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Growing Mathletes: A Model for Integrating Growth Mindset and Other Content in Informal Settings

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Abstract. Growing Mathletes is an NSF-funded program that is developing a curricular model to successfully integrate growth mindset principles, baseball, and math and science concepts for youth in grades 3 to 8 in out of school learning settings. Using a Design-Based Implementation Research framework for implementing, testing, and revising a curriculum and professional learning model, we are working on best practices to support youth learning and confidence as well as facilitator training and support in both afterschool and summer programs. We present youth outcomes as evidence of successes in how the program has integrated growth mindset with other content as a way to support youth's productive mindset in their own learning along with content gains.

1. Introduction

Growing Mathletes is an NSF-funded program that is developing a curricular model to successfully integrate growth mindset principles, baseball, and math and science concepts for youth in grades 3 to 8 in out of school settings. Informal opportunities to explore sports-related activities are particularly important for youth from low-income communities, including many African American and Latinx youth who often express interest in sports but have declining rates of participation due to rising costs (Aspen Institute, 2018). Growth mindset is a key component of the program because students with a growth mindset believe that intelligence is malleable rather than fixed; they see challenges as opportunities to deepen understanding and believe they can learn more through effort. In contrast, students with a fixed mindset see intelligence as fixed, innate trait; they may avoid challenges, and give up easily when faced with difficult tasks (Kravosky, 2007).

Using a Design-Based Implementation Research framework for implementing, testing, and revising a curriculum and professional learning model, we are working on best practices to support youth learning and confidence as well as facilitator training and support in both afterschool and summer programs.

1.1. Curriculum

The current developed curriculum is made up of 17 lessons and two performance-based tasks that include activities incorporating baseball, math, and growth mindset. Each lesson and performance-based task addresses key math standards for target grade levels, including measurement (linear measure, perimeter, area, angle measure), as well as operations with whole numbers and rational numbers (real world problem solving with four operations, number sense and operations with fractions and decimals). In addition, multiple lessons address representation and analysis of data, including line plots and histograms, and reasoning about measures of central tendency such as average. Both performance-based assessment tasks are clustered with a set of lessons that address similar mathematics concepts. Each lesson and performance task also addresses at least one of five growth mindset principles: a) the value of collaboration; b) effort and persistence; c) mistakes as opportunities for learning; d) the role of the malleability of the brain in learning, and e) praise the process, not the person.

1.2. Other Materials

In addition to the written curricular guides for lessons and performance tasks is a facilitator guide with information about key math concepts and growth mindset principles, tips for implementation, and adaptations for youth of different ages or for different space or schedule constraints. Each lesson includes curated Google slides for implementing activities with youth. These slides include supportive visuals to scaffold youth understanding, engaging video clips to explain concepts and activities, and prompts for discussion and reflection. Lastly, there are support materials online for facilitators including videos of implementation and on-demand resources about growth mindset, baseball, and mathematical concepts.

1.3. Core Growth Mindset Concepts

The key Growth Mindset Concepts that are central to the curriculum are (PERTS Mindset, 2022):

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. Our effort pays off when we persevere and keep working toward our 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 students when they work hard to accomplish a difficult task.

The table below shows the alignment between the lessons and key Growth Mindset Concepts. *Praise the process* is a concept infused for facilitators in how they engage with youth throughout the program but not an explicit piece of lessons.

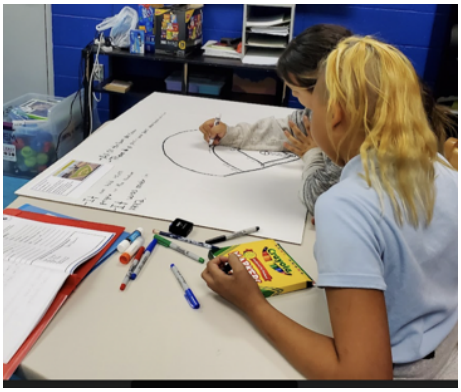
Table 1. Lessons and Key Growth Mindset Concepts

Lesson	Growth Mindset Principle
Base Running	#4 Malleability of the brain and the role of struggle in learning
Baseball Field Geometry	#4 Malleability of the brain and the role of struggle in learning
Baseball Positions	#1 The value of collaboration. Everyone has strengths to contribute to the team.
Batting Average	#3 The value of mistakes in supporting learning and #4 Malleability of the brain and the role of struggle in learning
Modeling Batting Average	#3 The value of mistakes in supporting learning
Fielding Percentage	#3 The value of mistakes in supporting learning
Launch Angles	#2 The power of effort and persistence
Measuring Heart Rate	#2 The power of effort and persistence
orts Vision	#4 Malleability of the brain and the role of struggle in learning
Strike Zone	#3 The value of mistakes in supporting learning
Throwing Distance	#1 The value of collaboration. Everyone has strengths to contribute to the team.
Broad Jump	#2 The power of effort and persistence
asticity	#4 Malleability of the brain and the role of struggle in learning
Nutrition	#2 The power of effort and persistence
Stealing Bases	#4 Malleability of the brain and the role of struggle in learning
Negro Leagues Road Trip	#1 The value of collaboration. Everyone has strengths to contribute to the team.
Wingspan	#2 The power of effort and persistence

In addition to the 17 lessons are two performance-based tasks that integrate multiple math and growth mindset concepts used as culminating activities: *Build your Own Roster* and *Design a Stadium* in which youth work in groups to create posters that are shared.

2. Implementation and Research

The Growing Mathletes curriculum has been iteratively developed and revised using a Design-Based Implementation Research framework (Penuel & Martin, 2015; Roschelle, Knudsen, Hegedu, 2010). As of fall 2022, the curriculum has been implemented in afterschool and summer settings in Arizona and Houston in Boys and Girls Clubs, Major



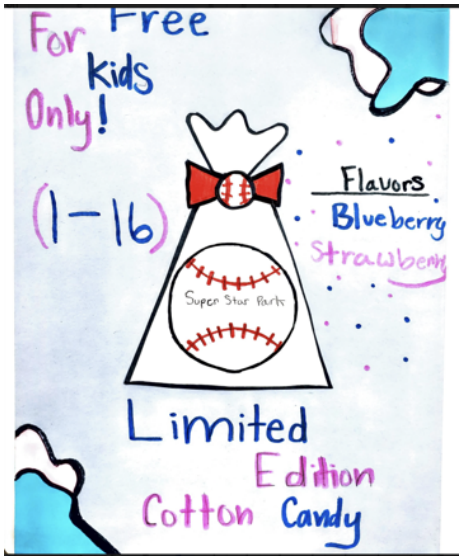


Figure 1. Youth working on Design a Stadium Task and poster created by youth in an afterschool program.

League Baseball Academies, and other summer camp sites. Data is collected from facilitators and youth which has led to continual improvement. Data collection includes video recordings of small groups of youth as they work on performance-based tasks, researcher field notes, youth surveys, facilitator and youth interviews, and youth's posters and planning work (worksheets, etc.).

2.1. Preliminary Findings

Overall, data collection is supporting the team to answer four research questions related to outcomes for youth and facilitators. Preliminary results show that youth have strong growth mindset for overall learning pre-program which increases slightly pre- to post-program. Youth have a strong average interest (3.7 out of 4 on a Likert-type scale) in math both before and after the program which does not significantly pre- to post-program. There has been a significant increase in youths' self-reported competency in STEM from pre- to post-implementation.

Analysis of 86 interviews has produced consistent evidence of youth understanding of key math concepts. Youth use experiential activities from the sessions to explain math ideas and describe how tools used in the sessions supported their understanding. Curriculum materials support youth to engage in key math practices including organizing and labeling mathematical work. Facilitator prompts are key in supporting youth to communicate reasoning to others. Lastly, many youth interviewed consider themselves to be math-orientated and are able describe the relevance of math not only in sports but also in other parts of their lives.

Facilitator outcomes demonstrate both successes and needed supports that are being integrated into the program. Facilitators show agency in their implementation of the lessons adapting the curriculum to be their own and providing feedback on the lessons. Most facilitators identified that their learning about the program and the content occurred during their initial training with the Growing Mathletes team. Facilita-

tors understand the math and mindset content but some struggle with their knowledge of baseball, depending on their background. Facilitators report that they need more support in time management during implementation so that they can more effectively balance the math, baseball, and mindset concepts.

The program is currently adapting the professional learning program to meet diverse facilitator needs and providing timely supports and coaching through consecutive implementation dates (e.g., week-long summer camps).

3. Connection of Growth Mindset Concepts to Astronomical Topics

Each growth mindset concept has a parallel in astronomy, with examples in the table below.

Table 2. Examples of growth mindset concepts with parallels in astronomy.

Growth Mindset Concept	Astronomical Topics
The value of collaboration.	Contemporary astronomy projects require large and diverse teams.
The power of effort and persistence.	Catalina Sky Survey, big astronomical discoveries over time.
The value of mistakes in supporting learning.	How discoveries are made building on models that are often updated.
Malleability of the brain and the role of struggle in learning.	Creativity and breakthroughs of discovery.
Praise the process, not the person.	Praise hard work not "smartness."

In addition, each growth mindset concept has a parallel in informal astronomy education, examples of which are in the table below.

Table 3. Examples of growth mindset concepts with parallels in informal astronomy education.

Growth Mindset Concept	Informal Astronomy Activities
The value of collaboration.	Research experiences, collaborative projects, creations of complex projects.
The power of effort and persistence.	Challenging activities, multi-day experiences, research experiences.
The value of mistakes in supporting learning.	Give examples of historical figures who made mistakes and pushed the field forward – e.g., Galileo.
Malleability of the brain and the role of struggle in learning.	Modeling productive struggle in writing and generating results.
Praise the process, not the person.	Not about being the smartest—about how you persist.

4. Conclusions

We have found success integrating STEM content with growth mindset concepts that have let to positive youth outcomes in a variety of informal education settings. This work has implications for informal astronomy education, particularly for increasing access with youth from historically marginalized communities. We provide suggestions that can be integrated in informal education settings as a basis for building on this work.

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