Towards an Ecological Approach to Measuring STEM Identity Shifts Amongst Non-Dominant Girls

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Introduction

Studies suggest that lack of opportunities, low STEM confidence, and isolating STEM environments are factors that highlight the racialized and gendered realities within STEM learning settings that make it difficult for many non-dominant girls to develop a positive STEM identity (e.g. Hall & Brown, 1976; Maltese & Tai, 2010; Margolis & Fisher, 2002; Johnson et al, 2011; Ko et al, 2014). In this poster, we describe an ecological approach to measuring shifts in interest and identity development amongst non-dominant middle school girls in a STEM maker program. Our driving questions for this work were: (1) How can we assess STEM identity shifts over the course of a computational making program and (2) How can we better understand the influence(s) of program components on youth developing STEM identities?

Context and Methods

Digital Youth Divas (DYD) is a blended online and face-to-face out-of-school program engaging middle school girls in design-based engineering and computer science activities (Pinkard et al., 2017). DYD is purposefully designed to impact girls' interest and identity, sense of community, and computational knowledge through five interconnected program components: (1) Self-paced, hands-on, project-based learning activities including introductory circuitry and programming projects through fabrication and design; (2) Narrative storylines with non-stereotypical characters; (3) An online social learning network where girls access resources, upload project work, and interact with others; (4) In-person and online mentorship from racially diverse, female mentors; and (5) Workshops with parents that create a supportive parent community.

We describe results of case study analysis of four girls who participated in DYD during a 20 week program in a large cohort (N=98 girls). Case data for each participant included attendance records, pre-post surveys (items about experience, interest, identity, e.g. Barron et al., 2014), interviews, program fieldnotes, virtual ethnographies (Hine, 2008) that describe online interactions, artifacts of participation, and parent surveys.

The four learners were from one focal cohort classroom (N=20) and were selected to represent a range of interest and prior experience as indicated on the pre-survey. Three identified as African American and one as Latina. Two were in fifth grade and two were in sixth. Household income ranged from $30-80K.

Perspectives

Our approach to investigating girls' STEM identity development assumes that identity shifts happen over time, are influenced by social, cultural, and institutional factors, and can only be measured by taking an ecological view of learning and STEM engagement (Barron, 2006; Nacu et al., 2014; Nasir, 2011). Specifically, we use longitudinal qualitative and quantitative data measures to understand identity shifts.

Framework

The sociopolitical framework proposed by McKinney de Royston & Nasir (2017) in their paper titled, *Racialized Learning Ecologies: Understanding Race as a Key Feature of Learning and Developmental Processes in Schools* was the best fit for our data. The authors propose a four-level framework based on the early works of Bronfenbrenner (1979), who argued for conceptualizing a developing child as an individual nested within multiple layers of context that shift over the timeline. The framework involves four tiers: social, institutional, cultural, and individual. Using this framework, we analyzed case data to understand possible shifts in participants' identities.

Results

Changes in interest and identity development were not obvious when using the more traditional identity and interest survey measures alone, although there was evidence of growth in qualitative analysis (Erete et al., 2017). Thus, we present the results of measuring STEM identity development using a sociopolitical framework (McKinney de Royston & Nasir, 2017) as an example of going beyond traditional quantitative measures to use both qualitative and quantitative data to explore the social, institutional, cultural, and individual factors that influence identity shifts.

SOCIAL

e.g. Racial, cultural narratives and histories; notions of stratification

Stereotypes constructed by the society related to people of certain race can seep into the minds of individuals leading them to form uninformed opinions about many issues.

Shifting perceptions of computer scientists from stereotypical to personalized: Through the DYD program with visible mentors and peers Alisha came to see computer scientists as people more like herself.

Alisha's initial perception of a computer scientist	*Alisha's perception of computer scientist after DYD*
In class the mentor asked "...what about a computer scientist, what do they look like?," and Alisha replied **"Lab coats and nerdy."** (starter interview). She had a similar answer in the Mid interview. When asked to describe an "engineering or techie person," Alisha said **"Kinda glasses, sweat... No. Like a long sleeved, buttoned up shirt, and then a t-shirt on top of it with a collar, and like a top hat or something."**	She said, during the final interview, **"They're kinda like an artist person and they like... They also like engineering and technology because that's me everyday... I'm always talking about something that involves technology or fashion…"**. A case memo states, "Based on photos taken in field notes it does not appear that Madison dresses the way she initially described a computer scientist dressing."

INSTITUTIONAL

e.g. Districts, schools, policies or reforms, classrooms

Family and the people in-charge of the learning environment i.e. the mentors, can be considered as the institutions which influence the perception of young girls.

Family's role in identity development and interest in STEM career: Jackie's father showed high level of interest in her computing activities and both parents enrolled her in STEM-oriented programs, which boosted her morale. Jackie expressed the importance of her family in her interest in Divas, saying *"[I want to get better at gaming] So that I could play with some of my friends and my brother… show them that I'm not bad at Minecraft or other video games."* (mid interview). Her perceived social supports in STEM learning increased over the course of DYD, suggesting recognition of these STEM connections at home:

Social supports	*Pre survey*	*Post survey*
My parents would like it if I choose a technology career	1	3
I know of someone in my family who uses technology in their career	2	5
My family likes me to learn about technology	3	5
Important people in my life think it's good for me to learn about tech	3	5

CULTURAL

e.g. Disciplinary (math, science, etc.), classroom, communities

For our data, we can define "culture" as the practices and the communication patterns in and outside of the classroom (i.e., at home, during the program, online) and the medium through which knowledge shared.

Confidence development through personal interactions: Kasey described key interactions with family members, saying *"I had to take out the conductive thread. And then me and my dad, we sewed it back… it was fun, and it was hard… because my dad didn't know what to do. I had to explain it to him… I thought he was gonna know because he's a fashion designer, but he didn't."* (Mid interview). Although the girls came in with confidence, all four rated their disciplinary confidence higher at post survey:

Confidence	*Pre survey*	*Post survey*
I believe people like me can do well in technology jobs	4	5
I believe people like me can create new technology inventions	4	5

INDIVIDUAL

e.g. Racial and ethnic, class, academic or domain-specific

This is an amalgamation of all the previously discussed factors which impact the individual's perception. The change in opinion about individual education and career options can be considered in this tier.

Emerging interest in STEM careers: Three of the four case study girls started to considered engineering as a potential educational or career choice by the end of the program. Jackie said she *"probably [wants to be] an engineer.. [because] I like building some stuff, then I like sketching,"* which was an interest that *"just started recently"* (exit interview). Her ranking of the types of people who should learn about CS shifted over the course of the program:

Who should learn about CS? (rank order/9)	*Pre survey*	*Post survey*
People close to my age	7	2
People like myself	8	3

Discussion and Scholarly Significance

This work provides an empirical example of how to operationalize a framework to understand shifts in identity that traditional survey measures may not be sensitive enough to discover. The qualitative data gave us a more nuanced understanding of the case learners and showed how social, institutional, and cultural factors impacted their interests and identities. For example, through interviews we saw stereotypes about computer scientists fade and we learned about interactions the girls had at home with family members around the artifacts the girls made in the DYD program. Connections between family and STEM activities (e.g., being able to make a website for a family member's business) were a crucial driver in the girls' interest in STEM domain learning and potential careers. These findings were not documented by surveys alone.

Our results provide insight into how non-dominant girls in STEM demonstrate shifts in identity over time, which could inform measures of long-term success of STEM programs targeting underrepresented girls (a goal of this symposium). Next steps include formalizing measures of program success that incorporate qualitative and quantitative data about social, institutional, and cultural factors that impact girls' STEM identity shifts over time.

References

Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learning ecologies perspective. Human Development, 49(4), 193–224.

Barron, B., Gomez, K., Pinkard, N., & Martin, C K. (2014). The digital youth network: Cultivating digital media citizenship in urban communities. Cambridge, MA: MIT Press.

Bronfenbrenner, U. (1979). Contexts of child rearing: Problems and prospects. American Psychologist, 34(10), 844.

Erete, S., Martin, C. K., & Pinkard, N. (2017). Digital youth divas: A program model for increasing knowledge, confidence, and perceptions of fit in STEM amongst Black and Brown middle school girls. In Rankin & J. Thomas (Eds.), Moving Students of Color from Consumers to Producers of Technology (pp. 152–173). Hershey, PA: IGI Global.

Hall, M., & Brown, J. W. (1976, April). The double bind: The price of being a minority woman in science [eport]. Washington, DC: American Association for the Advancement of Science.

Hine, C. (2008). Virtual ethnography: Modes, varieties, affordances. In N. G. Fielding, R. M. Lee, & G. Blank (Eds), The Sage Handbook of Online Research Methods (pp. 257–270). Thousand Oaks, CA: Sage.

Johnson, A., Brown, J., Carlone, H. & Cuevas, A. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. Journal of Research on Science Teaching, 48(4), 339–366.

Ko, Kachchaf, R.R., Hodari, A.K., & Ong, M. (2014). Agency of women of color in physics and astronomy: Strategies for persistence and success. Journal of Women and Minorities in Science and Engineering, 20(2), 171-195.

Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. International Journal of Science Education, 32(5), 669-685.

Margolis, J. and Fisher, A. (2002). Unlocking the clubhouse: women in computing. Cambridge, MA: MIT Press.

McKinney de Royston, M., & Nasir, N. (2017). Racialized Learning Ecologies: Understanding Race as a Key Feature of Learning and Developmental Processes in Schools. In N. Budwig, E. Turiel, & P. Zelazo (Eds.), New Perspectives on Human Development (pp. 258-286). Cambridge: Cambridge University Press.

Nacu, D. C., Martin, C. K., Pinkard, N., & Gray, T. (2014). Analyzing educators' online interactions: a framework of online learning support roles. Learning, Media and Technology, 41(2), 283-305.

Nasir, N. I. (2011). Racialized identities: Race and achievement among African American youth. Stanford, CA: Stanford University Press.

Pinkard N., Erete, S., Martin, C. K., & McKinney de Royston, M. (2017). Digital Youth Divas: Exploring Narrative-Driven Curriculum to Spark Middle School Girls' Interest in Computational Activities., Journal of the Learning Sciences.

Acknowledgements. This research is funded by an ITEST (Interactive Technology Experiences for Students and Teachers) grant (#1433838) from the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of funding organizations. This work is a collaborative effort on the part of Digital Youth Network researchers, designers, practitioners, educators, and youth.

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