STEM Identity and Education Research at The PAST Foundation

Annalies Corbin, Maria Green Cohen, Kayla Galloway, Cassie Davis, Zach Brooks, Lydia Wisne, and Lane Fargher-Navarro*

The PAST Foundation

*lfarghernavarro@pastfoundation.org

Introduction

The PAST Foundation believes that a student's STEM identity is a powerful determinant of success in educational environments and future STEM careers. We assert that positive academic experiences through Transdisciplinary Problem-Based Learning (TPBL) and Socioemotional Learning (SEL) play a co-active role in STEM identity development by recognizing aspects of students' self-image (Figure 1).

Developing a STEM identity requires consistent support and opportunities for students to engage in STEM practices, receive recognition, and see the relevance of STEM in their lives. It also involves exposing children to relatable STEM role models and encouraging connections with those individuals. We know that beginning to cultivate STEM identity early in a child's education can significantly increase the likelihood of pursuing and persisting in STEM fields later in life. To assess the impact of our programming, the PAST Foundation Research Team has collaboratively developed instruments with students and STEM educators to track STEM identity development and knowledge acquisition.

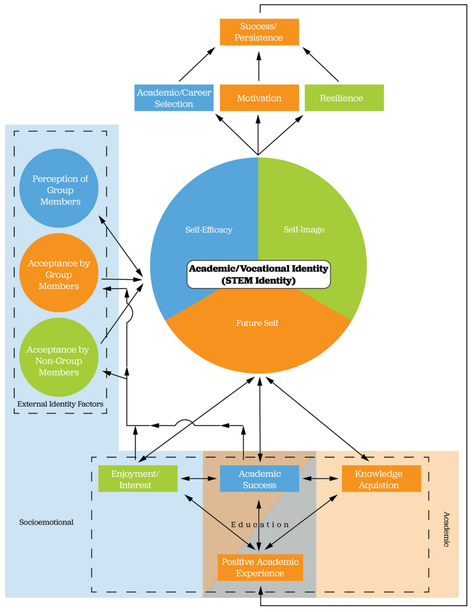

Figure 1: Factors Influencing STEM Identity and the Impact of STEM Identity on Success and Persistence

Methodology

The PAST Foundation Research Team has developed a suite of instruments to measure STEM identity development and knowledge acquisition in program participants:

STEM Identity Instrument (SII):
Assesses students' familiarity with STEM practitioners, self-image in relation to STEM, STEM aspirations, and perceived acceptance in STEM fields. Includes a unique drawing component to visualize students' perceptions of STEM people.

STEM Identity Status Instrument (SISI):
Measures students' commitment to STEM, categorizing them into four stages (Marcia, 1966):

- *Diffuse*: a lack of a commitment to or interest in a specific identity
- *Foreclosed*: Identity determined by authority figures
- *Moratorium*: Experimentation phase where STEM disciplines are explored
- *Achieved*: Considered options and committed to STEM identity

Personal Meaning Mapping (PMM):
A pretest - posttest method to evaluate the impact of our Transdisciplinary Problem-Based Learning (TPBL) and Socioemotional Learning (SEL) approaches on students' STEM knowledge acquisition and mastery. Students are presented with a prompt relating to STEM knowledge and write everything they can think of related to the prompt prior to and after programming.

These tools provide valuable insights into students' STEM identity formation and knowledge growth, helping us tailor our programs for maximum impact.

Results

PMMs were administered to students in an IT Bootcamp, where they were asked about their knowledge in “Cybersecurity” before and after programming (Figure 2). Change in number of terms and content (extent) from a PAST IT Bootcamp are shown in the graph below (Figure 2 and 3).

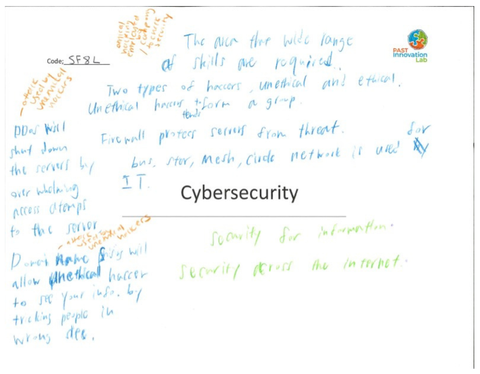

Figure 2: Example of Personal Meaning Mapping (Green: Pretest, Blue: Posttest, Orange: Follow-up Questions by Researcher).

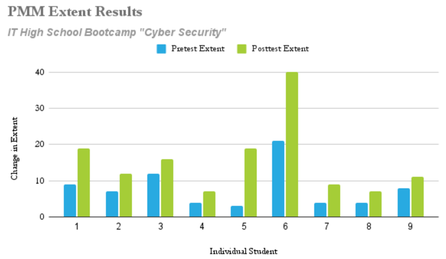

Figure 3: PMM Extent Results, or the quantity of unique vocabulary and content indicated, from a 2-week High School IT Bootcamp.

Our SISI, successfully piloted with 18 junior and senior STEM high school students, provided statistically valid results (Cronbach’s alpha = 0.8) and accurate student classification (Figure 4), as confirmed by a follow-up focus group. An interesting discovery was the classification of some students as both foreclosed and diffuse, indicating they felt obligated by adults to focus on STEM despite personal interests in other disciplines.

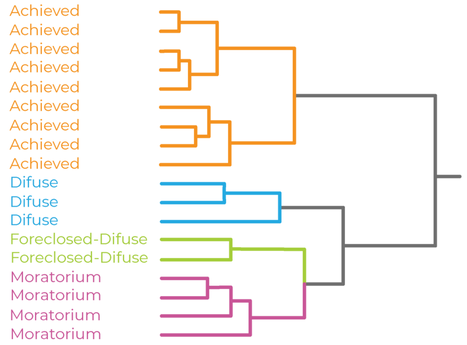

Figure 4: Hierarchical Cluster Analysis of Classification of Students’ Identity Status Using SISI.

Our drawing instrument (Figures 5 and 6), deployed among diverse students, including individuals from historically marginalized groups, revealed patterns of growth related to their understanding of STEM knowledge and practices, with students beginning to depict themselves as STEM individuals (Figure 6), or widen their idea of characteristics associated with STEM individuals (Figure 5). However, we found that students had limited exposure to diverse STEM fields and practitioners before PAST programming, highlighting an area for improvement.

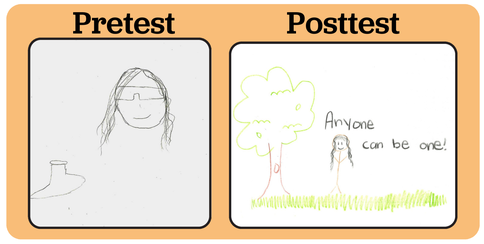

Figure 5: Pre- and post-drawing of Middle School Student A from PAST 2024 Summer Programming indicating what a Scientist Engineer, Technologist, or Mathematician looks like to them.

Figure 6: Pretest and posttest drawing of Elementary Student B from PAST 2024 after-school Programming indicating what a Scientist Engineer, Technologist, or Mathematician looks like to them.

Conclusion

Preliminary results suggest PAST’s programming involving TPBL and SEL contribute to knowledge acquisition and STEM identity development among children, especially among historically marginalized students. PAST programing is promoting a sense of belonging, capability, and interest in STEM among students that have not traditionally had an opportunity to participate in STEM. After PAST programming, these students are beginning to think, “I belong in STEM and I can do this!”

Future Steps

- Refine instruments as more data is collected to enhance validity and accuracy
- Seek funding to collaborate with Title I schools in Central Ohio to implement and evaluate the impact of TPBL and SEL on STEM identity in classrooms
- Share research results with PAST staff for continuous program improvement and incorporate strategies to expose students to diverse STEM disciplines, careers, and practitioners

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