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Approaches to learning and science education in Head Start: Examining bidirectionality

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ABSTRACT

Recent national focus on early childhood science education highlights the need for research on early science, particularly with children from low-income families, as science is the lowest performing school readiness domain in that population. Given this achievement gap, the Office of Head Start has emphasized the development of children's domain-general skills, such as approaches to learning, because they help children succeed in the classroom regardless of academic content area. Recent research suggests a unique relationship between early science and approaches to learning, in that approaches to learning predicts gains in science readiness more so than math or language readiness. This study further explored this relationship by examining the potential bidirectionality between science and approaches to learning. Results obtained from hierarchical linear modeling suggest a significant bidirectional relationship, such that residualized change approaches to learning across the school year predicted gains in science across the year, and residualized change in science across the year predicted gains in approaches to learning across the year. These results suggest that development of children's approaches to learning relates to gains science knowledge, and that gains in children's science knowledge relates to the positive development of approaches to learning across the school year. This study provides support for future research examining the potential of science interventions to serve as a context for developing approaches to learning skills that will in turn help children engage in quality science learning. Such research would leverage the bidirectional relationships between these two constructs and could be a step in the national attempt to narrow the science and school readiness achievement gaps.

1. Introduction

There is a growing recognition of the need for more effective science education in the United States, starting in early childhood (Morgan, Farkas, Hillemeier, & Maczuga, 2016). Simultaneously, a national achievement gap exists between children from low-income backgrounds and their higher income peers (Magnuson, Waldfogel, & Washbrook, 2012). The gap begins in early childhood and increases throughout formal schooling (Ryan, Fauth, & Brooks-Gunn, 2006). Disparities are evident across academic domains but are even more pronounced in science readiness. The Head Start framework (U.S. Department of Health and Human Services, 2015) identifies four academic readiness domains for preschoolers—language, literacy, math, and science—of the four, science is the lowest performing among preschoolers from low-income backgrounds served by Head Start (Greenfield et al., 2009). This is unfortunate considering science is an interactive content area that capitalizes on children's natural curiosity about the world and relates positively to other school readiness domains (e.g. math, language, and executive functioning) and high-quality teaching practices for children from low-income backgrounds (Cabell, DeCoster, LoCasale-Crouch, Hamre, & Pianta, 2013; Fuccillo, 2011; Nayfeld, Fuccillo, & Greenfield, 2013). The Head Start framework defines science readiness as "the emerging ability to develop scientific knowledge about the natural and physical worlds, learn scientific skills and methods, and continue developing reasoning and problem-solving skills" (U.S. Department of Health and Human Services, 2015).

Given the achievement gap in this population, recent research has focused on identifying domain-general skills that facilitate children's learning, regardless of content area (Li-Grinning, 2007; McClelland et al., 2007). Approaches to learning are a set of domain-

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general skills that have garnered increasing attention and have been recognized by the Office of Head Start as one of the foundational school readiness domains (U.S. Department of Health and Human Services, 2015). These skills involve persistence, motivation, and flexible thinking, and allow children to effectively engage in learning. Due to their domain-general nature, approaches to learning are difficult to teach in isolation, making it important to identify optimal learning contexts that provide opportunities to develop these skills.

Recent research suggests a unique link between science readiness and approaches to learning, such that children who have higher approaches to learning (i.e. persistent, focused, open-minded, and collaborative) make greater gains in science across the preschool year, as compared to gains in math and language (Bustamante, White, & Greenfield, 2016). This is an important finding suggesting that approaches to learning relate to children's development of science school readiness. However, the inverse relationship (i.e., if science readiness relates to the development of approaches to learning) has not yet been determined.

This relationship is important to understand the unique connection between approaches to learning and science school readiness and to identify content domains that can potentially promote development in approaches to learning. This study extended existing research by examining the bidirectional relationship between science readiness and approaches to learning across the academic year in a sample of diverse children attending Head Start. A bidirectional relationship would demonstrate that approaches to learning and science readiness share a unique connection and could be intentionally supported together to help children develop both domain-general learning skills and content knowledge.

1.1. Background

1.1.1. Approaches to learning

Approaches to learning refer to a set of learning styles and behaviors that affect how children approach any learning situation (Kagan, Moore, & Bredekamp, 1995; Vitiello, Greenfield, Munis, & George, 2011). Seven core sub-domains of approaches to learning have been identified; strategic planning, effectiveness motivation, interpersonal responsiveness in learning, vocal engagement in learning, sustained focus in learning, acceptance of novelty and risk, and group learning (McDermott et al., 2011). The development of these skills is grounded in the idea that children's learning experiences are greatly influenced by the motivational, attentional, and behavioral mechanisms they use to engage in learning tasks (McClelland & Morrison, 2003; McDermott et al., 2011).

Linking this conceptual background on approaches to learning with sociocultural and constructivist perspectives of child development (e.g. Vygotsky, 1986), this set of cognitive and behavioral skills can serve as "mental tools" that enable children to engage in learning and construct new knowledge (Bodrova & Leong, 2007; Paris & Winograd, 1990). Vygotsky's theory of sociocultural development also highlights the social context as critical for children's learning, which are inherent to some of the components of approaches to learning discussed above (e.g. vocal engagement and group learning). Thus, theoretical and conceptual background on child development and learning suggests that these skills play a key role in early learning and one would expect direct relationships with children's academic success.

These relationships are indeed empirically supported through concurrent and predictive relationships between approaches to learning and academic outcomes in early childhood and beyond (Fantuzzo, Perry, & McDermott, 2004; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010; McClelland, Morrison, & Holmes, 2000; McDermott, Rikoon, & Fantuzzo, 2014; McWayne, Fantuzzo, & McDermott, 2004; Vitiello et al., 2011). For example, children rated by teachers as having higher approaches to learning also show higher competency in math, language, and fine and gross motor coordination (McWayne et al., 2004). Additionally, research shows that children with higher approaches to learning in preschool demonstrate higher proficiency in reading, vocabulary, language, math, and science in second grade (McDermott et al., 2014). Taken together, theory and evidence suggest that these skills set the foundation for learning early in childhood.

Further, preschool is a particularly important time to examine the development of approaches to learning. Generally, the preschool years are recognized as a critical period in development due to the rapid cognitive changes that occur. During these years, the mental processes that support approaches to learning form and develop quickly, and set the foundation for future learning (Welsh, Nix, Blair, Bierman, & Nelson, 2010). This critical period in development often co-occurs with a child's first experience in a formal school setting, which brings with it a number of novel learning experiences and challenges that elicit children's approaches to learning. In order to effectively navigate these new contexts and optimize learning, children must learn to embrace challenges, work cooperatively with peers, and demonstrate sustained engagement, focus, and attention during interactions with both teachers and peers.

Unfortunately, children from low-income families lag behind their middle to high-income peers in their approaches to learning, indicating that they demonstrate fewer positive learning behaviors than their higher income peers (Fantuzzo, Gadsen, & McDermott, 2011; McDermott et al., 2011). In addition to the challenges associated with the first school experience discussed above, these children are faced with a myriad of additional barriers to their school and life success (i.e. food insecurity, lack of materials and resources, less exposure to rich language in the home) (Heckman, 2006; Magnuson & Duncan, 2006). For these reasons, an even greater focus on approaches to learning should be made for children from low-income backgrounds during this critical period of development.

As evidence for the importance of approaches to learning for children served by Head Start, curricular interventions centered on approaches to learning have demonstrated the malleability of these skills and positive impact on math and language achievement (Fantuzzo et al., 2011). In order to promote the development of approaches to learning in this population and simultaneously address the national science achievement gap, more research is needed to determine how approaches to learning and science readiness are related and if these mutual relationships could provide a framework to help facilitate positive learning behaviors and science readiness for young children.

1.1.2. Early childhood science

Science is now recognized as a key component of Head Start's Early Learning Outcomes Framework (U.S. Department of Health and Human Services, 2015), highlighting the need for more research that examines science education in early childhood. Science education, as defined by the National Research Council's Next Generation Science Standards (NGSS), encompasses science content knowledge (core facts and content of science; e.g. living things need water), crosscutting concepts (core concepts that unify the study of science; e.g. patterns, cause and effect relationships, structure and function relationships), and scientific practices (behaviors that promote engagement in science activity; e.g. observing, constructing explanations, analyzing and interpreting data), providing a framework for what students need to know to demonstrate sufficient and effective science learning (National Research Council, 2012). This approach to science is designed to help children build on and revise their knowledge through active engagement, and inte-