# CONCEPTUALIZING EARLY CHILDHOOD STEM INTEREST DEVELOPMENT AS A DISTRIBUTED SYSTEM: A PRELIMINARY FRAMEWORK

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*Head Start on Engineering (HSE)* is a collaborative, NSF-funded research and practice project designed to develop and refine a theoretical model of early childhood, engineering-related interest development. The project focuses on Head Start families with four-year-old children from low-income communities and is being carried out collaboratively by researchers, science center educators, and a regional Head Start program. The ultimate goal of the *HSE* initiative is to advance the field's understanding of and capacity to support interest development related to STEM broadly, especially for low-income families and those from traditionally underserved communities. In the short term, this project focuses on engineering, which has emerged as a critical topic in the STEM education field and a prominent aspect of recent educational standards and policies (Committee on K-12 Engineering Education et al., 2009; NSF, 2006; NGSS Lead States, 2013). This increased attention recognizes the need to maintain a strong and robust engineering workforce and to increase the diversity of individuals participating in engineering-related fields (Hill, Corbett, St. Rose, & American Association of University Women, 2010; National Research Council, 2007). Despite national consensus on the importance of these issues, major disparities persist in engineering- and STEM-related academic achievement and participation across gender, race and ethnicity, and socioeconomic background (Ceci & Williams, 2011; Corbett, Hill, & St. Rose, 2008; Gershenson, 2013; McGraw, Lubienski, & Strutchens, 2006; National Science Board, 2014; Orr, Ramirez, & Ohland, 2011).

Addressing these issues involves not only preparing children to succeed in engineering-related careers but also fostering a motivation to engage with and persist in STEM and engineering throughout school and beyond (NAS et al., 2011; NRC, 2009; NSTA, 2014). Interest in particular is a central motivational variable influencing engagement and persistence in STEM, school achievement, and ultimately career selection (Falk & Dierking, 2010; Maltese & Tai, 2010; National Research Council, 2009; Renninger & Hidi, 2011a). Unfortunately, youth, and especially girls, and their parents tend to have low levels of interest in engineering and negative or limited perceptions of the engineering field (ASQ, 2009; Hill et al., 2010). Although most efforts to foster and support STEM-related interest target older youth (Alexander et al., 2013), there is growing evidence that before they enter school, children have already begun to develop enduring interests, including STEM-related interests, that persist over time and have implications for long-term learning trajectories (e.g., Alexander, Johnson, & Kelley, 2012; Fisher, Dobbs-Oates, Doctoroff, & Arnold, 2012; Patrick, Mantzicopoulos, Samarapungavan, & French, 2008). These findings highlight the potential for supporting long-term engineering-related interest development through early childhood interventions and the critical need to understand how interests develop and can be supported before children enter school.

In this paper, we outline a preliminary conceptual framework for describing early childhood STEM interest development, which will be used to guide data collection and program development for the *HSE* project. Departing significantly from past conceptualizations, our approach frames interest development as a distributed, family-level phenomenon that is characterized by shifts in beliefs, behaviors, and resources across children and parents. To begin, we highlight current challenges in studying early childhood interest development, and family learning more broadly, that have motivated work on this systems-level approach. We then describe three theoretical perspectives that have informed this project and how we have applied these perspectives to our understanding of early childhood interest development.

## JUSTIFYING A SYSTEMS PERSPECTIVE

Within the fields of STEM education and educational research, there is a growing appreciation for the importance of understanding learning, including interest development, using ecological and systems perspectives. Although these perspectives are not new (e.g., Bronfenbrenner, 1979; Hutchins, 1995), there is renewed attention at the national level to the ways that learning occurs across multiple settings, is influenced by a variety of factors both proximal and distal to the lives and experiences of learners, and is characterized by changes in not only individuals but also groups, organizations, systems, and processes (Davis & Sumara, 2006; Lemke, Lecusay, Cole, & Michalchik, 2015; Lemke & Sabelli, 2008; National Research Council, 2009, 2015). Recent synthesis reports on educational policy and practice have highlighted approaches to accounting for this broader perspective on learning, such as by identifying "brokers" to help youth navigate complex ecological systems of learning (National Research Council, 2015). Similarly, researchers and evaluators are appreciating the need to move beyond the individual and capture changes in systems and system processes (Lemke et al., 2015).

These perspectives may be particularly relevant to the study of young children. Research suggests that early childhood development is highly transactional between caregivers and children (Hume, Lonigan, & McQueen, 2015; Martin, Ryan, & Brooks-Gunn, 2013; National Research Council, 2000; Sameroff, 2009), making it difficult or impossible to determine the directionality of influences among family members (Martin et al., 2013). This reciprocal relationship between children and adults, and especially their primary caregivers, has in fact been long understood as a central component of development:

> *The essential features of healthy, growth-promoting relationships in early childhood are best embodied in the concepts of contingency and reciprocity. That is to say, when young children and their caregivers are tuned into each other, and when caregivers can read the child's emotional cues and respond appropriately to his or her needs in a timely fashion, their interactions tend to be successful and the relationship is likely to support healthy development in multiple domains, including communication, cognition, social-emotional competence, and moral understanding" (National Research Council, 2000, p. 28).*

Similarly, building on the foundational work of Vygotsky (Vygotskiĭ, 1978), researchers have consistently highlighted how development is socially mediated (Rogoff & Lave, 1999; Rogoff, Mosier, Mistry, & Goncu, 1993; Vygotskiĭ, 1978) and that especially in the early years, children's cognitive, social, and emotional processes are supported and scaffolded by adults (Institute of Medicine & National Research Council, 2012; National Research Council, 2000; Vygotskiĭ, 1978). In fact, all of child development can be viewed as "an increasing capacity for self-regulation" (National Research Council, 2000, p. 26). In other words, throughout development, children rely on caregivers and adults to help them regulate their learning and behavior, accomplish tasks that would otherwise not be possible for them, and increase their own ability to guide and direct their learning. Thus, learning and behavior at an early age can be seen as distributed across both the child and the significant adults in their lives.

Given these characteristics of child development, ecological and systems frameworks may be critical to the underlying validity of early childhood research. For example, recent studies have highlighted the methodological limitations and challenges related to isolating parents and children as separate factors, including problems associated with determining directionality and issues with parent reports of child development indicators. Traditionally, researchers studying the influence of parents on early childhood interest development, as well as other areas of learning, have focused primarily on the unidirectional relationship from parents to children (e.g., Alexander, Johnson, & Leibham, 2015; Barron, Martin, Takeuchi, & Fithian, 2009; Sha, Schunn, Bathgate, & Ben-Eliyahu, 2015). However, speaking to research on early childhood reading interests, Hume and colleagues (2015) noted that there are "broader questions remaining concerning the directionality of the effects of parent literacy-promoting practices and child interest. Do children who are interested in literacy prompt their parents to engage in more literacy-promoting behaviours or do parents' literacy-promoting practices increase children's interest in literacy?" (p. 175). Researchers have documented parents themselves reflecting on this bi-directional relationship, describing how they continuously learn and change as caregivers through their ongoing experiences with their children (Pattison, 2014; Pattison & Dierking, 2016).

Based on their investigations of relations among early child interest, persistence, and parenting behaviors, Martin and colleagues (Martin et al., 2013) speculated on the variety of ways that child factors might influence parent behaviors: "While low-interest children may elicit greater effort (e.g., more bids for attention) from their mothers to engage them in activities in the context of a laboratory observation, high-interest children may provide more opportunities on a daily basis for mothers to display highly stimulating behaviors, such as scaffolding complex tasks and using varied language. Therefore, greater displays of interest may encourage more of the sensitive and stimulating parenting behaviors that are linked to higher achievement scores" (p. 660). Ultimately, the researchers did find evidence that children's interests and parenting behaviors transacted over time: "Specifically, maternal supportiveness during the earliest years may initiate a positive feedback loop in which early maternal supportiveness enhances child interest, which in turn enhances subsequent maternal supportiveness" (Martin et al., 2013, p. 665).

Similarly, scholars have highlighted a variety of issues with treating parents solely as reporters of their children's learning and development, including social desirability bias, or pressure for parents to report children's interest based on how they would like to be favorably perceived as parents by the researchers (Baroody & Diamond, 2013; Hume et al., 2015). Studying early childhood science interest development, Pattison and Dierking (Pattison, 2014; Pattison & Dierking, 2016) found evidence that parents' own awareness of and beliefs about their children's interests shift over time in parallel with their children, thus directly influencing how they think and talk about these interests with researchers. An important outcome of early childhood interest development may, in fact, be the stories and narratives that parents tell about their children's interests that subsequently provide coherence to family experiences and motivation for further interest-related activities (Pattison, 2014; Pattison & Dierking, 2016).

Some researchers have addressed these challenges at least partially by developing complex, cross-lagged longitudinal models of the transactional relations between parent and child factors (e.g., Martin et al., 2013). Another promising approach, however, is to conceptualize both parents and children as part of an evolving interest system that develops and changes over time. In the following sections, we review the theoretical perspectives that have shaped our understanding of early childhood interest development and use these to propose a preliminary framework for understanding early childhood interest as a family-level, systems phenomenon.

## THEORETICAL FRAMEWORK

In developing our distributed systems framework of early childhood STEM interest development, we have drawn primarily from three theoretical perspectives: the four-phase model of interest development, lines of practice theory, and distributed cognition. Although each of these perspectives is distinct in its analytical focus and theoretical assumptions, each provides an important and unique perspective on early childhood interest development. Combined, we believe the three perspectives offer a more complete picture of interest development in early childhood.

### The Four-Phase Model of Interest Development

Within the field of science education and learning, Renninger and Hidi (Hidi & Renninger, 2006; Renninger & Hidi, 2011b) have arguably developed the most broadly used and empirically supported theoretical conceptualization of science interest and interest development. In their four-phase model (Hidi & Renninger, 2006), interest is defined as "the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time" (p. 112).This theoretical perspective places individual interest at one end of a continuum of four phases of interest development, including two phases of situational interest (triggered and maintained) and two phases of individual interest (emerging and well-developed). The phases are characterized by varying amounts of affect, knowledge, and perceived value related to a specific topic or activity, with earlier phases of interest primarily consisting of focused attention and positive affect and later phases incorporating knowledge and value constructed over time.

For example, an individual may have a strong, positive affective response toward science while watching a demonstration at a science center. However, for that interest to be maintained and to continue to develop, the individual must, according to Hidi and Renninger, develop deeper knowledge of and an increased value for science. Therefore, as the researchers argued, support and opportunities to continuing to engage with the topic are necessary for individual interest to develop. This multi-construct conceptualization of interest development is supported by a variety of empirical studies (for reviews, see Hidi & Renninger, 2006; Renninger & Hidi, 2011b), including more recent quantitative modeling with international student data (Ainley & Ainley, 2011a, 2011b). Recently, Renninger and colleagues have also highlighted the importance of metacognitive awareness about one's own interests as an additional element of the interest development process (Renninger & Su, 2012).

### Lines of Practice Theory

Lines of practice theory (Azevedo, 2011, 2013) provides an important framework for understanding the individual, unique, and idiosyncratic nature of interest development (Crowley, Barron, Knutson, & Martin, 2015; National Research Council, 2009, 2015; Pattison & Dierking, 2016). Complementing the four-phase model, the theory broadens previous perspectives on interest and provides a new set of tools and concepts for understanding the complexities of short- and long-term interest development within the context of children's and adults' multifaceted lives.

Inspired by the work of Lave and Wenger (Lave & Wenger, 1991; Wenger, 2008) and Rogoff and colleagues (Rogoff, Paradise, Arauz, Correa-Chávez, & Angelillo, 2003), Azevedo defined a line of practice as a "distinctive, reoccurring pattern of long-term engagement in a person's practice participation" and suggested that these lines of practice are characterized by individual preferences as well as the conditions of practice in different sites of engagement (Azevedo, 2011, p. 147). Unlike previous theories of interest development, including the four-phase model, Azevedo argued that interest pathways are not solely defined by a single topic or domain but instead have a complex motivational structure extending to multiple preferences and multiple aspects of an individual's life. The theory invites, and provides a vocabulary for, exploration of the complex ways parents and children interpret their lived experiences, connect them with other interests and preferences, and extend the experiences in unique and idiosyncratic ways that may or may not be directly relevant to specific STEM topics or practices. As Azevedo (2013) argued: "lines of practice stress how interests are realized in the specific fabric of activities that a person fashions himself or herself and that by definition extends into many realms of the person's life" (p. 505).

Azevedo described one example of these dynamics in his study of a model rocketry enthusiast (Azevedo, 2011), who showed interest in the scientific topic of rocketry but also, often to a greater extent, appeared to be motivated to engage in the hobby based on his preferences towards socializing with friends and family, using tools and materials to build and create, enjoying the rocketry objects themselves, and more: "Thus it is that David's extended participation in model rocketry is contingent on his ability to simultaneously and differentially advance an identity of creativity and competence in the hobby, to engage design and construction, and to socialize, as well as to engage certain aspects of the rocketry 'content'" (Azevedo, 2011, p. 179). As described below, in the *HSE* project we expect we will observe similar dynamics in early childhood interest development, with family lines of practice connected to but not solely defined by engineering or other STEM topics.

### Distributed Cognition

In the 1980s, Edwin Hutchins began developing a new conceptualization of human cognition and learning that shifted focus away from the individual mind and towards distributed systems of people and objects

(Hutchins, 1995). This perspective came to be known as "distributed cognition" and has had a profound effect on the fields of psychology, education, and beyond (Hutchins, 2000; National Research Council, 2009).

According to Hutchins, distributed cognition is not actually a predictive theory of learning but rather a perspective that "begins with the assumption that all instances of cognition can be seen as emerging from distributed processes" (Hutchins, 2014, p. 3). These distributed processes might include neurons within the brain interacting with each other, individuals using tools and objects in their environments, or groups of individuals talking and working together (Hutchins, 2006). As Hutchins argued, learning and cognition are not just influenced by these distributed systems but are actually emergent properties of the systems themselves, exhibiting behaviors and characteristics that cannot be directly attributable to individual elements (Hutchins, 2006). From this perspective, learning specifically can be seen as "adaptive organization in a complex system" (Hutchins, 2000). For example, the National Research Council highlighted the distributed nature of learning between young children and their parents:

> *It is also common for elementary schoolchildren to bring the classroom home, to regale parents with stories of what happened in school that day and involve them in homework assignments. These events help to alert parents to child specific intellectual interests and may inspire family activities that feature these interests. A child's comments about a science lesson at school may encourage parents to work with the child on the Internet or take him or her to a zoo or museum or concoct scientific experiments with household items in order to gather more information. (National Research Council, 2009, p. 98)*

Beginning with this assumption, distributed cognition invites new questions about the nature of cognition and learning, including "the elements of the cognitive system, the relations among the elements, and how cognitive processes arise from interactions among those elements" (Hutchins, 2014, p. 3). An important aspect of distributed cognition research is determining the appropriate system boundaries and unit of analysis for understanding a particular distributed process. In some cases, the unit of analysis might be an individual and the objects and tools in their environment (e.g., Hutchins, 1995), while at other times the unit might be much broader, encompassing large groups of individuals working together and the influence of culture and cultural practices (e.g., Hutchins, 2006). As Hutchins noted, "for distributed cognition, the existence of boundaries and centers are empirical questions. Centers and boundaries are features that are determined by the relative density of information flow across a system. Some systems have a clear center while other systems have multiple centers or no center at all" (Hutchins, 2014, p. 4).

In recent writings, Hutchens has further emphasized how the intersection of culture, cultural practices, and distributed cognition processes can be seen as making up the complex systems of human experience and development: "Like any ecosystem, the cultural-cognitive ecosystem can be seen as a constraint satisfaction system that settles into a subset of possible configurations of elements. It is a dynamical system in which certain configurations of elements (what we know as stable practices) emerge (self-assemble) preferentially" (Hutchins, 2014, pp. 12–13). Again, this perspective emphasizes a holistic understanding of the elements within a system, how they interact and relate to each other, and how different constraints and affordances in the ecosystem, including neural mechanisms, resources and tools, social processes and conventions, and more, lead to certain configurations rather than others. Although these systems, Hutchins argued, are "dynamic and adaptive," they are also open to change and reconfiguration: "experience, training, and the design of environments can all be seen as ways to bias the probability of the dynamic formation of particular practices" (Hutchins, 2014, p. 13).

It is important to note that although distributed cognition can be seen as related to other ecological and systems perspectives on learning and development (e.g., Barron, 2006; Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2007; Mashburn & Pianta, 2010; National Research Council, 2015), it is distinct in its broadened unit of analysis. While other perspectives, including lines of practice theory, acknowledge the influences of systems and system factors at many levels, the primary unit of analysis remains the individual and individual-level interest development. Even in lines of practice theory, which conceives of a complex, multifaceted system of practices, behaviors, and preferences, the goal is to understand how these systems shape the development and motivations of individuals. In contrast, distributed cognition suggests that learning and development are not only influenced by system factors but can in fact productively be conceived of as properties of those systems, emerging from the systems and not solely attributable to specific individuals or elements. As we describe below, this has profound implications for how researchers understand and study early childhood interest development.

## THEORIZING EARLY CHILDHOOD INTEREST AS A DISTRIBUTED SYSTEM

Drawing together the three theoretical perspectives outlined above, we believe early childhood interest development can productively be conceptualized as a phased, multifaceted, family-level phenomenon that is driven by ongoing interactions between adult and child family members in a variety of settings and results in multiple, interrelated family beliefs and lines of practice that are characterized by engagement with and preferences for different activities, individuals, resources, and settings, some of which may be related to a particular STEM topic. We describe this preliminary conceptual framework below, focusing particularly on parents, children, and parent-child interactions as critical components of the family-level interest system.

### Interest as a Phased Process

Aligned with the four-phase model of interest development, we believe that there likely are distinct, recognizable phases of interest configurations that are characterized by not only different levels of cognitive engagement for adults and children (e.g., situational interest and affect, knowledge and skills, perceived value, and meta-awareness), but also different behaviors and relationships towards resources, settings, and organizations (e.g., characteristics of adult-child interactions related to topics of interest, engagement with new resources and activities). Researchers have already described evidence of phases in early childhood STEM interest development (Alexander et al., 2012, 2015; Pattison, 2014; Pattison & Dierking, 2016). For example Pattison and Dierking (2016), described the dynamics of sparked and maintained situational interest for Head Start families related to a variety of science topics and found evidence that for some families, these situational interests appeared to develop into emerging individual interests, characterized by repeated, self-initiated engagement in interest-related activities and broadened preferences around classes of topics or behaviors. Similarly, Alexander and colleagues (Alexander et al., 2012, 2015; Johnson, Alexander, Spencer, Leibham, & Neitzel, 2004) found extensive evidence of emerging individual interests for young children related to science and identified several factors that appeared to support the emergence and development of these long-term interests, such as parental beliefs about the importance of communication and consistency.

### Interest as Multifaceted Lines of Practice

In contrast to prior studies on early childhood STEM interest development, we believe it is critical to expand the notion of what counts as an interest focus, as suggested by lines of practice theory. As described above, lines of practice theory emphasizes how interest pathways are often not focused around a single topic, activity, or object, as posited in the four-phase model, but instead are motivated by multiple, interrelated preferences, activities, practices, and social communities.

In prior work, we have already observed elements of this multifaceted nature of interest development in studying preschool children. In our work with Head Start families (Pattison, 2014; Pattison & Dierking, 2015, 2016), one mother reported how the family reading session during the study had sparked her daughter's ongoing interest in water and the ocean. However, her responses during several in-depth interviews suggested that the family's relationship with these topics was complex and ongoing. The mother reported that several years ago, going to the community pool had been a favorite activity of the family. After reading one of the books about Jacques Cousteau and ocean exploration, the daughter became excited about visiting the pool again and even though it was still winter, her and the mother began regularly setting out her swimming clothes and goggles in anticipation of the pool opening soon. The daughter's older sister also went on a trip to Hawaii to visit family during the research study and pictures and stories from that trip, including pictures of the ocean and fish, became a topic of family conversation. Throughout, the daughter continued to show interest in reading the Cousteau book, which focuses on the wonder of the undersea world and the technological innovations that Cousteau developed to advance ocean exploration. In other words, although there was evidence that the daughter's interest revolved around a science topic, it was also connected to and supported by preferences for a particular activity (swimming), enjoyment of a family routine (going to the pool), and connections to her sister's experiences (a trip to Hawaii). We expect that these complex lines of practice will be more indicative of early childhood interest development than the four-phase model might suggest.

### Interest as a Family System

Finally, although lines of practice theory provides a powerful framework for broadening the notion of early childhood interest, we would like to further expand this concept by considering not only the multiple dimensions of children's interests and preferences but also expanding the unit of analysis to include both child and adult family members and their ongoing interactions. As described above, there are many theoretical and methodological challenges associated with isolating child-related aspects of development from overall family dynamics and the ongoing, transactional relationship between parents and children. Rather than focus on children's interests as the unit of analysis and constrain our investigations to identifying linear relationships between parent "inputs" (e.g., parent beliefs or supportive parenting approaches) and child "outputs" (e.g., indicators of interest development), we believe it is more productive to identify and explore the multiple, interrelated factors and processes that describe an evolving system of interest within a family. For example, in the *HSE* project we expect that children's and parents' awareness of and interest in engineering-related activities and topics may co-evolve, that the ways that children and parents interact and engage with engineering-related activities may shift in parallel, and that families may develop new patterns and routines of practice in response to children's and parents' developing and mutually reinforcing interests.

As noted above, this conceptualization aligns with developmental research on scaffolding and parental support throughout child development. Based on the work of Vygotsky (Vygotskiĭ, 1978), developmental researchers understand the ways that children's concept and skill development, such as language use, are often initially scaffolded and supported by adults as children gradually develop the abilities to successfully initiate and regulate these activities on their own (e.g., Callanan, Rigney, Nolan-Reyes, & Solis, 2012; Institute of Medicine & National Research Council, 2012; National Research Council, 2000; Wertsch, McNamee, McLane, & Budwig, 1980). Similarly, we believe that parents and other adults likely scaffold many aspects of interest development for young children, such as maintenance of situational interest, metacognitive awareness of emerging individual interest and individual interest narratives, and building of knowledge and value to support further interest development. Again, this implies that engineering-related interest in early childhood will likely involve parallel, interrelated changes in both parents and children.

Based on prior research and input from project partners, key aspects of these early childhood engineering-related interest development systems that we intend to explore include: (a) parent awareness, knowledge, and beliefs centered around engineering-related lines of practice; (b) children's interests and lines of practice related to engineering, including enjoyment, knowledge, values, and awareness; (c) the characteristics and nature of parent-child interactions while engaging with engineering-related activities; (d) and the characteristics and nature of broader family practices and resources associated with developing lines of practice related to engineering. Collectively, we believe these four facets begin to describe the holistic, interest systems for families with young children and will allow us to explore changes in the configuration of different system elements as family lines of practice change and evolve. For example, through involvement in the *HSE* program, we may see evidence that children increase their enjoyment of building activities and that parents report a growing awareness of this enjoyment, making connections between these interests and other family routines and practices. Similarly, we may identity ways that parents and children become more deeply and mutually engaged during joint engineering-related activities and ways parents seek out new engineering resources and experiences for their children, such as visits to a local maker space.

CONCLUSION AND NEXT STEPS

The conceptualization of early childhood interest as a distributed system of beliefs and practices is a major departure from previous research on early childhood STEM interest development and we are currently only in the preliminary stages of developing and testing these ideas. During the next two years of the *HSE* project, we will focus on (a) identifying and describing the salient aspects of early childhood engineering-related interest systems and (b) developing and piloting methods and measures to describe these systems and how they evolve over time. In the long term, we believe this work will allow us to develop a framework for understanding common configurations or phases of these systems and to investigate factors and processes that explain why some families move towards or develop particular configurations rather than others. One result of this research agenda may be a theoretical framework that parallels the four-phase model of interest development and describes characteristics of particular phases of family-level engineering interest pathways and lines of practice.

An important next step for the *HSE* project will be to develop tools and processes for studying early childhood interest development using the perspectives described above. Hutchins (2014) has suggested network analysis and approaches to "cognitive ethnography" as promising strategies for understanding systems of cognition and learning. Qualitative case study strategies (e.g., Creswell, 2013; Stake, 2006) also offer a variety of well-tested tools and approaches to coordinating, analyzing, and integrating data from multiple sources in order to develop holistic understandings of systems and processes. Similarly, Svarovsky and colleagues (Svarovsky, 2011) have borrowed tools from social network analysis to understand the interrelationship among learning facets and Pattison and colleagues have piloted techniques for coordinating micro video analysis with more holistic summaries of the lived experiences of individuals over time (Pattison, Gontan, & Ramos-Montanez, 2016). Over the next year, the *HSE* project team will draw from these techniques to explore ways of operationalizing early childhood engineering-related interest development and studying interest as a family-level systems phenomenon. Our hope is that this work will lay the foundation for a long-term research agenda and contribute significantly to the field's evolving understanding of early childhood STEM interest development.

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