Contemporary Educational Psychology 43 (2015) 25–38

Contents lists available at ScienceDirect

Contemporary Educational Psychology

journal homepage: www.elsevier.com/locate/cedpsych

Decreasing the SES math achievement gap: Initial math proficiency and home learning environments

Claudia Galindo *, Susan Sonnenschein

University of Maryland, Baltimore County, USA

ARTICLE INFO

Article history:
Available online 21 August 2015

Keywords:
Math skills
SES
Home learning environments

ABSTRACT

Many children in the U.S., particularly those from low socioeconomic status (SES) backgrounds, do not develop sufficient math skills to be competitive in today's technological world. We utilized a mediation/moderation framework and the ECLS-K dataset to investigate factors that can decrease the SES-related math achievement gap in kindergarten. Starting kindergarten proficient in math and experiencing a supportive home learning environment significantly decreased SES achievement differences. Proficiency in math at the start of kindergarten accounted for the greatest decrease in the SES-math achievement gap. Findings support the importance of comprehensive and multi-contextual approaches targeted to families and schools for improving children's exposure to math-relevant experiences.

1. Introduction

Many children in the U.S., particularly those from socioeconomically disadvantaged backgrounds, do not exhibit adequate mathematical skills (National Research Council, 2009). Math disadvantages associated with various indices of low socioeconomic status (SES) are evident by kindergarten (Arnold & Doctoroff, 2003; Byrnes & Wasik, 2009; Chatterji, 2005; Duncan & Magnuson, 2005; Jordan, Kaplan, Olah, & Locuniak, 2006; Lee & Burkam, 2002; Nores & Barnett, 2014) or even earlier (Burchinal et al., 2011). Children from families with low SES, on average, score about one half standard deviation below higher SES children on standardized measures of academic achievement (e.g., Bradley & Corwyn, 2002; Duncan & Magnuson, 2005).

This study uses data from the Early Childhood Longitudinal Study-Kindergarten cohort 1998–1999 (ECLS-K) to investigate two factors that could be associated with the SES-math achievement gap: starting kindergarten with age-appropriate math skills and children's home learning environments. We examine the extent to which math proficiency at entry to kindergarten attenuates (mediates) the relation between SES and math scores at the end of kindergarten. After controlling for math proficiency at the start of kindergarten, we also consider which, if any, indicators of the home learning environment in kindergarten further attenuate (or mediate) the SES-math achievement gap.

We next examine whether SES could also be framed as a moderator between initial math proficiency, indicators of the home learning environment in kindergarten, and children's math achievement (Beauchaine, Webster-Stratton, & Reid, 2005). We examine the extent to which initial math proficiency at the start of kindergarten and the home learning environment have similar associations for children from different SES groups. By utilizing a mediation/moderation framework, we assess the chain or path of associations at the same time that we address for whom these factors are relevant (Beauchaine et al., 2005). Understanding the nature of the relation will increase our knowledge of what processes account for associations between SES and math skills, and provide a foundation for the development of possible interventions that may decrease the SES-achievement gaps.

Most studies have considered math entry skills as a continuous variable (e.g., Byrnes & Wasik, 2009; Duncan et al., 2007; Jordan, Kaplan, Ramineni, & Locuniak, 2009); we consider it as a dichotomous one to assess threshold effects (discussed further in section 1.2). We focus on math proficiency at kindergarten entry (defined as proficiency at aspects of number sense; discussed further in section 2.2.2.) because starting kindergarten with well-developed number sense is an important predictor of more advanced math skills (e.g., Anders et al., 2012; Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Duncan et al., 2007; Geary, Hoard, Nugent, & Bailey, 2013; Jordan, Glutting, Dyson, Hassinger-Das, & Irwin, 2012; Jordan, Glutting, Ramineni, & Watkins, 2010; Lago & DiPerna, 2010; Watts, Duncan, Siegler, & Davis-Kean, 2014).

Although the exact definition of what is included in number sense varies across researchers (Lago & DiPerna, 2010), most agree that it includes an understanding of whole numbers, number operations, and number relations (Jordan et al., 2010; National Research

* Corresponding author. Sherman Hall 403, 1000 Hilltop Circle, Baltimore, MD 21250, USA. Fax: +1 410 455 3233.
E-mail address: galindo@umbc.edu (C. Galindo).

http://dx.doi.org/10.1016/j.cedpsych.2015.08.003
0361-476X/

Council, 2009). For example, Jordan et al. (2006) included counting, number knowledge, number transformation, estimation, and number patterns as components of number sense (see also National Mathematics Advisory Panel, 2008). Similarly, the National Council of Teachers of Mathematics (1989) defined number sense as the ability to understand the meaning of numbers, define relationships among numbers, recognize the relative size of numbers, and use referents for measuring objects. For example, children in preschool through second grade are expected to be able to connect number words and numerals with the quantities they represent, using various physical models and representations (National Council of Teachers of Mathematics, 1989; http://www.nctm.org/Standards-and-Positions/Principles-and-Standards/Principles,-Standards,-and-Expectations/). By third grade, children are expected to recognize equivalent representations for the same number and generate them by decomposing and composing numbers. Number sense has also been called informal or everyday math, suggesting that its roots generally lie in informal or daily experiences (Ginsburg, Lee, & Boyd, 2008) rather than the types of formal instruction experienced in elementary school.

1.1. Socioeconomic status and young children's math skills

There has been extensive research investigating the impact of SES on children's development (e.g., Bradley, Corwyn, McAdoo, & Garcia Coll, 2001; Byrnes & Wasik, 2009; Crosnoe & Cooper, 2010; Duncan & Magnuson, 2005; Gershoff, Aber, Raver, & Lennon, 2007; Guo & Harris, 2000; McLoyd, 1998). Children from low SES families are more likely to start school with lower academic skills; these differences between low SES children and their higher SES peers continue or expand as children proceed through school (Bradley & Corwyn, 2002; Caro, McDonald, & Willms, 2009; Sirin, 2005).

Consistent with findings of children's general academic skills, there are differences related to SES in children's acquisition of math skills (Jordan et al., 2006: National Research Council, 2009). Children from low SES backgrounds generally enter kindergarten with more limited math skills than their middle income peers (see Klein, Starkey, Clements, Sarama, & Iyer, 2008 for a review). For example, Jordan et al. (2006), among others, found that children from low income backgrounds generally began kindergarten with less well-developed number sense than their more affluent peers. Others have noted that most children develop basic counting skills by the start of kindergarten; however, SES related group-based differences emerge in the more advanced number sense skills (e.g., numerical magnitude estimation), and then in subsequent math skills (Claessens & Engel, 2013; National Research Council, 2009).

1.2. Children's math proficiency at kindergarten entry

Regardless of SES, young children acquire informal mathematical knowledge through their involvement in home activities before the start of formal schooling; such knowledge serves as the basis for development of math skills once they enter school (Ginsburg et al., 2008; National Research Council, 2009; Ramani & Siegler, 2014; Starkey, Klein, & Wakely, 2004). Children who start school with more limited number sense continue to have difficulties as they proceed through elementary school (Jordan, Kaplan, Locuniak, & Ramineni, 2007).

It is possible that children may need to display a certain level or threshold of math skills to achieve maximum benefit from teachers' instruction (e.g., Connor, Morrison, & Katch, 2004 for reading instruction). Research on children's math development shows the importance of achieving certain math skills as the threshold for future math development. For example, Siegler et al. (2012), using children in the U.S. and Great Britain, found that children's knowledge of fractions and division at the end of elementary school predicted their knowledge of algebra in high school, even after controlling for other math knowledge, SES, parents' education, intellectual abilities. In another study, Siegler and colleagues showed that number line estimation and calculation fluency in third grade were the major predictors of knowledge of fractions at the end of fifth grade (Bailey, Siegler, & Geary, 2014; see also Jordan et al., 2013). Most pertinent for this study, Claessens and Engel (2013), using the ECLS-K data set, found that what we are calling math proficiency at the start of kindergarten (attainment of proficiency level 2) was the strongest predictor of children's math skills in eighth grade. Proficiency level 2 included reading all single-digit numerals, counting beyond 10, recognizing a sequence of patterns, and using nonstandard units of length to compare objects. We do not yet know, however, whether starting kindergarten with a certain level of math skills attenuates the negative impact of SES on math achievement.

1.3. Home learning environments

The home environment is an important context or microsystem for young children's development (Bronfenbrenner, 1979). Growing up in a cognitively stimulating home predicts children's immediate and longer-term academic development (e.g., Crosnoe & Cooper, 2010; Crosnoe et al., 2010). A cognitively stimulating home learning environment typically has been defined as including a broad array of possible activities and interactions with others (e.g., Caldwell & Bradley, 1984; Crosnoe & Cooper, 2010).

Children from different SES levels do not have equal access to comparable home learning environments. Bradley et al. (2001), using the National Longitudinal Study of Youth data set, found that low income children had less access to learning tools at home than middle income children. Similarly, low income families spend less time than middle income ones in cognitively enriching environments outside the home (Phillips, 2011). Children from low income backgrounds are also less likely to engage in cognitively enriching verbal (Hart & Risley, 1995) or reading interactions (Guo & Harris, 2000; Serpell, Baker, & Sonnenschein, 2005). The differences in the language low and middle income children hear at home can result in differences in their readiness for or understanding of instruction at school (Hindman, Skibbe, Miller, & Zimmerman, 2010).

Parents' expectations for their children's development and achievement, and their involvement in their children's general educational development, particularly at school, are associated with children's academic achievement (Fan & Chen, 2001; Galindo & Sheldon, 2012; Hill & Taylor, 2004; Jeynes, 2005; Sonnenschein, Stapleton, & Metzger, 2014; Yamamato & Holloway, 2010). Dearing, Kreider, Simpkins, and Weiss (2006) found that the SES-related reading gap was eliminated when parents were involved at their children's schools. However, low income parents generally are less involved than middle-income parents (Grolnick, Benjet, Kurowski, & Apostoleris, 1997; Lee & Bowen, 2006; Reynolds, 1992). Based on the results of a meta-analysis with 25 studies, Fan and Chen (2001) found that parents' expectations for their children's future educational attainment accounted for more variance in children's academic achievement than other aspects of parent involvement. Most research has focused on parents' expectations for their children's future educational attainment; however, recent research shows the need to focus as well on expectations for what skills children need to have in kindergarten because of their predictive value for achievement (Sonnenschein & Galindo, 2015).

Children's early math skills can be acquired through their experiences at home and/or preschool (Ginsburg et al., 2008). However, our knowledge of what specific aspects of the home environment foster children's math skills is still fairly limited. Research has shown links between literacy-related activities, other components of the home learning environment and children's math skills. For example, reading at home and parents' expectations for their children's future educational achievement are associated with children's math