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Twianie Roberts,

Annette Roberts-Murray

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Twianie Roberts, Annette Roberts-Murray

Tennessee State University, Nashville, USA

Email: trober25@tnstate.edu

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Abstract

In the United States, there is an increased demand for professionals in science, technology, engineering and math (STEM). Research indicates that individuals with higher levels of self-efficacy and grit have higher levels of academic achievement. Traditional research has focused on the self-efficacy and grit of students. Realizing the impact that parents and educators have in the lives of students, the purpose of this model is to determine the effect that parent and educator self-efficacy and grit training has on the pursuit of STEM careers for elementary students from traditionally underrepresented groups. The data gathered, will examine the impact that professional development has on student career choice. This model has implications for curriculum development, professional development, instruction and policy articulation.

Keywords

Self-Efficacy, Grit, Parents, Teachers, Professional Development, Underrepresented Groups, STEM, Elementary

1. Introduction

Perseverance is persistence in doing something despite difficulty or delay in achieving success (Merriam Webster's Collegiate Dictionary, 2022).

The road to attaining a career in Science, Technology, Engineering and Mathematics (STEM) is replete with failures, disappointments and perseverance. Once a STEM career is attained, breakthroughs in the STEM field continue to be preceded by failures, disappointments and perseverance. Albert Einstein stated, "It's not that I'm so smart, it's just that I stay with problems longer (Mayer et al.,

2003)”.

Research indicates that students in STEM related areas outperform students in non-STEM areas (Saraç, 2018; Yildirim, 2016) because they tend to “stay with problems longer.” In his research findings, Sarac concluded that additional research is needed on STEM education practices to determine the effect of learned knowledge on permanence. Permanence indicates the retention of learned information. Academic ability alone does not address the skills needed when one encounters failures and disappointments. One explanation is that students, who persevere, have a higher degree of Grit. Bekir Yildirim conducted an analyses and meta-synthesis of research on STEM education utilizing 33 different studies. He concluded that teacher STEM knowledge should be developed utilizing STEM pedagogical practices. Within the proposed model, these practices are within Mastery Experiences—PreK-2 STEM Lab.

Grit is composed of passion (consistency of interest) and perseverance (consistency of effort) for long-term goals (Duckworth et al., 2007; Duckworth & Quinn, 2009).

Grit = Passion (Consistency of Interest) + Perseverance (Consistency of Effort)

Passion or consistency of interest refers to setting a goal and sticking with the plan to achieve the goal. Personal interests may influence Passion. Consistency of interest drives the individual to remain on task through challenging experiences. Passion or engagement implies involvement, commitment, enthusiasm, absorption, focused effort, zeal, dedication, and energy (Schaufeli, 2013). Antonyms for engagement include disengagement, uncommitted, apathetic, distracted, unfocused, indifferent, uninterested, and inefficient.

Perseverance of effort is the second component of Grit. Perseverance manifests as continued dedication to a task while experiencing failures, disappointments and setbacks. The individual that perseveres believes that their continued efforts will yield better results. They view each failure or setback as a learning experience. Each attempt gets them closer to their goal (Baruch-Feldman & Caren, 2017).

In STEM areas, a positive correlation exists between grit and academic achievement (Al-Mutawah & Fateel, 2018). Mutawah’s research was conducted utilizing high school students in Bahrain. Bahrain is an archipelago of 33 islands in the Persian Gulf located off the eastern coast of Saudi Arabia. Per Mutawah, more research is needed to determine how non-cognitive factors affect math and science performance to improve these subjects’ outcomes. These factors may include academic mindsets, social skills, academic perseverance, and learning strategies. So, can grit be taught? Is passion innate? Can a student’s life experiences teach them to persevere in life?

Carol Dweck, developed research on two different types of mindsets—a growth mindset and a fixed mindset. Mindsets can be taught.

A person with a fixed mindset: believes talent and intelligence are fixed, believes effort is fruitless, believes failure defines an individual, avoids challenges, ignores feedback, views feedback as personal criticism and feels threatened by

others' success.

An individual with a growth mindset: believes talent and intelligence can be developed, believes effort is needed to attain mastery, believes mistakes are a part of learning, embraces challenges, embraces feedback and views others success as inspirational (Dweck, 2006).

The Incremental Theory of Intelligence is a psychological intervention that changes beliefs about effort (Dweck & Leggett, 1988). It stresses that the brain can grow and change through:

Dedication, hard work on challenging tasks, finding the right learning strategies, and seeking assistance from others. Hence, with a growth mindset, a person believes that the brain can grow.

The psychologist Albert Bandura developed the concept of self-efficacy. It is an individual's belief in their capability to exercise control over their own functioning and over events that affect their lives. Self-efficacy is achieved through:

- 1) Mastery experiences—How well you have “Mastered” a task in the past.
- 2) Vicarious Experiences—Seeing others “like you” succeed at a task.
- 3) Social Persuasion—Receiving positive verbal feedback that instills within an individual that they can accomplish a task and
- 4) Emotional states—“The emotional, physical, and psychological well-being of a person can influence how they feel about their personal abilities in a particular situation.” (Bandura, 1977).

In the review of the literature, we were unable to find research that utilized Parent and Educator Self Efficacy and Grit Training to encourage the pursuit of STEM careers for elementary students from traditionally underrepresented groups (Cheng et al., 2017, King & Trinidad, 2021). Cheng examined parent growth mindset and determined that it is positively associated with student non-cognitive skills and outcomes, though the effect seemed to fade away over time. Parent's, predominately mothers, and a math teacher, were given questionnaires that focused on growth mindset, self-efficacy, and effort. The data did not provide information about growth mindset of all the students' teachers or the influence that both teacher and parent has. Ronnel King's research concluded that, “a growth mindset positively predicted achievement only among students from more advantaged families but not among those from less advantaged families”. His research did not utilize vicarious STEM contributions from underrepresented groups.

Since research has shown the impact that self-efficacy and a Growth Mindset has on academic achievement, this indicated the need to present this model.

2. Problems to Be Addressed

The purpose of the model is to determine:

- Does parent and teacher Growth Mindset training affect student Growth Mindset?
- Is parent and teacher Growth Mindset training retained (permanence)?

- After parent and teacher Growth Mindset training is administered, is student Growth Mindset retained (permanence)?
- Does student education, home income level, race and/or gender affect student Growth Mindset?
- Does parent education, income, race and/or gender affect student Growth Mindset?
- Does teacher education, income, race and/or gender affect student Growth Mindset?

Research Process

1) Research Process—Administer the Growth Mindset Scale yearly to teachers, parents and students. Record and monitor data on Growth Mindset Permanence, Growth and Correlations. Please note the student, parent and teacher’s education, income, race and gender.

<https://docs.google.com/document/d/1m5V7w7PslqBS-nYxnsZAMB11dXiBc1MPGoXWMzMQ9g/edit>

2) Parents and PreK-Grade 5 teachers will then receive monthly professional development each year on the following topics (**Table 1**):

The Professional Development sessions can be offered by grade band or individual grade level.

Table 1. Parent and teacher professional development topics.

Month	PreK—Grade 2 Parent and Teacher PD Topics	Grade 3 - 5 PD Parent and Teacher Topics
1	Updated Self-Efficacy and Perseverance (Research and Activities for PreK-2)	Updated Self-Efficacy and Perseverance (Research and Activities for Grades 3 - 5)
2	Vicarious Experiences—How to promote Self-Efficacy and Perseverance: culturally relevant examples (ex. Movie Hidden Figures and <u>Others</u>)	Vicarious Experiences—How to promote Self-Efficacy and Perseverance: culturally relevant examples (ex. Movie Hidden Figures and <u>Others</u>)
3	Mastery Experiences—PreK-2 STEM Lab—Pedagogy	Mastery Experiences—Grade 3 - 5 STEM Lab—Pedagogy
4	The Power of Hard Work and Dedication—Developing a strong work ethic (home/school examples)	The Power of Hard Work and Dedication—Developing a strong work ethic (home/school examples)
5	Social Persuasion—The Power of Words: Receiving positive verbal feedback that instills within a child that they can accomplish a task	Social Persuasion—The Power of Words: Receiving positive verbal feedback that instills within a child that they can accomplish a task
6	Emotional States—“What do I feel about my abilities?” —The Power of Emotions	Emotional States—“What do I feel about my abilities?” —The Power of Emotions
7	How to Foster a Growth Mindset Part 1	How to Foster a Growth Mindset Part 1
8	How to Foster a Growth Mindset Part 2	How to Foster a Growth Mindset Part 2
9	Leveling Up—Next Level Resources: Providing ongoing activities and resources that are <i>at or above</i> grade level. (Ongoing and end of year)	Leveling Up—Next Level Resources: Providing ongoing activities and resources that are <i>at or above</i> grade level. (Ongoing and end year)

Broader Impacts

This model will change professional development for parents and teachers. It will also increase the number of students who enter into STEM fields, leverage additional funding and collaborations to increase efforts regarding STEM. Overall, the potential of the proposed activity to benefit society and contribute to the achievement of specific desired societal outcomes include:

- Increased student achievement
- Increased participation of students in STEM related fields;
- Improved mathematics education and educator development;
- Development of a diverse, globally competitive mathematics (STEM) related workforce
- Use of STEM Educator best practices to inform public policy

Intellectual Merit

The goal of this model is to provide high quality professional development to parents and educators by utilizing culturally relevant Self Efficacy and Growth Mindset training. This approach can potentially advance knowledge in the field of professional development by providing a model to create, train, and support parents and educators. This model can be researched and replicated worldwide for all content areas and K-12 grade levels.

3. Conclusion

Research supports the benefits of self-efficacy and growth mindset training. In the past, the training in this area focused on students and educators but it did not examine the long-term effects of the impacts of the most powerful voices in a child's life. These voices include the child's community, parents and teachers. Longitudinal research is needed in this area for elementary, middle and high school students.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Web Resources

1) National Science Foundation:

<https://www.nsf.gov/news/classroom/education.jsp>

2) NASA STEM Resources:

<https://www.nasa.gov/stem/foreducators/k-12/index.html>

3) Department of Energy:

<https://www.energy.gov/diversity/student-educational-resources-stem>

4) MAGNET Schools Assistance Program:

<https://msapcenter.ed.gov/stem/STEMResources.aspx>

5) I-STEM:

<https://www.istemnetwork.org/parents-students/stem-activities-for-students/>