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The Relationship between Academic Self-concept and Math Achievement Among Students without and with Learning Disabilities in Early and Late Adolescence

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THE RELATIONSHIP BETWEEN ACADEMIC SELF-CONCEPT AND MATH ACHIEVEMENT AMONG STUDENTS WITHOUT AND WITH LEARNING DISABILITIES IN EARLY AND LATE ADOLESCENCE

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Academic self-concept has been extensively studied in terms of its relationship with academic achievement. The existing research has portrayed three theoretical models for this relationship: Self-Enhancement Model, Skill Development Model, and Reciprocal Model. The majority of results have provided support for a Reciprocal Model. So far, little research has been done in this area for students with learning disabilities (LD). Previous research has suggested that students without and with LD demonstrate differing developmental patterns in academic self-concept and math achievement. This study thus examined the relationship between academic self-concept and math achievement among students without and with LD. Further, the relationship between academic self-concept and math achievement may differ based on the types of math achievement measures used. Thus, this study also examined the relationship between academic self-concept and math achievement using two types of math achievement measures: high-stakes (math Florida Comprehensive Achievement Test [MFCAT]) and low-takes (Woodcock-Johnson III Broad Math Test [WBMT]) standardized tests. This study used data from an existing federally-funded seven-year longitudinal study database (2001–2008, Principal

Investigator: Marjorie Montague), which included 165 students without LD and 30 students with LD. Hierarchical regression analyses were conducted to examine the relationship between academic self-concept and two measures of math achievement from Grades 8 to 10 at different time points in early and late adolescence. The findings of this study found that WBMT scores in Grade 8 significantly predicted academic self-concept in Grade 10 in both students without and with LD. However, when using the MFCAT measure, MFCAT scores in Grade 8 predicted academic self-concept in Grade 10 only in students without LD but not students with LD. Recommendations for practice and future research are provided.

DEDICATION

To Ryan Kairalla

My best friend, my soulmate, and the love of my life.

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Studying in America is every Chinese student’s dream, and I am no exception. When I was in my sophomore year in college in my hometown, I attended the seminar of a senior student who had successfully gained admission into the graduate school of a university in the United States. In that seminar, she shared her experiences regarding how to prepare for English tests and apply to American universities. I cannot recall what she said exactly, but one thing that I can remember from that seminar was thinking to myself: “I wish I could be like her someday, to receive the best higher education in the world and see what the rest of world looks like." However, it seemed like studying in America would be a complicated process that was beyond my means. At that time, a U.S. graduate education was like a distant dream. It was far away from me and buried in my heart. I would have never thought that, just ten years later, I would be receiving a doctoral degree from a prestigious university in the United States. Life is amazing. You never know what will happen in the future.

My life has had many ups and downs, and my years in doctoral study were no exception. There were some happy moments where I had some thrilling experiences, but there were also some frustrating moments that provided plenty of challenges for me. Pursing a Ph. D. is a long and arduous process. I could not have made it through without a lot of people’s love and support. In that regard, I would like to express my sincere gratitude and thankfulness to the following individuals who have helped me, encouraged me, and accompanied me throughout this journey:

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small ones. I am grateful for all of the difficult days that I have endured and the hard choices that I have made. They helped me become a better person and meet the perfect man in my life.

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Chapter 1

Introduction

Over the past several decades, self-concept research has drawn a lot of attention in the field of education. Students' maintaining healthy and positive self-concept is thought of as an important goal for educators (Marsh & Craven, 1997). Previous research has indicated that positive self-concept can promote students' academic and social outcomes, such as academic achievement (Marsh, 1990c; Marsh & Martin, 2011; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005), post-secondary school studies (Parker, Schoon, Tsai, Nagy, Trautwein, & Eccles, 2012), and school adjustment (Chen et al., 2004; Haynes, 1990).

The understanding of self-concept has evolved over time. In early studies, self-concept was considered a unitary construct (Rosenberg, 1965). In later studies, the unidimensional view was challenged by many researchers who believed that self-concept was a multidimensional construct. One of the widely used models was proposed by Shavelson, Hubner, and Stanton (1976), in which self-concept was conceptualized as a multidimensional and hierarchically ordered structure. In this structure, global self-concept, which referred to an individual' global self-perception, was at the apex of the structure. Global self-concept was divided into two facets: academic and nonacademic self-concept. Further, academic self-concept was found to be divided into subject-specific components: English, history, math, and science self-concept. Nonacademic self-concept was divided into social, emotional, and physical self-concepts (Shavelson, Hubner, & Stanton, 1976).

Over the past several decades, academic self-concept has been extensively studied in terms of its relation with academic achievement. Numerous studies have found that academic self-concept was substantially related with academic achievement across academic domains, ages, and cultures (e.g., Marsh, 1992; Marsh et al., 2015). A number of researchers have further engaged in exploring how academic self-concept and academic achievement are correlated from a developmental perspective. The relevant research has portrayed three theoretical models to explain the relationship between academic self-concept and academic achievement: (a) Self-Enhancement Model, in which the increases in students' academic self-concept enhance academic achievement (Calsyn & Kenny,1977), (b) Skill Development Model, in which the increases in academic achievement improve students' academic self-concept (Calsyn & Kenny, 1977), and (c) Reciprocal Model, in which academic self-concept and achievement are reciprocally related and facilitate each other (Marsh,1990c). A large number of studies have been conducted to examine these three models. The majority of results have provided support for the Reciprocal Model (e.g., Guay, Marsh, & Boivin, 2003; Marsh, 1990c). For example, Marsh and O'Mara (2008) examined the relationship between academic self-concept and school grades as well as educational attainment across five time points, using a National Youth in Transition Database of all 10th grade boys in public high schools in 1966. The results showed that academic self-concept had a strong reciprocal relationship with both school grades and educational attainment.

Compared to the large number of studies regarding the relationship between academic self-concept and academic achievement for students without disabilities, little research has been done in this area involving students with LD. Therefore, it is still unclear whether or not these findings found in the sample of students without disabilities can be applied to students with LD. Existing relevant research for students with LD has produced mixed findings in terms of whether academic self-concept and academic achievement are correlated, as well as the correlated direction and strength. Some studies found that academic self-concept and academic achievement are significantly correlated, with a wide range of correlation coefficients from -0.57 to +0.51 (e.g., Möller, Streblow, & Pohlmann, 2009; Strein, 2006). However, the majority of studies did not find a significant correlation (e.g., Feiwell, 1997; Tabone, 2011). The inconsistent findings may stem from the fact that very few longitudinal studies have been done to examine this relationship among students with LD. The lack of this research for students with LD is problematic, as previous research has suggested that students without and with LD demonstrate differential developmental patterns over time in terms of academic self-concept as well as academic achievement, respectively. On the one hand, for students without disabilities, previous research found that academic self-concept decreased from early preadolescence to middle adolescence, and then increased through early adulthood (Liu, Wang, & Parkins, 2005; Marsh, 1989). By contrast, Chapman (1988a) found that academic self-concept of students with LD decreased by Grade 3 and stayed constant through high school.

Further, there has been a persistent math achievement gap between students without and with LD, and this achievement gap has been widening over time (National Assessment of Educational Progress, NAEP, 2013). On the basis of NAEP 2013, 55% of Grade 4 students with disabilities compared to 86% of Grade 4 students without disabilities scored above the basic level. At the Grade 8 level, the percentages were 35%

and 79%, respectively. By Grade 12, the percentages were 25% and 69%, respectively. The above data indicates that the math achievement gap between students without and with LD widened from Grade 4 (31%) to Grade 8 (44%) and 12 (44%). In addition, in their meta-analysis study, reviewing 14 relevant studies published from 1974 to 2013 that focused on students with disabilities, Zhang and Cavendish (2015) found that although there was no significant correlation between academic self-concept and math achievement for students with disabilities, grade level moderated the relationship between self-concept and math achievement. The correlation increased from elementary school to middle school but decreased at high school, with the strongest magnitude at middle school. Therefore, in order to understand the nature of the relationship between academic self-concept and academic achievement for students with LD, it is crucial to examine this relationship at different time points in the future research.

While closely examining the relationship between academic self-concept and academic achievement, researchers have reported that achievement in math has a stronger relationship to academic self-concept than other subjects (Jansen, Schroeders, Lüdtke, & Marsh, 2015; Marsh & Yeung, 1997a; Möller, Streblow, & Pohlmann, 2009). For example, Marsh and Yeung (1997a) found that the magnitude of relationship between academic self-concept and academic achievement tended to be larger and more systematic for math than for science and English (Marsh & Yeung, 1997a). Moreover, since 1989, the National Council of Teachers of Mathematics (NCTM) has published a series of math standards to help improve math achievement of all students in America, including students with disabilities. However, while these standards provide useful guidance to students for teachers and schools for teaching mathematics, equity in mathematics education is still a concern with regard to students with diverse backgrounds, especially for students with LD. As mentioned above, there has still been a persistent math achievement gap between students with and without LD, which keeps widening from Grade 4 to Grade 12 (NAEP, 2013). Therefore, additional attention should be paid to math achievement for students with LD.

Adolescence is an important period for personal development. During adolescence, children experience a series of affective, cognitive, and behavioral changes (Steinberg, 2005). Academic self-concept and math achievement may change greatly through adolescence among both students without and with LD. With regard to academic self-concept, previous studies showed inconclusive findings with regard to the developmental patterns of academic self-concept from early to late adolescence. Some scholars have demonstrated a general declining trend of academic self-concept across adolescence. For example, Jacobs, Lanza, Osgood, Eccles, and Wigfield (2002) examined gender differences in the growth of self-competence beliefs (i.e., math, language arts, and sports) and task values among 761 students across Grades 1 and 12, using a cross-sequential design. The results showed that self-competence beliefs in all three domains declined from Grades 1 to 12, which was statistically significant. By contrast, other scholars did not find a consistent decreased pattern of academic self-concept from early to late adolescence. For example, Marsh (1989) examined self-concept development in various domains of 12,266 students from preadolescence to early adulthood. Marsh (1989) found a “U-shaped quadratic effect” of academic self-concept from early to late adolescence, in which academic self-concept stayed high in Grade7, and later went down during Grades 8 and 9, and then increased in Grades 10 and 11. With regard to students with LD, in a review, synthesizing 20 studies examining academic self-concept of students with LD, Chapman (1988a) found that academic self-concept of students with LD decreased by Grade 3 and stayed constant through high school.

Furthermore, researchers have examined the relationship between academic achievement and math achievement. Findings showed that there was a general declining trend in the relationship between academic achievement and math achievement from early to late adolescence. For example, Byrne and Gavin (1996) investigated the relationship between global and academic self-concept and academic achievement (i.e., English, math) among 3rd, 7th, and 11th graders. The results indicated that the average correlations between academic self-concept and achievement in English and math declined from Grade 7 (Mean $r = .78$) to Grade 11 (Mean $r = .50$).

Since there has been little research that investigated the relationship between academic self-concept and math achievement for students with LD at different time points, it is still unknown whether this declining trend from early to late adolescence found in the general population can be generalized for students with LD, considering their differences in academic self-concept as well as math achievement mentioned above. Therefore, the first purpose of this study was to examine the relationship between academic self-concept and math achievement among students with and without LD at different time points in early and late adolescence.

The second purpose of this study was to examine the relationship between academic self-concept and math achievement among students with and without LD, based on different measures of math achievement. There are two types of standardized tests that have mainly been used in the research literature to assess students' math achievement:

high-stakes state-mandated achievement tests and low-stakes standardized achievement tests. The existing studies have indicated that the relationship between academic self-concept and math achievement may differ based on the type of standardized math test used. Some researchers found academic self-concept has a stronger relationship with high-stakes math achievement tests than with low-stakes math achievement tests (e.g., Marsh, Hau, & Kong, 2002). This is probably the case because high-stakes tests have significant consequences to students, which may facilitate their motivation to do well in the tests (Firestone & Mayrowetz, 2000; Jones, Jones, Hardin, Chapman, Yarbrough, & Davis, 1999). However, since students with LD have generally demonstrated lower academic self-concept and math achievement than students without LD, no study has tested how academic self-concept and math achievement are related for students with LD when using high-stakes and low-stakes math tests. Thus, the second purpose of this study was to explore the relationship between academic self-concept and math achievement among students with and without LD, using two different measures of math achievement.

To summarize, there have been two main limitations in previous relevant research in the relationship between academic self-concept and math achievement. First, there is little research that examines the relationship between academic self-concept and math achievement for students with LD at different time points. Second, no study has examined this relationship with high-stakes and low-stakes standardized achievement tests for students with LD. To address these two limitations, this study explored the relationship between academic self-concept and math achievement among students without and with LD at different time points in early and late adolescence, using two math achievement measures: a high-stakes state-mandated achievement test (math

Florida Comprehensive Assessment Test [FCAT]) and a low-stakes standardized achievement test (Woodcock-Johnson III Broad Math Test).

Chapter 2

Literature Review

The Definition and Measures of Global Self-concept

The understanding of self-concept has evolved over time. From a broad perspective, self-concept can be understood as an individual's perception of himself or herself (Shavelson, Hubner, & Stanton, 1976). In early studies, self-concept was considered a unitary construct (Coopersmith, 1967; Rosenberg, 1965). The earliest account of self-concept can be traced to the work of William James (1890/1983). James (1890/1983) noted that self-esteem was a global construct affected by individuals' presumed abilities and actual accomplishments. Driven by this unidimensional idea of self-concept, other scholars developed a series of self-esteem scales to measure individuals' global self-esteem/self-concept. For example, the *Rosenberg Self-Esteem Scale* (RSES, Rosenberg, 1965) was developed to measure an individual's global self-worth in terms of both positive and negative feelings about himself or herself. Another scale that emerged during this period was the *Coopersmith Self-Esteem Inventory* (CSEI, Coopersmith, 1967). The CSEI consisted of items using forced-choice (like me or unlike me) format, and was used to measure an individual's general attitudes toward himself or herself. The unitary nature of the RSES and the CSEI limited its value in research and practice. As is common in such scales, items can be "unevenly" weighted in one self-concept domain compared to other domains, leading to "equivocal and nonreproducible" global self-concept scores across different studies (Bracken, 1992).

In later studies, the unidimensional view of self-concept was challenged by many researchers who believed that self-concept was a multidimensional construct. One of the widely used models was proposed by Shavelson, Hubner, and Stanton (1976), in which self-concept was conceptualized as a multidimensional and hierarchically ordered structure. In this structure, global self-concept, which referred to individuals' global self-perceptions, was at the apex of the structure. As the structure became differentiated from the top to the bottom, global self-concept was divided into two facets: academic and nonacademic self-concept. Academic and nonacademic self-concept contained more specific components in the bottom order of the structure, respectively. Academic self-concept was divided into subject-specific components: English, history, math, and science self-concept. Nonacademic self-concept was divided into social, emotional, and physical self-concepts, each of which was further divided into more specific components (e.g., physical self-concept was divided into physical ability and physical appearance) (Shavelson, Hubner, & Stanton, 1976).

In addition, Shavelson at al. (1976) identified seven characteristics in the definition of self-concept: (1) Self-concept is an organized or structured construct, in which individuals categorize the great amount of information that they perceive about themselves into simpler categories or forms. (2) It is a multifaceted structure, in which individuals' perceptions about themselves includes different subdomains, such as academics, sports, and social acceptance. (3) It is a hierarchical structure, in which global self-concept is at the apex of the structure. Global self-concept is divided into two facets: academic and nonacademic self-concept. (4) Global self-concept is stable, implying that global self-concept is relatively stable at the apex of the structure. As the contexts become more specific from top to the bottom of the structure, self-concept becomes less stable. (5) It has a developmental nature, meaning that the structure of self-concept becomes more differential as one individual grows. (6) It has a self-evaluative function, which means that in addition to a description of oneself, such as “who I am”, self-concept also allows one to evaluate oneself, such as “I am good at reading”. (7) It can be differentiated from other constructs. For example, academic self-concept is a different construct from physical appearance self-concept.

Subsequent studies provided evidence supporting this multidimensional and hierarchical model of self-concept (e.g., Byrne & Shavelson, 1986; Marsh & Shavelson, 1985). For example, Byrne and Shavelson (1986) measured the self-concept of 991 students in Grades 11 and 12, using different self-concept measures. The results of an exploratory factor analysis indicated four clear constructs: global, academic, math, and English self-concept, supporting the multidimensional structure of self-concept. The results of correlational analyses of self-concept measures supported a hierarchical structure of self-concept. Marsh (1990b) therefore believed that “self-concept cannot be adequately understood if this multidimensionality is ignored” (p. 77).

Building off Shavelson at al.’s (1976) multifaceted and hierarchical structure of self-concept, Marsh and colleagues developed the *Self-Description Questionnaires (*SDQ), which had three versions (preadolescents, adolescents, late adolescents), based on different ages (e.g., Marsh & O'Neill, 1984). Each of these three scales contained three domains: academic, nonacademic, and global self-concept, while the numbers of items and subscales under each domain varied in each scale. Expanding Shavelson at al.’s (1976) multidimensional model of self-concept, Bracken (1992) further defined self-concept as “a multidimensional and context-dependent learned behavioral pattern that reflects an individual’s evaluation of past behaviors and experiences, influences an individual’s current behaviors, and predicts an individual’s future behaviors” (Bracken,1992, p.10). Bracken (1992) also developed a *Multidimensional Self-Concept Scale* (MSCS, Bracken, 1992) to assess an individual’s self-concept. The MSCS comprises 150 items rated on a 4-point Likert scale. There are six subdomains in the MSCS: social, competence, affect, family, physical, and academic self-concept.

Empirical Research on Global Self-concept

Students’ maintaining healthy and positive self-concept is considered an important goal for educators (Marsh & Craven, 1997). Previous research has indicated that self-concept is positively related to a battery of students’ academic and social outcomes, such as academic achievement (Marsh, 1990c; Marsh & Martin, 2011; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005), post-secondary school studies (Parker, Schoon, Tsai, Nagy, Trautwein, & Eccles, 2012), and school adjustment (Chen et al., 2004; Haynes, 1990).

The existing research on global self-concept for students with learning disabilities (LD) has produced mixed results. A number of researchers demonstrated that students with LD had similar global self-concept as students without disabilities (e.g., Bear, Minke, & Manning, 2002; Gans, Kenny, & Ghany, 2003; Vaughn, Elbaum, & Schumm, 1996). For example, in a meta-analysis, Bear and colleagues (2002) reviewed 61 studies on the global self-concept of students with LD. The results indicated that there was no significant difference in global self-concept between students without and with LD. Gans, Kenny, and Ghany (2003) compared the self-concept of 50 students without disabilities and 70 students with LD at the middle school level. They found no difference in global self-concept between students without and with LD. Similarly, Vaughn and colleagues (1996) investigated and compared the self-concept of three achievement groups in Grades 2-4 in inclusive settings: students with LD, low-achieving students, and average/high-achieving students. The results suggested that there was no significant difference in global self-concept among the three achievement groups.

In contrast, some other scholars found that students with LD had a lower global self-concept than students without disabilities (e.g., Chapman, 1988a; Zeleke, 2007). In a meta-analysis of 21 studies of the global self-concept of students with LD, Chapman (1988a) found that students with LD had lower global self-concept than students without disabilities. Zeleke (2007) compared the self-concept of three groups of Grade 4-6 students: students with math LD, average-achieving students, and high-achieving students. The findings suggested that students with LD showed a significantly lower global self-concept than high-achieving students, but there was no significant difference in global self-concept between students with LD and average-achieving students.

The Definition of Academic Self-concept

Academic self-concept is one of the core components of self-concept (Shavelson at al., 1976). Academic self-concept refers to an individual's knowledge and perceptions about his or her academic ability (Marsh & Seaton, 2013). Since the proposal of Shavelson et al.'s (1976) multidimensional model of self-concept, academic self-concept has been extensively studied in the subsequent research wherein the structure of academic self-concept was tested and further revised.

The Marsh/Shavelson Model of Academic Self-concept. One classic perspective of conceptualizing academic self-concept is the Marsh/Shavelson model of academic self-concept, which was originally proposed by Shavelson, Hubner, and Stanton (1976), and later revised by Marsh and Shavelson (1985). In the original Shavelson Model of self-concept, academic self-concept and nonacademic self-concept were in the second order of self-concept underneath global self-concept in the model. Academic self-concept was further divided into more subject-specific components: English, history, math, and science self-concept. Based on the Shavelson Model, Byrne and Gavin (1996) collected data of global, academic, math, and English self-concept from 252 Grade 3 students, 290 Grade 7 students, and 335 Grade 11 students. Consistent with the Shavelson Model, the findings supported a hierarchical and multidimensional structure of academic self-concept through adolescence. In addition, Byrne and Gavin (1996) found that the magnitudes of correlation coefficients between the four self-concept components increased from preadolescence to early adolescence, and decreased to late adolescence, which did not provide evidence supporting the hypothesis of an increasing differential structure of academic self-concept with age.

In the later research, Marsh and Shavelson (1985) tested the Shavelson Model of self-concept among students in Grades 2-5. Marsh and Shavelson (1985) found that global self-concept in the first order of structure was well supported. However, verbal and math self-concept were found to be nearly unrelated to each other, and thus could not be merged into a common academic self-concept. Based on this finding, Marsh and Shavelson (1985) further revised the original Shavelson Model, a revision characterized as the Marsh/Shavelson Model of academic self-concept. In the Marsh/Shavelson Model, academic self-concept in the original Shavelson Model was broken down into Reading/Academic and Math/Academic self-concept. Therefore, two models of academic self-concept --- Reading/Academic and Math/Academic self-concepts constructs --- and one nonacademic self-concept were in the second order of the new model of self-concept. The subsequent research provided support for Marsh/Shavelson Model of academic self-concept (Marsh, 1990a; Marsh, Byrne, & Shavelson, 1988). For example, Marsh, Byrne, and Shavelson (1988) tested the Marsh/Shavelson Model among 991 Canadian high student students by measuring their verbal, math, and global self-concept, using different self-concept scales. The results showed that there was no significant correlation between verbal and math self-concept, providing evidence for the Marsh/Shavelson Model.

Empirical Research on Academic Self-concept

Previous research has found that academic self-concept is related to desirable educational actions, such as course selection (Marsh & Yeung, 1997b), interest (Trautwein, Lüdtke, Marsh, Köller, & Baumert, 2006), homework effort (Trautwein, Lüdtke, Schnyder, & Niggli, 2006), and educational aspirations (Marsh, 1991). However, such relationships have not been reported with nonacademic (e.g., social, emotional, and physical) self-concept (Marsh & Hau, 2003).

Students' academic self-concept has also been found to be affected by the school and class achievement level. One theory regarding academic self-concept is the big-fish-little pond effect (BFLPE), proposed by Marsh and colleagues, which has been supported by numerous studies (e.g., Marsh, 1984a, 1984b, 2005). The BFLPE effect posits that students have lower academic self-concept in high-achieving classes or schools, in which they compare themselves to other more able students. By contrast, students have higher academic self-concept in low-achieving classes or schools, in which they compare themselves to other less able students.

While there have been discrepant findings with regard to global self-concept between students without and with LD, the results of research have consistently found that students with LD showed lower academic self-concept than students without LD (e.g., Bear, Minke, & Manning, 2002; Chapman, 1988b; Stone & May, 2002). For example, Chapman (1988b) compared the academic self-concept, academic locus of control, and achievement expectations between 78 students with LD and 71 students without disabilities at the middle school level over two years. The results showed that students with LD had lower academic self-concept, higher learned helplessness, and lower achievement expectations than students without LD throughout two years. Stone and May (2002) investigated academic self-concept and the accuracy of estimation of academic skills between 52 students with LD and 49 students without disabilities at the high school level. The findings suggested that, in comparison with students without disabilities, students with LD had significant lower academic self-concept.

The Relationship between Academic Self-concept and Academic Achievement

Over the past several decades, academic self-concept has been extensively studied in terms of its relationship with academic achievement. Numerous studies have found that academic self-concept was substantially related with academic achievement across academic domains, ages, and cultures (e.g., Marsh, 1992; Marsh et al., 2015). In an early meta-analysis reviewing 128 studies that examined the relationship between self-related measures (i.e., self-concept/self-esteem) and academic achievement, Hansford and Hattie (1982) found that the overall correlation between global self-concept/self-esteem and academic achievement was relatively low but positive (.21). However, when examining academic self-concept measures, Hansford and Hattie (1982) found the overall correlation coefficient with academic achievement increased to .42.

In a later meta-analysis, reviewing 56 longitudinal studies that examined the relationship between self-related beliefs (i.e., self-concept, self-esteem, self-efficacy, and self-description) and academic achievement, Valentine, DuBois and Cooper (2004) found that after controlling for initial achievement, self-concept had a small and positive effect on the subsequent achievement (.07). However, Valentine, DuBois and Cooper (2004) found a stronger relationship between self-related beliefs of academic achievement when measures of self-beliefs and achievement were matched by domains (.12). Therefore, academic self-concept and academic achievement had a stronger relationship when there was a match in a specific subject between academic self-concept (e.g., math self-concept) and academic achievement (e.g., math achievement).

A number of researchers have further engaged in exploring how academic self-concept and academic achievement are related from a longitudinal perspective. The research has examined three theoretical models to explain the relationship between academic self-concept and academic achievement.

Self-Enhancement Model. The Self-Enhancement Model holds that increases in students' self-concept enhance subsequent academic achievement (Calsyn & Kenny, 1977). The assumption underlying the Self-Enhancement Model indicates that academic self-concept has motivational properties that can affect subsequent academic achievement (Byrne, 1996). Only a very small number of early studies provided support for this model. Marsh (1990a) examined the relationship between academic self-concept and academic achievement using the data collected from a national Youth in Transition study of all 10th grade high school boys in 1966. Academic self-concept and school grades of 1,456 male students in Grade 10 were collected over four time points during two year periods (Time 1: early Grade 10 Time 2: late Grade 11; Time 3: late Grade 12; Time 4: one year after high school). The results showed that academic self-concept in previous years can significantly predict students' school grades in Grades 11 and 12. However, students' school grades in previous years did not have a significant predictive effect on subsequent academic self-concept.

Shavelson and Bolus (1982) examined the relationship between academic self-concept and academic achievement in a sample of 130 students in Grades 7 and 8. Participants' global, academic and domain-specific (i.e., English, math, and science) self-concept was measured along with their school grades in English, math, and science over two time points. The results suggested that academic self-concept can significantly predict school grades in the subjects of English, math, and science, whereas school grades in these three subjects could not predict academic self-concept one year later.

Skill Development Model. The Skill Development Model posits that increases in academic achievement improve students' academic self-concept (Calsyn & Kenny, 1977). A few studies have provided support for the Skill Development Model. In an early study, Calsyn and Kenny (1977) compared self-enhancement and skill development models among 556 students. Participants' academic self-concept and grade point average (GPA) were collected over five years from Grades 8-12. The results showed that GPA significantly predicted academic self-concept, but not the converse. This predictive effect was much stronger for female students than for male students. The results therefore supported the Skill Development Model instead of the Self-Enhancement Model.

Skaalvik and Valas (1999) examined the relationships between achievement, self-concept, and motivation in the subjects of math and language arts. The participants, 1,005 elementary and middle school students, completed measures of achievement, self-concept, and motivation in math and language arts over two time points. The results demonstrated that, in both subjects, academic achievement significantly predicted subsequent academic self-concept for their respective subject. However, no evidence was found that academic self-concept predicted later academic achievement. Skaalvik and Valas'(1999) study thus supported the Skill Development Model rather than the Self-Enhancement model. Skaalvik and Hagtvet (1990) examined the relationships among academic self-concept, achievement, and global self-esteem among two groups of students (Grades 3 and 6). Participants completed the measures of academic self-concept and global self-esteem and teacher ratings of student academic achievement over two time points. The results supported the Skill Development Model of academic self-concept in Grade 3 students. That is, academic achievement in Grade 3 predicted academic self-concept in Grade 4. The strength of this prediction on academic self-concept was stronger than on global self-esteem.

Reciprocal Model. The Reciprocal Model posits that academic self-concept and achievement are reciprocally related and facilitate each other (Marsh, 1990c). A large number of studies have provided support for the Reciprocal Model (e.g., Guay, Marsh, & Boivin, 2003; Marsh, 1990c; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). For example, Kurtz-Costes and Schneider (1994) conducted a two-year longitudinal study of 46 second and fourth grade students to examine the relationships between academic self-concept, attributional beliefs, and school grades in math and German. The results of structural equational modeling (SEM) analyses showed that the path coefficient from academic self-concept in Grade 2 to grades in Grade 4 was .28, and that the path coefficient from grades in Grade 2 to academic self-concept in Grade 4 was .16, both of which were statistically significant. Therefore, Kurtz-Costes and Schneider’s (1994) study supported the Reciprocal Model.

Marsh and Yeung (1997a) examined the relationship between academic self-concept and academic achievement using SEM analyses in a sample of 603 male students in Grades 7-10. School grades (in English, math, and science), teacher ratings of student achievement, teacher ratings of homework quality, and academic self-concept were collected over three time points across three years. The results showed that in all three subjects, most path coefficients from prior self-concept to subsequent achievement and from prior academic achievement to subsequent academic self-concept were statistically significant. The findings suggested a reciprocal relationship between academic self-concept and academic achievement. In addition, the magnitudes of path coefficients from academic achievement to subsequent academic self-concept were similar for three school subjects (i.e., math, science, and English), whereas the magnitudes of path coefficients from academic self-concept to subsequent achievement were stronger for math than for science and English.

By using a longitudinal design over one year, Guay, Marsh and Boivin (2003) examined the relationship between academic self-concept and academic achievement among three age cohorts of 385 French students in Grades 2, 3, and 4. The results indicated that the Reciprocal Model was supported both in the whole sample and three age cohorts. This study extended the evidence of the Reciprocal Model from older middle and high school students into younger elementary school children.

Marsh, Hau, and Kong (2002) examined the relationship between academic self-concept, academic achievement, and language of instruction (Chinese vs. English) in a sample of 7,802 Hong Kong students in Grade 6. Data were collected over six time points: standardized tests were conducted in at Time 0 –Time 3 (Grades 6-9) and Time 4 (Grade 11), and academic self-concept was collected at Time 2 -Time 5 (Grades 8-11). The results of the SEM analyses revealed that most path coefficients from prior academic self-concept to subsequent achievement and from prior academic achievement to subsequent academic self-concept were statistically significant. That is, there was support for the Reciprocal Model. In addition, the magnitude of this reciprocal relationship did not differ on the basis of language of instruction (Chinese vs. English). In a further study, Marsh and O'Mara (2008) examined the relationship between academic self-concept and school grades as well as educational attainment across five time points (Time 1: Grade 10, Time 2: Grade 11, Time 3: Grade 12, Time 4: 1 year after graduation, and Time 5: 5 years after graduation), using a Youth in Transition database of all 10th grade boys in public high schools in 1966. The results showed that academic self-concept had a strong reciprocal relationship with both school grades and educational attainment.

Thus, the majority of relevant studies have provided support for the Reciprocal Model (e.g., Guay, Marsh, & Boivin, 2003; Marsh, 1990c; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). Understanding the relationship between academic self-concept and academic achievement has significance for the development of educational interventions and teaching practices. If the Self-Enhancement Model is valid, which means that academic self-concept can significantly associate with subsequent academic achievement, the interventions based on enhancing academic self-concept will lead to better academic achievement. If the Skill Development Model is valid, which means that increases in academic achievement can improve students' academic self-concept, educators should make efforts to improve student achievement, thus enhancing academic self-concept. If the Reciprocal Model is valid, which means that academic self-concept and achievement are reciprocally related and facilitate each other, interventions and instructions should be designed based on both academic self-concept and academic achievement at the same time (Marsh & Seaton, 2013). Understanding the relationship between academic self-concept and academic achievement is particularly essential for students with LD. As academic self-concept has been found to be related to school persistence and work effort (Trautwein, Lüdtke, Schnyder, & Niggli, 2006). Students with LD have reported a relatively high school dropout rate compared to students without LD; thus, the increase in academic self-concept may help reduce the school dropout rate and increase the chance for advancing into next school level or admission into college for students with LD, which may further benefit their future career and subjective well-being in a long term.

The Relationship between Academic Self-concept and Academic Achievement for Students with LD

Compared to the large number of studies regarding the relationship between academic self-concept and academic achievement for students without disabilities, little research has been done in this area involving students with LD. Therefore, it is still unclear whether or not these findings can be applied to students with LD. Existing relevant research for students with LD has produced mixed findings in terms of whether academic self-concept and academic achievement are correlated, as well as the correlated direction and strength. Some studies found a significant correlation between academic self-concept and academic achievement, with a wide range of correlation coefficients from -0.57 to +0.51 (e.g., Möller, Streblow, & Pohlmann, 2009; Strein, 2006). However, the majority of studies did not find a significant correlation (e.g., Feiwell, 1997; Tabone, 2011). For example, Möller, Streblow, and Pohlmann (2009) investigated the correlation between math and verbal self-concept and achievement in math and German among 270 students with LD in Grades 5-9. The results showed that, when the subjects were matched, correlation coefficients between academic self-concept and achievement were .51 (math) and .34 (German), which were statistically significant, whereas when the subjects of self-concept and achievement were not matched, the correlation coefficients were, respectively, -.12 and .06, which were not statistically significant.

Using the Early Childhood Longitudinal Study--- Kindergarten Cohort (ECLS-K) database, Strein (2006) compared academic, math, and reading self-concept as well as achievement in math and reading between 7,448 students without LD and 412 students with LD in Grade 3. The results showed that, for students with LD, the correlation between reading self-concept and reading achievement was only .05, which was not statistically significant. The correlation coefficients between general academic self-concept and reading and math achievement were -.19 and -.19, respectively, and the correlation coefficient between math self-concept and math achievement was .12. However, Strein (2006) noted that as the magnitudes of correlation coefficients between general academic self-concept and reading and math achievement were very small, this result should not be "over-interpreted" (p.5). While all of three correlation coefficients were statistically significant, given a large sample size and no effect size being reported, as well as negative correlations found in this study, the results still need further examination.

These inconclusive findings may stem from the fact that very few longitudinal studies have been done to examine academic self-concept and academic achievement among students with LD. The lack of this research for students with LD is problematic, as previous research has suggested that students without and with LD demonstrate differing developmental patterns over time in terms of academic self-concept and academic achievement. For students without disabilities, previous research found that academic self-concept decreased from early preadolescence to middle adolescence, and then increased through early adulthood (Liu, Wang, & Parkins, 2005; Marsh, 1989). In contrast, Chapman (1988a) found that academic self-concept of students with LD decreased by Grade 3 and stayed constant through high school.

Further, there has been a persistent math achievement gap between students with and without LD, and this achievement gap has been widening over time (National Assessment of Educational Progress, NAEP, 2013). On the basis of NAEP 2013, 55% of Grade 4 students with disabilities compared to 86% of Grade 4 students without disabilities scored above the basic level. At the Grade 8 level, the percentages were 35% and 79%, respectively. By Grade 12, the percentages were 25% and 69%, respectively. The above data indicates that the math achievement gap between students without and with LD widened from Grade 4 (31%) to Grade 8 (44%) and 12 (44%). In addition, in their meta-analysis study, by reviewing 14 studies published from 1974 to 2013 that focused on students with disabilities, Zhang and Cavendish (2015) found that although there was no significant correlation between academic self-concept and math achievement for students with disabilities, grade level moderated the relationship between self-concept and math achievement. The correlation increased from elementary school to middle school but decreased at the high school level, with the strongest magnitude at middle school. Therefore, in order to understand the nature of the relationship between academic self-concept and academic achievement for students with LD, it is crucial to provide this relationship at different time points in the future research.

While taking a closer look at the relationship between academic self-concept and academic achievement, researchers have reported that achievement in math has a stronger relationship to academic self-concept than in other subjects (Jansen, Schroeders, Lüdtke, & Marsh, 2015; Marsh & Yeung, 1997a; Möller, Streblow, & Pohlmann, 2009). For example, Marsh and Yeung (1997a) found that the magnitude of relationship between academic self-concept and academic achievement was found to be larger and more systematic for math than for science and English (Marsh & Yeung, 1997a). In a meta-analysis, reviewing 37 studies regarding the relationship between academic self-concept (i.e., math, verbal) and achievement (i.e., math, verbal), Möller, Streblow, and Pohlmann (2009) found that the mean correlation coefficient between math self-concept and math achievement (Mean $r = .61$) is higher than is it between verbal self-concept and verbal achievement (Mean $r = .49$).

Moreover, since 1989, the National Council of Teachers of Mathematics (NCTM) has published a series of math standards to help improve math achievement of all students in America, including students with disabilities. However, while these standards provide useful guidance of teaching mathematics to students for teachers and schools, equity in mathematics education is still a concern among students with diverse backgrounds, especially for students with LD. As mentioned above, there has still been a persistent math achievement gap between students with and without LD, which keeps widening from Grade 4 to Grade 12 (NAEP, 2013). Therefore, additional attention should be paid to math achievement for students with LD.

Academic Self-concept and Math Achievement from Early to Late Adolescence

Adolescence is an important period for personal development. During adolescence, children experience a series of affective, cognitive, and behavioral changes (Steinberg, 2005). Academic self-concept and math achievement also change greatly through adolescence among both students without and with LD. However, little research has examined the relationship between academic self-concept and math achievement for students with LD at different time points.

Previous studies have showed inconclusive findings with regard to the developmental patterns of academic self-concept from early to late adolescence. Some scholars demonstrated a general declining trend of academic self-concept across adolescence. For example, Jacobs, Lanza, Osgood, Eccles, and Wigfield (2002) examined gender differences in the growth of self-competence beliefs (math, language arts, and sports) and task values among 761 students across Grade 1 and Grade 12, using a cross-sequential design. The results showed that self-competence beliefs in all three domains declined from Grade 1 to 12, which was statistically significant. Similarly, using a cross-sequential design, Watt (2004) examined the growth of self-perceptions (math and English), values, and task perceptions among 1,323 Australian students from Grade 7 to

11. The findings suggested that self-perceptions in math, as well as English, and values decreased across adolescence, whereas task perceptions increased in terms of task difficulty and effort required. Musu-Gillette, Wigfield, Harring, and Eccles (2015) followed the developmental patterns of self-concept of ability in math, interest in math, and perceptions of the importance of math among 421 students from Grade 4 to college, and examined their effects on students' collage major choices. They found that students' self-concept of ability declined over time from Grade 4 to college.

By contrast, some other scholars did not find a consistent decreased pattern of academic self-concept from early to late adolescence. For example, Marsh (1989) examined self-concept development in various domains of 12,266 students from preadolescence to early adulthood. Marsh (1989) found a "U-shaped quadratic effect" of academic self-concept from early to late adolescence, in which academic self-concept stayed high in Grade7, and later went down during Grades 8 and 9, and then increased in Grades 10 and 11. Cole et al. (2001) used a longitudinal cross-sequential design to examine self-concept development in five domains (academic competence, physical appearance, behavioral conduct, social conduct, and sports competence) for two cohorts of students: 936 students in Grades 3-5 and 984 students in Grades 6-8. Self-concept in five domains was measured over six years across Grades 3 to 11. The results indicated that academic self-concept increased during elementary school, significantly went down during the transition to middle school, increased through middle school, and stayed high during high school. With regard to students with LD, in a review synthesizing 20 studies examining academic self-concept of students with LD, Chapman (1988a) found that academic self-concept of students with LD decreased by Grade 3 and stayed constant through high school.

With respect to the relationship between academic self-concept and math achievement, researchers found a general decline trend from early to late adolescence. For example, Byrne and Gavin (1996) used SEM analyses to examine the relationship between global and academic self-concept and academic achievement (i.e., English, math) among 252 students in Grade 3, 290 students in Grade 7, and 335 students in Grade 11. The results indicated that the average correlations between academic self-concept and achievement in English and math declined from Grade 7 ($\bar{r}$= .78) to Grade 11 ($\bar{r}$=.50).

Using a longitudinal design, Silverthorn, DuBois, and Crombie (2005) examined the relationship between self-perceptions of ability and academic achievement (math, science, and English) from Grade 8 to 11 among 616 students. The results of their SEM analyses suggested that, while most path coefficients of academic self-concept on academic achievement were significant and positive from Grade 8 to 11, the magnitudes of the path coefficients decreased over time.

In their meta-analysis, Valentine and colleagues (2004) reviewed 56 longitudinal studies that examined the relationship between self-related beliefs (i.e., self-concept, self-esteem, self-efficacy, and self-description) and academic achievement (i.e., math, reading). The results showed that school transition had a significant moderating effect on self-concept and academic achievement (i.e., math, reading), with a smaller effect size during school transition time. However, Valentine and colleagues (2004) did not differentiate between academic and global self-concept.

Many studies have demonstrated that students experience a math achievement loss during the transition from middle to high school. Using Missouri Mastery and Achievement Test (MMAT) scores, Alspaugh (1998) compared academic achievement (in reading, math, science, and social studies) of three groups of students from 16 rural school districts during the transition from elementary to middle school (Grades 5-6) and the transition from middle school to high school (Grades 8-9). The results showed achievement losses both in the transition from elementary to middle school and the transition from middle to high school. The average achievement loss was higher in the transition to high school than was it in the transition to middle school. Gutman (2006) examined the impact of student and parent goal orientations and classroom goal structures on math GPA and math self-efficacy in 50 African American adolescents in the transition to high school from Grade 8 to 9. The results showed a significant declining trend in math GPA from Grades 8 to 9.

The Relationship between Academic Self-concept and Math Achievement: Differences in the Types of Achievement Measures

There are two types of tests that have mainly been used to assess students' math achievement: high-stakes state-mandated achievement tests and low-stakes achievement tests. The existing studies have found that the relationship between academic self-concept and math achievement with high-stakes test is stronger than with low-stakes test (e.g., Marsh, Hau, & Kong, 2002), as high-stakes test have significant consequences to students, promoting their motivation to do well in the tests (Firestone & Mayrowetz, 2000; Jones, Jones, Hardin, Chapman, Yarbrough, & Davis, 1999). However, since students with LD have lower academic self-concept and math achievement than do students without LD, it is still unknown how academic self-concept is related to math achievement for students with LD when using different types of math achievement tests.

Math Achievement Measures: High-Stakes State-mandated Achievement Tests

Being accountable for improving students' academic performance, many states have designed their own curriculum standards and developed standardized tests to assess students' achievement. These standardized tests are considered "high-stakes" tests, in that they have significant consequences to students, such as determining whether students can be promoted to the next grade level or graduate from their current school (DeVillier, 2003). For example, the state of Florida implemented the Florida Comprehensive Assessment Test (FCAT) to measure student achievement based on the Sunshine State Standards. The FCAT was used to assess academic progress and performance of students in Grades 3-10 in various subjects, including mathematics, reading, and writing. Students were required to pass the 10^{th} grade FCAT in order to receive a standard high school diploma.

State-mandated high-stakes tests have several characteristics. First, they promote students' extrinsic motivation by associating test results with rewards (Jones, 2007). The extrinsic rewards include being promoted to next grade and graduation, as well as giving students specific rewards, thereby motivating students to work harder in school (Firestone & Mayrowetz, 2000; Jones, Jones, Hardin, Chapman, Yarbrough, & Davis, 1999). Second, they may undermine students' intrinsic motivation (Jones, 2007). For example, Jones and Egley (2004) investigated perceptions of FCAT scores among 708 teachers in Grades 3-5 from 30 school districts. Jones and Egley (2004) found that around 40% of teachers believed that high-stakes tests caused students to feel too much pressure and stress and negatively affected students' enjoyment of school or interest in school. Ysseldyke et al. (2004) found that high-stakes tests made students with LD feel stressed and anxious as well. Third, students are only provided information as to their score or whether they passed or failed the test. In many cases, they are not given specific feedback in terms of reviewing the test and correcting their wrong answers for understanding (De Villier, 2003). Fourth, state-mandated high-stakes tests may harm the self-esteem of students with LD. In her study, Holbrook (2001) described stories of several elementary students with LD in Massachusetts who could not pass the Massachusetts Comprehensive Assessment System (MCAS). She described: For "[m]y fourth-graders, the present MCAS is a ridiculous waste of time, emotion, and self-esteem" (p.784). However, there is a lack of empirical studies to support this assumption.

Math Achievement Measures: Low-stakes Achievement Test

Low-stakes achievement tests are another common standardized measurement of student academic achievement and have been widely used in educational research and practices. Unlike high-stakes tests, low-stakes achievement tests generally do not have significant or meaningful consequences to students (e.g., Stanford Achievement Test, The Woodcock-Johnson Tests of Achievement) (Abbott, 2014). The results of low-stakes tests do not affect whether students receive a diploma or are promoted to next grade level.

Low-stakes standardized tests are an objective and reliable measure of student academic achievement. Thus, the test results can be comparable across school districts or states (Willingham, Pollack, & Lewis, 2002). By contrast, high-stakes state-mandated tests can be comparable across students within states. Also, national standardized test results were found to be an effective predictor of students' future performance. By reviewing studies that examined the relations between standardized test scores and students' performance in graduate school, Kuncel and Hezlett (2007) noted that standardized achievement test scores were positively related to various measures (e.g., first-year GPA, graduate GPA, degree attainment) of students' graduate accomplishments in various fields (e.g., social science, biological sciences, mathematics, and medicine). However, standardized tests only focus on students' academic achievement and cannot reflect students' nonacademic qualities, such as perseverance, effort, and sociability (Hopkins, George, & Williams, 1985).

In addition, Greene, Winters, and Forster (2004) examined the relationship between scores on nine state-mandated high-stakes standardized tests and a low-stakes standardized test (the Stanford-9 Test, 2003). The results showed an overall strong correlation across nine tests (Mean $r = .88$), with a highest correlation coefficient in the state of Florida ($r = .96$). Additionally, Greene, Winters, and Forster (2004) also found that the correlations of achievement gains between high-stakes state tests and low-stakes standardized tests were in a wide range from -.06 to 0.71 (Mean $r = .45$).

In summary, despite that high-stakes state-mandated and low-stakes test can both provide an evaluation of student achievement, they can be different from each other in terms of whether they have significant or meaningful consequences to students or not (Penk, Pöhlmann, & Roppelt, 2014). For high-stakes state-mandated tests that have significant consequences to students, students tend to have high motivation to do well on the tests, possibly leading to a stronger relationship with academic self-concept. For the low-stakes achievement tests that do not have significant or meaningful consequences to students, students may have low motivation to do well on the tests, possibly resulting in a weak relationship with academic self-concept (Marsh, Hau, & Kong, 2002; Penk, Pöhlmann, & Roppelt, 2014).

A few empirical studies have provided support for this assumption (Marsh, Hau, & Kong, 2002). In a longitudinal study, Marsh and colleagues (2005) found the correlations between math self-concept and math achievement with high stakes grade measure (r = .41 and.44) were both higher than those with math test measure at two time points (r = .32 and .29), though they did not test whether the two types of measurements were statistically significant different or not in their study. Marsh, Hau, and Kong (2002) examined the relationship between academic self-concept, academic achievement, and language of instruction (Chinese vs. English) in a sample of 7,802 Hong Kong students in Grade 6. The results revealed that academic self-concept had a stronger relation with high-stakes standardized achievement scores (the examination scores for high school and college entrance) than with low-stakes standardized achievement scores (test designed particularly for the research). Marsh, Hau, and Kong (2002) noted that for high-stakes tests, students may have high motivation to do well in the tests. Thus, nonacademic factors, such as effort or persistence, tended to affect students' subsequent achievement. However, since students with LD have lower academic self-concept and math achievement than students without LD, it is still unknown how academic self-concept is related to math achievement for students with LD when using different types of math achievement tests.

Research Questions

To summarize, there have been two main limitations in the previous relevant research regarding the relationship between academic self-concept and math achievement. First, there is little research that examines the relationship between academic self-concept and math achievement for students with LD at different time points. Second, no study has examined this relationship with high-stakes and low-stakes standardized achievement tests for students with LD. Thus, this exploratory study examines the relationship between academic self-concept and math achievement among students without and with LD at different time points from early to late adolescence, using two math achievement measures: a high-stakes state-mandated achievement test (math Florida Comprehensive Assessment Test [FCAT]) and a low-stakes standardized achievement test (Woodcock-Johnson III Broad Math Test). Specifically, two research questions were investigated in this study:

1. What is the relationship between academic self-concept and math achievement in early and late adolescence for students without and with LD?
2. Are there differences in the relationship between academic self-concept and math achievement among students without and with LD, using different achievement measures (a high-stakes state-mandated achievement test vs. a low-stakes standardized achievement test)?

Chapter 3

Method

This study explored the relationship between academic self-concept (ASC) and math achievement among students without and with LD at different time points in early and late adolescence (Grades 8 and 10), using two types of math achievement measures (a math Florida Comprehensive Assessment Test [MFCAT] vs. a Woodcock-Johnson Broad Math Test [WBMT]). This study used the data collected from an existing federally-funded seven-year longitudinal study database (2001–2008; Principal Investigator: Marjorie Montague). Five steps were followed to analyze the data. First, preliminary analyses were conducted to examine: (a) group means of academic self-concept for students with and without LD from Grades 8 to 11, (b) math achievement for students without and with LD (Grades 8 and 10), (c) the group comparison in academic self-concept (Grades 8-11) and two math achievement measures (Grades 8 and 10), using an analysis of covariance (ANCOVA), (d) trajectory of academic self-concept for students with and without LD from Grades 8 to 11 for a subgroup of students (N = 99) with complete academic self-concept data, and (e) correlations between all variables. Second, hierarchical regression analyses were conducted to examine the relationship between academic self-concept and two measures of math achievement. Third, a simple slope test was conducted to examine how the relationship between academic self-concept and two measures of math achievement differed based on students' LD status.

Participants

Participants were drawn from an existing federally-funded seven-year longitudinal study database (2001–2008) (see Montague, Cavendish, Enders, & Dietz, 2010; Montague, Enders, Dietz, Dixon, & Cavendish, 2008 for more information regarding this database). The data were first collected from 179 students without disabilities and 33 students with LD in Grade 7 from seven public middle schools in a large southeastern urban district in 2001. After removing 17 students who did not have academic self-concept or MFCAT/WBMT information, there were 165 students without disabilities and 30 students with LD in this current study (N = 195). However, the number of participants was different at each time point due to missing data (see Table 1). Data collection was conducted twice per year (in fall and spring) from Grades 7 to 12 between 2001 and 2008. Based on the availability of data at each time point, this study selected academic self-concept (Grades 8-11) and math achievement (Grades 8 and 10) from spring of each year from the whole database to represent participants' early and late adolescence. Students with LD were identified by the school district.

The demographic information of participants included gender, race/ethnicity, and free lunch status in this study. Among the whole sample of the dataset in Grade 8, the proportion of males and females was 45.1% and 54.9%, respectively. The percentage of Hispanic, black, and white participants was 54.9%, 35.4%, and 9.2%, respectively. The proportion of participants who received free lunch and no free lunch was 63.5% and 36.4%, respectively. The proportion of students without LD and students with LD was 84.6% and 15.4%, respectively. In terms of the composition of participants across all time points, for students without LD, the percentage of females was higher than was that of males in each time point measure of academic self-concept and math achievement. Also, almost two thirds of participants had free lunch in each time point of measure. Furthermore, more than a half of participants were Hispanic students, and white students had the least proportion in the racial composition in each time point measure. Students without LD had similar compositions of gender, race/ethnicity, and free lunch status as student without LD. The number of students without LD was much larger than was it of students with LD. The proportion of students with LD was slightly above the national proportion (10-12%) for students, thus the sample was fairly representative of students with and without LD.

Measures

Multidimensional Self-concept Scale (MSCS, Bracken, 1992). The MSCS is a self-report scale and includes six dimensions: Social, Competence, Affect, Academic, Family, and Physical self-concept. The MSCS is composed of 150 items rated on a 4-point Likert scale, ranging from to 1 (*strongly agree*) to 4 (*strongly disagree*). Each of six subdomains contains 30 items, which was assessed with a 30-120 scale. The MSCS has both positive items and negative items. Negative items are reverse coded in scoring (per MSCS technical manual). Academic self-concept was measured via participants' scores in the academic self-concept subdomain of the MSCS. The examples include: "*I am good at mathematics*" and "*Has problems with mathematics*". The higher scores in the academic self-concept domain of the MSCS represent higher self-evaluation of respondents. The MSCS has demonstrated a satisfactory test-retest reliability over a four week period (. 90) and good concurrent validity with other measures of self-concept (Bracken, 1992), which was tested in a representative sample of 2051 young students in Grades 5-12 across United States. The test-retest correlation coefficient of the academic self-concept scale is high (.81). Participants' academic self-concept scale scores from spring of Grades 8-11were used in this study.

Woodcock-Johnson III Test of Achievement (WJ III, Woodcock, McGrew, & Mather, 2001). The Woodcock-Johnson III Test of Achievement is a widely used standardized achievement test to assess students' performance in reading, mathematics, written language, and knowledge. Participants' scores on the WJ III Broad Math Test were used in this study, which includes three math subtests: calculation, math fluency, and applied problems. Respondents took the same text of the WJ achievement test. Respondents' raw scores were converted into age- and grade- equivalent scores based on the number of correct items. The WJ III Broad Math Subtest has been demonstrated to have strong reliabilities of .80 or higher, which was assessed with a 0-200 scale and tested in 8,000 individuals from 2 to 90 years old across United States. The scale scores for achievement are based on age norm groups and reported in percentiles. Participants' scale scores on the WJ III Broad Math Subtest in Grades 8 and 10 were reported as measures of participants' math achievement in this study.

The Florida Comprehensive Assessment Test (FCAT). The Florida Comprehensive Assessment Test (FCAT) was a state-mandated standardized test implemented by the Florida Department of Education. The FCAT was used to assess academic progress and performances of students in Grades 3-10 in various subjects, including mathematics, reading, science, and writing. The FCAT scores were assessed with a 100-500 scale, which was further divided into five achievement levels, ranging from 1 (lowest) to 5 (highest). The range of FCAT in math for achievement levels 1-5 in Grade 8 in 2003 were 100- 280 (Level 1), 281-310 (Level 2), 311-347 (Level 3), 348-371 (Level 4), and 372-500 (Level 5). The range of FCAT in math for achievement levels 1-5 in Grade 10 in 2005 were 100-287 (Level 1), 288-315 (Level 2), 316- 340 (Level 3), 341-

375 (Level 4), and 376-500 (Level 5). The passing score of FCAT in math is 300. Respondents' raw scores are converted into a scale score, which "was created using vertical scaling techniques to place Grades 3 through 11 on a comparable metric. Students should receive higher scores as they move from grade-to-grade according to their increased achievement" (Florida Department of Education, 2003, p. 3). Scale scores are also linked to sunshine state standards mastery for each of those grade levels. The developmental scale scores allow for examining change over time. The FCAT was administered by the school in the spring of each academic year. Beginning in 2011, Florida started the transition process from the FCAT to End-of-Course (EOC) that measures the Florida Standards (FS) or the Next Generation Sunshine State Standards (NGSSS) for various courses. The reliability and validity coefficients of FCAT have been reported to be over .80 (Florida Department of Education, 2004). Participants' scale scores in math in Grades 8 and 10 were used in this study.

Procedures

Participants' information of academic self-concept in Grades 8-11 and math achievement in Grades 8 and 10 was drawn from an existing federally-funded seven-year longitudinal study database (2001–2008) (Principal Investigator: Marjorie Montague), following the institutional review board (IRB) protocol. Woodcock-Johnson III Broad Math Test and the MSCS (which includes the academic self-concept subdomain) were administrated by research team to students in spring semester at school each year. Participants' demographic information and math FCAT scores were gathered from the official school records. Students with LD in this study were on a standard diploma track in general classroom settings and did not receive alternate test assessment for the FCAT.

The math FCAT was administrated to participants in groups in school and the Woodcock-Johnson III Broad Math Test was administrated individually by members of the research team. Four waves of academic self-concept (Grades 8-11) of academic self-concept and two waves of two math achievement measures (math FCAT and WJ III Broad Math Test scores) (Grades 8-10) were selected and analyzed in this study. Also, at each time point, the number of participants changed due to missing data, which may stem from participants' transferring to other schools or absence from class during test administration time. Group means of academic self-concept and two measures of math achievement at different time points were reported in this study.

Data Analyses

This study aimed to provide an exploratory examination of the relationship between academic self-concept and math achievement (high-stakes and low-stakes math tests) for students without and LD at different time points in early and late adolescence. Five steps were followed to analyze the data. First, preliminary analyses were conducted as follows: (a) group means of academic self-concept for students with and without LD from Grades 8 to 11, (b) math achievement for students without and with LD (Grades 8 and 10), (c) the group comparison in academic self-concept (Grades 8-11) and two math achievement measures (Grades 8 and 10), using an analysis of covariance (ANCOVA), (d) trajectory of academic self-concept (ASC) for a subgroup of students with and without LD from Grades 8 to 11 with complete ASC data, and (e) correlations between all variables. This study used an ANCOVA to compare the group mean differences in academic self-concept and math achievement between students without and with LD at each time point. In the ANCOVA, LD status was an independent variable, and academic self-concept (Grades 8-11) and two math achievement measures (WBMT vs. MFCAT) (Grades 8 and 10) were dependent variables. Previous studies found that there were gender, socioeconomic status (SES), and racial/ethnic differences in academic self-concept and math achievement (e.g., De Fraine, Van Damme, & Onghena, 2007; Liu & Wang, 2005; NAEP, 2013); this study thus considered gender, free lunch status, and race/ethnicity as control variables for each group comparison. In the dataset, gender was coded as “1” (male) and “2” (female). Race/ethnicity was coded as “1” (Hispanic), “2” (white), and “3” (black). Free lunch status was coded as “1” (yes) and “2” (no). The SPSS 19.0 software was used to analyze the data.

Second, hierarchical regression analyses were used to examine the relationship between academic self-concept and two measures of math achievement. The hierarchical regression model allows to examine the prediction of one independent variable or a set of independent variable on the dependent variable, in which the independent variables are entered into the regression model one or a batch at a time (Gelman & Hill, 2006). In the hierarchical regression, change in explained variance (ΔR^2) of the dependent variable is used to test whether adding one independent variable or a set of independent variables significantly predicts the dependent variable. In order to test the sample size of participants required for the hierarchical regression analyses in this study, a power analysis was conducted with G*Power software (Keith, 2014). The results of a power analysis showed that there should be at least 77 participants for the regression analyses in this study based on detecting a medium effect size (.15), with critical $\alpha \leq .05$, and with power of 80%. Thus, the change of the number of participants across waves in this study did not affect the power of the regression models as the smallest N at any time point was

77. In the regression analysis, race/ethnicity was represented as two dummy variables (i.e., Hispanic, black) with white as the reference group. Free lunch status, gender, and LD status were recoded as dummy variables too. G8 MFCAT, G8 WBMT, and G8 ASC were centered.

Prior to the hierarchical regression analyses, three assumptions of regression were tested: (a) the model was properly specified, meaning that all important independent variables were included in the regression models, which was determined by study design, (b) normality of the residuals, which was tested via histogram to see if the residuals were normally distributed, and (c) homogeneity of the residuals, referring to that the variances of error are equal across independent variables, which was tested via a scatterplot. In addition, because of a large number of predictors, there was a need to test the multicollinearity (MC). Multicollinearity exists when two or more independent variables in a regression are moderately or strongly correlated. Detection of multicollinearity is based on two indicators: Variance Inflation Factor (VIF) for each independent variable and the Tolerance. According to Tabachnick and Fidel (1996), multicollinearity is detected when the value of VIF is greater than 10 or Tolerance is smaller than .10.

The first two regression models examined the relationship of academic self-concept to math achievement (WBMT and MFCAT), in which G8 ASC was examined for an effect on G10 WBMT and G10 MFCAT. There were a total of four steps in each of these two regression models. First, the variables, including participants' gender, race/ethnicity, free lunch status, and G8 math achievement (WBMT/MFCAT), were entered at step 1. Because G8 MFCAT/WBMT was highly correlated with G10 MFCAT/WBMT, G8 WBMT/MFCAT was considered as control variables as well at step 1. Then, G8 ASC was entered at step 2 to examine the effect of G8 ASC on G10 WBMT/G10 MFCAT. Next, LD status was entered at step 3 to examine the effect of LD status on G10 WBMT/G10 MFCAT. Lastly, G8 ASC *LD status was entered at step 4 to examine the effect of interaction between G8 ASC and LD status on G10 WBMT/G10 MFCAT. The first full two regression model formulas are described as follows:

$Y_1 = b_0 + b_1$ (Gender) + b_2 (Hispanic) + b_3 (black) + b_4 (free lunch status) + b_5 (G8ASC) + b_6 (LD status) + b_7 (G8 ASC*LD status) +e

$Y_2 = b_0 + b_1$ (Gender) + b_2 (Hispanic) + b_3 (black) + b_4 (free lunch status) + b_5 (G8ASC) + b_6 (LD status) + b_7 (G8 ASC*LD status) +e

In these two models, Y_1 and Y_2 were dependent variables, which represented G10 FCAT and G10 WBMT respectively. The b_0 is the intercept for G10 MFCAT/G10WBMT scores (the average G10 MFCAT/G10 WBMT score when all predictors are 0. The b_{1-3} and b_6 are intercept differences for predictors. b_5 and b_7 are slopes/slope differences for predictors. The e is the residual.

The last two regression models examined the relationship of math achievement (WBMT vs. MFCAT) to academic self-concept, in which G8 WBMT/G10 MFCAT had an effect on G10 ASC. There were a total of four steps in each of these two regression models. First, the variables, including participants' gender, race/ethnicity, free lunch status, and G8 ASC, were entered at step 1. Because G8 ASC was highly correlated with G10 ASC, G8 ASC was considered as control variables as well at step 1. Then, G8 WBMT/G8 MFCAT, was entered at step 2 to examine the effect of G8 WBMT/ G8 MFCAT on G10 ASC. Next, LD status was entered at step 3 to examine whether the effect of LD status on G10 ASC. Lastly, G8 WBMT/ G8 MFCAT *LD status was entered at step 4 to examine the effect of interaction between G8 WBMT/ G8 MFCAT and LD status on G10 ASC. Only the interaction between LD status and math achievement score was entered as interaction term because based on the results of ANCOVA, none of interaction affects between LD status and other variables was statistically significant. The last two full regression model formulas can be descried as follows:

$Y_3 = b_0 + b_1$ (Gender) + b_2 (Hispanic) + b_3 (black) + b_4 (free lunch status) + b_5 (G8MFCAT) + b_6 (LD status) + b_7 (G8MFCAT *LD status) +e

$Y_4 = b_0 + b_1$ (Gender) + b_2 (Hispanic) + b_3 (black) + b_4 (free lunch status) + b_5 (G8WBMT) + b_6 (LD status) + b_7 (G8WBMT*LD status) +e

In these two models, Y_3 were dependent variable, which represented G10 ASC. The b_0 is the intercept for G10 ASC scores (the average G10 ASC score when all predictors are 0). The b_{1}-$_{3}$ and b_6 are intercept differences for predictors. b_5 and b_7 are slopes/slope differences for predictors. The e is the residual.

Third, if there was a statistically significant interaction effect in the regression results, a simple slope effect test was conducted to further analyze how the relationship between academic self-concept and math achievement (WBMT and MFCAT) differed based on students' LD status. According to the recommendations of Aiken, West, and Reno (1991), the variables of LD status was recoded (assigning NLD as "-1" vs. LD as "1"), in order to test the statistical significance of separate slopes in a regression.

Chapter 4

Results

This study explored the relationship between academic self-concept and math achievement for students without and with LD, using a high-stakes state-mandated test (MFCAT) and a low-stakes standardized test (WBMT). This results section is composed of three parts: (a) results of preliminary analyses, including group means of academic self-concept (Grades 8-11), math achievement for students without and with LD, group comparison in academic self-concept (Grades 8-11) and two math achievement measures (Grades 8 and 10), using an ANCOVA, trajectory of academic self-concept for students with and without LD from Grades 8 to 11 for the subgroup of youth with complete ASC data, and correlations between all variables (Grades 8 and 10) for students without and with LD; (b) the results of hierarchical regression models to explore the reciprocal relationship between academic self-concept and math achievement; and (c) the result of a simple slope effect test, which was used to further analyze how the relationship between academic self-concept and math achievement (WBMT vs. MFCAT) differed based on students' LD status.

Descriptive Statistics

Descriptive statistics, including means, standard deviations, and the number of participants, are summarized in Table 1. As shown in Table 1, the group means of academic self-concept of female participants were generally higher than that of male participants in Grades 8 to 11. The group means of academic self-concept of participants who received free lunch were generally higher than were those of participants who did not receive free lunch. The group means of academic self-concept of black participants

Table 1.
Results of Descriptive Statistics

Variable		G8ASC	G9ASC	G10ASC	G11ASC	G8MFCAT	G10MFCAT	G8WBMT	G10WBMT
Gender									
Male	M	91.79	82.05	100.27	101.09	293.07	289.19	86.03	86.84
	(SD)	(9.04)	(4.32)	(11.18)	(13.44)	(61.44)	(61.45)	(12.38)	(12.82)
	N	82	66	64	48	57	36	34	67
Female	M	92.58	82.05	105.37	106.07	291.68	311.49	88.47	86.52
	(SD)	(8.15)	(5.27)	(13.90)	(13.19)	(52.21)	(33.83)	(12.64)	(12.82)
	N	98	92	93	73	84	61	43	88
Free Lunch									
No	M	91.66	81.78	103.46	102.72	306.38	312.14	88.04	87.45
	(SD)	(7.01)	(4.39)	(11.16)	(14.06)	(55.10)	(37.97)	(10.45)	(13.16)
	N	64	56	56	41	47	29	28	53
Yes	M	92.53	82.20	103.19	104.80	285.17	299.41	87.02	86.25
	(SD)	(9.31)	(5.14)	(14.06)	(13.17)	(55.26)	(50.14)	(13.63)	(12.69)
	N	116	102	101	80	94	68	49	102
Race/ethnicity									
Hispanic	M	90.26	83.03	101.35	102.11	294.53	309.32	87.90	87.22
	(SD)	(7.41)	(4.54)	(12.96)	(12.62)	(44.25)	(40.29)	(11.42)	(11.47)
	N	105	88	85	71	80	65	50	87
Black	M	95.60	80.92	106.33	108.16	277.21	272.58	82.28	83.42
	(SD)	(9.87)	(5.36)	(13.19)	(14.28)	(61.96)	(52.90)	(14.92)	(13.83)
	N	59	56	56	38	49	25	19	56
White	M	92.78	80.36	102.25	101.13	331.08	345.14	92.25	95.33
	(SD)	(7.16)	(3.91)	(11.77)	(12.02)	(78.58)	(27.57)	(6.30)	(11.80)
	N	16	14	16	12	12	7	8	12
LD Status									
NLD	M	92.68	82.15	103.79	105.31	298.22	310.30	88.97	88.47
	(SD)	(8.41)	(4.46)	(12.94)	(13.74)	(48.97)	(36.21)	(11.94)	(12.16)
	Min	68.50	70.00	78.00	77.00	100	209	55	53
	Max	134.00	97.00	141.00	141.00	412	384	127	125
	Range	65.50	27.00	63.00	64.00	312	175	72	72
	N	153	137	137	106	125	83	69	132
LD	M	89.63	81.43	99.85	95.53	245.56	261.21	73.75	76.26
	(SD)	(9.04)	(7.17)	(13.70)	(6.67)	(82.06)	(76.30)	(8.65)	(11.74)
	N	27	21	20	15	16	14	8	23
	Min	75.00	66.00	78.00	87.50	150	100	62	59
	Max	110.50	93.00	125.00	112.00	500	385	86	108
	Range	35.50	27.00	47.00	24.50	350	285	24	49
Total	M	92.22	82.05	103.29	104.09	292.24	303.22	87.39	86.66
	(SD)	(8.55)	(4.88)	(13.06)	(13.46)	(55.91)	(47.00)	(12.50)	(12.83)
	N	180	158	157	121	141	97	77	155
	Min	68.50	66.00	78.00	77.00	100	100	55	53
	Max	134.00	97.00	141.00	141.00	500	385	127	125
	Range	65.50	31.00	63.00	64.00	400	285	72	72

Note. LD = Learning Disabilities. NLD = Not Learning Disabilities. M = Mean. SD = Standard Deviation. N = Number of Participants. ASC = Academic Self-concept. MFCAT= Florida Comprehensive Assessment Test WBMT = Woodcock-Johnson Broad Math Test. Min = Minimum. Max = Maximum.

were higher than were those of white participants. With regard to two measures of math achievement, there was no significant difference in the group means of MFCAT and WBMT score between female and male students. Students who did not receive free lunch had slightly higher MFCAT and WBMT scores than did students who received free lunch. The group means of MFCAT and WBMT scores of white participants were much higher than were those of Hispanic and black participants. Further, there was a smaller range within the ASC scores for students with LD, suggesting greater variability of ASC scores for students without LD. It may be likely due to smaller number of students with LD. Also, while the minimum scores were similar between two groups, the range of students without LD reached to significantly higher scores on the ASC. With regard to WBMT score, there was a smaller range for students with LD, suggesting greater variability of WBMT scores for students with LD. With regard to MFCAT score, there was a larger range for students with LD, suggesting greater variability of MFCAT scores for students with LD. A minimum score of 100 on the MFCAT means essentially a floor score (no points earned). This score was the minimum score for at least one of the students without LD at Grade 8 but not at Grade 10, suggesting at least some level of effort (minimum score 209) on the Grade 10 FCAT for students without LD. The minimum score of MFCAT for students with LD in Grades 8 and 10 were 100 and 150 respectively. Also, the mean score of students with LD was significantly lower than students without LD, suggesting a greater proportion of students with LD at the lower end of the range

Preliminary Analyses

Group means of academic self-concept of students without and with LD. The group means of academic self-concept scores of students without and with LD from Grades 8 to 11 are presented in Figure 1.

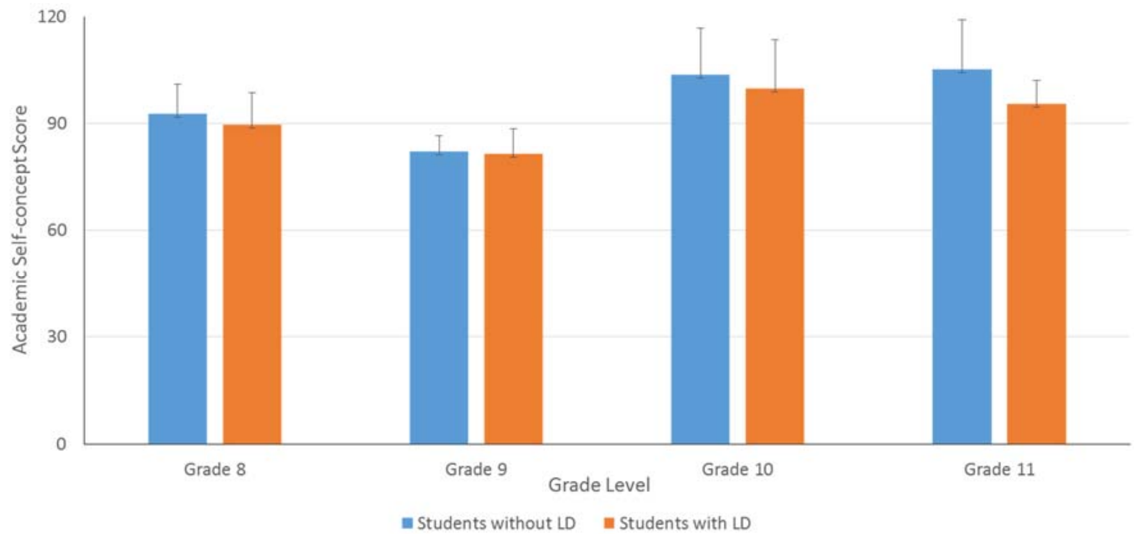

Figure 1. Group Means of Academic Self-concept of Students without and with LD from Grades 8 to 11

As shown in Table 1 and Figure 1, the academic self-concept score group mean of students without LD was generally higher than that of students with LD in Grades 8, 10, and 11, and students without and with LD had similar group means in Grade 9. The group mean difference between students without and with LD widened from Grade 9 to 11 (group mean difference: Grade 8 = 3.05, N = 180; Grade 9 = .62, N= 158; Grade 10 = 4.33, N = 157; Grade 11 = 8.65, N= 121). The result of group means with a changing number of participants at each time point provided a snapshot of academic self-concept of students without and with LD at each time point.

Math achievement for students without and with LD. As demonstrated in Table 1, with regard to the math achievement, for students without LD, there was almost no difference in the group means of MFCAT and WBMT between Grades 8 and 10. By contrast, for students with LD, MFCAT and WBMT test scores were generally higher in Grade 10 than in Grade 8. Especially, the mean group MFCAT score of students with LD was higher in grade 10 (261.21) than in grade 8 (245.56). The passing score of MFCAT is 300. The proportion of students with LD who did not pass math FCAT at the first time in Grade 10 (83.3%) was much larger than was that of students without LD (40.5%).

Group comparison in academic self-concept and math achievement. The results of the group comparison of academic self-concept (Grades 8-11) and two math achievement measures (Grades 8 and 10), using ANCOVA analyses, are shown in Table 2.

First, ANCOVA with interactions between gender/race/ethnicity /free lunch status and LD status were tested. The results showed that only the effect of interaction between free lunch status and LD status on G10 MFCAT was statistically significant ($F_{(1, 88)}$ = 8.42, $p < 0.1$, $\eta^2 = .09$) with a small effect size, indicating that the effect of free lunch status on G10 MFCAT differed based on participants' LD status. The rest of interaction effects were not significant. While the effect of interaction between free lunch status and LD status on G10 MFCAT was significant, the examination of the interaction between free lunch and LD status was not the focus of this study. Thus, the interaction between free lunch status and LD was status was not included in the regression models. Also, the main effects of gender and free lunch status on G10 MFCAT were statistically significant

Table 2.

ANCOVA Results for Group Comparison in Academic Self-concept, MFCAT, and WBMT, Controlling for Gender, Race/Ethnicity, and Free Lunch Status.

	Source	SS	*df*	MS	*F*	*p*	η^2
G8ASC	Gender	10.81	1	10.81	.14	.68	.00
	Race/Ethnicity	607.75	2	606.75	8.61***	.00	.05
	Free Lunch Status	134.42	1	133.42	1.92	.15	.01
	LD status	178.69	1	176.69	2.56	.11	.01
	Error	12212.91	174	69.49			
	Total	1543984.00	189				
G9ASC	Gender	1.32	1	1.30	.07	.80	.00
	Race/ethnicity	156.95	2	154.85	6.45**	.02	.04
	Free Lunch Status	.54	1	.54	.02	.88	.00
	LD Status	11.73	1	11.73	.50	.48	.00
	Error	3565.79	152	23.31			
	Total	1067525.75	157				
G10 ASC	Gender	905.16	1	905.16	5.50*	.02	.03
	Race/ethnicity	467.49	2	467.49	2.84	.09	.02
	Free Lunch Status	17.80	1	17.80	.11	.74	.00
	LD Status	142.53	1	142.53	.87	.35	.01
	Error	25030.06	151	164.67			
	Total	1701621.75	156				
G11 ASC	Gender	506.73	1	506.73	3.07	.08	.03
	Race/ethnicity	790.56	2	791.56	4.79*	.03	.04
	Free Lunch Status	342.22	1	342.22	2.08	.15	.02
	LD Status	1087.93	1	1047.93	6.60**	.01	.05
	Error	19128.25	115	164.90			
	Total	1332861.75	120				
G8MFCAT	Gender	577.02	1	577.02	.20	.65	.00

	Race/Ethnicity	2018.11	2	2018.11	.71	.40	.01
	Free Lunch Status	9404.75	1	9404.75	3.33	.07	.02
	LD Status	38062.54	1	38062.54	13.47***	.00	.09
	Error	384294.82	135	2825.70			
	Total	12479786.00	140				
G8WBMT	Gender	60.92	1	60.92	.44	.51	.01
	Race/ethnicity	222.08	2	222.08	1.60	.21	.02
	Free Lunch Status	12.73	1	12.73	.09	.76	.00
	LD Status	1642.50	1	1642.50	11.87***	.00	.14
	Error	9965.18	71	138.41			
	Total	599925.00	76				
G10MBMT	Gender	134.46	1	134.46	.91	.34	.01
	Race/ethnicity	131.67	2	131.67	.89	.35	.01
	Free Lunch Status	3.34	1	3.34	.02	.88	.00
	LD Status	3020.56	1	3020.56	20.32***	.00	.12
	Error	22111.67	149	147.41			
	Total	1189316.00	154				

Note. LD = Learning Disabilities. ASC = Academic Self-Concept. MFCAT = Math Florida Comprehensive Assessment Test. WBMT=Woodcock-Johnson Broad Math Test.
*p<.01, **p<.01, ***p<.001.

(Gender: $F_{(1, 88)} = 5.71$, $p < 0.5$, $\eta^2 = .09$; Free lunch status: $F_{(1, 88)} = 8.77$, $p < 0.1$, $\eta^2 = .06$), with small effect sizes. Then, the ANCOVA analyses for main affects were conducted. As shown in Table 2, the results indicated that there was a significant mean difference in academic self-concept between students without with LD only in Grade 11, after controlling for differences in gender, race/ethnicity, and free lunch status ($F_{(1, 115)} = 6.6$, $p < 0.1$, $\eta^2 = .05$), with a small effect size. In addition, results showed that there were significant racial differences in academic self-concept in Grades 8, 9, and 11, and that black students had significant higher academic self-concept in Grade 8, 9, and 11 than did Hispanic and white students. Also, there was a significant effect of gender on G10 ASC ($F_{(1, 151)} = 5.50$, $p < 0.5$, $\eta^2 = .02$). However, since the effects of gender on academic self-concept were not statistically significant in other grades, this result should not be overly interpreted. Because of the group means and changing number of participants, the composition of each group at each time point was slightly different.

With regard to two types of math achievement, the MFCAT and WBMT scores were both significantly higher for students without LD than for students with LD in Grades 8 and 10, controlling for differences in gender and race/ethnicity (G8MFCAT: $F_{(1, 135)} = 13.47$, $p < 0.001$, $\eta^2 = .09$; G8WBMT: $F_{(1, 71)} = 11.87$, $p < 0.001$, $\eta^2 = .14$, G10WBMT: $F_{(1, 149)} = 20.49$, $p < 0.001$, $\eta^2 = .12$). All four effect sizes were small.

Trajectory of academic self-concept of students without and with LD. In addition to the group means of academic self-concept of students without and with LD, this study also took a closer exploratory look at means/standard deviations and the trajectories of academic self-concept of students without and with LD for the subgroup, who completed all academic self-concept measures from Grades 8 to 11 (See Table 3 and Figure 2).

Among the sample with full academic self-concept measures (N = 99), for students without LD, the proportion of males and females was 33.3% and 66.7%, respectively. The percentage of Hispanic, black, and white participants was 55.7%, 11.1%, and 33.3%, respectively. The proportion of participants who received free lunch and no free lunch was 66.7% and 33.3%, respectively. For students with LD, the proportion of males and females was 66.7% and 33.3%, respectively. The percentage of Hispanic, black, and white participants was 62.2%, 28.9%, and 8.9%, respectively. The proportion of participants who received free lunch and no free lunch was 67.8% and 32.2%, respectively. Because of a small number of students with LD, adding 1-2 cases changed the proportion significantly though males were over represented and blacks were underrepresented in the sample. The demographic composition of students without LD for the subgroup was roughly equivalent to that of larger sample, and students with LD had similar racial/ethnic and free lunch status composition as the larger sample.

Table 3.

Means, Standard Deviations, and T Test of Academic Self-concept of Participants Who Completed All Academic Self-concept Measures from Grades 8 to 11

		ASC1	ASC2	ASC3	ASC4
LD Status					
NLD	M (SD)	92.95 (7.72)	82.37 (4.50)	104.42 (13.73)	106.29 (13.84)
	N	90	90	90	90
LD	M (SD)	91.61 (10.57)	81.38 (5.50)	94.61 (13.87)	97.11 (6.67)
	N	9	9	9	9
Total	M (SD)	92.82 (7.97)	82.28 (4.58)	103.53 (13.06)	105.11 (13.46)
		99	99	99	99
t-value		1.13	1.06	1.95*	2.06*
df		97	97	97	97

Note. LD = Learning Disabilities. NLD = Not Learning Disabilities. ASC = Academic Self-Concept. N = Number of Participants

*p<.01, **p<.01, ***p<.001.

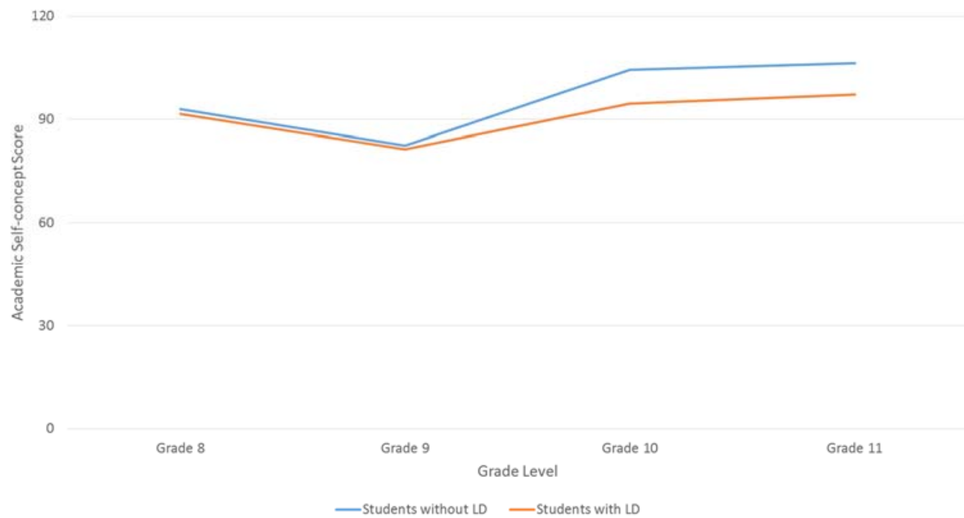

Figure 2. Trajectory of Academic Self-concept of Students without and with LD from Grades 8 to 11

As shown in Table 3, for students without LD with full academic self-concept information, the mean score of academic self-concept decreased from Grade 8 (Mean = 92.95) to 9 (Mean = 82.37), and later increased until Grade 11 (Mean = 106.69). For students with LD, the mean score of academic self-concept decreased from Grade 8 (Mean = 91.61) to 9 (Mean = 81.38), and later increased from Grades 9 to 11 (Mean = 97.11).

A t-test was conducted to examine the difference between students without and with LD in academic self-concept at all time points. The results showed that there was a statistically significant difference between students without and with LD in Grades 10 and 11 (Grade 10: $t_{(97)} = 1.95$, $p = .05$; Grade 11: $t_{(97)} = 2.06$, $p < .05$), representing lower scores at grade 10 and grade 11 for students with LD.

Bivariate correlations between variables. Bivariate correlations between all variables for students without and with LD are shown in Table 4 and 5.

Table 4.
Correlations for Academic Self-concept, MFCAT, and WBMT for Students without Learning Disabilities

Variable		1	2	3	4	5	6
	r	-					
1.G8ASC	N	147					
	r	.62***	-				
2.G10ASC	N	124	132				
	r	.15	.24**	-			
3.G8MFCAT	N	117	122	122			
	r	.13	.29**	.81***	-		
4.G10MFCAT	N	74	79	78	79		
	r	.06	.35**	.81**	.71**	-	
5.G8WBMT	N	66	57	55	50	66	
	r	.10	.23*	.74***	.68**	.92**	-
6.G10WBMT	N	120	120	115	78	56	128

Note. ASC=Academic Self-concept. MFCAT=Math Florida Comprehensive Assessment Test. WBMT=Woodcock-Johnson Broad Math Test. r = Correlation Coefficient. N = Number of Participants. *p<.05; **p<.01;***p<.001.

As shown in Table 4, for students without LD, the correlations between G10 ASC and MFCAT and WBMT scores in Grades 8 and 10 were statistically significant, whereas all the correlations between G8 ASC and MFCAT/WBMT scores in Grades 8 and 10 were not statistically significant. With regard to the correlations between MFCAT and WBMT, all of the correlations were statistically significant, with a medium to strong correlated magnitude ranging from .67 to.92.

Table 5.

Correlations for Academic Self-concept, MFCAT, and WBMT for Students with Learning Disabilities

Variables		1	2	3	4	5	6
1. G8ASC	r	-					
	N	27					
2.G10ASC	r	.20	-				
	N	17	20				
3.G8MFCAT	r	.21	-.11	-			
	N	14	16	16			
4.G10MFCAT	r	.31	.20	.61*	-		
	N	12	14	13	14		
5.G8WBMT	r	.30	.31	.75	.90*	-	
	N	8	6	5	5	8	
6.G10WBMT	r	.30	-.05	.78*	.45	.72*	-
	N	21	19	16	14	8	23

Note. ASC=Academic Self-concept. MFCAT=Math Florida Comprehensive Assessment Test. WBMT=Woodcock-Johnson Broad Math Test. r = Correlation Coefficient. N = Number of Participants. *p<.05; **p<.01;***p<.001.

As shown in Table 5, for students with LD, none of ASC and FCAT/WBMT score was significantly correlated. With regard to the correlations between two measures of math achievement, except that the correlations between G8 MFCAT and G8WBMT and between G10 MFCAT and G10 WBMT were not statistically significant, the rest of correlations between two measures of math achievement were statistically significant. The number of students with LD for the G8WBMT was too small to draw conclusions. As shown in Table 4 and 5, students without LD had generally higher correlations between academic self-concept and MFCAT/WBMT scores in Grade 8 but lower correlations in Grade 10 than students with LD.

Hierarchical Regression Analyses

Hierarchical regression models were conducted to examine the relationship between academic self-concept and math achievement for students without and with LD. Race/ethnicity gender, and free lunch status were included as control variables. The control variables were held constant in order to eliminate their potential influences on the relationship between academic self-concept and math achievement.

Relationship of academic self-concept to math achievement. To examine whether prior academic self-concept predicted subsequent math achievement for students without and with LD, hierarchical regression analyses were conducted, with two math achievement measures as the criterion variables respectively. Although there was no significant correlation between G8ASC and G10FCAT/G10WMBT for student without and with LD, a simple correlation cannot test potential moderating effects. That is, a correlation analyses were not able to examine whether or not the predictive effect of G8 ASC on G10FCAT/G10WMBT differed based on LD status. Given the fact that this study was an exploratory investigation of the relationship between academic self-concept and math achievement at different time points, in order to better inform a more complete longitudinal design in the future research, it was essential to conduct hierarchical regression analyses, because there might be an significant interaction between Grade 8 ASC and LD status on G8 math achievement, after controlling for a series of other predictors. Gender, race/ethnicity, G8 MFCAT/G8 WMBT, G8 ASC, LD status, and interaction between G8 ASC and LD status were included as independent variables. The reason that interaction between G8 ASC and LD was included in the regression because the aim of this study primarily focused on possible differences in the relationship between academic self-concept between students without and with LD. Based on the results of assumptions test, the first assumption that the model was properly specified which was determined by study design, and the other two assumptions were met. Also, the result of multicollinearity test showed that multicollinearity was not evident because there was no predictor having VIF greater than 10 or Tolerance smaller than .10.

The results of the hierarchical regression analyses regarding the relationship of academic self-concept to math achievement are shown in Table 6 and 7. In Table 6 with MFCAT as a math achievement measure, at step 1, gender, race/ethnicity, free lunch status, and G8 MFCAT were first entered in the regression model, which accounted for 70.5% of variance of G10 MFCAT. The model 1 was statistically significant ($F_{(5, 81)}$ = 38.74, $p < .001$), in which G8 MFCAT was found to be a significant predictor. At step 2, G8 ASC was entered into the regression model, which accounted for 0.3% of variance of G10 MFCAT. The model 2 was not statistically significant ($F_{(1, 80)}$ = .80, $p = .11$), indicating that G8 ASC was not a significant predictor of G10 MFCAT scores, after controlling for gender, race/ethnicity, free lunch status, and G8 MFCAT. At step 3, LD status was entered into the regression model, which accounted for 0.3% of variance of G10 MFCAT. The model 3 was not statistically significant ($F_{(1, 79)}$ = .67, $p =.08$), indicating that LD status was not a significant predictor of G10 MFCAT, after controlling for gender, race/ethnicity, free lunch status, G8 MFCAT, and G8 ASC. At step 4, LD status * G8 ASC was entered into the regression model, which accounted for 1.2% of variance of G10 MFCAT. The model 3 was not statistically significant ($F_{(1, 78)}$ = 3.28, $p =.15$), indicating that the interaction between G8 ASC and LD status was not a significant predictor of G10 MFCAT, after controlling for gender, race/ethnicity, free lunch status, G8 MFCAT, G8 ASC, and LD status. This demonstrates that the effect of G8 ASC on G10 MFCAT did not differ depending on participants' LD status.

In Table 7 with WBMT test as the math achievement measure, at step 1, gender, race/ethnicity, free lunch status, and G8 WBMT test were first entered into the regression model, which accounted for 84.9% of variance of G10 WBMT test scores. The model 1 was statistically significant ($F_{(5, 61)} = 68.72$, $p< .001$), in which G8 WBMT was found to be a significant predictor. At step 2, G8 ASC was entered into the regression model, which accounted for 0.2% of variance of G10 WBMT. Change in R^2 in model 2 was not statistically significant ($F_{(1, 60)} = .68$, $p = .21$), indicating that G8 ASC was not a significant predictor, after controlling for gender, race/ethnicity, free lunch status, and G8WBMT. At step 3, LD status was entered into the regression model, which accounted for 1.3% of variance of G10 WBMT test score. Change in R^2 in model 3 was statistically significant ($F_{(1, 59)} = 5.60$, $p < .05$), indicating that LD status was a significant predictor of G10 WBMT test score, after controlling for gender, race/ethnicity , free lunch status, G8 WBMT, and G8 ASC. At step 4, LD status * G8 ASC was entered into the regression model, which accounted for 0.3% of variance of G10 WBMT. Change in R2 in model 3was not statistically significant ($F_{(1, 58)} = 1.15$, $p =.22$), indicating that the interaction between G8 ASC and LD status was not a significant predictor of G10 WBMT, after controlling for gender, race/ethnicity, free lunch status, G8 WBMT, G8 ASC, and LD status. This demonstrates that the effect of G8 ASC on G10 WBMT did not differ depending on LD status.

Table 6.

Summary of Hierarchical Regression Analyses for G8ASC Predicting G10 MFCAT.

Step/Predictor		Step 1			Step 2			Step 3			Step 4		
		B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Step1	Gender	8.08	4.77	.11	7.43	4.83	.10	6.71	4.92	.08	7.66	[illegible]	.10
	Free Lunch Status	-2.46	5.19	-.03	-3.13	5.25	-.04	-3.19	5.26	-.04	-2.18	[illegible]	-.03
	Hispanic	4.36	8.93	.08	2.54	9.17	.03	3.56.	9.27	.04	3.81	[illegible]	.05
	Black	12.79	10.68	.14	12.36	10.70	.14	14.16	10.94	.16	14.64	10.79	.16
	G8 MFCAT	.53***	.05	.77	.53***	.05	.77	.51***	.05	.75	.52***	[illegible]	.76
Step2	G8 ASC				.28	.31	.06	.32	.32	.07	.56	[illegible]	.12
Step3	LD Status							-6.00	7.35	-.06	-3.98	[illegible]	-.04
Step4	LD Status*G8ASC										-1.42	[illegible]	-.13
	R^2			.705			.708			.711			.722
	ΔR^2						.003			.003			.012
	$F_{(df1, df2)}$	$F_{(5, 81)}$ = 38.74***			$F_{(1, 80)}$ = .80,				$F_{(1, 79)}$ = .67		$F_{(1, 78)}$ = 3.28		

Note. Race/ethnicity was represented as two dummy variables with White serving as the reference group. G8ASC were centered.

ASC=Academic Self-concept. MFCAT=Math Florida Comprehensive Assessment Test.

WBMT=Woodcock-Johnson Broad Math Test.

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

Table 7.

Summary of Hierarchical Regression Analyses for G8ASC Predicting G10 WBMT.

Step/Predictor		Step 1			Step 2			Step 3			Step 4		
		B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Step 1	Gender	1.01	1.33	.04	.93	1.34	.04	.79	1.29	.03	.96	1.30	.04
	Free Lunch Status	-.18	1.48	-.007	-.31	1.49	-.01	.12	1.45	.01	.18	1.45	.01
	Hispanic	.93	2.34	.04	.71	2.37	.03	1.58	4.19	.06	1.65	2.30	.06
	Black	3.46	2.61	.12	3.63	2.62	.13	4.19	2.54	.14	4.77	2.59	.16
	G8 WBMT	.86***	.05	.89	.85***	.05	.88	.81***	.06	.83	.80***	.06	.83
Step 2	G8 ASC				.07	.09	.05	.05	.08	.03	.10	.10	.06
Step 3	LD Status							-4.87*	2.06	-.13	-5.56*	2.15	-.14
Step 4	LD Status*G8ASC										-.22	.20	-.07
	R^2			.849			.851			.864			.866
	ΔR^2						.002			.013*			.003
	$F_{(df1,df2)}$	$F_{(5, 61)} = 68.72$***			$F_{(1, 60)} = .68$			$F_{(1, 59)} = 5.60$			$F_{(1, 58)} = 1.15$		

Note. Race/ethnicity was represented as two dummy variables with white as the reference group.

G8ASC were centered.

ASC=Academic Self-concept. MFCAT=Math Florida Comprehensive Assessment Test.

WBMT=Woodcock-Johnson Broad Math Test.

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

Relationship of math achievement to academic self-concept. To examine whether prior math achievement predicted subsequent academic self-concept for students without and with LD, hierarchical regression analyses were conducted, with G10 ASC as the criterion variables. Gender, race/ethnicity, free lunch status, G8 ASC, G8 MFCAT/G8 WBMT, LD status, and interaction between G8 MFCAT/G8 WBMT and LD status were included as independent variables. Similarly, based on the results of assumptions test, the assumption that the model was properly specified which was determined by study design and the other two assumptions were met. The result of MC test showed that MC was not evident because there was no predictor having VIF greater than 10 or Tolerance smaller than .10.

The results of the hierarchical regression analyses regarding the relationship of academic self-concept to math achievement are shown in Table 8 and 9. In Table 8 with MFCAT as a math achievement measure, at step 1, gender, race/ethnicity, free lunch status, and G8 ASC were first entered and accounted for 37.2% of variance of G10 ASC. The model 1 was statistically significant ($F_{(5, 128)} = 15.16$, $p < .001$), in which G8 ASC was found to be a significant predictor. At step 2, G8 MFCAT was entered into the regression model, which accounted for 1.3 % of variance of G10 ASC. Change in R^2 in model 2 was not statistically significant ($F_{(1, 127)} = 2.60$, $p =.18$), indicating that G8 ASC was not a significant predictor, after controlling for gender, race/ethnicity, free lunch status, and G8 ASC. At step 3, LD status was entered into the regression model, which accounted for 0.1% of variance of G10 ASC. Change in R^2 in model 3 was not statistically significant ($F_{(1, 126)} =.14$, $p =.25$), indicating that LD status was not a significant predictor of G10 ASC, after controlling for gender, race/ethnicity, free lunch status, G8 ASC, and G8 MFCAT. At step 4, LD status * G8 MFCAT was entered into the regression model, which accounted for 3% of variance of G10 MFCAT. Change in R^2 in model 3 was statistically significant ($F_{(1, 125)} = 6.44$, $p < .05$), indicating that the interaction between G8 MFCAT and LD status was a significant predictor of G10 MFCAT, after controlling for gender, race/ethnicity, free lunch status, G8 ASC, G8 MFCAT, and LD status. This indicated that the effect of G8 MFCAT on G10 ASC significantly differed depending on LD status.

In Table 9, with WBMT test as a math achievement measure, at step 1, gender, race/ethnicity, free lunch status, and G8WBMT were first entered into the regression model, which accounted for 34.8% of variance of G10 ASC. The model 1 was statistically significant ($F_{(5, 60)} = 6.42$, $p<.001$), in which G8 ASC was found to be a significant predictor. At step 2, G8 WBMT was entered into the regression model, which accounted for 5.4% of variance of G10 ASC. Change in R^2 in model 2 was statistically significant ($F_{(1.59)} = 5.29$, $p <.05$), indicating that G8 WBMT was a significant predictor, after controlling for gender, race/ethnicity , free lunch status, and G8 ASC. At step 3, LD status was entered into the regression model, which did not account for any of variance of G10 ASC. Change in R^2 in model 3 was not statistically significant ($F_{(1, 58)} =.002$, $p =.29$), indicating that LD status was not a significant predictor of G10 ASC, after controlling for gender, race/ethnicity , free lunch status, G8 ASC, and G8WBMT. At step 4, LD status * G8 WBMT was entered into the regression model, which accounted for 0.1% of variance of G10 WBMT either. Change in R2 in model 4 was not statistically significant ($F_{(1, 57)} = .08$, $p =.78$), indicating that the interaction between G8 WBMT

Table 8.

Summary of Hierarchical Regression Analyses for G8MFCAT Predicting G10 ASC.

Step/Predictor		Step 1			Step 2			Step 3			Step 4		
		B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Step 1	Gender	4.34*	1.90	.16	4.34*	1.89	.16	4.26*	1.90	.16	4.34*	1.87	.16
	Free Lunch Status	-.85	2.05	-.03	-.47	2.05	-.02	-.41	2.07	-.02	-.81	2.03	-.03
	Hispanic	.41	3.39	.02	-.37	3.40	-.02	-.14	3.47	-.01	.09	3.39	-.003
	Black	-1.50	3.57	-.05	-2.82	3.64	-.10	-2.45	3.78	-.09	-2.47	3.70	-.09
	G8 ASC	.94***	.13	.56	.90***	.13	.54	.90***	.13	.54	.90***	.12	.54
Step 2	G8 MFCAT				.03	.02	.12	.03	.02	.11	.05**	.02	.21
Step 3	LD Status							-1.23	3.27	-.03	24.88*	10.78	.58
Step 4	LD Status*G8MFCAT										-.10*	.04	-.61
	R^2			.372			.384			.385			.415
	ΔR^2					.013			.001			.030	
	$F_{(df1, df2)}$	$F_{(5, 128)} = 15.16$***			$F_{(1, 127)} = 2.60$			$F_{(1, 126)}=.14$			$F_{(1, 125)}=6.44$*		

Note: Race/ethnicity was represented as two dummy variables with white serving as the reference group. G8ASC were centered.

ASC=Academic Self-concept. MFCAT=Math Florida Comprehensive Assessment Test.

WBMT=Woodcock-Johnson Broad Math Test.

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

Table 9.

Summary of Hierarchical Regression Analyses for G8WBMT Predicting G10 ASC.

Step/Predictor		Step 1			Step 2			Step 3			Step 4		
		B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Step 1	Gender	4.88	2.75	.19	3.66	2.71	.14	3.67	2.74	.14	3.73	2.78	.15
	Free Lunch Status	-.12	3.16	-.004	-.63	3.06	-.02	-.65	3.13	-.02	-.70	3.16	-.03
	Hispanic	3.25	4.92	.12	1.24	4.82	.05	1.21	4.93	.04	1.34	4.99	.05
	Black	3.56	5.46	.11	-2.22	5.45	.01	.29	5.60	.01	.48	5.69	.02
	G8 ASC	.95***	.20	.55	.86	.19	.50	.86***	.19	.50	.86***	.20	.50
Step 2	G8 WBMT				.26*	.11	.25	.26*	.12	.25	.26*	.12	.25
Step 3	LD Status							.19	4.89	.004	11.42	40.88	.28
Step 4	LD Status* G8WBMT										-.15	.53	-.25
	R^2			.348			.402			.402			.403
	ΔR^2						.054*			.000			.001
	$F_{(df1,df2)}$	$F_{(5, 60)} = 6.42$***			$F_{(1, 59)} = 5.29$*			$F_{(1, 58)} = .002$			$F_{(1, 57)} = .08$		

Note: Race/ethnicity was represented as two dummy variables with white serving as the reference group.

G8 ASC were centered

ASC = Academic Self-concept. MFCAT = Math Florida Comprehensive Assessment Test.

WBMT = Woodcock-Johnson Broad Math Test.

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

and LD status was not a significant predictor of G10 MFCAT, after controlling for gender, race/ethnicity, free lunch status, G8ASC, G8 WBMT, and LD status. This indicated that the effect of G8 WBMT on G10 ASC did not differ depending on LD status.

A Simple Slope Effect Test

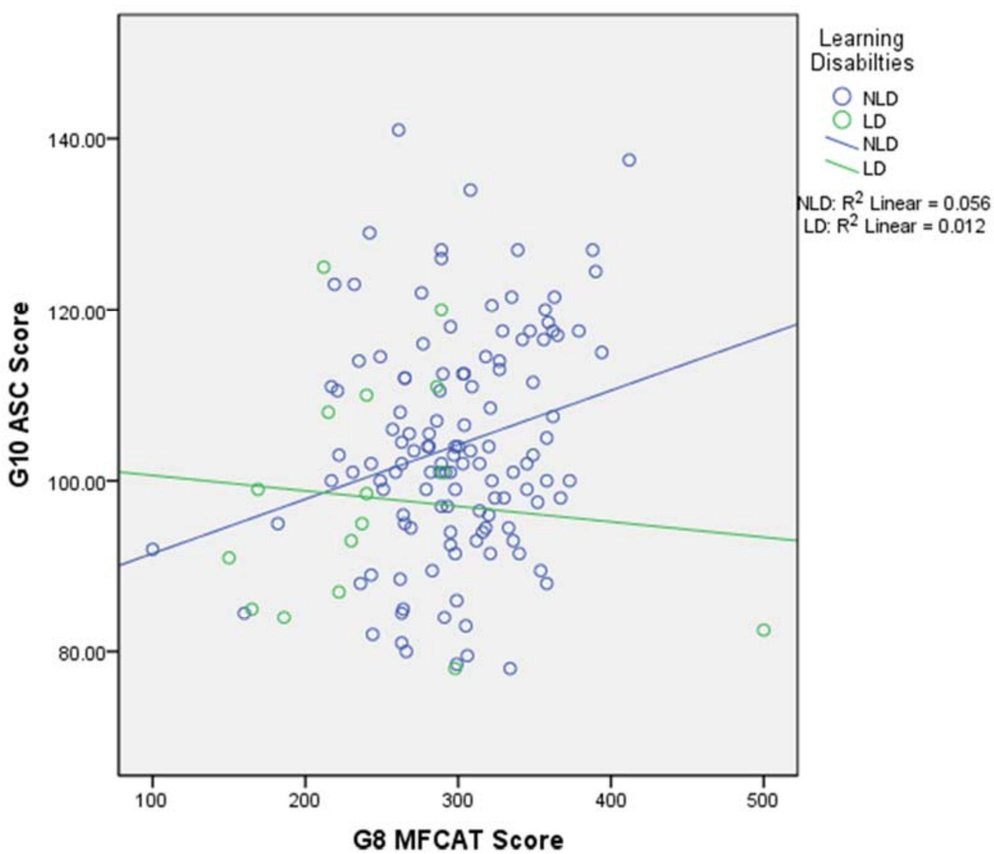

Figure 3. The Effect of G8 MFCAT on G10 ASC based on Students' LD Status.

Note. The dark line indicated that G8MFCAT score significantly predicted G10 ASC for students without LD; The light line indicated G8MFCAT score did not significantly predict G10 ASC for students with LD. NLD = Not Learning Disabilities. LD = Learning Disabilities. ASC = Academic Self-concept. MFCAT = Math Florida Comprehensive Assessment Test. WBMT=Woodcock-Johnson Broad Math Test.

Since there was a significant effect of interaction between G8 MFCAT and LD status on G10 ASC, a simple slope effect test was conducted to further investigate how the effect of G8 MFCAT on G10 ASC differed based on students' LD status. The results showed that for students without LD, G8MFCAT score significantly predicted G10 ASC (β = .15, *SE* = 0.05, $t_{(134)}$ = 2.87, p <.01), whereas, G8MFCAT score did not significantly predict G10 ASC for students with LD (β = -0.05, *SE* = 0.04, $t_{(134)}$ = -.21, p =.16).

Chapter 5

Discussion

This study provided an exploratory investigation of the relationship between academic self-concept math achievement at different time points in early and late adolescence, using high-stakes and low-stakes standardized math tests (MFCAT vs. WBMT). Two main research questions were addressed in this study: (a) What is the relationship between academic self-concept and math achievement in early and late adolescence for students without and with LD and (b) are there differences in the relationship between academic self-concept and math achievement among students without and with LD, using different achievement measures (MFCAT vs. WBMT)? The findings of this study indicated that WBMT scores in Grade 8 significantly predicted academic self-concept in Grade 10 in both students without and with LD. However, when using the MFCAT measure, the MFCAT scores in Grade 8 can only predict academic self-concept in Grade 10 in student without LD but not students with LD.

Group Means and Trajectory of Academic Self-concept of Students without and with LD from Grades 8 to 11

The findings of this study suggested differing group means of academic self-concept for students without and with LD from Grades 8 to 11. The group mean of academic self-concept for students with LD was generally lower than was it for students without LD at each time point. The mean difference widened from Grade 9 to 11 (Mean differences in academic self-concept score = .62, 4.33, 8.65), which was statistically significant at Grade 11. While taking a closer look at the trajectory of academic self-concept of students without and with LD from Grades 8 to 11 who completed all academic self-concept measures from Grades 8 to 11, for both subgroups of students without and with LD, the mean score of academic self-concept decreased from Grade 8 to 9 and later increased at Grade 10 until Grade 11. The decrease in academic self-concept from Grade 8 to 9 may result from the fact that students are experiencing a transition period from middle to high school. The transition period from middle to high school is a stressful, challenging, and uncertain process (Facchin, Margola, Molgora, & Revenson, 2014). During the school transition periods, such as the periods from elementary to middle school or from middle to high school, students are dealing with a series of challenges, such as "a new academic environment, a new social structure, and more difficult academic work" (Valentine et al., 2004, p. 117), which may have a negative effect on academic self-concept temporally (Seidman, Allen, Aber, Mitchell, & Feinman, 1994; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991). Therefore, it was no surprise that academic self-concept of students without and with LD decreased from Grades 8 to 9 and then increased from Grades 9 to 10 in this study.

Previous studies have showed inconclusive findings with regard to the development of academic self-concept across adolescence. Some scholars demonstrated a general declining trend of academic self-concept across adolescence (e.g., Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Musu-Gillette, Wigfield, Harring, & Eccles, 2015), whereas other scholars did not find a consistent decreased pattern of academic self-concept (e.g., Marsh 1989, Cole et al., 2001). The findings of this study supported the second argument that the development of academic self-concept may not follow a consistent decreased pattern. In particular, this study provided evidence for Marsh's "U-shaped quadratic effect" of academic self-concept for students without LD, in which academic self-concept declined during Grades 8 and 9 and then increased from Grades 9 to 11.

Nevertheless, despite the fact that the academic self-concept of students with LD was generally lower than was that of students without LD, the difference between two groups in Grades 8, 9, and 10 was not statistically significant, after controlling for differences in gender, race/ethnicity, and free lunch status. This result was inconsistent from previous relevant findings. Many studies showed that the academic self-concept of students with LD was significantly lower than that of students without LD. For instance, Stone and May (2002) investigated academic self-concept and the accuracy of estimation of academic skills between 52 students with LD and 49 students without disabilities at the high school level. The findings suggested that, compared to students without disabilities, students with LD had significantly lower academic self-concept than did students without LD at the high school level. However, in their study, Stone and May (2002) did not differentiate participants from different high school grade levels and instead pulled 9th-12th graders together as participants.

The lack of difference in academic self-concept between students without and with LD in Grades 8-10 may be explained by positive illusions and self-protective mechanisms of students with LD (Heath & Glen, 2005). Researchers found that students with LD tended to overestimate their academic abilities and skills compared to the ratings of others and to their actual academic performance (Stone & May, 2002). These overly positive self-evaluations of academic abilities can protect students with LD from anxiety and hurt feelings (Heath & Glen, 2005). It can only be speculated, but the self-protective mechanisms of students with LD may be related to the result of no significant difference compared to students without LD in academic self-concept in Grades 8, 9, and 10 in this study.

However, the results of ANCOVA showed that the group mean difference between students without and with LD was significant in Grade 11, after controlling for differences in gender, race/ethnicity, and free lunch status, with a small effect size ($F_{(1, 116)} = 6.6, p < 0.1, \eta^2 = .05$). With regard to the trajectory of academic self-concept of subgroups of students without and with LD, the results of t-test showed that there were significant differences in academic self-concept between subgroups of students without and with LD in Grade 10 and 11 and academic self-concept of students with LD was consistently lower than that of students without LD. It may be because in Grades 10, when the FCAT is administrated, 83% of students with LD did not pass FCAT in math at the first time (in 10th grade). This academic failure in a high-states math test may undermine the self-protective mechanism of students with LD, possibly leading to a decline in academic self-concept for students with LD in Grades 10 to 11.

Math Achievement for Students without and with LD

The findings showed that students with LD had significantly lower MFCAT/WBMT scores than did students with LD in Grades 8 and 10 was consistent with previous findings. This finding mirrors the results of NAEP (2013) investigation that there has been a persistent math achievement gap existing between students with and without LD. Also, the group means of MFCAT and WBMT scores of students without LD were similar in Grades 8 and 10. In contrast, the group means of MFCAT and WBMT scores of students with LD in Grade 10 were higher than were those in Grade 8.

With regard to gender differences in MFCAT and WBMT scores, female participants had significant higher MFCAT scores in Grade 10 than those of male participants, and there was no significant difference in other math measures. In addition, black students were found to have lowest scores and white students had highest scores in both MFCAT and WBMT across waves—this was also consistent with NAEP scores. Also, there was no significant difference in both math tests between students who received free lunch and did not receive free lunch. The proportion of students with LD who did not pass math FCAT at the first time in Grade 10 (83.3%) was much larger than was that of students without LD (40.5%).

The Relationship between Academic Self-concept and Math Achievement

Hierarchical regression models were conducted to explore the relationship between academic self-concept and math achievement for students without and with LD. The results showed that academic self-concept in Grade 8 did not predict FCAT or WBMT in Grade 10, whereas WBMT scores in Grade 8 could predict academic self-concept in Grade 10 for both students without and with LD. Nevertheless, interestingly, when using the MFCAT measure, MFCAT in Grade 8 can predict academic self-concept in Grade 10 in student without LD but not students with LD. For students with LD, the results suggest a negative relationship between MFCAT in Grade 8 and academic self-concept in Grade 10. In this study, in Grade 10 when FCAT was administrated as a high-stakes test, the majority of students with LD did not pass math FCAT at the first time. This academic failure in the high-stakes math test may have led to a negative association between academic self-concept and MFCAT for students with LD.

In this study, for both students without and with LD, academic self-concept in Grade 8 did not predict MFCAT or WBMT score in Grade 10. There may be two possible explanations; first, according to Valentine et al. (2004)'s meta-analysis study, long delays between data collection waves was a significant moderator affecting the relationship between self-concept and academic achievement. Thus, the relatively long period of two years between Grades 8 and 10 may weaken the effect of academic self-concept in Grade 8 on math achievement in Grade 10.

Second, Grade 8 and Grade 10 are respectively in two different school levels: middle and high school. Participants in this study experienced a school transition from middle to high school, leading to a decline in academic self-concept from Grade 8 to 9. In Valentine et al. (2004)'s meta-analysis study, the effect of prior self-related beliefs on subsequent academic achievement during school transition was smaller than was that with no school transition. Thus, because of school transition from middle to high school, the decline in academic self-concept may be not strong enough to have a significant impact on subsequent math achievement. In previous studies, some researchers found that, during early school years, students' self-concept had not fully developed and that students may experience a "process of shaping and reshaping," which was largely from their academic experience (Skaalvik & Valas, 1999, p. 145). As students grow older, self-concept may be better developed and become more stable and reliable, possibly affecting students' motivation, and further affecting subsequent academic achievement. Previous studies have only tested this assumption in the elementary and middle school level but not the high school level. The current study explored this assumption into the transition from middle to high school. As stated before, according to Shavelson at al. (1976)'s self-concept model, self-concept has a developmental nature, which means that academic and nonacademic self-concept becomes more distinct in the structure of self-concept as one individual grows. It is possible that academic self-concept becomes more stable and well established at an even later age (e.g., late high school) than does general self-concept. Thus, academic self-concept may not be stable and reliable in early and late adolescence, which limits the examination of academic self-concept and the possible relationship with subsequent math achievement.

This study suggests a possible relationship between WBMT scores in Grade 8 and academic self-concept in Grade 10 in both students without and with LD. Nevertheless, interestingly, the results also indicted that this relationship might differ depending on the use of high-stakes or low-stakes math tests: MFCAT scores in Grade 8 were related to academic self-concept in Grade 10 only in students without LD but not students with LD. As a high-stakes state mandated test, the MFCAT score has significant consequences for a student’s graduation from their current school. Over the past few decades, there has been a debate on how high-stakes tests affect students (Reardon, Arshan, Atteberry, & Kurlaender, 2010). Some researchers argue that high-stakes tests can promote students’ motivation to work harder and do well in these tests and increase students’ academic achievement (Firestone & Mayrowetz, 2000; Jones, Jones, Hardin, Chapman, Yarbrough, & Davis, 1999). In contrast, others contend that high-stakes tests are not only ineffective, but also may increase school dropout rates, harm higher order thinking skills, and discourage students (Jacob, 2001). For students with LD, high-stakes tests may cause students to feel anxious and harm their self-esteem (Holbrook, 2001; Jones & Egley, 2004; Ysseldyke et al., 2004).

This study's exploratory findings suggest that the effect of high-stakes tests in math may differ for each group: For students without LD, high-stakes tests scores may promote students' motivation to work harder, possibly increasing their academic self-concept; for students with LD or low-achieving students, high-stakes tests may discourage them, and cause them to feel anxious, thus harming their academic self-concept. It may be because passing the FCAT plays a significant role in whether a student graduates. Also, previous research has found only a small percentage of students with LD graduate with a standard high school diploma because of low FCAT scores (Cavendish, 2013). In this study, the proportion of students with LD who did not pass the math FCAT in Grade 10 (83.3%) was much larger than was that of students without LD (40.5%). Thus, the academic failure in high-stakes math tests may lead to a decline in academic self-concept in Grades 10 and 11, and a possible negative association between FMCAT and academic self-concept for students with LD.

In the existing research, there are two hypotheses with regard to the understanding of individuals' difficulties in the social, emotional, and behavioral domains: the "primary-cause hypothesis" and "secondary-cause hypothesis" (Al-Yagon & Margalit, 2013, p. 279). The "primary-cause hypothesis" refers to that "internal neurological factors (e.g., information-processing disorders) that affect these individuals' academic skills may also affect their social emotional perceptions and interpretation, which, in turn, may impair their social emotional, and behavioral skills" (Al-Yagon & Margalit, 2013, p. 279). The "secondary-cause hypothesis" indicates that individuals' social and emotional difficulties result from or is a "secondary effect" of their basic academic difficulties. While many studies provided evidence for the "primary-cause hypothesis", this study suggests that failure in academic performance for students with LD may be also part of the reason of their social and emotional difficulties to a certain extent.

Limitations

This study provides an exploratory examination of the relationship between academic self-concept for students without and with LD. However, several limitations should be considered while interpreting the findings. First, this study had a relatively small sample size of participants and only focused on math achievement, which limited the generalization of the findings of this study.

Second, because of missing data at each time point for each measure, the missing cases may differ from the cases with data. Thus, the change in the number of participants at different time points may pose a threat to internal validity of this study.

The third limitation of this study was that the content areas of self-concept and achievement did not match exactly (i.e., math self-concept, math achievement). Previous research found a stronger relationship between self-concept and academic achievement when they are measured in the same domain (Valentine et al, 2004). Thus, the mismatch in the content area of self-concept and achievement may affect the relationship between academic self-concept and math achievement.

Fourth, previous studies found a variety of factors that may affect the relationship between academic self-concept and math achievement, such as educational placement settings and class achievement level. This study does not rule out the potential effects of these factors on the relationship between academic self-concept and math achievement for students without and with LD.

Finally, considering the fact that the participants experienced a school transition from middle to high school in this study, these findings of this study should not be generalized into other age groups.

Implications

The findings of this exploratory study suggest support for the relationship between academic self-concept and math achievement, in which WBMT scores in Grade 8 may significantly predict academic self-concept in Grade 10 in both students without and with LD. Nevertheless, when using the high-stakes MFCAT measure, Grade 8 MFCAT score can only predict Grade 10 academic self-concept in student without LD but not in students with LD.

There are potential implications for educational practice that can be drawn from the findings in this study. First, understanding the relationship between academic self-concept and academic achievement may have significance for the development of educational interventions and teaching practices. As the findings of this study may suggest that prior math achievement can predict subsequent academic self-concept, educators should make efforts to improve student achievement, thus enhancing academic self-concept. While academic self-concept is not equivalent to self-esteem, both constructs are both an individual's perception of oneself. The results suggest possible support for Baumeister (2003) findings that improving self-esteem through school interventions did not result in positive outcomes (Baumeister, Campbell, Krueger, & Vohs, 2003). Instead, he was opposed to the "enthusiastic claims of the self-esteem movement" and argued that "the effects of self-esteem are small, limited, and not all good (Baumeister, 1996, p. 14). Although academic self-concept can be viewed as a "primary determinant" of a series of desirable academic outcomes in previous studies (Marsh & Hau, 2003, p. 365), such as school interest (Trautwein, Lüdtke, Marsh, Köller, & Baumert, 2006), homework effort (Trautwein, Lüdtke, Schnyder, & Niggli, 2006), and educational aspirations (Marsh, 1991); a relationship to students' math achievement seems to be very limited in this study. Thus, when developing interventions, educators and researchers should be aware that simply enhancing students' academic self-concept might not be sufficient to enhance students' subsequent math achievement in early and late adolescence.

It has been recommended that teachers should mainly focus on improving students' math skills and abilities "as the best way to improve self-concept" (Marsh, & Martin, 2011, p. 72). This finding may be particularly essential as well for students with LD. Academic self-concept has been found to be related to school persistence and work effort (Trautwein, Lüdtke, Schnyder, & Niggli, 2006). Students with higher academic self-concept tend to be more persistent and engage more effort in school work than students with lower academic self-concept. As students with LD reported a relatively high school dropout rate compared to student without LD, the improvement of academic self-concept of student with LD may help reduce school dropout rate and increase the chance for advancing into next school level for students with LD, which may further benefit their subjective well-being in the long term.

Researchers and practitioners should also consider that the social development and academic outcomes of students are not independent from each other. Some studies have designed the self-concept intervention programs solely to improve students' social aspects (e.g., behavioral monitoring, communication skills) (Sridhar & Vaughn, 2002).

However, based on the exploratory findings of this study, academic self-concept interventions may be more effective if incorporated with strategies that facilitate students' academic achievement (Klusmann, Kunter, Trautwein, Ludtke, & Baumert, 2008). This is consistent with Elbaum and Vaughn (2001), who found that "the most effective interventions for elementary students with LD were those that focused on improving students' academic skills" (p. 50). For students with LD, this kind of combination of academic self-concept and academic interaction may be particularly effective and essential for students with LD, considering their lower achievement and academic self-concept (Sridhar & Vaughn, 2002).

The relationship between academic self-concept and math achievement might also differ depending on the use of high-stakes or low-stakes math tests. High-stakes math tests can have a significant consequence to students. In this study, the majority of students with LD were found not to pass math FCAT. The academic failure in high-stakes math tests may have a negative effect on self-concept for students. Given the lower academic performance on achievement tests for students with LD, they may be more vulnerable to academic failure inherent with high-stakes testing relative to students without LD. Thus, while making efforts to improve the performance of students with LD in high-stakes tests, it has been suggested by researchers that educators should provide students with LD with additional psychological and emotional support and specific interventions tailored for students with LD to help them cope with school failure (Kruger, Wandle, & Struzziero, 2007).

Implications for research. This exploratory study suggests several potential directions for future research. First, this study suggests that there may be differences in relationship between academic self-concept and math achievement between students without and with LD at different time points in early and late adolescence. This finding suggests a need for further longitudinal design that could include the transition to middle and high school to tests if this relationship remains consistent (with the drop at the transition year).

Second, the trajectory of academic self-concept in this study provides a picture over time of academic self-concept development for students without and with LD in early and late adolescence, indicating that the development of academic self-concept may be dynamic changing process, which relies on their academic experiences. Thus, further research should examine the effects of possible moderators that affected the relationship between academic self-concept and math achievement for students without and with LD (e.g., educational placements, class achievement level, social support), which may allow researchers to provide specific intervention recommendations which this current study cannot.

Third, as this study has a relatively small sample size of participants in this study with missing data over time points, future research should use national or international large-scale datasets, which could be analyzed with more sophisticated statistical techniques (e.g. structural equation modeling) that allows to examine more complex relationship with the inclusion of possible additional moderating factors (e.g., motivation, attribution) and conduct multiple group comparison among different subgroups (e.g., gender, race/ethnicity).

Fourth, because of this study only focused on the math achievement content area and tested participants from early and late adolescence, future studies should examine the relationship in other subjects such as reading, writing, language, science and across other age groups for students without and with LD.

Finally, future research may include a focus on the coherence of the academic domain-specificity when exploring the relationship between self-concept and academic achievement for students without and with LD and also examine this relationship with additional measures of achievement, other than standardized tests, such as teachers' assessments of academic achievement (i.e., grades, teachers' ratings), as previous research suggested that the relationship between academic self-concept and academic achievement may be affected by the use of different types of teachers' assessments (Trautwein, Lüdtke, Köller, and Baumert, 2005; Marsh & Yeung, 1998a; Möller, Retelsdorf, Köller, & Marsh, 2011).

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