Supporting Youth STEM Learning and Growth Mindsets Through Baseball-Themed Activities in Informal Education Settings

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Subject and Problem

What does “science education for the rest of us” mean?

- STEM education focused on STEM workforce development → negative attitudes, limited interest for students who do not see themselves in STEM
- Low-income, BIPOC youth are historically & remain underrepresented in STEM (e.g., CAWMSET, 2000)
- Informal settings are important sites of STEM learning

Subject and Problem

There are rich connections to STEM content in sports.

- Low-income, BIPOC youth often express strong interest in sports (Aspen Institute, 2018)
- Integration of STEM & sports → increased engagement, interest, & perceived success (Dorph et al., 2017; Nasir, 2002; Vincent-Ruz & Schunn, 2017)
- Some programs exist, e.g., Science of Sport

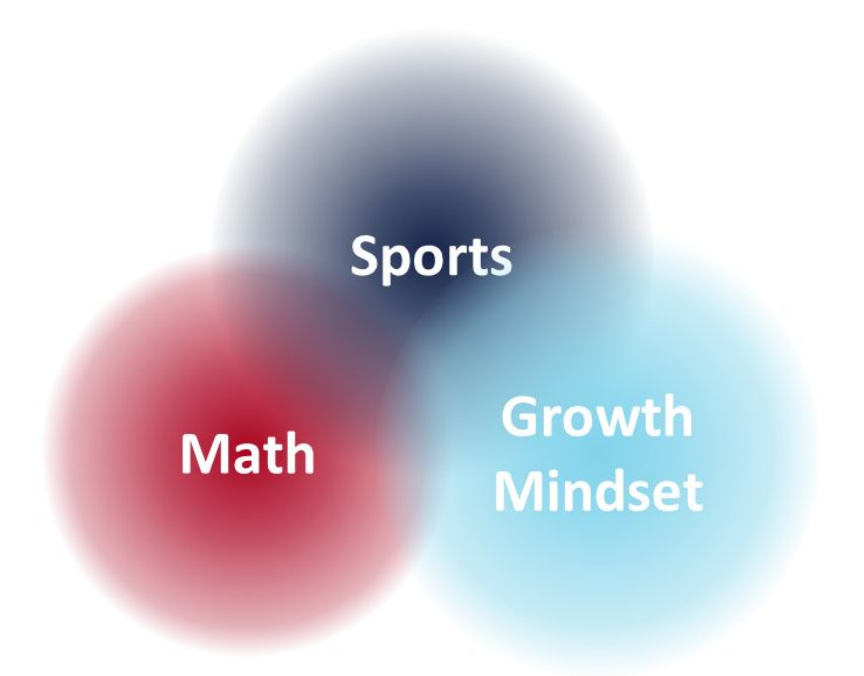
Subject and Problem

Developing a growth mindset has positive effects on student learning:

- In school (Blackwell et al., 2007; Dweck, 2012)
- In math (Blackwell et al., 2007; Degol, Wang, Zhang, & Allerton, 2018; Good & Dweck, 2006; Romero et al., 2014)
- In athletic settings (Biddle et al., 1996; Sarrazinet al., 1996)

Subject and Problem

Growing Mathletes



Research Questions

RQ1. How does participation in Growing Mathletes impact **youths' mindsets about learning** and **interest & perceived competencies in STEM**?

RQ2. How do **youth reflect on their math learning and mindsets** through participation in Growing Mathletes?

Design and Procedure

Qualitative and quantitative methods used to understand youth outcomes from multiple sites:

	FA21	SP22	SU22	FA22	SP23	SU23
Sites	2 BGC - AZ	2 BGC - AZ	2 Baseball camps - AZ & TX*	1 BGC - AZ	1 STEM program - CA	1 Baseball camp - MO*

Data include pre- and post-program surveys, youth interviews, and observations of performance-based tasks

Survey Data Collection and Analysis

117 youth completed surveys (paired *t*-tests):

- Items were related to youths' 1) **overall growth mindset for learning**, 2) growth mindset for learning **math**, 3) growth mindset for learning in **sports**, 4) ***relevance of math** in their lives, 5) **math competency**, and 6) **STEM competency**.
- Reliability of item groups were used to confirm previously used groups of items and eliminate items that did not "fit" with these participants.
    - *All groups had at least three items except relevance of math in future lives which were two single items used to compare to interview data.

Findings - Overall Growth Mindset for Learning

Youth increased in their overall growth mindset for learning with a **statistically significant average increase** from pre (mean=4.27) to post (mean=4.55), $t(114) = 5.08$, $p<.001$ with a **small effect size** d=.47.

This significant increase was seen in both the afterschool and summer implementations. There was a large increase pre to post program with a **medium effect size** for the change pre to post for *summer implementations* (d=.56).

Findings - Growth Mindset for Math and Sports

Youth showed a **small, non-significant increase** in their **overall growth mindset for math** pre (mean = 4.37) to post (mean = 4.48), t (76) = 1.56, p=.062 with a small effect size, d=.17.

Youth showed a **small, non-significant increase** in their **overall growth mindset for sports** pre (mean = 4.46) to post (mean = 4.49), t (112) = .395, p=.694 with a very small effect size, d=.037.

Findings - Math and STEM Competency

Youth showed a **small, non-significant increase** in their **overall math competency** pre (mean = 3.87) to post (mean = 3.91), t (108) = .829, p= .205 with a small effect size, d=.8.

Youth increased in their **overall STEM competency** with a **statistically significant average increase** from pre (mean=3.18) to post (mean=3.2), t(100) = 2.18, p<.05 with a **small effect** size d=.22.

Findings - Math Relevance Items

In the future, I could do harder math problems.

Youth showed a **small, non-significant increase** in this item pre (mean = 4.28) to post (mean = 4.41), t (112) = 1.27, p=.103 with a small effect size, d=.12.

When I'm older, I might choose a job that uses math.

Youth increased in this item with a **statistically significant average increase** from pre (mean=3.30) to post (mean=3.56), t(114) = 1.93 p<.05 with a **small effect size** d=.18.

Youth Interview Data Collection and Analysis

At each site, 2-5 youth were interviewed after each session.

Preliminary analysis of 120 interviews from 32 youth from across six different implementations.

- Thematic coding, consensus between 2-3 coders
- Youth math identity and math mindset, athletic mindset, math understanding, math relevance
- Patterns across codes resulted in 10 analytic memos

Preliminary Findings - Youth Interviews

Math understanding

The curriculum offered particular support for understanding **fractions and decimals** but less for topics related to **measurement**.

Math relevance

Youth were able to make **connections** between the math used during the lessons and the use of math in their own lives.

“With chores, for laundry you got to count. How much you need to fold and how much you need to put away."

Youth Statements About Growth Mindset

Making Mistakes

You can learn a lot [from making mistakes]. *It helps with your growth mindset. Even if you mess up, it's okay. You still have another chance, especially on the field. You miss a fly ball or grounder, get the next play. … [making mistakes in math] just helps with thinking more, getting you prepared for a next question that might be harder.*

Value of Collaboration

[The activity] was fun. I like the part where we put the cones down because ***it really felt like we were working together****, one was measuring, one was looking at the shape, another one was trying to fix the cones to make sure it was straight, another one was helping the guy measuring, and* ***it was really fun just working as a team****.*

Effort and Persistence

I'm not the strongest at math, but if I try, it could get to my mind and I'll do it. And I'll realize that it's not that hard. But then ***it's like about practice and working on it every day*** *and stuff like that.*

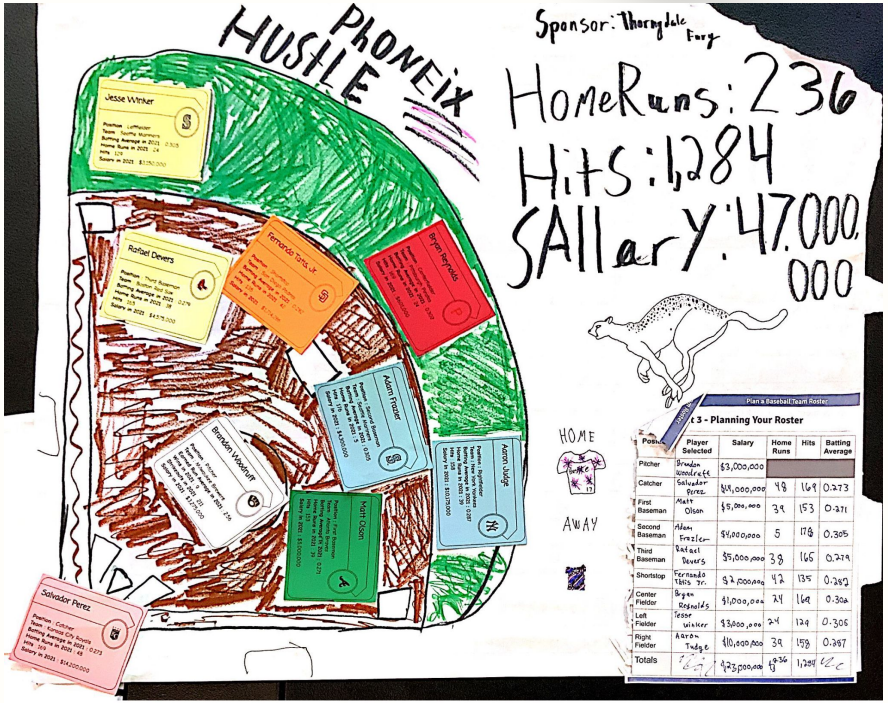
Malleability of the Brain

I kind of think of the brain as a muscle. ***When you flex and work different parts of your brain, they get stronger and they get better and more adept*** *to doing those specific tasks. So when it comes to math, when you're stressing it or when you're working your brain on a specific problem on a calculation. Something like that, and your brain [can] get stronger.*

Observation Data Collection and Analysis

Youth completed one of two performance-based tasks (Design a Stadium or Build a Team Roster) at the end of the program.

19 small group videos and artifacts (e.g., posters) were collected.



Preliminary Findings - Observations

Almost all groups demonstrated **strong evidence of number sense and operations to solve problems**.

Observations showed **evidence of equitable participation and the use of peers and facilitators** as resources in their decisions.

Groups **less often focused on precision or the strategic use of tools** to support calculations.

Youth **needed more support to develop mathematical arguments and to reason across multiple data sources** to support decisions.

Contribution

Sites of informal education represent important avenues for providing STEM learning to underserved communities (Dorphet al., 2017; Nasir, 2002; Vincent-Ruz & Schunn, 2017).

“Science education for the rest of us” means to relate STEM content to real-world contexts and go beyond abstract STEM content delivery.

Growing Mathletes offers a useful program for supporting youth STEM learning and mindset in informal contexts.

Thank You and Contact Information

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STEM for ALL 2022 Video Showcase:
https://stemforall2022.videohall.com/presentations/2605

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Growth Mindset Principles

1. ***The value of collaboration. Everyone has strengths to contribute to the team.*** Many tasks require a number of different skills and abilities. None of us may have all of these skills and abilities, but as a team we can draw on the strengths of each team member to succeed.
2. ***The power of effort and persistence.*** We can improve and reach our goals through goal setting, effort, and progress tracking. Effort pays off when we persevere and keep working toward goals.
3. ***The value of mistakes in supporting learning.*** Mistakes are a normal and valuable part of the learning process. We can learn from our mistakes through reflecting on our errors and taking lessons from them. Mistakes make our brain grow!
4. ***Malleability of the brain and the role of struggle in learning.*** The brain can get stronger and smarter. New connections between neurons in the brain change all the time as a result of our experiences.
5. ***Praise the process, not the person.*** Modify your language to focus on the process instead of the person. Praise youth when they work hard to accomplish a difficult task.