



Math self-concept in preschool children: Structure, achievement relations, and generalizability across gender



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ABSTRACT

This three-wave, longitudinal study explored the math self-concept of German preschool children ($N=420$) with respect to its differentiation into competence and affect components, cross-sectional and longitudinal relations to early math achievement, and invariance across gender. Findings demonstrated that preschool children's math self-concept can be separated into competence and affect components, with the competence component displaying higher relations to early math achievement than the affect component. The competence component but not the affect component was found to be related to prior math achievement, providing evidence of the skill-development model of self-concept–achievement relations in preschool years. Boys and girls demonstrated similar self-concept–achievement relations and mean levels in the competence and affect components of math self-concept. Given so far little research on self-concept in preschool children, this study offers important insights and expands current knowledge.

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1. Introduction

Students' academic self-concept can be generally defined as students' academic self-perceptions (Shavelson, Hubner, & Stanton, 1976) and has been a widely examined and important construct in educational and developmental psychology. The importance of academic self-concept is due to its relations to a wide range of outcomes including achievement (Huang, 2011; Marsh & O'Mara, 2008; Valentine, DuBois, & Cooper, 2004), motivation (Nagengast et al., 2011; Wigfield & Eccles, 2000), effort (Trautwein, Lüdtke, Schnyder, & Niggli, 2006), and educational choices (Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014). Besides investigating relations with outcome variables, researchers have invested considerable effort into studying the internal structure of academic self-concept and gender differences (Marsh & Craven, 2006; Marsh & O'Mara, 2008). Respective studies, however, predominantly focused on elementary and secondary school students, and less research has been conducted with children before the beginning of formal schooling (i.e., preschool or kindergarten children). Yet,

due to cognitive limitations and differences in the learning environment, preschool children's academic self-concept might differ from that of school students. The present longitudinal study focuses on different research questions related to math self-concept in German preschool children. These questions address the possibility of further differentiating math self-concept into competence and affect components, its cross-sectional and longitudinal relations to early math skills, and the generalizability of findings across gender.

2. The construct of academic self-concept

2.1. Twofold multidimensional structure

Academic self-concept was originally assumed to comprise math and verbal self-concepts as subcomponents (Shavelson et al., 1976). Math and verbal self-concepts have been found to be nearly uncorrelated leading to the accepted conceptualization of academic self-concept as a domain-specific construct with distinct math and verbal self-concepts (Marsh, 1990; Möller, Pohlmann, Köller, & Marsh, 2009). The domain specificity of academic self-concept is also incorporated in the Self-Description Questionnaires (SDQ), an extensively validated and widely used series of instruments to assess students' self-concept in different age groups (Byrne,

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1996; Marsh, 2007). The SDQ instruments encompass separate math and verbal self-concept scales with items asking for students' self-perceptions of competence in the respective academic domains (i.e., math, verbal) as well as items addressing students' motivational and affective responses to these domains. The competence-related and affect-related items were originally combined to unified scales (Marsh, 2007). However, well-established theories on motivation in education differentiate between competence self-perceptions and affective-motivational constructs. For example, the expectancy-value model (Eccles & Wigfield, 1995; Nagengast et al., 2011; Wigfield & Eccles, 2000) conceptualizes the expectancy and value components as two separate, yet interacting constructs. Competence self-perceptions can be regarded as a subcomponent of the expectancy component while motivational and affective responses are conceptually similar to intrinsic value (liking, enjoyment, interest) as a subfacet of the value component. Hence, it might be reasonable to assume that competence-related and affect-related self-concept items form separate constructs. This assumption could be indeed supported in recent studies showing that math and verbal self-concepts can each be differentiated into a competence component depicting students' self-evaluation of competence and an affect component of students' motivational-affective reactions (Arens & Hasselhorn, 2015; Arens, Yeung, Craven, & Hasselhorn, 2011; Marsh, Craven, & Debus, 1999; Marsh et al., 2013; Pinxten, Marsh, De Fraine, Van Den Noortgate, & Van Damme, 2014). This finding originates from confirmatory factor analyses (CFA) comparing a 1-factor model with a 2-factor model. The 1-factor model assumes a global factor for a domain-specific academic self-concept (e.g., math self-concept) which is defined by both competence and affect-related items. The 2-factor model states separate factors, one for the competence component and one for the affect component related to a domain-specific academic self-concept (e.g., math competence self-concept and math affect self-concept), each defined by only the competence-related or affect-related items.

2.2. Relations between self-concept and achievement

Research endeavors on academic self-concept trace back to the proposition that holding a high self-concept is an important outcome in its own right and yields positive impact on a wide range of desirable outcomes including academic achievement (Marsh, 2007; Marsh & O'Mara, 2008). Indeed, academic self-concept has been consistently found to be substantially related to academic achievement (Marsh & Craven, 2006). Self-concept–achievement relations follow a domain-specific pattern since the relation between math self-concept and math achievement is higher than the relation between math self-concept and verbal achievement—a finding that again demonstrates the domain specificity of academic self-concept (Marsh & Craven, 2006; Marsh & O'Mara, 2008).

The investigation of self-concept–achievement relations further substantiates the assumption of a distinction between competence and affect components within domain-specific academic self-concepts since both components share differential relations to outcome criteria. The competence component has been found to be more highly related to achievement (Arens et al., 2011; Marsh et al., 2013) whereas the affect component seems to be more highly associated with behavioral indicators including effort expenditure (Arens & Hasselhorn, 2015; Pinxten et al., 2014). Based on these findings, academic self-concept has been conceptualized as comprising a twofold differentiation: first, a differentiation into math and verbal domains (domain specificity), and second, a differentiation into competence and affect components (Arens et al., 2011).

Considering longitudinal relations between self-concept and achievement, originally, the skill-development model (achievement

is assumed to impact upon self-concept) was contrasted with the self enhancement model (self-concept is assumed to impact upon achievement; Caslyn & Kenny, 1977). Recent findings have suggested mutually reinforcing relations between self-concept and achievement and therefore argue in favor of the reciprocal effects model (REM; Marsh & Craven, 2006). The REM combines the assumptions of the skill-development and the self enhancement models as it proposes that self-concept is an outcome as well as an antecedent of achievement. The REM has been supported by a range of empirical studies (Huang, 2011; Marsh & Craven, 2006; Marsh & Martin, 2011) and has been found to be generalizable across different educational systems and cultures (Germany: Marsh & Köller, 2004; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Möller, Retelsdorf, Köller, & Marsh, 2011; Niepel, Brunner, & Preckel, 2014; Hong Kong: Marsh, Hau, & Kong, 2002; Taiwan: Chen, Yeh, Hwang, & Lin, 2013).

2.3. Gender differences

Studies investigating gender differences in mean levels of academic self-concepts have generally found that such differences follow gender stereotypes. Hence, girls have been found to display higher mean levels of verbal self-concept whereas boys have been found to have higher mean levels of math self-concept (Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Marsh, 1989; Skaalvik & Skaalvik, 2004; Wilgenbusch & Merrell, 1999). Besides mean differences in academic self-concepts, other studies investigated whether boys and girls differ in the relations between academic self-concept and achievement. Stereotypic socialization processes including reinforcements, feedback, and expectations might lead boys to establish a stronger association between math achievement and math self-concept than girls (Marsh, 1993). However, existing studies have demonstrated gender-invariant instead of gender-stereotypic patterns of self-concept–achievement relations so that boys and girls demonstrated similar relations between math (verbal) self-concept and math (verbal) achievement (Helmke & van Aken, 1995; Marsh, Trautwein, et al., 2005; Marsh & Yeung, 1998; Valentine et al., 2004).

To sum up, considerable effort has been invested into research on the construct of academic self-concept including its structure, achievement relations, and gender differences. However, most of these studies have been conducted with elementary and secondary school students. Fewer studies have focused on the academic self-concept of young children who have not yet entered formal schooling and attend preschool.

3. Academic self-concept in preschool children

In the present study, we focus on German preschool children's academic self-concept which might differ from that of school-age students for various reasons. Academic self-concept has been assumed to be influenced by experiences with and within the environment (Shavelson et al., 1976). In Germany, notable differences exist between the academic environment and learning experiences of preschool and school-age children. Children usually enter kindergarten at the age of three or four and stay there until entering the compulsory elementary school at about six years of age. In German kindergartens, no formal instruction is provided with respect to academic skills. Preschool children rather acquire and improve their skills by playful and informal interactions with peers, parents, and educators. Instruction and learning opportunities are adapted to an individual child's learning preconditions and circumstances. Achievement feedback mainly aims to motivate a child for further learning and thus relies on intraindividual, temporal comparisons focusing on a child's improvement.

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