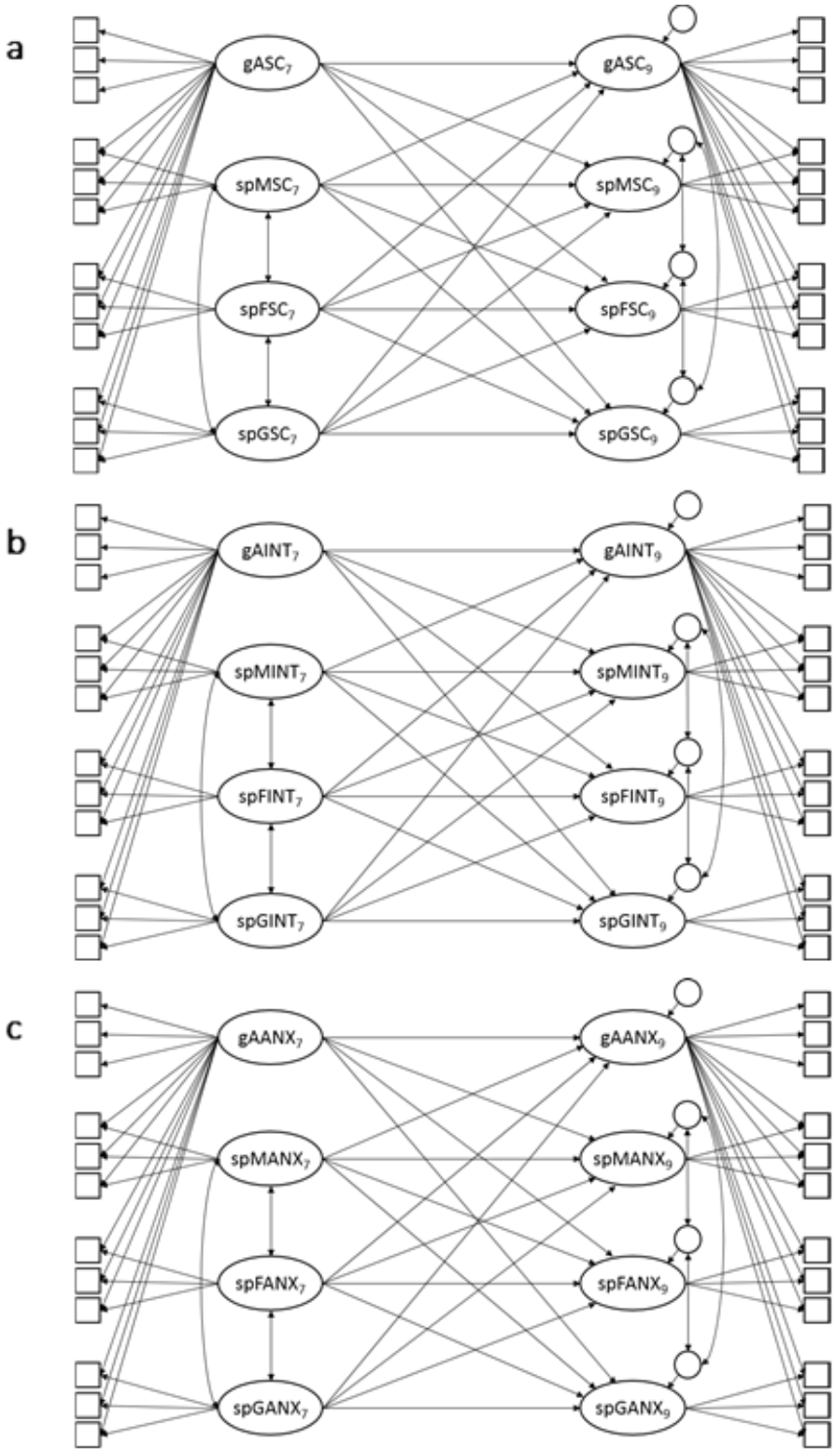

Figure 4.2. Schematic diagrams of the longitudinal nested-factor models for (a) academic self-concept, (b) academic interest, and (c) academic anxiety. Residuals and their across-time correlations are not depicted in the model to ensure the clarity of the figure. The suffixes 7 and 9 in the factor names indicate Grades 7 and 9, respectively. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept; gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest; gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety.

4.2.3.2. Missing data and the nested data structure

Missing data are unavoidable in any large-scale assessment. The highest sample-specific percentages of missing data in the final sample were 1.9% in S1 for item AX_A1_7, which assessed general academic anxiety in the seventh grade, and 1.5% in S2 for item SC_M3_7, which assessed self-concept in mathematics in the seventh grade. We used the full information maximum likelihood procedure (FIML) implemented in Mplus to account for the pattern of missing data as observed in the present study. Moreover, the "complex" option in Mplus (with class in the seventh grade as a cluster variable) was used to obtain standard errors and fit statistics that were corrected for the nonindependence of observations given that the students were not independently sampled but rather nested within classes. The model parameters were estimated by the MLR estimator, which is an appropriate variant of the maximum likelihood estimator (ML) for data with missing values and nonindependence of observations (see Muthén & Muthén, 1998 – 2012).

4.2.3.3. Examining measurement invariance

We tested the measurement invariance of the investigated models in two consecutive steps. In the first step, we tested for configural invariance (i.e., AS.1, AI.1, and AA.1), which requires the same pattern of zero and nonzero factor loadings across the time points. Second, we additionally constrained the unstandardized factor loadings of corresponding items to be equal across time to test for metric invariance (i.e., AS.2, AI.2, and AA.2). To evaluate measurement invariance, first, we examined the fit of the models by computing a chi-square test of overall model fit as well as the recommended descriptive fit indices. Second, when the overall model fit was satisfactory, we examined the difference in model fit between the less and the more constrained models (see Supplemental Appendix B in online supplement for details).

4.2.3.4. Examining differential stabilities

After establishing measurement invariance, we examined the differential stability of the general and subject-specific components of academic self-concept, interest, and anxiety. To this

end, we analyzed the autocorrelations of the corresponding latent variables across time.

4.2.3.5. Examining the causes of change

Subsequently, we regressed the latent variables that represented the general or subject-specific components of the constructs in Grade 9 on the latent variables representing the general or subject-specific components in Grade 7. Specifically, as the directed paths that link the corresponding factors between the time points are called autoregressions and account for individual differences stability of the factors across time, the directed paths from other factors indicate influences that are predictive of the cross-time changes (see Little, Bovaird, & Slegers, 2006). These effects can thus indicate whether interindividual differences in change in general or subject-specific components in Grade 9 are related to prior status in general or subject-specific components in Grade 7.

4.3. Results

4.3.1. Measurement invariance

The results of the analyses of measurement invariance can be summarized as follows (see Supplemental Appendix B in online supplement for a detailed description of these analyses and the model fit results for the invariance conditions specified in Table B4.1): For all constructs in both samples, the models specifying configural and metric invariance provided an adequate overall fit to the data, and the differences in model fit between the less and the more constrained models were acceptable. The adequate fit of the metric-invariant model specifications indicated that the nested-factor models were appropriate for representing the structural relations of the general and subject-specific components of the respective construct in both grade levels and that the corresponding latent variables had the same meaning across time.

Moreover, the factor loadings on all factors were substantial in both samples, showing that the latent variables representing general academic self-concept, interest, and anxiety as well

as the subject-specific factors were well-defined for students in Grades 7 and 9 (see Tables B4.2, B4.3, and B4.4 in Supplemental Appendix B in online supplement for the complete factor loading matrices obtained for the constrained models, AS.2, AI.2, and AA.2, respectively). This pattern of results supported the hierarchical and multidimensional structure of the constructs. Finally, the subject-specific factors were negatively related across the different subjects in all models and at both time points (see Tables B4.2, B4.3, and B4.4 for the correlations between factors obtained for the academic self-concept, interest, and anxiety models, respectively). This result indicates separation between the subject-specific components for all constructs.

4.3.2. Differential stabilities

The confirmation of metric invariance for the nested-factor models of academic self-concept, interest, and anxiety indicated that further analyses on the developmental dynamics of these constructs could be justified. Differential stabilities for the general components of the constructs were highly consistent across samples. Values ranged between r = .42 for academic self-concept and r = .48 for academic anxiety in S1 and between r = .42 for academic interest and r = .55 for academic anxiety in S2 (see Table 4.1). The differential stability coefficients for the subject-specific components were also highly consistent across samples: For academic self-concept, the values ranged from r = .56/.54 (mathematics; in S1/S2) to r = .73/.72 (French). Autocorrelations for the subject-specific interest components ranged from r = .47/.45 (mathematics) to r = .61/.57 (French). Differential stability for the subject-specific anxiety components ranged from r = .45/.48 (mathematics) to r = .60/.57 (German). Overall, the autocorrelations observed for the general and subject-specific components of the academic self-concept, interest, and anxiety factors were positive and indicated moderate levels of differential stability, respectively.

Table 4.1

Correlations between Factors over Time and their 95% Confidence Intervals [CIs] Obtained for the Academic Self-Concept, Academic Interest, and Academic Anxiety Models

	Sample 1				Sample 2			
				Academic self-concept				
	$gASC_9$	$spMSC_9$	$spFSC_9$	$spGSC_9$	$gASC_9$	$spMSC_9$	$spFSC_9$	$spGSC_9$
$gASC_7$	**.42** [**.38, .47**]	.01 [-.03, .05]	-.05 [-.09, -.02]	.05 [.01, .09]	**.44** [**.40, .48**]	.04 [.00, .07]	-.06 [-.09, -.03]	.03 [.00, .07]
$spMSC_7$	-.01 [-.05, .02]	**.56** [**.52, .60**]	-.19 [-.23, -.02]	-.15 [-.19, .09]	.03 [-.01, .07]	**.54** [**.50, .57**]	-.14 [-.18, -.10]	-.21 [-.25, -.17]
$spFSC_7$	.01 [-.03, .04]	-.14 [-.18, -.10]	**.73** [**.71, -.02**]	-.47 [-.51, .09]	.01 [-.02, .04]	-.17 [-.21, -.14]	**.72** [**.70, .74**]	-.45 [-.48, -.41]
$spGSC_7$	.04 [-.01, .07]	-.23 [-.28, -.19]	-.47 [-.50, -.02]	**.64** [**.61, .09**]	.01 [-.02, .04]	-.21 [-.25, -.17]	-.46 [-.49, -.43]	**.65** [**.62, .68**]
				Academic interest				
	$gAINT_9$	$spMINT_9$	$spFINT_9$	$spGINT_9$	$gAINT_9$	$spMINT_9$	$spFINT_9$	$spGINT_9$
$gAINT_7$	**.46** [**.42, .5]**	.03 [-.01, .07]	.00 [-.04, .04]	.03 [-.01, .07]	**.42** [**.38, .46**]	-.01 [-.05, .03]	.03 [-.01, .06]	.02 [-.02, .06]
$spMINT_7$	-.02 [-.06, .02]	**.47** [**.43, .51**]	-.10 [-.14, -.06]	-.07 [-.11, -.02]	.01 [-.03, .05]	**.45** [**.41, .48**]	-.09 [-.13, -.04]	-.15 [-.19, -.11]
$spFINT_7$	.04 [.00, .08]	-.09 [-.13, -.04]	**.61** [**.57, .64**]	-.31 [-.36, -.27]	.06 [.02, .10]	-.12 [-.16, -.08]	**.57** [**.53, .61**]	-.28 [-.32, -.24]
$spGINT_7$	.01 [-.03, .05]	-.15 [-.19, -.11]	-.35 [-.39, -.30]	**.48** [**.44, .52**]	-.01 [-.05, .03]	-.10 [-.14, -.07]	-.31 [-.35, -.26]	**.49** [**.45, .53**]
				Academic anxiety				
	$gAANX_9$	$spMANX_9$	$spFANX_9$	$spGANX_9$	$gAANX_9$	$spMANX_9$	$spFANX_9$	$spGANX_9$
$gAANX_7$	**.48** [**.44, .52**]	.02 [-.02, .06]	-.06 [-.10, -.02]	.01 [-.04, .05]	**.55** [**.52, .58**]	.03 [-.01, .07]	-.06 [-.09, -.02]	.00 [-.04, .04]
$spMANX_7$	.02 [-.03, .07]	**.45** [**.38, .51**]	-.14 [-.20, -.08]	-.19 [-.26, -.12]	.01 [-.03, .06]	**.48** [**.43, .52**]	-.09 [-.14, -.04]	-.19 [-.24, -.13]
$spFANX_7$	-.03 [-.07, .01]	-.12 [-.18, -.06]	**.50** [**.45, .55**]	-.32 [-.38, -.26]	-.04 [-.08, -.01]	-.14 [-.19, -.08]	**.51** [**.47, .56**]	-.29 [-.34, -.24]
$spGANX_7$	.05 [.00, .09]	-.21 [-.27, -.15]	-.29 [-.34, -.24]	**.60** [**.54, .65**]	.03 [-.01, .07]	-.17 [-.23, -.12]	-.29 [-.34, -.24]	**.57** [**.52, .62**]

Note. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept; gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest; gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety; The suffixes 7 and 9 in the factor names indicate Grades 7 and 9, respectively. Autocorrelations of factors (i.e., stability coefficients) are in bold.

Table 4.2

Standardized Regression Coefficients between General and Subject-Specific Components over Time and their 95% Confidence Intervals [CIs] Obtained for the Academic Self-Concept, Academic Interest, and Academic Anxiety Models

	Sample 1				Sample 2			
				Academic self-concept				
	$gASC_9$	$spMSC_9$	$spFSC_9$	$spGSC_9$	$gASC_9$	$spMSC_9$	$spFSC_9$	$spGSC_9$
$gASC_7$	.42 [.38, .47]	.01 [-.03, .05]	-.05 [-.09, -.02]	.05 [.01, .09]	.44 [.40, .48]	.04 [.00, .07]	-.06 [-.09, -.03]	.03 [.00, .07]
$spMSC_7$	.02 [-.04, .07]	.49 [.44, .54]	-.07 [-.12, -.03]	-.07 [-.12, -.02]	.06 [.00, .11]	.46 [.42, .51]	-.04 [-.08, 0]	-.12 [-.16, -.07]
$spFSC_7$	.05 [-.02, .11]	-.11 [-.17, -.05]	.63 [.59, .68]	-.21 [-.27, -.15]	.05 [-.01, .11]	-.14 [-.19, -.09]	.64 [.59, .68]	-.22 [-.27, -.16]
$spGSC_7$	.07 [-.01, .14]	-.17 [-.23, -.10]	-.15 [-.20, -.10]	.51 [.45, .57]	.05 [-.01, .11]	-.15 [-.20, -.10]	-.15 [-.20, -.11]	.51 [.46, .56]
				Academic interest				
	$gAINT_9$	$spMINT_9$	$spFINT_9$	$spGINT_9$	$gAINT_9$	$spMINT_9$	$spFINT_9$	$spGINT_9$
$gAINT_7$	.46 [.42, .5]	.03 [-.01, .07]	.00 [-.04, .04]	.03 [-.01, .07]	.42 [.38, .46]	-.01 [-.05, .03]	.03 [-.01, .06]	.02 [-.02, .06]
$spMINT_7$	-.01 [-.06, .03]	.45 [.41, .49]	-.05 [-.09, -.01]	-.05 [-.10, .00]	.02 [-.03, .06]	.43 [.39, .46]	-.05 [-.09, -.01]	-.12 [-.16, -.08]
$spFINT_7$	.05 [.00, .10]	-.06 [-.11, -.01]	.54 [.50, .58]	-.19 [-.23, -.14]	.07 [.02, .11]	-.10 [-.14, -.06]	.52 [.47, .56]	-.18 [-.22, -.13]
$spGINT_7$	.03 [-.02, .07]	-.12 [-.16, -.07]	-.18 [-.22, -.14]	.42 [.37, .46]	.01 [-.03, .05]	-.08 [-.12, -.04]	-.16 [-.21, -.12]	.42 [.38, .46]
				Academic anxiety				
	$gAANX_9$	$spMANX_9$	$spFANX_9$	$spGANX_9$	$gAANX_9$	$spMANX_9$	$spFANX_9$	$spGANX_9$
$gAANX_7$	.48 [.44, .52]	.02 [-.02, .06]	-.06 [-.10, -.02]	.01 [-.04, .05]	.55 [.52, .58]	.03 [-.01, .07]	-.06 [-.09, -.02]	.00 [-.04, .04]
$spMANX_7$	.04 [-.04, .12]	.40 [.30, .50]	-.09 [-.18, .01]	-.05 [-.15, .05]	.02 [-.05, .09]	.45 [.37, .52]	-.05 [-.12, .03]	.00 [-.09, .08]
$spFANX_7$	.00 [-.07, .08]	-.06 [-.17, .04]	.42 [.33, .50]	-.12 [-.22, -.02]	-.03 [-.10, .04]	-.08 [-.16, .01]	.46 [.38, .53]	-.06 [-.14, .02]
$spGANX_7$	.06 [-.02, .15]	-.11 [-.21, .00]	-.15 [-.24, -.06]	.54 [.43, .64]	.03 [-.05, .10]	-.04 [-.13, .05]	-.11 [-.20, -.03]	.55 [.45, .64]

Note. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept; gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest; gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety; The suffixes 7 and 9 in the factor names indicate Grades 7 and 9, respectively.

4.3.3. Prediction of change

The autocorrelations obtained for the general and subject-specific components of the constructs were uncontaminated by measurement error, and thus, autocorrelations less than 1 could be interpreted as indicative of interindividual differences in intraindividual change (Nesselroade, 1991). All autocorrelations depicted in Table 4.1 as well as all autoregressions depicted in Table 4.2 were clearly less than 1, thus implying that there were substantial reliable individual differences in change in the general and subject-specific components of academic self-concept, anxiety, and interest, respectively. How can these interindividual differences in change be explained?

First, we found little evidence for substantial top-down processes in which the general components affected change in the subject-specific components of the constructs. The values for the corresponding standardized regression coefficients β were negligible for academic self-concept ($-.05 \leq \beta \leq .05$ in S1; $-.06 \leq \beta \leq .04$ in S2), interest ($.00 \leq \beta \leq .03$ in S1; $-.01 \leq \beta \leq .03$ in S2), and anxiety ($-.06 \leq \beta \leq .02$ in S1; $-.06 \leq \beta \leq .03$ in S2).

Second, we also found little evidence for substantial bottom-up processes in which the subject-specific components affected change in the general components of the constructs. The values for the corresponding standardized regression coefficients were negligible for academic self-concept ($.02 \leq \beta \leq .07/.05 \leq \beta \leq .06$), interest ($-.01 \leq \beta \leq .05/.01 \leq \beta \leq .07$), and anxiety ($.00 \leq \beta \leq .06/-.03 \leq \beta \leq .03$) in S1 and S2, respectively.

Third, we found evidence for substantial (i.e., $|\beta| \geq .10$) negative effects of subject-specific components in Grade 7 on change in the specific components of other subjects in Grade 9. These effects can be interpreted as (negative) ipsative comparison processes.

As for academic self-concept, specific French self-concept in Grade 7 was negatively related to change in specific German self-concept in Grade 9 in both samples ($\beta = -.21/-.22$); specific German self-concept in Grade 7, on the other hand, was negatively related to change

in specific French self-concept 2 years later in both samples (β = –.15/–.15). Further, we found that change in specific math self-concept in Grade 9 was consistently negatively related to specific German self-concept (β = –.17/–.15) and specific French self-concept (β = –.11/–.14) in Grade 7 in both samples. Finally, albeit negative, specific math self-concept in Grade 7 showed no substantial relations to change in specific German self-concept or change in specific French self-concept in Grade 9 (with all | βs | < .10) with one exception (i.e., $spGSC_9$ regressed on $spMSC_7$ with β = –.12 in S2).

It is important to note that the patterns of results obtained for interest and academic anxiety demonstrated several similarities but also some differences compared with the pattern observed for academic self-concept. Particularly, in both samples, specific interest in French in Grade 7 was negatively related to change in specific interest in German in Grade 9 (β = –.19/–.18); specific interest in German in Grade 7, on the other hand, was negatively related to change in specific interest in French self-concept 2 years later (β = –.18/–.16). The relation of change in specific interest in mathematics in Grade 9 to specific interest in German in Grade 7 was substantial in S1 (β = –.12) but not in S2 (β = –.08); its relation to specific interest in French in Grade 7 was substantial in S2 (β = –.10) but not in S1 (β = –.06). Finally, albeit negative, specific interest in mathematics in Grade 7 showed no substantial relations to change in specific German self-concept and change in specific French self-concept in Grade 9 (with | βs | < .10), with only one exception (i.e., $spGINT_9$ regressed on $spMINT_7$ with β = –.12 in S2).

Finally, as for academic anxiety, specific anxiety in French in Grade 7 was negatively related to change in specific anxiety in German in Grade 9 in S1 (β = –.12) but not in S2 (β = –.06); specific anxiety in German in Grade 7, on the other hand, was negatively related to change in specific anxiety in French 2 years later in both samples (β = –.15/–.11). The relation of change in specific anxiety in mathematics in Grade 9 to specific anxiety in German in Grade 7 was substantial in S1 (β = –.11) but not in S2 (β = –.04); its relation to specific anxiety in

French in Grade 7 was not substantial in any sample (β = –.06/–.08). Finally, specific anxiety in mathematics in Grade 7 was not substantially related to change in specific anxiety in German or change in specific anxiety in French in Grade 9 (with | βs | < .10).

4.4. Discussion

The overarching goal of the present study was to examine the developmental dynamics of the general and subject-specific components of students' academic self-concept, anxiety, and interest, respectively. Following the methodological advice given by Cumming (2014) and Bonett (2012) for carrying out replication studies, we drew on two representative longitudinal samples to tackle two key objectives of developmental research (Baltes & Nesselroade, 1979): to analyze differential stabilities and to predict change in these affective-motivational constructs. In doing so, the present results empirically underscore several vital structural and developmental characteristics that are shared by academic self-concept, academic interest, and academic anxiety. Our discussion of the major findings of the present study will focus on the results that were replicated in both samples as these findings demonstrate broad generalizability and robustness.

First, the multidimensional and hierarchical organization of self-concept with general academic self-concept operating at the apex of the hierarchy has received ample empirical support by research on the nested Marsh/Shavelson model (Brunner et al., 2010; Brunner et al., 2008, 2009). However, regarding academic interest and academic anxiety, although general and subject-specific conceptualizations appear to coexist in the literature, previous research did not formally relate the two approaches to each other: Some scholars have conceived of academic interest as strongly subject-specific (e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 1991), whereas another emphasized the idea that students may also have a general individual interest in learning (Ainley, Hidi, & Berndorff, 2002). Likewise, in the last 10 to 15 years, academic anxiety has been considered to be specific to subjects (Goetz et al., 2007), whereas

earlier research focused on the general nature of academic anxiety (Zeidner, 1998). Therefore, a vital strength of the present study was that we applied nested-factor models that captured the subject-specific nature of these constructs as well as the hierarchical relations between the general and subject-specific components of the constructs to integrate subject-specific and general approaches of academic interest and academic anxiety (and, of course, academic self-concept). By doing so, we were able to show that academic self-concept, interest, and anxiety share—at least for students in Grades 7 and 9—vital structural characteristics: (a) a multidimensional nature with respect to different subjects, (b) a hierarchical organization with a general component at the apex of the hierarchy, and (c) a strong separation between the subject-specific components.

Second, the nested-factor models accounted for the influence of the general components of the constructs on the subject-specific measures. This has important advantages when studying individual development, for example, because differential stabilities of subject-specific construct components are not confounded with the stabilities of general construct components. Regarding the differential stabilities of general as well as subject-specific components of academic self-concept, interest, and anxiety, moderate levels of stability were observed. Thus, there is a substantial level of differential stability in the individual configuration of the general level as well as the subject-specific strengths and weaknesses of students' profiles of these affective-motivational constructs. The highest stability coefficients were observed for self-concept in French and German. This result is somewhat contrary to the seminal theoretical conceptualization of self-concept by Shavelson et al. (1976), where general academic self-concept was predicted to show higher levels of differential stability than the subject-specific self-concepts. Moreover, it is interesting that the lowest stabilities of subject-specific affective-motivational components were observed for mathematics. This result may be associated with the significance that this subject gains as students advance in their school careers. For many students, mathematics is a domain that gains (or loses) substantive

importance, and this in turn may affect the differential stability of students' self-concept, interest, and anxiety in mathematics.

Third, theoretical considerations of the direction of causal flow in the self-concept hierarchy have been ambiguous. Several scholars have predicted bottom-up processes that flow from subject-specific to general academic self-concept (e.g., Harter, 1986; Rosenberg, 1979; Shavelson et. al, 1976). Brown (1993), on the other hand, argued for top-down processes that flow from general to subject-specific self-concepts. Given that structural models that integrate hierarchical relations between general and subject-specific components have not been tested for academic interest or anxiety, this question has not been empirically addressed before for these two constructs. However, but well in line with the results of Marsh and Yeung's (1998) still unique study of academic self-concept, we did not find support for longitudinal (a) top-down or (b) bottom-up processes that affect change in subject-specific or general components for any of the constructs under investigation.

Fourth, our results showed that change in the subject-specific components of academic self-concept, interest, and anxiety could be partially explained by ipsative comparison effects between noncorresponding subjects. These results are in line with predictions from the RI/E model and the ipsative hypothesis that forms the basis of dimensional comparison theory (Möller & Marsh, 2013). These theories imply that self-concept in one subject has a negative effect on change in other domains (see Parker et al., 2015) especially when the subjects are not closely related (Marsh et al., 2015). Given that the general components of the constructs were controlled for in the subject-specific measures, the present analyses strongly support the idea that these ipsative processes are (a) operating at the level of subjects and (b) do not result from (additional) top-down processes that flow from the general components to the subject-specific components.

Moreover, the present study extends findings on ipsative developmental processes to the realm of academic interest and anxiety. Specifically, we found substantial ipsative

developmental processes between specific French and specific German components for all constructs that we investigated. Thus, these findings are well aligned with results from other studies that have investigated self-concept formation for languages that are vital in students' lives (Brunner et al., 2010; Marsh, Kong, & Hau, 2001; Marsh & Yeung, 2001). The ipsative developmental effects between mathematics and the two specific verbal components were in most cases slightly lower yet in many cases still substantial. It is important to note that these results (in combination with the moderate stabilities of the general and subject-specific components of the constructs) indicate that students' affective-motivational profile shapes become magnified over time. This means that ipsative profile differences between verbal subjects (i.e., French and German) become larger but so do differences between mathematics on the one side and verbal subjects on the other. For example, a student who has a strong self-concept in German tends to (a) retain his or her level of German self-concept, (b) develop a weaker self-concept in French, and (c) develop a weaker self-concept in mathematics as well. As affective-motivational constructs determine academic effort, choices, and success, these (ipsative) developmental processes may have important implications for students' future educational careers (e.g., as students tend to select courses and curricula that match their affective-motivational profiles).

4.4.1. Limitations and outlook

Certain limitations should be considered when interpreting the results of our study. First, the generalizability of our results may be limited by the fact that the data were obtained only from samples of adolescents in Luxembourg. For example, there are indications that the relations between the language-specific self-concepts may depend on the role of the languages in the various curricula and societies (see Brunner et al., 2010). In Luxembourg, both German and French play important roles in school and society. Therefore, further research is needed to investigate whether the ipsative processes found in the present study can also be found in different cultural contexts.

Second, we capitalized on data from two representative samples with students attending Grades 7 and 9. Future research may benefit from collecting data with a larger number of measurement points (e.g., in Grade 8) to allow for analyses with a higher resolution of the developmental processes that affect stability and change in students' affective-motivational constructs. Specifically, stronger relations may be expected for general but also subject-specific construct components when the time lags are shorter. Thus, the results in the present study (with a time lag of 2 years) can be interpreted as lower-bound estimates. Further, by focusing on substantial coefficients (i.e., $|\beta s| \geq .10$) and on the results that were found in both samples, we might have missed some dynamics that have smaller effects on students' affective and motivational development.

Next, the stability of affective-motivational constructs were examined only with regard to change from the seventh to the ninth grade. Stability across a broader time frame should be investigated to obtain a fuller understanding. Specifically, as students in Luxembourg are assigned to different secondary tracks at the end of Grade 6 and therefore have to accommodate to new social frames so that external and internal comparisons become actualized, the stability coefficients and cross-lagged effects found in the present study may be viewed as lower bound estimates.

Third, in nested-factor models, the subject-specific components are uncorrelated with the general components. However, this assumption may be unrealistic in some situations (Marsh & Grayson, 1995; Pohl, Steyer, & Kraus, 2008). In fact, it might be quite reasonable from a substantial point of view to allow for correlations between these components. It might, for example, be possible that the subject-specific deviations from the general level of affective-motivational constructs covary with the general level of the constructs. Hence, future research may benefit from studying development in students' affective-motivational constructs by using, for example, the latent difference model, which allows for such correlations (Geiser, Eid, West, Lischetzke, & Nussbeck, 2012; Pohl et al., 2008).

4.4.2. Implications

Regarding implications for future research, our results show that the different affective-motivational constructs share vital characteristics concerning (a) their structure and (b) their developmental dynamics. Therefore, a comprehensive longitudinal structural model, analogous to Gogol et al.'s (2015) integrative model, could be developed to parsimoniously integrate the structural and developmental similarities of different affective-motivational constructs in a single model. Moreover, negative ipsative comparison processes across subjects imply that several subject-specific components have a negative effect on change in specific components of other subjects. These effects suggest that intervention efforts intended to increase academic self-concept or interests and to decrease students' academic anxiety should not rely on targeting one subject alone but rather should take into consideration students' subject-specific affective-motivational experiences in other subjects (see also Parker et al., 2015).

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4.6. Appendix A to Chapter 4

Table A4.1

Items Assessing Academic Self-Concepts, Academic Interests, and Academic Anxieties

General academic self-concept	
SC_A1	I do well on tests in most school subjects.
SC_A2	I learn things quickly in most school subjects.
SC_A3	I am good at most school subjects.
Subject-specific academic self-concepts	
SC_[S]1	[SUBJECT] is one of my best subjects.
SC_[S]2	I learn things quickly in [SUBJECT].
SC_[S]3	I am good at [SUBJECT].
General academic interest	
INT_A1	I am interested in most school subjects.
INT_A2	Most school subjects are important to me personally.
INT_A3	I enjoy most school subjects.
Subject-specific academic interests	
INT_[S]1	I am interested in [SUBJECT].
INT_[S]2	[SUBJECT] is important to me personally.
INT_[S]3	I enjoy [SUBJECT].
General academic anxiety	
ANX_A1	I am afraid of most school subjects.
ANX_A2	I get very nervous before tests in most school subjects.
ANX_A3	I am worried before tests in most school subjects.
Subject-specific academic anxieties	
ANX_[S]1	I am afraid of [SUBJECT] class.
ANX_[S]2	I get very nervous before tests in [SUBJECT].
ANX_[S]3	I am worried before tests in [SUBJECT].

Note. To assess subject-specific constructs, [SUBJECT] was replaced by mathematics, French, or German, respectively.

[a] Students responded to these items on a rating scale with four categories: *disagree*, *disagree somewhat*, *agree somewhat*, and *agree*.

Table A4.2

Sample 1: Descriptive Statistics, Correlations (below the Diagonal), and Covariances (above the Diagonal) for the Scale Scores Assessing Academic Self-Concept, Interest, and Anxiety

		Grade 7												Grade 9											
		SA	SM	SF	SG	IA	IM	IF	IG	AA	AM	AF	AG	SA	SM	SF	SG	IA	IM	IF	IG	AA	AM	AF	AG
Seventh grade	SA	-	.21	.14	.20	.17	.15	.09	.15	-.14	-.13	-.10	-.11	.12	.09	.04	.10	.06	.06	.01	.06	-.06	-.04	-.02	-.06
	SM	.42	-	-.03	.03	.14	.52	-.02	.03	-.16	-.42	.00	-.02	.09	.38	-.09	.00	.04	.29	-.07	-.01	-.08	-.23	.04	-.01
	SF	.26	-.04	-	-.21	.10	-.01	.54	-.13	-.03	.07	-.36	.20	.06	-.04	.53	-.23	.06	-.02	.38	-.13	.02	.08	-.23	.18
	SG	.39	.03	-.28	-	.12	.01	-.16	.51	-.14	-.03	.07	-.40	.10	-.06	-.27	.43	.03	-.05	-.21	.29	-.10	.00	.10	-.28
	IA	.43	.24	.17	.20	-	.27	.25	.26	-.03	-.03	-.02	.00	.09	.08	.06	.06	.18	.14	.12	.13	.02	.01	.02	.02
	IM	.29	.72	-.02	.01	.47	-	.14	.16	-.07	-.28	.04	.04	.07	.32	-.05	-.01	.12	.33	.03	.07	-.02	-.16	.05	.03
	IF	.18	-.02	.71	-.22	.44	.19	-	.05	.03	.10	-.23	.20	.05	-.01	.42	-.18	.14	.08	.40	-.03	.07	.08	-.15	.18
	IG	.29	.04	-.18	.70	.46	.22	.07	-	-.05	.03	.10	-.24	.08	-.03	-.16	.31	.13	.04	-.07	.32	-.03	.03	.09	-.15
	AA	-.28	-.23	-.04	-.20	-.05	-.10	.04	-.07	-	.47	.41	.41	-.09	-.10	.03	-.09	.00	-.03	.06	-.02	.26	.23	.15	.20
	AM	-.24	-.57	.09	-.04	-.05	-.38	.13	.04	.66	-	.29	.29	-.08	-.28	.10	-.03	.01	-.17	.11	.02	.22	.32	.09	.13
	AF	-.19	.00	-.47	.10	-.03	.05	-.31	.14	.59	.39	-	.19	-.07	-.02	-.25	.08	-.01	.01	-.15	.08	.17	.12	.29	.04
	AG	-.22	-.03	.26	-.55	-.01	.06	.28	-.33	.60	.39	.26	-	-.07	.01	.23	-.28	.02	.06	.21	-.13	.21	.13	.03	.34
Ninth grade	SA	.34	.18	.12	.19	.22	.15	.09	.16	-.18	-.15	-.13	-.13	-	.22	.14	.19	.20	.18	.11	.14	-.06	-.04	-.01	-.05
	SM	.16	.49	-.05	-.07	.13	.41	-.01	-.03	-.13	-.34	-.03	.02	.39	-	-.02	-.02	.16	.62	.01	-.01	-.07	-.39	.06	.06
	SF	.06	-.11	.64	-.33	.09	-.06	.52	-.20	.04	.12	-.31	.28	.24	-.02	-	-.23	.14	.03	.60	-.09	.07	.16	-.31	.26
	SG	.19	.00	-.30	.58	.10	-.01	-.24	.42	-.13	-.04	.10	-.38	.36	-.02	-.28	-	.13	.02	-.14	.50	-.07	.06	.17	-.32
	IA	.16	.07	.10	.06	.39	.21	.24	.22	.00	.01	-.02	.04	.48	.25	.22	.21	-	.28	.27	.27	.06	.06	.07	.07
	IM	.11	.37	-.03	-.06	.24	.43	.10	.05	-.05	-.22	.01	.07	.32	.73	.03	.02	.45	-	.16	.15	.03	-.22	.10	.11
	IF	.03	-.09	.48	-.27	.20	.03	.53	-.09	.09	.14	-.20	.27	.21	.01	.72	-.19	.45	.19	-	.07	.14	.19	-.14	.27
	IG	.12	-.01	-.17	.39	.23	.09	-.04	.44	-.03	.03	.10	-.18	.28	-.01	-.11	.66	.46	.19	.10	-	.04	.14	.18	-.12
	AA	-.13	-.12	.03	-.14	.04	-.02	.10	-.04	.40	.33	.26	.31	-.12	-.10	.10	-.10	.12	.04	.20	.06	-	.46	.36	.40
	AM	-.07	-.30	.10	.00	.02	-.20	.10	.04	.31	.41	.16	.17	-.08	-.47	.18	.08	.10	-.26	.23	.18	.65	-	.29	.30
	AF	-.04	.06	-.31	.13	.03	.07	-.20	.13	.22	.13	.39	.04	-.03	.08	-.38	.23	.12	.13	-.18	.24	.54	.37	-	.18
	AG	-.12	-.01	.24	-.39	.04	.05	.25	-.21	.29	.19	.05	.48	-.10	.07	.33	-.45	.13	.14	.37	-.17	.61	.40	.26	-
	M	3.03	2.95	2.74	2.98	3.09	3.03	2.87	2.91	2.08	1.98	1.98	1.88	2.86	2.60	2.51	2.84	2.70	2.65	2.59	2.61	2.13	2.22	2.09	1.88
	SD	.60	.85	.88	.86	.67	.85	.86	.85	.81	.87	.85	.85	.60	.93	.94	.87	.69	.91	.88	.86	.78	.90	.86	.83
	ω	.76	.90	.90	.89	.74	.86	.86	.87	.80	.82	.83	.83	.77	.90	.91	.89	.76	.87	.87	.87	.79	.83	.82	.82

Note. Scale scores for academic self-concepts, interests, and anxieties were computed as the mean of the respective item scores. Reliability estimates were calculated as coefficient ω (McDonald, 1999) and were based on congeneric first-order factor models. ω can be interpreted in the same way as any other reliability coefficient, with values that can range from 0 (no reliability) to 1 (perfect reliability). SA = academic self-concept; SM = mathematics self-concept; SF = French self-concept; SG = German self-concept; IA = academic interest; IM = mathematics interest; IF = French interest; IG = German interest; AA = academic anxiety; AM = mathematics anxiety; AF = French anxiety; AG = German anxiety.

Table A4.3

Sample 2: Descriptive Statistics, Correlations (below the Diagonal), and Covariances (above the Diagonal) for the Scale Scores Assessing Academic Self-Concept, Interest, and Anxiety

		Grade 7												Grade 9											
		SA	SM	SF	SG	IA	IM	IF	IG	AA	AM	AF	AG	SA	SM	SF	SG	IA	IM	IF	IG	AA	AM	AF	AG
Seventh grade	SA	-	.22	.13	.17	.16	.15	.09	.11	-.15	-.16	-.10	-.12	.13	.11	.04	.09	.06	.08	.01	.04	-.08	-.07	-.04	-.07
	SM	.43	-	-.03	.00	.12	.52	-.03	.00	-.17	-.47	.00	-.01	.11	.41	-.05	-.03	.04	.29	-.06	-.05	-.10	-.27	.00	.00
	SF	.25	-.03	-	-.20	.11	.01	.53	-.13	-.02	.06	-.37	.21	.07	-.05	.52	-.21	.07	-.02	.38	-.13	.02	.09	-.25	.16
	SG	.35	-.01	-.27	-	.10	-.02	-.14	.47	-.15	-.01	.09	-.43	.07	-.05	-.27	.40	.02	-.04	-.19	.26	-.09	.01	.10	-.28
	IA	.41	.21	.19	.18	-	.24	.24	.22	-.01	-.02	-.01	.01	.08	.06	.06	.05	.15	.11	.11	.11	.02	.02	.00	.02
	IM	.30	.71	.01	-.03	.44	-	.14	.11	-.08	-.30	.03	.05	.08	.32	.00	-.04	.11	.31	.05	.01	-.04	-.17	.02	.05
	IF	.18	-.04	.71	-.20	.43	.19	-	.04	.03	.10	-.24	.20	.04	-.04	.40	-.15	.14	.04	.38	-.03	.06	.11	-.15	.15
	IG	.23	.00	-.18	.68	.41	.16	.05	-	-.05	.05	.12	-.25	.05	-.05	-.15	.27	.09	.02	-.06	.28	-.01	.06	.10	-.13
	AA	-.31	-.24	-.03	-.21	-.02	-.12	.05	-.07	-	.49	.42	.44	-.10	-.13	.04	-.10	.01	-.05	.09	-.01	.30	.27	.18	.23
	AM	-.29	-.60	.07	-.02	-.04	-.39	.13	.06	.65	-	.30	.29	-.10	-.31	.08	-.02	.01	-.18	.12	.05	.26	.38	.14	.15
	AF	-.18	.00	-.48	.12	-.01	.05	-.32	.16	.57	.37	-	.18	-.08	-.02	-.27	.08	-.01	.02	-.16	.09	.20	.13	.32	.06
	AG	-.23	-.01	.27	-.59	.01	.07	.26	-.34	.61	.37	.24	-	-.06	.01	.24	-.31	.03	.05	.22	-.15	.24	.17	.05	.36
Ninth grade	SA	.37	.22	.14	.15	.20	.16	.09	.10	-.21	-.18	-.16	-.13	-	.21	.14	.16	.17	.16	.10	.11	-.09	-.07	-.04	-.06
	SM	.19	.50	-.06	-.07	.10	.40	-.05	-.06	-.16	-.37	-.02	.01	.39	-	-.03	-.03	.14	.62	-.02	-.02	-.09	-.43	.06	.06
	SF	.06	-.06	.64	-.34	.11	.00	.50	-.20	.05	.10	-.33	.30	.26	-.03	-	-.22	.15	.01	.60	-.10	.06	.14	-.32	.25
	SG	.18	-.04	-.29	.57	.08	-.06	-.22	.39	-.15	-.02	.11	-.42	.33	-.03	-.28	-	.10	.00	-.15	.44	-.09	.05	.13	-.35
	IA	.14	.06	.13	.03	.36	.19	.24	.17	.03	.02	-.02	.06	.44	.23	.24	.19	-	.26	.27	.24	.05	.05	.04	.06
	IM	.14	.37	-.03	-.06	.20	.40	.06	.03	-.06	-.22	.02	.07	.31	.73	.02	.00	.44	-	.13	.13	.00	-.24	.11	.11
	IF	.02	-.07	.49	-.26	.20	.07	.51	-.08	.12	.15	-.20	.29	.20	-.02	.73	-.20	.47	.17	-	.07	.13	.19	-.15	.25
	IG	.08	-.07	-.18	.38	.20	.01	-.04	.41	-.02	.07	.12	-.21	.23	-.03	-.13	.64	.45	.17	.10	-	.03	.12	.15	-.15
	AA	-.17	-.15	.03	-.14	.03	-.06	.08	-.01	.47	.37	.29	.35	-.19	-.13	.08	-.14	.09	.00	.19	.04	-	.46	.37	.41
	AM	-.13	-.34	.11	.01	.03	-.22	.14	.08	.36	.47	.17	.21	-.14	-.51	.17	.06	.08	-.29	.24	.16	.65	-	.26	.28
	AF	-.08	.00	-.33	.14	.00	.02	-.21	.14	.26	.18	.43	.06	-.09	.07	-.41	.18	.07	.14	-.21	.22	.56	.34	-	.19
	AG	-.14	.00	.22	-.40	.04	.07	.21	-.19	.34	.20	.08	.50	-.12	.07	.32	-.51	.11	.14	.35	-.22	.63	.38	.27	-
	M	3.01	2.94	2.76	2.95	3.14	3.07	2.97	2.96	2.12	2.01	1.99	1.92	2.89	2.64	2.54	2.88	2.78	2.71	2.62	2.69	2.16	2.22	2.09	1.89
	SD	.59	.86	.88	.84	.65	.84	.85	.82	.83	.90	.88	.87	.58	.93	.94	.83	.66	.90	.87	.82	.78	.90	.84	.83
	ω	.75	.90	.91	.88	.74	.86	.86	.85	.81	.83	.84	.83	.78	.92	.92	.89	.77	.88	.87	.87	.81	.84	.82	.83

Note. Scale scores for academic self-concepts, interests, and anxieties were computed as the mean of the respective item scores. Reliability estimates were calculated as coefficient ω (McDonald, 1999) and were based on congeneric first-order factor models. ω can be interpreted in the same way as any other reliability coefficient, with values that can range from 0 (no reliability) to 1 (perfect reliability). SA = academic self-concept; SM = mathematics self-concept; SF = French self-concept; SG = German self-concept; IA = academic interest; IM = mathematics interest; IF = French interest; IG = German interest; AA = academic anxiety; AM = mathematics anxiety; AF = French anxiety; AG = German anxiety.

4.7. Appendix B to Chapter 4 (Online Supplementary Material)

Measurement Invariance

Examining measurement invariance. To evaluate measurement invariance of the investigated models, first, we examined the fit of the models by computing a chi-square test of the overall model fit as well as the recommended descriptive fit indices (Hu & Bentler, 1998) such as the Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). The CFI values were calculated with respect to a null model (i.e., Model 0A) that is appropriate for investigating measurement invariance as suggested by Widaman and Thompson (2003): In addition to being specified as mutually uncorrelated, the variances and means of the manifest variables were constrained to be equal for the seventh and ninth grades. SRMR values below .08, RMSEA values below .06, and CFI values greater than .95 are usually considered to reflect good model fit (Browne & Cudeck, 1993; Hu & Bentler, 1998). Second, when the overall model fit was satisfactory, we examined the difference in model fit between the less and the more constrained models. Specifically, we inspected differences in the χ^2 goodness-of-fit statistic ($\Delta\chi^2$) and differences in the descriptive fit indices (ΔRMSEA, ΔSRMR, and ΔCFI). According to Chen (2007) and Cheung and Rensvold (2002), a change in fit of less than or equal to .01 for the CFI as well as less than .015 for the RMSEA can be treated as support for the more constrained model. In a more recent study, Meade, Johnson, and Braddy (2008) recommended a more conservative cut-off value of .002 for the decrease in the CFI. However, it has to be noted that these recommendations were formulated on the basis of simple-structure models (each indicator loads on only one factor). Khojasteh and Lo (2015) recommended a cut-off of .003 to .004 for the change in the CFI for evaluating metric invariance in nested-factor

models in which the indicators load on two factors.

Results for measurement invariance. Model fit statistics for the specified invariance conditions are reported in Table B4.1. The *p*-values for the χ^2 statistics for all models in both samples were below .01, indicating statistically significant discrepancies between the hypothesized model and the observed data. However, it is well-known that the χ^2 statistic is sensitive to sample size, whereby trivial model misfit may result in significant values with modest sample sizes (Iacobucci, 2010). Given the large sample sizes in the present study, we therefore focused our evaluation of model fit on the descriptive fit indices. The descriptive fit indices indicated that for all constructs and in both samples, the specified nested-factor models with configural as well as metric invariance provided an adequate overall fit to the data according to the recommended benchmark values. Further, the χ^2 goodness-of-fit statistic deteriorated significantly (at $p < .01$) in both samples with the factor loadings constraint that was introduced. However, the χ^2 difference test is considered to be too sensitive to trivial fluctuations and differences in the context of invariance testing (Little, 2013, p. 155), especially with large samples. Notably, with respect to descriptive model fit indices, the differences in model fit between the less and the more constrained models were acceptable for all constructs in both samples, even when the more conservative cut-off values were applied.

Table B4.1

Investigation of Measurement Invariance: Fit Statistics Obtained for the Nested-Factor Model

Model	χ^2	*df*	CFI	RMSEA	SRMR	Model comparison					
						Compare	$\Delta\chi^2$	Δdf	ΔCFI	ΔRMSEA	ΔSRMR
Sample 1											
AS.1	565.81	170	.991	.026	.019						
AS.2	610.04	187	.990	.025	.020	AS.2 vs. AS.1	44.23	17	-.001	-.001	.001
AI.1	629.59	164	.988	.028	.021						
AI.2	711.96	181	.986	.029	.024	AI.2 vs. AI.1	82.37	17	-.002	.001	.003
AA.1	591.57	164	.988	.027	.019						
AA.2	643.60	181	.987	.027	.023	AA.2 vs. AA.1	52.03	17	-.001	.000	.004
Sample 2											
AS.1	525.50	170	.993	.023	.018						
AS.2	547.65	187	.993	.022	.018	AS.2 vs. AS.1	22.15	17	.000	-.001	.000
AI.1	761.20	164	.986	.031	.025						
AI.2	835.64	181	.985	.031	.027	AI.2 vs. AI.1	74.44	17	-.001	.000	.002
AA.1	626.90	164	.989	.027	.019						
AA.2	665.44	181	.988	.026	.021	AA.2 vs. AA.1	38.54	17	-.001	-.001	.002

Note. AS = academic self-concept model; AI = academic anxiety model; AA = academic anxiety model; The numbers 1 and 2 in the model names indicate models with configural and metric invariance, respectively.

df = degrees of freedom; CFI = Comparative Fit Index; RMSEA= Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.

All χ^2 goodness-of-fit tests were statistically significant at $p < .001$.

Values for $\Delta\chi^2$ were calculated according to the formula provided by Muthén (1998–2004, Formula 120) for the nested data structure. CFI values were calculated according to a null model (Model 0A) that is appropriate for investigating measurement invariance as suggested by Widaman and Thompson (2003).

Table B4.2

Academic Self-Concept: Standardized Factor Loadings and Latent Correlations as Obtained for the Metric Invariance Model (S1/S2)

	Seventh grade				Ninth grade			
Item	gASC	spMSC	spFSC	spGSC	gASC	spMSC	spFSC	spGSC
Standardized factor loadings								
SC_A1	.65/.63				.65/.66			
SC_A2	.71/.71				.73/.75			
SC_A3	.80/.78				.79/.80			
SC_M1	.36/.40	.79/.77			.33/.37	.81/.81		
SC_M2	.44/.44	.68/.70			.42/.41	.71/.73		
SC_M3	.47/.47	.79/.78			.43/.43	.80/.82		
SC_F1	.20/.20		.84/.85		.19/.19		.85/.87	
SC_F2	.27/.28		.79/.79		.26/.27		.81/.82	
SC_F3	.30/.30		.86/.87		.29/.29		.88/.88	
SC_G1	.31/.28			.78/.78	.31/.28			.78/.79
SC_G2	.43/.36			.73/.73	.42/.37			.72/.73
SC_G3	.45/.40			.78/.80	.44/.40			.77/.81
Correlations between factors								
spMSC	0	-			0	-		
spFSC	0	-.25/-.23	-		0	-.18/-.21	-	
spGSC	0	-.26/-.28	-.55/-.50	-	0	-.29/-.27	-.50/-.48	-

Note. See Table A4.1 for descriptions of the individual items. gASC = general academic self-concept; spMSC = specific mathematics self-concept; spFSC = specific French self-concept; spGSC = specific German self-concept. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B4.3

Academic Interest: Standardized Factor Loadings and Latent Correlations as Obtained for the Metric Invariance Model (S1/S2)

	Seventh grade				Ninth grade			
Item	gAINT	spMINT	spFINT	spGINT	gAINT	spMINT	spFINT	spGINT
Standardized factor loadings								
INT_A1	.82/.82				.82/.85			
INT_A2	.62/.60				.61/.62			
INT_A3	.66/.65				.70/.69			
INT_M1	.50/.50	.80/.82			.48/.48	.81/.83		
INT_M2	.48/.45	.57/.57			.47/.45	.60/.61		
INT_M3	.39/.36	.69/.71			.38/.35	.71/.72		
INT_F1	.45/.47		.79/.79		.46/.48		.78/.77	
INT_F2	.42/.42		.51/.52		.44/.45		.52/.53	
INT_F3	.39/.38		.78/.78		.40/.40		.77/.77	
INT_G1	.45/.42			.76/.78	.45/.43			.75/.75
INT_G2	.49/.43			.57/.58	.50/.47			.57/.58
INT_G3	.42/.37			.75/.78	.42/.39			.74/.77
Correlations between factors								
spMINT	0	-			0	-		
spFINT	0	-.14/-.11	-		0	-.09/-.12	-	
spGINT	0	-.11/-.12	-.32/-.29	-	0	-.15/-.10	-.28/-.27	-

Note. See Table A4.1 for descriptions of the individual items. gAINT = general academic interest; spMINT = specific mathematics interest; spFINT = specific French interest; spGINT = specific German interest. All factor loadings were statistically significantly different from zero at $p < .05$.

Table B4.4

Academic Anxiety: Standardized Factor Loadings and Latent Correlations as Obtained for the Metric Invariance Model (S1/S2)

	Seventh grade				Ninth grade			
Item	gAANX	spMANX	spFANX	spGANX	gAANX	spMANX	spFANX	spGANX
Standardized factor loadings								
ANX_A1	.57/.57				.53/.54			
ANX_A2	.85/.85				.83/.86			
ANX_A3	.79/.80				.78/.81			
ANX_M1	.45/.44	.42/.44			.40/.39	.44/.44		
ANX_M2	.66/.65	.49/.54			.63/.64	.57/.59		
ANX_M3	.72/.69	.45/.50			.68/.67	.51/.54		
ANX_F1	.26/.27		.45/.49		.23/.25		.45/.46	
ANX_F2	.67/.65		.58/.60		.65/.64		.62/.61	
ANX_F3	.61/.59		.59/.62		.58/.58		.63/.63	
ANX_G1	.41/.39			.52/.49	.38/.38			.48/.47
ANX_G2	.60/.62			.54/.54	.60/.63			.55/.54
ANX_G3	.66/.64			.55/.56	.65/.65			.54/.56
				Correlations between factors				
spMANX	0	-			0	-		
spFANX	0	-.24/-.18	-		0	-.13/-.19	-	
spGANX	0	-.32/-.36	-.40/-.43	-	0	-.28/-.32	-.35/-.31	-

Note. See Table A4.1 for descriptions of the individual items. gAANX = general academic anxiety; spMANX = specific mathematics anxiety; spFANX = specific French anxiety; spGANX = specific German anxiety. All factor loadings were statistically significantly different from zero at $p < .05$.

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Chapter V – General Discussion

The major goal of the present dissertation was to scrutinize students' affect and motivation with respect to (a) possibilities for economic assessment, (b) structure, and (c) development. To this end, I focused on three central constructs from the comprehensive expectancy-value theory by Eccles (Parsons) and colleagues (1983): academic self-concept, academic interest, and academic anxiety. The dissertation includes three studies that were based on large-scale data sets. In the following sections I will, first, discuss the vital contributions of the studies to the body of knowledge on students' affective-motivational constructs (Chapter 5.1.). Second, interpretational considerations with regard to the nested-factor models applied in Studies 2 and 3 to represent the affective-motivational constructs will be presented in more detail (Chapter 5.2.). And finally, general limitation and resulting possible directions for future research will be discussed in Chapter 5.3.

5.1. Major contributions of the present dissertation

5.1.1. Economic assessment of students' affect and motivation

The present dissertation contributes to an economic assessment of students' affect and motivation by examining psychometric properties of three item and single-item measures for two core affective-motivational constructs: academic self-concept and academic anxiety. Systematic analyses of the psychometric qualities of short measures of these constructs have been rare in previous educational research. This is surprising given the fact that three-item and single-item scales have sometimes been applied in previous empirical studies. Thus, the findings from Study 1 contribute substantially to existing knowledge, by showing that academic self-concept and academic anxiety can be assessed in an economic and psychometrically sound way with three-item scales and even single items, in research contexts where short measures are needed. Moreover, the brief measures that were developed and empirically supported in

Study 1 can be used, for example, in future educational large scale studies in which multiple constructs need to be assessed at one time and long scales are therefore not applicable. Importantly, by reducing the questionnaire length, the short scales not only contribute to easing the burden of participation but have also economic advantages of reducing time and financial costs of application.

5.1.2. Structure of students' affect and motivation

Whereas much theoretical and empirical research has been devoted to structural characteristics of academic self-concept, little knowledge exists on the structural organization of academic interest and academic anxiety. Thus, the present dissertation makes a significant contribution to research on the hierarchical structure of these affective-motivational constructs. First, the findings provide further empirical support for the nested Marsh/Shavelson model (Brunner et al., 2010; Brunner, Keller, Hornung, Reichert, & Martin, 2009; Brunner, Lüdtke, & Trautwein, 2008) in Grade 7 (two samples in Study 2) and Grade 9 (six samples altogether in Studies 2 and 3). Second, and even more importantly, the present dissertation reconciles the general and subject-specific conceptualizations of academic interest and academic anxiety that appear to coexist in the literature and had not been formally linked to each other in previous research. Specifically, the nested-factor models developed in Studies 2 and 3 provided empirical evidence that academic interest and academic anxiety indeed share important structural characteristics with academic self-concept: (a) subject-specificity, (b) a hierarchical organization with a general component at the apex of the respective hierarchy, and (c) strong separation between the subject-specific components. The results point also to a structural difference between the constructs. They differ, namely, with respect to their degree of generality across different school subjects: academic anxiety is the most general construct of the investigated ones, followed by academic interest and academic self-concept.

Further, the integrative model developed in Study 2 accounted for the complex interplay of the general and subject-specific (i.e., mathematics, French, and German) components of the

three affective motivational constructs (i.e., academic self-concept, interest and anxiety) in a parsimonious way and thereby contributes to a more comprehensive picture of the constructs and their relations than was possible before. On the one hand, a parsimonious model such as this one can jeopardize precision and accuracy, but on the other hand, it offers an attractive simplicity and practical utility. Specifically, the integrative model not only helped to formally integrate the fragmented and diverse research on the key affective-motivational constructs but also provided new insights. Specifically, the results from Study 2 showed the importance of components at the more global level: the general components at the top of the hierarchy of each construct and the subject-specific components common to the different affective-motivational constructs. These global components accounted for the major part of the reliable variance in the subject-specific scale scores of the constructs and almost all relations between the subject-specific scale scores and students' achievement indicators (i.e., grades and standardized test scores). Moreover, the results pointed to the central role that academic self-concept plays in the common subject-specific components.

The integrative model can be seen as a first step toward unifying the previous research on different affective-motivational constructs. Specifically, the integrative model may help in the development of an open structural architecture to formally organize the plentitude of affective-motivational constructs (e.g., goals, self-efficacy, different academic emotions, attributions, and value beliefs) under a coherent theoretical or at least psychometric umbrella.

5.1.3. Developmental dynamics of students' affect and motivation

The present dissertation contributes to a more nuanced understanding of the developmental dynamics of academic self-concept, academic interest, and academic anxiety. Specifically, the applied longitudinal nested-factor models, which captured the hierarchical and multidimensional organization of the constructs made it possible, first, to estimate the differential stabilities of the subject-specific components of the constructs that are not confounded with the stabilities of the general components. Second, longitudinal causal

processes across the construct hierarchy as well as longitudinal ipsative comparison effects across different school subjects could be investigated simultaneously. In this way, the ipsative processes between different school-subjects could be disentangled from the effects of the general components on the subject-specific components.

Moreover, the integrative model developed in Study 2 opens a new avenue for future research on the development of students' affect and motivations. Specifically, this model will allow researchers to simultaneously and parsimoniously study the complex developmental dynamics of affective-motivational constructs and to do this across multiple constructs in multiple dimensions (i.e., general and different subject-specific components; see Figure 5.1).

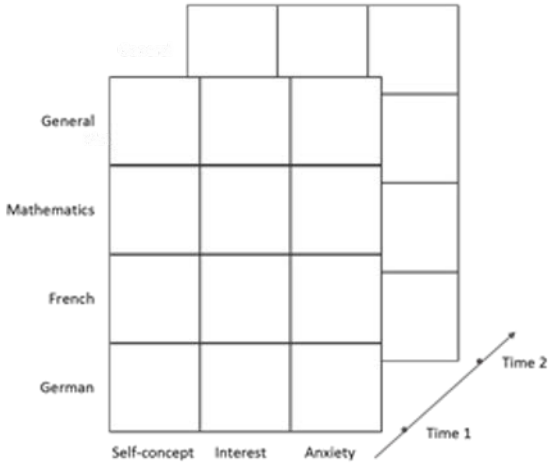

Figure 5.1. Schematic representation of an integrative research approach in longitudinal research on affective-motivational constructs

5.1.4. Replication

"Replication is a means of increasing the confidence in the truth value of a claim" (Nosek, Spies, & Motyl, 2012, p. 617). Thus, the need for replication for the cumulative establishment of scientific knowledge has been repeatedly expressed in psychological research in the past (e.g., Amir & Sharon, 1990; Cohen, 1994; Smith, 1970). However, the community

of psychology researchers seems to have paid limited attention to this issue, as only about 1% of publications from 1900 through May, 2012, across 100 psychology journals were replications (Makel, Plucker, & Hegarty, 2012). In recent years, a new and considerable wave of attention and concern has been observed (e.g., Asendorpf et al., 2013; Bonnett, 2012; Cumming, 2014; Earp & Trafimow, 2015; Funder et al., 2013; Ioannidis, 2012; Pashler & Harris, 2012; Roediger, 2012) and has been reinforced by studies that have shown that the replicability of research findings, not only in psychology, is questionable (e.g., Ioannidis, 2005; Open Science Collaboration, 2015). In the present dissertation replication was conducted in a threefold way. In Study 1, the psychometric properties of the short forms and single-item measures were investigated across three different subject areas (i.e., mathematics, French, and German) as well as the general level. Second, in Studies 2 and 3, we conducted our analyses separately on four and two independent samples, respectively, with representative data. Further, in Study 3, the findings on the nested-factor models of academic self-concept, academic interest, and academic anxiety were replicated in students from two grades: seven and ninth. By applying such replications across different content areas (Study 1), samples (Studies 2 and 3), and grades (Study 3) some empirical support for the robustness and generalizability of the findings is provided.

5.2. Interpretational considerations regarding nested-factor models

5.2.1. The nested-factor model as a measurement model

Reflective factor models such as the nested-factor models specified in the present dissertation, represent the causal relations between hypothetical latent variables (e.g., general academic anxiety) and their indicators (e.g., measures of general academic anxiety), such that the indicators are the outcomes of the latent variables (Bollen & Lennox, 1991; Edwards, 2011; Markus & Borsboom, 2013). An interpretation of a reflective factor model that relates latent variables to their observed indicators as a measurement model implies a philosophical realist

position that latent variables represent "real" theoretical entities or attributes that exist independently of the measurement process and cause responses on the corresponding items (e.g., Borsboom, 2005; Borsboom, Mellenbergh, & Van Heerden, 2003; Howell, Breivik, & Wilcox, 2007b; but see Bagozzi, 2007, for an alternative position). However, the specific latent variables in the nested-factor models of academic self-concept, academic interest and academic anxiety (e.g., spMSC; spFINT, spGANX) pose difficulties for substantive interpretations (see also Brunner, 2008, and Brunner et al., 2013). These specific factors are not unambiguously operationalized as they represent the common variance of self-concept measures in a specific school subject while simultaneously partialling out the variance that is shared with the general academic self-concept factor. Thus, it remains questionable whether these specific factors reflect "real" entities because an appropriate theory to support such an interpretation is missing. Thus, the causal language was used to describe the relations between latent and manifest variables in the present dissertation only for readability reasons because this form of description is commonly used to describe reflective factor models in the literature.

5.2.2. The nested-factor model as a statistical model

Given the interpretational challenges associated with latent variables in the applied nested-factor models described above, these models can probably be best interpreted as statistical models that have the instrumental function of decomposing the variances and covariances of the observed measures (see also Hood, 2008). What does this mean specifically for the nested-factor models of academic self-concept, interest, and anxiety?

Students differ in how they describe and evaluate their affect and motivation in particular subjects as well as at a general level that is not tied to any particular subject. In order to illustrate this idea, Figure 5.2 shows the academic self-concept (Figure 5.2c), academic interest (Figure 5.2a) and academic anxiety (Figure 5.2b) profiles of two fictive students: Linda and Peter. Linda and Peter differ not only in their general levels of academic self-concept, academic interest, and academic anxiety, but also in the shapes of their respective profiles. For

example, whereas Linda judges her French abilities as stronger than her mathematics and German abilities and her mathematics abilities as better than her German abilities, Peter evaluates his German abilities as better than his mathematical and French abilities and his mathematical abilities as better than his French abilities. The nested-factor models can account for such profiles of academic self-concept, interest, or anxiety (see also Brunner et al., 2008, 2009, for academic self-concept profiles, and Brunner et al., 2008, 2013, and Gustafsson & Snow, 1997, for ability and achievement profiles). In the following, I will illustrate this idea in detail with the example of academic self-concept. The interpretations of the academic interest and anxiety profiles are analogous.

As the general academic self-concept factor (i.e., gASC) influences general and subject-specific measures of academic self-concept, it can be interpreted as representing interindividual differences in the overall level of the academic self-concept profile.[12] The subject-specific factors (i.e., spMSC, spFSC, and spGSC) capture the variance common to the specific subjects in the respective subject-specific measures after the variance shared with general academic self-concept is partialled out. Thus, these subject-specific factors can be interpreted to represent the subject-specific shapes of the self-concept profile as they capture interindividual differences in intraindividual school-subject-specific deviations from the overall profile level.

[12] Please note that the overall level of the profile in the applied nested-factor models does not represent profile elevation as defined by Cronbach and Gleser (1953) as a mean level of the profile elements. Usually the mean of a profile is operationalized as the arithmetic mean of the elements or the influence of a general common factor of the profile elements (see Lohman, Gambrell, & Lakin, 2008; Marsh, Lüdtke, Trautwein, & Morin, 2009; Morin & Marsh, 2015). However, in the applied nested-factor models for academic self-concept, interest, and anxiety, no specific factor was specified to influence the general measures (e.g., "I'm good at most school subjects") of the constructs (beyond gASC, gINT, and gAANX, respectively). Consequently, the general factors (i.e., gASC, gAINT, and gAANX) are specific to the general indicators that have no specific factor, and therefore have a clearer meaning (see also Eid et al., 2003; Geiser, Koch, & Eid, 2014). For example, for academic self-concept, the general factor represents a student's mental representation of his/her academic abilities that is not tied to any particular subject and could consequently be interpreted as representing the *perceived overall/mean level* of the profile. Moreover, not specifying a specific factor for general items also offers statistical advantages of facilitated identification, convergence, and parameter estimation (Brunner et al., 2010; Eid et al., 2003; Geiser, Koch, & Eid, 2014). It is important to note that as different school subjects can be viewed as "fixed effects" rather than "random effects" which means that they are not selected randomly from a universe of different school subjects and are, thus, not "interchangeable" such operationalization may be considered to be recommended by Eid et al. (2008).

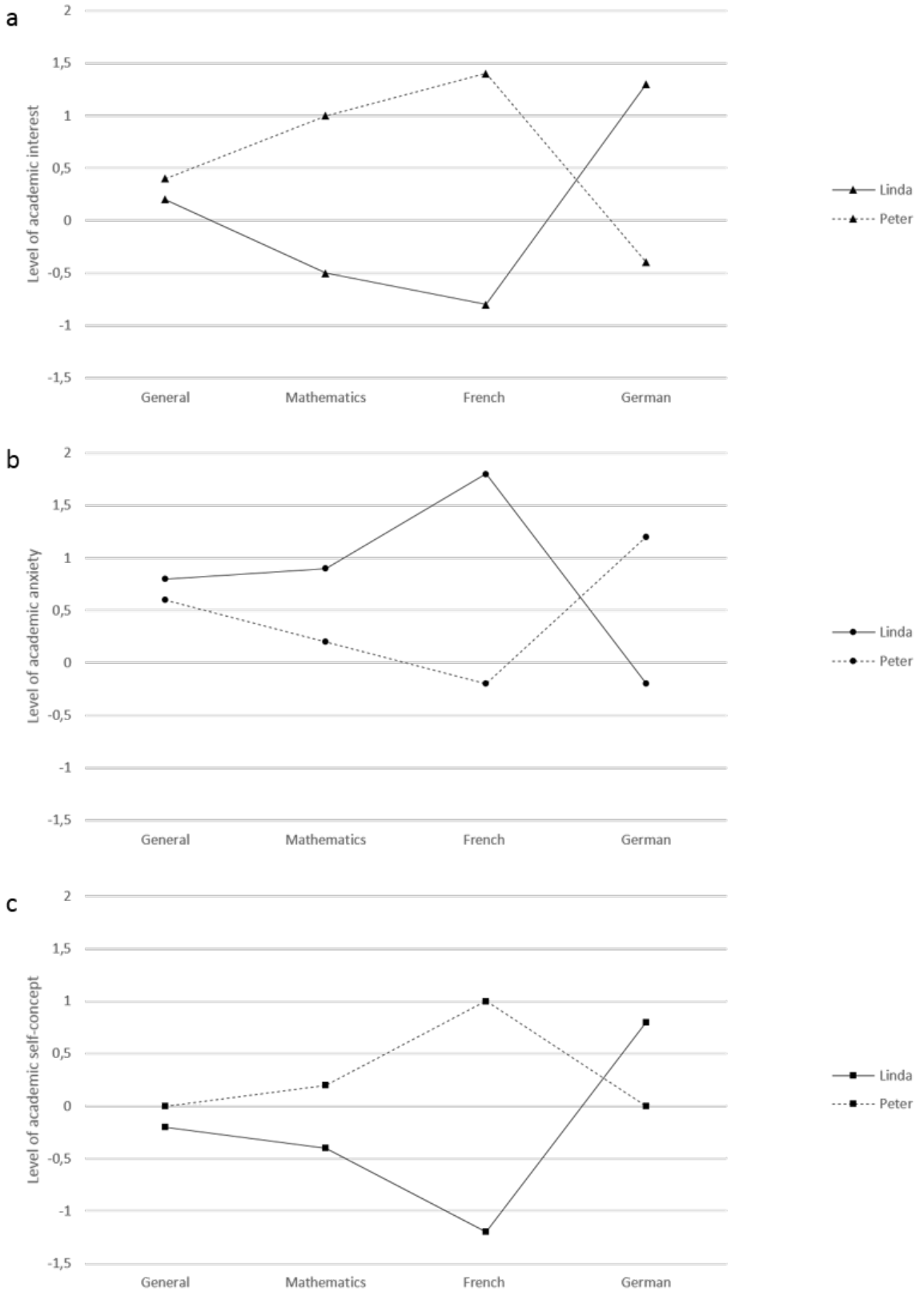

Figure 5.2. Profiles of two fictive students showing general and subject-specific (i.e., mathematics, French, and German) (a) academic interests, (b) anxieties, and (c) self-concepts. Scale scores for these constructs were z-standardized to $M = 0$ and $SD = 1$.

Summing up, the nested-factor models can be interpreted as statistical models that can be used to disentangle interindividual differences in the overall levels of the academic self-concept, academic interest, or academic anxiety profiles from interindividual differences in specific strengths and weaknesses in different school subjects. It is important to note that decomposing the overall level and the shape differences is necessary for understanding the unique information in a profile's shape (Gustafsson, 2002; Gustafsson & Snow, 1997) when the overall profile level has a substantive meaning (Morin & Marsh, 2015).

Similarly, the integrative nested-factor model developed in Study 2 can be described as a statistical model that enables researchers to disentangle the variance of subject-specific measures into components that are (a) construct-specific and generalize across different subjects, (b) subject-specific and common to different constructs, and (c) specific to a construct in a certain subject. This model therefore synthesizes students' profiles across different affective-motivational constructs. Specifically, the gASC, gAINT, and gAANX factors can be interpreted as indicating the overall level of students' academic self-concept, interest, and anxiety profiles, respectively. The common subject-specific factors (i.e., cM, cF, and cG) represent the commonality of the respective subject-specific deviations from the overall levels of the academic self-concept, interest, and anxiety profiles and, thus, determine the subject-specific profiles' shapes common to different affective-motivational constructs.

5.2.3. The nested-factor model as a structural model

A critical concern in considerations regarding the structural conceptualization of affective-motivational constructs is the direction of structural relations between the general and subject-specific components of the constructs. With regard to academic self-concept, the theoretical considerations have been contradictory (see also Marsh & Yeung, 1998). First, Shavelson et al.'s (1976) theoretical considerations seem logically contradictory: On the one hand, they introduced the hierarchical nature of academic self-concept as analogous to the hierarchical model of general intelligence with a general *g* factor at the apex as an influence on

specific cognitive abilities (Vernon, 1950). Accordingly, in the numerous studies that have tested the “Shavelson model” with regard to academic self-concept, general academic self-concept was represented as a higher-order factor that was inferred from general and subject-specific first-order factors, however, without explicitly interpreting the direction of the structural relations between the different hierarchy levels as top-down (e.g., Marsh, 1990; Marsh, Byrne, & Shavelson, 1988; Marsh, Smith, & Barnes, 1985). On the other hand, Shavelson et al. (1976) explicitly stated that “to change general self-concept, many situation-specific instances, inconsistent with general self-concept, would be required” (p. 414), indicating hierarchical bottom-up influences. Also, in a later study, Shavelson and Bolus (1982) stated that "our theory posits changes in self-concept at higher levels to be a function of changes in self-concept at lower levels" (p. 9), which further supported the bottom-up interpretation of their theoretical considerations. It is important to note that this bottom-up conceptualization is in line with Rosenberg’s (1979) and Harter’s (1986) theoretical considerations. Second, Brown (1993) advocated for top-down influences from the apex to the base of the self-concept hierarchy.

Because general and subject-specific conceptualizations of academic interest and academic anxiety were not linked to each other in previous research, and there has been a dearth of theoretical considerations with regard to causal influences between the subject-specific and general components of these constructs (see also Chapter 3), further theoretical research is needed in this regard. For example, it could be argued that as academic anxiety seems to have characteristics of a general trait and is thereby characterized by a general disposition to experience anxiety in different subjects (see Sarason & Sarason, 1990; Zeidner, 1998), a top-down model may be more appropriate than a bottom-up model.

In their work on the nested Marsh/Shavelson (NMS) model, Brunner and colleagues have not addressed the issue of the direction of structural relations between the general and subject-specific components of academic self-concept (Brunner et al., 2008, 2009, 2010).

Although it could be argued that it might be problematic to interpret the NMS model of academic self-concept (as well as the nested-factor models of academic interest and anxiety developed in Study 2 of the present dissertation) as representing the "true" structure of the affective-motivational constructs because the latent factors might not represent "real" entities (see Chapter 5.2.1; see also Hood, 2009), such nested-factor models can be understood as implying causal top-down relations across the different levels of the respective construct hierarchy (i.e., subject-specific vs. general) as the general factors (i.e., gASC, gAINT, and gAANX) (directly) influence the subject-specific measures of the constructs. These hierarchical structural relations are more apparent when considering a model that is conceptually close to the nested-factor (NF) model: a higher-order (HO) factor model.[13] Figure 5.3.a exemplarily presents such a model for academic self-concept.

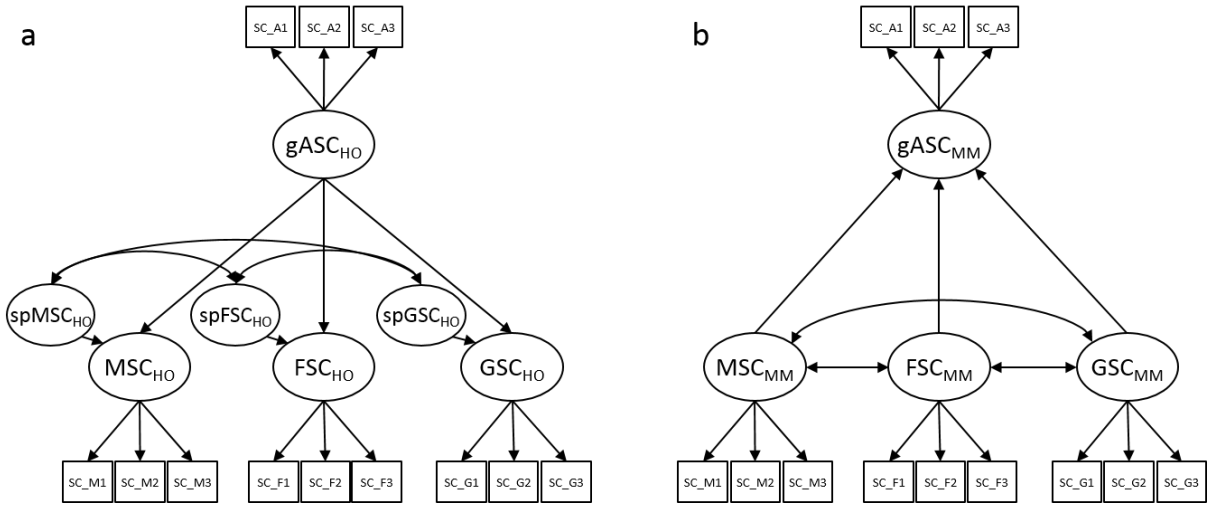

Figure 5.3. Schematic diagrams of alternative conceptualizations of the hierarchical relations between the general and subject-specific components of academic self-concept: (a) the top-down model, and (b) the bottom-up model.

[13] The NF model can be viewed as a generalization of the higher order factor (HO) model (see Brunner et al., 2012; Yung, Thissen, & McLeod, 1999). Specifically, the HO model is nested within the NF model (Yung et al., 1999) as it specifies that the lower order factors fully mediate the relations between the higher-order factor and the observed variables (Gignac, 2008; Murray & Johnson, 2013), thus imposing a "proportionality constraint" on the variance ratios of the general and subject-specific factors in the observed indicators (see Brunner et al., 2012; Chen, West, & Sousa, 2006; Yung, Thissen, & McLeod, 1999). When the proportionality constraint holds in the NF model, the two models are equivalent (Murray & Johnson, 2013).

The interpretation of the specific factors in the NF model (e.g., spMSC, spFSC, and spGSC) corresponds to the residual factors (e.g., $spMSC_{HO}$), that is, to the variance of the subject-specific first-order factor (MSC_{HO}) controlled for the influence of the general factor (i.e., $gASC_{HO}$). Similarly, the general factor from the NF model (e.g., gASC) corresponds to the general factor in the HO model (ASC_{HO}) with the major difference that the influence of the general factor on the manifest indicators is modeled as indirect in the HO model and as direct in the NF model.[14]

How can the results of the present dissertation be interpreted with regard to the direction of structural relations between constructs' hierarchical levels? Although the nested-factor models that imply top-down processes in the construct hierarchy fit the data well in Studies 2 and 3, they cannot be taken as proof of a top-down model or as an argument against bottom-up influences. Specifically, data from a single time point were used to specify such nested-factor models, and this limits inferences about the directions of the causal relations. It is important to note that the correlational pattern found in the observed measures is also compatible with the opposite causal direction, like, for example, represented in the bottom-up model in Figure 5.3.b (a so-called "mixed model" [MM]; Markus & Borsboom, 2013, p. 122). Study 3 employed longitudinal data, which usually provide a more convenient way to study causal relations, and little support was found for top-down processes (that were not mediated by the general construct in Grade 9) or bottom-up processes for the time period of 2 years. However, these results do not have to cast doubts on the usefulness of the hierarchical representation of self-concept or the existence of top-down or bottom-down processes between general and subject-specific components of the affective-motivational constructs that were investigated. First, from the conceptual considerations, it is not clear what would be an appropriate time lag for studying the causal processes as different results could be observed with different time lags (Dormann &

[14] The specific (and general) factors in the NF model and the residual (and general) factors in the HO model are identical only when the proportionality constraint is imposed or holds in the NF model (see Brunner et al., 2012).

Griffin, 2014). Second, the causal effects might be instantaneous, for example, if judgments of general academic self-concept were used as a heuristic for judging subject-specific academic self-concepts or vice versa. Such rapid processes cannot be addressed with longitudinal studies (Lucas, 2004).

Although questions about the causal directions of the relations between general and subject-specific components of affective-motivational constructs are complex and may be unanswerable, more theoretical and empirical research is needed to gain a deeper understanding of the possible causal dynamics. For example, it would be important to identify appropriate time lags and instrumental variables as well as to conduct experimental and intervention studies. Moreover, a possible contextual dependence of the hierarchical relations should be taken into account (see Trautwein, Lüdtke, Köller, & Baumert, 2006; Yeung et al., 2000). In addition, future research should take more into account the possibility that theories and empirical models that refer to the interindividual level do not necessarily translate to the intraindividual level (i.e., psychological structures and processes as experienced by individuals) and vice versa (Borsboom et al., 2003; Borsboom, Kievit, Cervone, & Hood, 2009; Cervone, 2005).

5.3. Limitations and avenues for future research

5.3.1. School subjects as an organizational unit

In the present dissertation specific school subjects constitute the organizational unit of investigated affective-motivational constructs. This is in line with the theoretically and empirically supported common notion in educational research that specific school subjects serve as an important psychological organizer of students' learning-related affect and motivation in the school context (e.g., Gottfried, 1985; Goetz et al., 2007, 2010, 2014; Green, Martin, & Marsh, 2007; Guay et al., 2010; Marsh, 1990; Marsh & Yeung, 1996; Simpson, Licht, Wagner, Stader, 1996; Shavelson et al., 1976) as curricula in schools are generally organized with regard to specific subjects. However, more specific units of the organization of

the affective-motivational constructs could also be differentiated to gain a deeper understanding of students' affect and motivation in school. In light of the specificity matching principle (e.g., Swann, Chang-Schneider, & McClarty, 2007) useful to assess affective-motivational constructs at more specific levels than school subject to get a fuller understanding of relations of student´s affect and motivation and their outcomes. For example, different topical areas within a school subject (e.g., algebra within mathematics), different activities within a subject matter (e.g., preparing an experiment in physics, as distinguished in the topological model of interest, Häußler, 1987) or specific skills within a school subject (e.g., writing, reading, speaking, and listening components of academic self-concept in verbal subjects; e.g., Arens & Jansen, 2015; Lau, Yeung, Jin, & Low, 1999; Yeung et al., 2000) could be used as a level of differentiation.

Moreover, students' affect and motivation in different academic settings that differ in their functions and social structures such as attending class, studying, and taking tests can be differentiated (Achievement Emotions Questionnaire, AEQ, Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). It would be interesting to examine whether school subjects provide the stronger organizational framework for affect and motivation in the school context or whether different settings as defined in the AEQ (Pekrun et al., 2011) are more important. A factor-analytic approach to students' answers to items assessing an affective-motivational construct in different settings in different school subjects might provide some indications in this regard. Furthermore, think-aloud protocols to generation of answers on global items such as "I am afraid of school" could be analyzed to identify which organizational framework the students tend to use.

It is important to note that the construct components that are distinguished should not be based only on psychometric arguments. As McDonald (1999) stated, it is "reasonable to suggest that any dimensional structure in cognition, personality, and so on, 'discovered' by factor analysis is there to discover because it was put there by the tests psychologists choose to invent" (p. 167). Also Hattie (2003) warned that subjecting different self-report items to a factor analytic procedure can lead to "spurious dimensions of self" (p. 7). It could be possible that

when respondents are confronted with items from different potential dimensions, they feel encouraged to respond to them in a differentiated way (a potential contrast effect that also suggests that different relations between construct components may depend on the items included in the questionnaire; see Jansen & Hecht, 2015; see Jansen & Hecht, 2015). Therefore, it is important that component differentiation is theoretically (and empirically) underpinned as to which components are meaningful and useful (Hattie, 2003; Edwards, 2001).

Furthermore, an important avenue for future research is to better understand the commonly applied organization of students' affect and motivation with respect to school subjects. So far only a few studies have been conducted in this regard. For example, teacher consistency as an element of the classroom setting has been shown to function as a moderator of the between-subject relations of academic emotions (Goetz, Frenzel, Lüdtke, & Hall, 2011). Moreover, Goetz et al. (2014) showed that the pattern of between-subjects relations of students' judgements of subjects' characteristics (e.g., difficulty and quantity of material) was similar to the pattern of between-subject relations of academic emotions, thus indicating that the subject-specific organization of students' academic emotions reflects students' judgments of subjects' similarities.

5.3.2. Affective-motivational constructs versus personality constructs

In the present dissertation different affective-motivational constructs were investigated in a specific, learning-related context. However, their link to broader personality characteristics should be clarified in future research. Personality traits are commonly defined as relatively consistent patterns of thoughts, feelings, and behaviors (Roberts, 2009). The structure of personality is commonly represented with the Five Factor Model, which consists of the traits of openness, conscientiousness, extraversion, agreeableness, and neuroticism (Costa & McCrae, 1995). Whereas these five constructs are considered to be *core* personality traits, academic self-concept as a person's self-view, as well as goals, values, and interests could be seen as *surface* characteristics of personality (Asendorpf & van Aken, 2003; McCrea & Costa,

2008; but see Kandler, Zimmerman, McAdams, 2014). Core traits are assumed to show stronger cross-situational and temporal stability, whereas surface characteristics are considered to be more context-dependent and less stable over time (Asendorpf & van Aken, 2003). Thus, core personality traits are typically operationalized at the global, context-independent level, whereas affective-motivational constructs are usually operationalized at a context-specific level (e.g., school or specific school subjects). However, it could also be argued that academic interest or academic anxiety represent different context-specific components of core personality characteristics. This perspective is in line with the idea of the situation specificity of personality traits (see Fleeson, 2001; Mischel & Shoda 1995) and the contextualized personality trait measures to particular settings (see Roberts, 2006; Wood, 2007). Specifically, anxiety has been conceptualized as a facet of neuroticism in the NEO-PI-R (Costa & McCrae; 1995) and test anxiety has been viewed as a component of trait anxiety (Spielberger, Anton, & Bedell, 1976; Zeidner, 1998). Analogously, academic anxiety could be seen as representing anxiety/neuroticism at a more specific level of abstraction. There is also a conceptual closeness between the construct of openness that inter alia reflects intellectual curiosity and the construct of academic interest.

Unfortunately, in spite of an increase in the amount of attention being paid to students' core personality traits in educational research with numerous studies investigating the role of personality traits for learning and education (Bratko, Chamorro-Premuzic, & Saks, 2006; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2006; Propat, 2009; Spengler, Lüdtke, Martin, & Brunner, 2013; Spinath, Freudenthaler, & Neubauer, 2010; Steinmyar & Spinath, 2007; Trautwein et al., 2015; Trautwein, Lüdtke, Roberts, Schnyder, & Niggeli, 2009; Trautwein, Lüdtke, Schnyder, & Niggeli, 2006), little is known about the relations between different affective-motivational constructs in the school context and the core personality traits. The results from the few studies that have simultaneously investigated core personality traits and affective-motivational constructs have shown academic self-concept/competence beliefs to be

positively associated with conscientiousness (Marsh et al., 2006; Spengler et al., 2013; Steinmayr & Spinath, 2007; Trautwein et al., 2009) and openness (Marsh et al., 2006; Spengler et al., 2013). Further, academic interest has been found to be positively related to conscientiousness (Spengler et al., 2013; Trautwein et al., 2015) and openness in verbal subjects but not in mathematics (Spengler et al., 2013). Finally, academic anxiety has been shown to be positively correlated with neuroticism and extraversion (Spengler et al., 2013). The correlations seem to be stronger for neuroticism and conscientiousness than for openness (Spengler et al., 2013). The reason why openness has shown only low correlations with academic interest could be that the personality scale (BFI-10; Rammstedt & John, 2007) applied in Spengler and colleagues' study seems to represent the *fantasy* and *aesthetics* facets of openness. The results might have been different if the *ideas* facet, which reflects intellectual curiosity, had been applied. Moreover, to better understand the relations between core and surface personality characteristics, it would be important to assess the core personality traits and the affective-motivational constructs at the same level of context-specificity.

5.3.3. Alternative modeling strategies

The nested-factor models of the affective-motivational constructs applied in the present dissertation can be seen as versions of the Correlated Trait–Correlated Method Minus One (CT–C[M−1] model (Eid, Lischetzke, Nussbeck, & Trierweiler, 2003) with one trait factor (e.g., gAINT for the nested-factor model of academic interest) and three method factors (i.e., spMINT, spFINT, and spGINT). Analogous to the CT–C(M−1) model, the subject-specific factors are defined as residual factors with respect to the general factor (i.e., residual factors from which the influence of the general factor has been partialled out). The definition of the specific factors as residual factors implies that their means are zero and, as a consequence, the trajectory of mean development cannot be analyzed. Therefore, an interesting alternative would be to specify a model in which the subject-specific factors are not defined as residuals but as difference factors relative to the general factor (see Geiser, Burns, & Servera, 2014; Geiser,

Eid, West, Lischetzke, & Nussbeck, 2012; Pohl, Steyer, & Kraus, 2008). Such difference factors would represent the subject-specific affective-motivational factors as an absolute deviation from the general factor. To be able to meaningfully interpret such subject-specific factors, the general and subject-specific factors have to be assessed on the same metric. Specifically, strong measurement invariance is needed (Geiser et al., 2014). The evaluation of measurement invariance requires parallel wording of the items measuring the general and subject-specific components of the constructs. The specification of specific factors as difference scores would, moreover, allow such subject-specific factors to be correlated with the general factor.

A similar concern applies to the autoregressive models used in Study 3. In this model, the interindividual differences in intraindividual change are not modeled directly, but are indirectly represented as a residuum (Hertzog & Nesselroade, 2003). In other words, the intraindividual change does not represent the absolute difference between the measurement points but the change between the time points in the relative standing of the individual within a reference group (Little, Bovaird, & Slegers, 2006). A compelling alternative would be to model change in the common-factor latent change score model (McArdle, 2009; McArdle & Nesselroade, 2014) where the across-time change are represented as a latent factor with the variance directly representing interindividual differences in intraindividual absolute change. The advantage of this modeling technique is that the latent change factor can be used as outcome, cause, and mediator in relation to the other variables (Hertzog & Nesselroade, 2003).

Further, the importance of studying profile patterns across different construct dimensions has been expressed for a long time in personality research (e.g., Allport, 1938; Stern, 1911; see also Asendorpf, 2015). However, in educational research on students' affect and motivation, the investigation of students' individual profiles has gained less attention (for exceptions, see Marsh, Lüdtke, Trautwein & Morin, 2009; Nagy, Trautwein, & Maaz, 2012; Pastora, Barrona, Millera, & Davis, 2007). The present dissertation by using the applied nested-

factor models of affective-motivational constructs contributes to research from the profile perspective because, for each investigated school subject, the nested-factor models quantify the interindividual differences in the intraindividual deviations from the overall level of a profile (i.e., interindividual differences in the profile shape within one school subject). However, these models do not model any interindividual differences in the overall shape of the profile across all the investigated school subjects. Even if the negative correlations between subject-specific factors across different school subjects indicate that a profile's high points in one school subject are associated with the profile's low points in other domains, these correlations reflect the population level and do not have to hold for each student. A student may deviate from this population pattern by being strong in both mathematics and German. Therefore, it would be important to investigate the heterogeneity of students with regard to the overall profile shape across different school subjects to obtain a deeper understanding of students' affective-motivational profiles and the role of such profiles in the school context. For example, a latent profile analysis that is based on the subject-specific factors in the nested-factor models would allow researchers to investigate qualitative interindividual differences in the overall profile shape. Such an analysis would allow researchers to identify groups of students that differ in the overall shapes of their profiles (as the overall level of the profile would be accounted for by the respective general factor) and examine how these overall constellations of the subject-specific strengths and weaknesses of affective-motivational profiles are related to important educational outcomes.

5.4. References

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Declaration

I hereby declare that the present dissertation is my own work and that, to the best of my knowledge and belief, it contains no materials previously published or written by another person except where due acknowledgement has been made in the text. I furthermore declare that this work has not been submitted for the award of any other degree or diploma at a university other than the University of Luxembourg and the Free University of Berlin.

Katarzyna Gogol

2nd December 2015

Curriculum Vitae

Der Lebenslauf ist aus Gründen des Datenschutzes nicht enthalten.

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