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Approaches to learning and school readiness in Head Start: Applications to preschool science

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ABSTRACT

Approaches to learning are a set of domain-general skills that encompass curiosity, persistence, planning, and engagement in group learning. These skills play a key role in preschoolers' learning and predict school readiness in math and language. Preschool science is a critical domain for early education and facilitates learning across domains. However, no studies to date have examined how approaches to learning affect science outcomes in preschoolers. This study addressed this gap in the literature by testing predictive associations between approaches to learning and gains in science, as well as, math, vocabulary, and listening comprehension, across the school year, in a sample of preschoolers from low-income families. Results indicated that approaches to learning significantly predicted gains in science, and trended towards predicting gains in math, but not vocabulary or listening comprehension. These findings highlighted the potential of approaches to learning to facilitate early science learning for children from low income families.

1. Introduction

Upon school entry, children from low-income backgrounds lag significantly behind their higher-income peers in academic achievement (Magnuson & Duncan, 2006). This gap continues into primary school and increases over time (Ryan, Fauth, & Brooks-Gunn, 2006). Previous research has demonstrated the importance of domain-general skills, which are teachable and malleable, and facilitate learning regardless of content area (George & Greenfield, 2005). Given the documented readiness achievement gap, these skills are particularly important to identify and foster among children from low-income families (McClelland, Morrison, & Holmes, 2000).

Approaches to learning are a set of domain-general skills that have been identified by Head Start as one of the core school readiness domains (U.S. Department of Health and Human Services [U.S. DHHS], 2015). Approaches to learning skills encompass curiosity, persistence, planning, motivation, and engagement in group learning, and significantly predict school readiness in math and language among preschoolers from low-income families (McWayne, Fantuzzo, & McDermott, 2004; Schaefer & McDermott, 1999).

No study has examined the relationship between approaches to learning and preschool science, nor have any studies examined how this relationship may differ from those between approaches to learning and math, vocabulary, and listening comprehension, respectively. Preschool science is a critically important content area, which is reflected in Head Start's national recognition of science as a core school readiness domain (U.S. DHHS, 2015). Additionally, science relates to vocabulary, listening comprehension, and executive functioning (EF) skills, in preschool (Nayfeld, Fuccillo, & Greenfield, 2013). Despite these findings, science instruction is largely neglected in preschool, and preschoolers from low-income families have deficits in science readiness (Greenfield et al., 2009). Similarly, the majority of studies examining academic achievement in preschool fail to assess children's science knowledge, due to a lack of measures of preschool science (Greenfield, Dominguez, Greenberg, Fuccillo, & Maier, 2011).

Research is needed to understand how approaches to learning contribute to academic achievement, particularly in the domain of early science. This study examined if approaches to learning predicted spring school readiness outcomes (controlling for fall scores) across four distinct domains: science, math, vocabulary, and listening comprehension.

1.1. Approaches to learning and school readiness

Approaches to learning has received increased attention by researchers and policymakers as one of the most important school readiness domains, considering its broad impact on child development (Kagan, Moore, & Bredekamp, 1995; McDermott, Rikoon, & Fantuzzo, 2014). This set of learning styles and behaviors affects how children approach learning situations, including motivation, persistence, initiative, and a positive disposition towards learning (Kagan et al., 1995; Vitiello, Greenfield, Munis, & George, 2011). These skills have been described as

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foundational for school success, due to their malleability and positive implications for academic achievement (Schaefer & McDermott, 1999). The EPIC curriculum (Fantuzzo, Gadsden, & McDermott, 2011), which uses intentional instruction of approaches to learning as the foundation for a Head Start classroom-based intervention, provides evidence for the malleability of these skills. EPIC utilizes four evidence-based approaches to learning modules (attention control, frustration tolerance, group learning, and task approach) designed to enhance math, language, and literacy development. EPIC provides evidence of a causal link between approaches to learning and academic outcomes (i.e. math and listening comprehension). Interventions like EPIC highlight the importance of emphasizing the development of these powerful domain-general skills early to guide at-risk children towards a trajectory of academic success.

Preschool is a critical period for the development of approaches to learning, as it is one of children's earliest formal school experiences, and they are challenged each day with novel learning situations, both academically and socially (Bulotsky-Shearer, Dominguez, & Bell, 2012; Welsh, Nix, Blair, Bierman, & Nelson, 2010). During preschool, children must learn to engage and work cooperatively with peers and teachers, while remaining focused, persistent, and motivated when faced with the inevitable challenges inherent to learning. Children who demonstrate adaptive learning behaviors have greater school success throughout their academic career (Fantuzzo, Perry, & McDermott, 2004; George & Greenfield, 2005; Li-Grining, Votruba-Drzal, Maldonado-Carreno, & Haas, 2010; Matthews, Kizzie, Rowley, & Cortina, 2010; McClelland et al., 2000; McDermott et al., 2014; McWayne et al., 2004; Vitiello et al., 2011). This has been found across multiple domains of academic achievement, including math, vocabulary, and listening comprehension.

For example, McWayne et al. (2004) found that approaches to learning predicted a composite of early academic success, which assessed various indicators of child development, including literacy, numeracy, and fine and gross motor coordination in a sample of preschoolers served by Head Start. A recent longitudinal study examined children attending Head Start through 2nd grade and found that approaches to learning in the preschool years predicted proficiency in reading, vocabulary, language, math, and science in 2nd grade (McDermott et al., 2014). Some findings indicate a domain-specific effect, such that early positive learning behaviors like approaches to learning may be more important for math than language achievement (e.g. Ponitz, McClelland, Matthews, & Morrison, 2009; Vitiello, 2009; McDermott et al., 2011). Theory suggests that the complexity and unfamiliarity of math concepts requires a greater use and activation of domain-general skills (such as approaches to learning, EF, etc.), as compared to language, which children are exposed to with greater frequency throughout early development (Clements, Sarama, & Germeroth, 2016; Connor, Morrison, & Slominski, 2006; Miller, Kelly, & Zhou, 2005; NICHD Early Childcare Research Network, 2002; Ponitz et al., 2009).

1.2. Approaches to learning and science

Although prior studies have shown that approaches to learning predict early language and math outcomes, its relationship to science achievement in preschool has not been examined. Science is now recognized as its own school readiness domain by Head Start (U.S. DHHS, 2015), making it a crucial construct to include when measuring school readiness. Science is an interactive and engaging content area that capitalizes on young children's natural curiosity about their surrounding world. In the preschool classroom, science is evident as children explore cause and effect relationships (e.g. rolling a marble down a ramp to knock down a block), concepts such as force and gravity (e.g. pushing a ball off the table and watching it fall), and use of their senses to observe properties of objects (e.g. passing around a shell during circle time to allow children to feel the weight and texture with their hands). By going beyond rote learning and memorization, science encourages children to explore their environment and engage in science practice skills (e.g. asking questions, making predictions, conducting experiments, and recording observations) to increase their understanding of the natural world (Greenfield et al., 2009; Schweingruber, Duschl, & Shouse, 2007; U.S. DHHS, 2015).

Approaches to learning skills may help children engage effectively in scientific exploration, however, this relationship remains unexplored. McDermott et al. (2011) identified 7 components of approaches to learning that include strategic planning, effectiveness motivation, interpersonal responsiveness in learning, vocal engagement, sustained focus, acceptance of novelty and risk, and group learning. Children who display positive approaches to learning will likely navigate the scientific process more effectively. Higher levels of strategic planning, for example, are particularly useful for learning in the science domain (Urdan & Schoenfelder, 2006). Strategic planning helps children devise a thoughtful strategy before conducting an experiment. This planning ability will also allow children to set goals, plan an experiment or exploration, make predictions about what might happen and adapt their behaviors, experimentations, and explorations. Effectiveness motivation (i.e. perseverance and persistence), sustained focus in learning, and acceptance of novelty and risk equip young children with the tools to effectively deal with setbacks and failures that naturally occur during science learning and experimentation. These approaches to learning skills coalesce to aid children in effective execution of the scientific method.

For example, imagine a child who wants to build a ramp that will make a marble go fast. She can manipulate many variables, but will have to isolate them one at a time in order to identify which variable most impacts the outcome. With her teacher present to scaffold her through the process, she hypothesizes that the color of the ramp (red vs. blue) will change the speed of the marble. After testing this hypothesis she concludes that the color of the ramp does not affect the speed of the marble, leading her to revise her initial plan. She proceeds by testing if changing the slope of the ramp, by adding blocks to the base, will make her marble roll faster. After testing her second hypothesis, she concludes that a steeper slope does in fact make her marble go faster. During this process, the child demonstrated adaptive approaches to learning skills (e.g. planning, flexibility, and persistence), increased her understanding of physical science, and reached a conclusion supported by evidence. This example illustrates the importance of approaches to learning skills in the context of science learning.

Vocal engagement, another aspect of approaches to learning, helps children ask questions, verbalize frustrations, demonstrate understanding, and seek answers to problems. These are key components of inquiry, which is at the core of science learning. Children who engage in inquiry describe phenomena, ask questions, construct explanations, test them, and communicate their results to others (National Research Council, 1996). In turn, those who display more engagement in learning, via inquiry, have been shown to have better academic outcomes (Newman, 1998).

Often these information-seeking behaviors occur in social contexts within the classroom. Science activities typically occur in group settings, and children who can collaborate with peers are able to receive and provide feedback and solve problems more efficiently. Group learning and interpersonal responsiveness, the most socially-based factors of approaches to learning, lend themselves to science learning as children work together to make sense of their world. Collaboration and teamwork are integral components of science learning and children who can utilize their peers as learning resources are likely to make greater gains in their own knowledge.

In summary, approaches to learning skills may be critical for children's engagement in early science education. Given the national science achievement gap (Morgan, Farkas, Hillemeier, & Maczuga, 2016), it is important to develop domain general skills that will help children have positive experiences while learning science early in their school career. Science takes advantage of young children's natural curiosity about their immediate world and provides teachers with an engaging, interactive, hands-on, minds-on context for learning, and

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