# Pandemic! Influencing Girls' Fear of Failure in a STEM + Computational Thinking Program (Work in Progress)

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*"Failure should be our teacher, not our undertaker. Failure is delay, not defeat. It is a temporary detour, not a dead end. Failure is something we can avoid only by saying nothing, doing nothing, and being nothing." - Denis Waitley*

## Introduction

This research is a work in progress, an offshoot of an exploratory integration study of STEM + computational thinking (STEM+C) for minority girls. The larger study is a joint effort amongst a community center, an educational research institute and a STEM center at a university. These partners designed, tested and implemented the integration of new computational thinking (CT) practices into a research-based STEM program. The study is longitudinal, spanning two school years, in 10-week, twice weekly, 90-minute program. One of the goals of the program is to learn how to inspire, motivate and bolster minority girls STEM and CT abilities and perceptions. The purpose of this work in progress is to study how an intervention implemented year two to mitigate fear impacted the girls before, during and after the COVID-19 pandemic.

## Background

In the first year of the study our observation was that the girls were hesitant to share in most of their discourse, whether it be in class at their table group, or while presenting and even during meeting with mentors and women in STEM. This behavior did not support one of our research goals. We were also concerned that students' fear of failure would create procrastinators, or a permanent fear of STEM later. Our intent was to increase student voice to produce a socio-cultural environment to bolster collaboration and communication amongst the girls. *Education Reform* defines "student voice" as the following:

> In education, **student voice** refers to the values, opinions, beliefs, perspectives, and cultural backgrounds of individual students and groups of students in a school, and to instructional approaches and techniques that are based on student choices, interests, passions, and ambitions.

In year two, we changed our instructional methodology to increase student voice, exposure to presenting and more interaction with local women sharing their stories of how they became STEM professionals.

## Literature Review

The literature review on the fear of failing was followed by a literature search on the influence of the pandemic on student cognition, motivation, affects and behaviors. Much has been said over the past year about teaching and learning difficulties of a virtual "school,"

especially in under-privileged neighborhoods. Additionally, the effect of COVID-19 on the Black community is proportionally higher than for other groups of people. Some believe it is due to the tight living quarters in urban areas plus the lack of medical care.

In November of 2020, The Orlando Sentinel 's front page read that more poor, Black and Hispanic students opted for online learning. How would this turn out? Would children learn? What can we do to mitigate not only the fear of failure but also lack of success? In Florida, Black students were not returning to school. Postal, at the Sentinel, said that:

> Parents earning less than $50,000, they found, were far more likely to think that if infected with the corona virus they would be hospitalized or die compared with those who earned more than $150,000 (Postal, 2020).

The author also reported that a reason might be that:

> …low-income families, often have more health problems that could make them at higher risk of complications, live with older people, have worsening economic struggles, and more worries about paying for health care should family members become ill (Postal, 2020).

The National Association for the Advancement of Colored People (NAACP) and major news stations reported similar impact of COVID-19. That is, race and socioeconomic status were already responsibility for disparities, but that COVID-19 was deepening the divide. The NAACP said that one of the bigger challenges is that we know early education helps children thrive, yet COVID-19 has accelerated the need for high-quality affordable childcare. But many poor and underprivileged families cannot find, access or afford available childcare. Additionally, many recent reports indicate Black woman, who are a hard hit population segment, have low-income jobs without adequate benefits.

Additionally, in recent research  of by Besser, Flett, and Zeigler-Hill (2020), college-aged students have "pervasive negative reactions" to the online versus face-to-face learning conditions. Besser, Flett, and Ziegler-Hill also stated that more positive reactions of students reported greater feelings of belonging and mattering. Now, with on-line learning, students procrastinate and lose their ability to self-regulate and maintain positive reactions. Besser, Flett and Zeigler-Hill (2020) also indicated in their study that "females students compared to males scored higher in fear of failure and organizing," making this topic even more important. The Need Achievement Theory is the need to succeed and not fail ((Atkinson 1957; McClelland, 1965), and socio-cultural theory (that students will learn from each other through collaborative dialogue (Vygotsky, 1978) guide this study.

**Demographics**

In this African -American community, we found children and their parents had a number of hurdles to overcome. One was the high incidence of the COVID-19 virus reducing the number of grandmothers available for childcare but increasing the risk of exposure. Another was school closures. Schools were also where most of the students ate, leaving them without food until

school reopened (the activity center follows the school calendar). And there was the ever present lack of money (Table 1.1).

| Table 1.1 Demographics of Community-2010 Census | |
|---|---|
| Population | 25,377 (2020) |
| Black or African -American | 97% (2020) |
| Median Value of Owner-occupied Housing Unit | $54,500 |
| Median Household Income | $24,343 |
| Persons in Poverty | 33.4% |
| COVID-19 | Almost half of confirmed coronavirus cases in St. Clair County were Black patients, though Black people make up just 30% of the population. A quarter of cases were White people, who account for 62% of the population. |

**Methodology**

**Pre-COVID-19.** Our original participants in the program were black girls, grade 2-8. In year two grades 4-5 were separated from the other girls. Most days our attendance averaged between 8-10, as low as one and as high as 15 girls. The girls were dropped off by parents, even though most lived next door. Some of the girls' parents or grandparents worked at the activities center, occasionally stopping in, especially if the girls were rambunctious. Ava's father worked as security at the center and Katie's grandfather often volunteered (Ava and Katie are pseudonyms). The families who came to the activities center were acquainted with each and with staff. In addition to improved self-efficacy and lessened fear of failure in the girls, our relationships with families improved by attending and creating additional events. For example, I created a group called Women of Color in STEM. Female STEM professionals visited us and shared their personal and career journeys. The event significantly added and diversified the girls' STEM Career Interest. One girl changed her career goal from "teacher," to "aeronautical engineer." Our changes included exposure to presenting and more interaction with local women sharing their stories of how they became STEM professionals.

In addition to expanding opportunities for the girls to express themselves (communicating with each other, families and the community), we began implementing the instructional methodology changes in the fall of 2019. The instructional methodology and data collection tools were adjusted to capture student voice, and more real time discourse and behavior of the girls. We maintained pre-, post- and think aloud interviews and engagement surveys, but added exit slips, and formative assessments at all lessons. The students engaged

better with the material as the class progressed. One major addition to instruction was a design process exercise called "Works/Doesn't," where students were encouraged to discuss successes and failures in their projects. By this process, the experience of failing became normalized and students could focus on problem-solving and sharing results. As a result, the pressure to "perform" was reduced and students could engage in more creative aspects of the lessons, which were often their favorite part of the process.

The changes to the year two curriculum also included a revision in the schedule to a shorter duration of the class (from 90 minutes to one hour), and who instructed the class. A seasoned STEM teacher from the STEM Center, a research scientist, a graduate student and one of the coordinators continued with the program. Our results were positive, with girls now competing to share. These methods appeared to mitigate fear of failure, improving agency and empowering the girls. But then came March of 2020.

**During COVID-19.** The program was immediately halted as an intervention to a "life-impacting disaster." When the COVID-19 pandemic arrived, schools closed, and all in-person contact between the university and the girls was put on hold. Over the summer the structure changed for most university programs to a virtual, at-home format. Some of the existing university programs, like *STEM at Home,* expanded and prospered during the pandemic.

The girls usually attended local elementary schools, but during COVID-19 "school" took place at the neighborhood activity center, situated next door to the housing project many called "home." The girls often worked on their program activities with the coordinator after school.

Our assignments were on-line, but our interviews and surveys were either on-line or by telephone. The engagement survey also continued on-line. Lessons were on Zoom as were the weekly reviews. Specifically, we created a page on our website to list the Monday lessons (in PDF format) and to connect with the group to review/answer questions. The webpage was publicly available but unlinked (no other page on our site or another site connected directly), only easily found by our participants. The URL was made simple enough to convey over the phone or by text, which the center staff relied on for direct contact with students. The curriculum revisions (Figure 1.1) attempted to maintain the content focus of the original lessons.

**Revised Curriculum**

**Biometrics**
1. September 21: Fingerprinting, Part 1-video on-line
   September 24: **Friday Live Chat on Biometrics**

2. September 28: Fingerprinting, Part 2- video on-line
   October 1: **Thursday Live Chat on Biometrics**

**Health and Beauty: Biodiversity I**
3. October 5: Estimating Biodiversity- video on-line
**October 8: Thursday Live Chat on Biodiversity**
4. October 12: Estimating Population Sizes video on-line

**Health and Beauty: Biodiversity II**
5. October 19: Managing Biodiversity, Part 1- video on-line
6. October 26: Managing Biodiversity, Part 2- video on-line

**Fisheries I**
7. November 2: Modeling a Fishery with Food- video on-line
   November 5: **Thursday  Live Chat on Fisheries**
8. November 9: Sustainable Fisheries- video on-line

**Fisheries II**
9. November 16: **Bunny Population-** video on-line

**Biodiversity Barriers**
10. November 30: Building a Model of a Reserve- video on-line
11. December 7: Fragmented Habitats- video on-line
12. Dec 14  **Review and assessments**

*Figure 1.1*
COVID-19 Revised Curriculum/Lesson Plans-Online videos with access to worksheets  and surveys.

**Revised Research Methods**

This curriculum was supported by online video lessons and activities, and weekly recorded Zoom calls with all students and our team to discuss the work. Our university Internal Research Board required a revised n and signed consent/assent forms to allow online learning and research. Interviews and surveys were mostly conducted on-line, by Zoom, or by telephone. Fortunately, we were able to keep our coordinator in place. She was well acquainted with both the girls, and their families, the center's staff and us. She helped the girls understand the videos, review their homework instructions, kept track of their work and their families. Usually, she called the parents to remind them of classes and visited the girls during their lunch break but also after school at the center. Although we could not finish the previous semester's lessons, observations, interviews, assessment, presentations, and events, we were prepared to finish as much work as possible and continue the assessments.

**Preliminary Results**

In the fall of 2020, the girls attended our first Monday lesson on finger printing. The three girls were engaged, asking and answering questions about finger printing and its purpose. All the girls said it was easy and that they learned the lesson quickly. We stopped meeting the girls for Monday lessons because the girls did not complete homework in time for discussion. Instead, we conducted a review session each Thursday and sporadically conducted interviews. Our attendance high was four girls but dwindled down to zero on one occasion.

**Surveys.** We were able to complete one engagement survey (Figure 1.2, Table 1.2). Mary Ann and Denise were the two girls who completed the first survey on 12/18/18 and also the last on 9/24/20, the final engagement survey. The final engagement survey occurred after the on-line lesson on fingerprinting which the girls did on their own and said was easy and that they knew was important for identifying bad guys). Overall, there was no consistency in individual questions (for example, a question always either high or low interest). However, Table 1.2 indicated student engagement increased over time.

Directions: Circle the choice that shows how you feel.

1. During this activity: I felt bored.
   YES!   yes   no   NO!

2. During this activity: I felt happy.
   YES!   yes   no   NO!

3. During this activity: I felt excited.
   YES!   yes   no   NO!

4. During this activity: I was daydreaming a lot.
   YES!   yes   no   NO!

5. During this activity: I was focused on the things we were doing most of the time.
   YES!   yes   no   NO!

6. During this activity: Time went by quickly.
   YES!   yes   no   NO!

7. During this activity: I was busy doing other tasks.
   YES!   yes   no   NO!

8. During this activity: I talked to others about stuff *not* about what we were doing.
   YES!   yes   no   NO!

*Figure 1.2*
Engagement Survey

**Table 1.2**
*Engagement Survey (1-4 Likert Scale)*

| | | Mary Ann | Denise |
|---|---|---|---|
| Engagement 1 | 12/18/2018 | 2.6 | 2.4 |
| Engagement 2 | 10/7/2019 | 3.3 | |
| Engagement 3 | 11/6/2019 | | 2.9 |
| Engagement 4 | 9/24/2020 | 4.0 | 3.5 |

STEM + C: Exploring Global Challenges
Student Pre-Interview Protocol

Research Questions:
1. What aspects of the integration of CT and STEM increase the likelihood of girls acquiring CT skills?
2. What aspects of the integration of CT and STEM increase the likelihood of girls acquiring STEM content knowledge?
3. How does the integration of CT and STEM affect minority girls' self-perceptions as future technologists?

Interview Questions:

*Designing Engaging CT-Integrated Activities (can also ask about last week)*
1. What is STEM?
2. What do you think you will be doing in the STEM program?
3. How did you feel about doing the STEM program? *[May probe for specific parts and/or stages of the activity (e.g., beginning, end).*
4. Which parts of STEM activities do you think you will like? Why?
5. Which parts of STEM activities do you think you will not like? Why?
6. Tell me about a time you enjoyed sharing. Why did you enjoy it?

*Perception of Self as Future Technologist*
7. What kinds of jobs do you imagine doing when you grow up? *[May probe for specific job examples/titles.]*
8. What kinds of technology (e.g., computers, smart phones, 3-D printers, scanners) do you imagine using in your "grown-up job"? What kinds of things would you use the technology for?
9. What kinds of people do these kinds of technology jobs? *[What do they need to know? What kinds of things do they like to do? How do they act?]*

*Understanding STEM*
10. Why is it important to recycle plastic instead of making brand new plastic? [*What is regular plastic made out of? Why is bioplastic better for the planet?*]
11. Can you tell me about some different types of energy? Can you give me an example where one kind of energy changes to another kind?
12. Why is it important to have many different kinds of animals in an area? [*What if you only had deer in an area and no wolves? What if you have nothing but corn growing?*]
13. Name a renewable resource. What makes it renewable?

*Figure 1.2*
Interview Protocol

**Interviews.** At the end of the semester, December 15, 2020, we interviewed Ava and Danielle. When I asked Mary Ann in October of 2018 "How do you feel about being in this program?" her response was "good." However, in December of 2020 when I asked her how she felt about the on-line school, she said, "I really miss my friends and it is harder to concentrate," indication both socialization and cognition may be affected. Ava was the only one of the three who said she liked the online classes because she did not have to get dressed. During the interviews all three girls would turn their video and audio on and off. They all said their hair looked bad. Zena said she did not turn on video because her house is a mess. Danielle, the oldest sibling was often frustrated. She had to watch her younger siblings who were noisy. She would often leave in the middle of a response and turned off the audio. When she returned she said, "I am sorry, I have to go and watch them closer." Figure 1.3 is a typical interview protocol. Questions were added and deleted to customize the interviews to the information needed. For example, questions were added on perception of failure and on on-line learning.

## Discussion

In our pre-COVID-19 work, we saw that individuals who demonstrated fear of failure are unsure about their ability to be successful (Covington & Omelich,1991) but the fear can be mitigated. However, during the pandemic the lack of attendance, perhaps a result of students having to watch younger siblings, has prevented the creation of a learning community. Only Ava said she like on-line better. She was also the only one of the four girls whose parents have jobs. Some schools have been successful in offering novel ideas, but they are the exception. For example, one of the schools in the Postal (2020) article seemed more successful by "offering small, and low-cost, "learning pods" for parents who need their children supervised because they work outside their homes but don't want them with hundreds of others on campus." Theories regarding the development of fear of failure have identified the experience of shame as being a significant contributor will be studied  at a later date (McGregor, 2003).

This new delivery system worked well and lessons were distributed as intended with no reported issues of access or technical glitches. When the community center re-opened in the fall of 2020, stringent procedure had to be followed. University faculty were refrained from visiting the center. One of the coordinators worked with the girls on the new lessons to help recreate some of the community present before (although one-on-one now, with no community). Lessons seemed to be easy to comprehend and there were no reported issues with locating the simplified materials on our list.

However, execution suffered and impact was not as strong as we hoped. While those students who attempted to access and complete the lessons reported no issue (and we had no outsiders disrupting our process) the number who we could reach was much lower than previous totals. Only a few students completed each of the lessons and the Zoom sessions attracted one or two at most. Those girls who did attend Zoom usually were reluctant to share as freely as we were used to and they almost always stayed muted and with cameras off unless called on directly. These students were also attending school remotely using similar means so an after-school program involving more screen time and more questions from adults on some distant computer was perhaps too much.

**Future Work**

COVID-19 created many program many limitations, primarily the ability for the students to learn in a socio-constructed environment, discussion ideas and. comparing results. We do not believe we could do anything differently with the program as it stands. The curriculum, instructional methodology and research methods were the best ideas for continuing to work with this curriculum with the CAC. It was not especially effective. The alternative would be to organize the program ourselves (with a long lead-in time to gather participants), use a completely different curriculum that's designed specifically for remote learning, or (ideally) both. At our STEM Center we have a prosperous *STEM at Home* program that may serve as a future baseline.

To continue to evolve the girls' abilities to appreciate failure, the girls will continue to participate, present and interview others. In the summer of 2021, we will hold another Women of Color in STEM event to provide those opportunities. Their school will resume in-person learning in the Fall of 2021. Our research methods will also be revisited, that is, the interviews, and adapted once we can meet with the girls consistently. Then we will create a post-pandemic plan to broaden the methods, i.e., students self-collecting some of the data outside, possibly with recordings, photographs and videos created by the students.

Continuing the work to understand fear is important for girls to realize success and a sense of belongingness and an identity, especially in engineering. The implications of mitigating fear of failure, evolving to an appreciation of the value of failure in engineering design, are limitless. A change in both the reputation of engineering from an exclusive to a welcoming profession, and a change in the girls' attitudes towards engineering as a place for success are possible.

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