Success for all: fostering early childhood STEM identity

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Abstract

Purpose – This paper discusses early childhood classrooms as powerful spaces for identity work and, more specifically, as a place (or not) for supporting early STEM identity development. It makes the case for educators and researchers alike to promote an expanded role of early childhood STEM education in the daily lives of young children.

Design/methodology/approach – This paper uses a qualitative interpretive methodology, drawing from a wide array of research and theoretical literature from early childhood and STEM education and developmental psychology, as well as public policy.

Findings – Today, both research and interventions aimed at fixing the "leaking STEM pipeline" and theory/research on STEM identity development focus on children in middle school and above. Yet, children's attitudes about STEM and about themselves as STEM learners are formed early, and identity work is a task of early childhood. This suggests a need to focus on young children's engagement with STEM education as a means of nurturing their early STEM identity development.

Originality/value – This paper synthesizes previous research to outline the need for expanding STEM education in early public schooling. It proposes a conceptualization of early STEM academic identity development (based on the premise that middle school is too late to fix the leaking STEM pipeline).

Keywords Early childhood education, STEM identity development

Paper type Viewpoint

Schools are powerful spaces for identity work (Kaplan *et al.*, 2014; Langer-Osuna and Nasir, 2016). Exploring roles, the positioning it produces during social interaction and the related educational actions embodied by children are critical to the identity-making process, as well as to the self-understandings that are eventually adopted by students (Davies and Harré, 2008; Talafian *et al.*, 2019). Yet, many children (particularly racially minoritized children and those from low socioeconomic status backgrounds) do not see themselves in STEM roles nor do they develop STEM identities by the end of elementary school (Talafian *et al.*, 2019).

Academic identity refers to a person's self-understanding related to feelings of school-belonging and commitment to the ways of an academic community; it is a vital indicator of educational choice, and it is positively linked to academic motivation, performance and outcomes (Beier and Rittmayer, 2008; Dunham, 2016; Kaplan *et al.*, 2014; Pantoya *et al.*, 2015). STEM identity, a sub-category of academic identity, can be considered a chosen/role identity akin to developing a soccer player identity or a skateboarder identity. This type of identity development focuses on constructing or discovering an aspect of self through socioculturally mediated meaning-making (Kaplan and Garner, 2017; Kaplan *et al.*, 2014). STEM identity denotes the extent to which individuals identify as members of a STEM field and view themselves/others in terms of prototypes [norms, attitudes, traits, values, behaviors] in those

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fields (Kim *et al.*, 2018). Research with older children and adults reports that feelings of belonging in STEM and social experiences are major factors in nurturing or hampering STEM identity (Cheryan *et al.*, 2015; Talafian *et al.*, 2019).

For young children, early STEM identity development can be conceived as a social identity bound by early and deliberate exploration of STEM and an explicit recognition of the relevance of STEM-related activity in daily life. This stance is drawn from research on academic identity and STEM identity development, although related research primarily focuses on middle school and beyond. Hawkins (2005) contends that for young children to gain school-affiliated identities, they must acquire the language, behaviors and ways of engaging needed to display the identity of a successful student. Applied specifically to STEM in the early years, this social self is embodied in young children deliberately enacting authentic STEM-related practices and roles, and the related sociocultural interactions that contextualize early acquisition of STEM content knowledge in meaningful, successful and positive ways. The emphasis on positive and authentically meaningful STEM-related interactions is important, as STEM content is neither objective nor culture-free; young children internalize both explicit and implicit messages about an academic subject, and this serves to shape later attitudes and beliefs about their ability to succeed in STEM (Cheryan *et al.*, 2015; Crespo *et al.*, 2014; Early STEM Working Group, 2017; Martin-Hanson, 2018; Saurcerman and Vaquez, 2014).

Further support for this position on early STEM identity development is drawn from the wider developmental literature. The two processes of exploration and commitment are central to most theories of identity development (Kaplan *et al.*, 2014; van der Gaag *et al.*, 2017). For example, early race and culture identity development have been defined in terms of affiliation with, and commitment to, one's ethnic/racial group (Phinney, 1990). Gender identity development is similarly situated; children internalize social cues and demonstrate preferences and behaviors aligned with gender categories (Martin and Ruble, 2004). Research on ethnic/racial and gender identity development shows that young children actively use social cues for interpretation, and then they utilize these interpretations to direct their attention, guide behavior and organize memories (Martin and Ruble, 2004). Evidence further upholds that educational activity centered on the cultural experiences of children nurtures both positive racial/ethnic identity and academic identity development (Langer-Osuna and Nasir, 2016). Thus, young children's socially derived meanings from everyday experiences become central to the self-understandings they live in the present, as well as forming the basis for facets of their future identities. In a similar vein, early STEM identity development is a social process negotiated in early childhood classrooms during deliberate exploration of STEM, with evaluative and motivational consequences to children's current and future sense of belonging and interest in STEM. As such, the ecology of early childhood classrooms can either afford or deny access to relevant experiences that help young children develop critical foundational self-understandings and ways of positioning themselves as "scientist", "technologist", "engineer" and "mathematician".

Yet, many investigations of daily practice up to third grade in US public schooling report that STEM education (and a related focus on early STEM identity development) is missing, and further research shows that STEM education is not well understood by early childhood teachers (who receive greater training in early literacy pedagogy) (Bassok *et al.*, 2016; Author, 2013; Pantoya *et al.*, 2015; STEM Smart, 2013). A recent study by Tao (2019) reports that early childhood teachers are not familiar with STEM education and have low self-efficacy for teaching STEM. Similar findings are reported by DeJarnette (2018), with lack of early childhood teacher training/low self-confidence of educators resulting in little time devoted to teaching STEM. Pantoya *et al.* (2015) report that less than 10% of kindergarten through second-grade instructional time is devoted to STEM content. Currently, the roles young children play and the appearances and postures (all aspects of the search for identity

(Erikson, 1994)) that they are conditioned to adopt in early childhood classrooms are framed by a hegemony of early literacy instruction (i.e. Bassok *et al.*, 2016; Early Childhood STEM Working Group, 2017; Gerde *et al.*, 2017; Hachey, 2013), limiting both young children's current roles and their imagined futures to that of readers.

The general absence of STEM in the early childhood classroom disallows STEM-related exploration and role-taking and provides an implicit message of STEM (both individual subjects and collectively) as not being important. This denies young children the opportunity to form a deep affiliation with STEM content and practices that stimulates the habits of mind that are critical to STEM identity development, and that prepares children for later competencies in STEM disciplines. The results of the current neglect of STEM identity development may be witnessed by the "leaking STEM pipeline"; research shows that by the fourth grade, students who have limited exposure to early STEM education are lacking key mathematics and science skills and knowledge, as well as declining or a complete lack of interest in STEM (in particular for girls and minoritized groups), that impact later postsecondary enrollment in STEM-related fields (Pantoya *et al.*, 2015; National Academies Press, 2011; STEM Smart, 2013).

van der Gaag *et al.* (2017) contend that it is essential to identify who are in, or who are headed for, suboptimal identity statuses or pathways. Today, both research and interventions aimed at fixing the "leaking STEM pipeline" and research on STEM identity development focus on children in middle school and above, as identity development is most often viewed as an adolescent task. Yet, children's attitudes about STEM and about themselves as STEM learners are formed early (Early Childhood STEM Working Group, 2017; Saucerman and Vasquez, 2014). And, captured in the notion of a "leaking STEM pipeline" is the idea that focused attention on STEM education earlier in children's schooling could potentially result in an increased number of students later entering into fields associated with STEM (Porfeli *et al.*, 2008). This has been voiced in recent educational policy reports which explicitly note that early public schooling in the USA has traditionally been focused on cultivating young children's literacy development (with a bit of math), and which now calls for more/equal emphasis on early STEM learning (i.e. STEM Smart, 2013; Early STEM Working Group, 2017).

Modest interventions with young children have been shown to promote positive mindsets about STEM (Early Childhood STEM Working Group, 2017), and initial evidence shows that children's early STEM identities may be formulated through collaborative science investigations whereby students adopt the role of scientists and engineers (Reveles *et al.*, 2004; Pantoya *et al.*, 2015). Yet, there is still a need to assess current and developing Early childhood (EC) STEM efforts, particularly ones meant to empower role-taking, new forms of social interactions and new means of personal expression during meaningful and engaging STEM instruction. If we seek the success of all – *all* students in *all* academic subjects – then researchers and educators alike should be concerned with the early STEM identity development of young children and with promoting a larger role for EC STEM education in early public schooling.

References

Bassok, D., Latham, S. and Rorem, A. (2016), "Is kindergarten the new first grade?", *AERA Open*, available at: https://journals.sagepub.com/doi/full/10.1177/2332858415616358 (accessed 28 December 2019).

Beier, M.E. and Rittmayer, A.D. (2008), "Literature overview: motivational factors in STEM: interest and self-concept. SWE-AWE-CASEE ARP resources", available at: https://www.engr.psu.edu/AWE/misc/ARPs/ARP_SelfConcept_Overview_122208.pdf (accessed 30 December 2019).

Cheryan, S., Master, A. and Meltzoff, A.N. (2015), "Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes, *Frontiers in Psychology*, Vol. 6, pp. 1-8.

Crespo, M.N., Kraatz, E. and Pallansch, L. (2014), "From fearing STEM to playing with it: the natural integration of STEM into the preschool classroom", *SRATE Journal*, Vol. 23 No. 2, pp. 8-16.

Davies, B. and Harré, R. (2008), "Positioning: the discursive production of selves", *Journal for the Theory of Social Behavior*, Vol. 20, pp. 43-63.

DeJarnette, N.K. (2018), "Implementing STEAM in the early childhood classroom", *European Journal of STEM Education*, Vol. 3, No. 3, available at: https://files.eric.ed.gov/fulltext/EJ1190735.pdf (accessed 14 October 2019).

Dunham, N. (2016), "Student academic identity and early childhood field-based initial teacher education", *AARE Conference* 2016, available at: https://files.eric.ed.gov/fulltext/ED591856.pdf (accessed 14 October 2019).

Early Childhood STEM Working Group (2017), "Early stem matters, providing high-quality stem experiences for all young learners: a policy report by the early childhood stem working group", Erikson Institute. available at: http://d3lwefg3pyezlb.cloudfront.net/docs/Early_STEM_Matters_FINAL.pdf (accessed 14 October 2019).

Erikson, E.H. (1994), *Identity: Youth and Crisis*, W. W. Norton, New York, NY.

Gerde, H.K., Peirce, S.J., Lee, K. and Van Egren, L.A. (2017), "Early Childhood educators' self-efficacy in science, math, and literacy instruction and science practice in the classroom", *Early Education and Development*, Vol. 29 No. 1, pp. 70-90.

Hachey, A.C. (2013), "The early childhood education mathematics revolution", *Early Education and Development*, May-June, pp. 419-430.

Hawkins, M.R. (2005), "Becoming a student: identity work and academic literacies in early schooling", *Tesol Quarterly*, Vol. 39 No. 1, pp. 59-80.

Kaplan, A. and Garner, J.K. (2017), "A complex dynamic systems perspective on identity and its development: the dynamic systems model of role identity", *Developmental Psychology*, Vol. 53 No. 11, pp. 2036-2051.

Kaplan, A., Sinai, M. and Flum, H. (2014), *Design-based Interventions for Promoting Students' Identity Formation within the School Curriculum*, Motivational Interventions- Emerald Group Publishing Limited, pp. 243-291.

Kim, A.Y., Sinatra, G.M. and Seyranian, V. (2018), "Developing a STEM identity among young women: a social identity perspective", *Review of Educational Research*, Vol. 20 No. 10, pp. 1-37.

Langer-Osuna, J.M. and Nasir, N.S. (2016), "Rehumanizing the "other" race, culture, and identity in education research", *Review of Research in Education*, Vol. 40 No. 1, pp. 723-743.

Martin, C.L. and Ruble, D. (2004), "Children's search for gender cues: cognitive Perspectives on gender Development", *Current Directions in Psychological Science*, Vol. 13 No. 2, pp. 67-70.

Martin-Hanson, L. (2018), "Examining ways to meaningfully support students in STEM", *International Journal of STEM Education*, Vol. 5, Article 53 (2018).

National Academies Press (2011), *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*, National Academic Press, Washington, DC.

Pantoya, M.E., Aguirre-Munoz, Z. and Hunt, E.M. (2015), "Developing an engineering identity in early childhood", *Journal of Engineering Education*, Vol. 6 No. 2, pp. 61-68.

Phinney, J.S. (1990), "Ethnic identity in adolescents and adults: review of research", *Psychological Bulletin*, Vol. 108, pp. 499-514.

Porfeli, E.J., Hartung, P.J. and Vondracek, F.W. (2008), "Children's vocational development: a research rationale", *The Career Development Quarterly*, Vol. 57, pp. 25-37.

Reveles, J.M., Cordova, R. and Kelly, G.J. (2004), "Science literacy and academic identity formation", *Journal of Research in Science Teaching*, Vol. 41 No. 10, pp. 1111-1144.

Saucerman, J. and Vasquez, K. (2014), "Psychological barriers to STEM participation for women over the course of development", *Adultspan Journal*, Vol. 13 No. 1, pp. 46-64.

STEM Smart: Lessons Learned from Successful Schools (2013), "Nurturing stem skills in young learners, prek–3. stem smart brief-early childhood learning", Washington, DC, available at: http://docplayer.net/7429009-Stem-smart-brief-stem-smart-lessons-learned-from-successful-schools.html (accessed 26 February 2019).

Talafian, H., Moy, M.K., Woodard, M.A. and Foster, A.N. (2019), "STEM identity exploration through an immersive learning environment", *Journal for STEM Education Research*, Vol. 2, pp. 105-127.

Tao, Y. (2019), "Kindergarten teachers' attitudes toward and confidence for integrated STEM education", *Journal for STEM Education Research*, Vol. 2, pp. 154-171.

van der Gaag, M.A.E., Albers, C.J. and Kunnen, E.S. (2017), "Micro-level mechanisms of identity development: the role of emotional experiences in commitment development", *Developmental Psychology*, Vol. 53 No. 11, pp. 2205-2217.

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