

Evaluation of
the Rice University Robert Noyce Master Teaching Fellowship Program

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Submitted to:

Anne Papakonstantinou, Ed.D.

Clinical Professor of Mathematics, Wiess School of Natural Sciences

Director, Rice University School Mathematics Project

Submitted by:

Ann R. McCoy, Ph.D.

4514 Kingfisher Drive

Houston, TX 77035

The Rice University Robert Noyce Master Teaching Fellowship Program (RU-MTF)

Introduction

Located in the heart of the greater-Houston metropolitan area, Rice University recognizes its responsibility and role to fully engage with the city of Houston and the Houston Independent School District (HISD). The Rice University Robert Noyce Master Teaching Fellowship Program (RU-MTF) is a partnership between the Rice University School Mathematics Project (RUSMP) and HISD to increase the mathematics expertise of secondary teachers. RUSMP identified 16 Master Teaching Fellows (MTF) and in June of 2017 began providing them with focused professional development, leadership development experiences, and salary supplements.

RU-MTF extends RUSMP's prior NSF Mathematics Leadership Institute (MLI) and MLI's Noyce Supplemental Award work, which developed and supported high school teacher leaders. Knowledge about and experience with MLI ensure that all aspects of RU-MTF are designed for maximum impact on mathematics education in the greater-Houston area. RU-MTF expands on MLI's work with high schools to include both middle and high schools.

Over five years (2016-2021) the RU-MTF will deepen the grounding of Master Teaching Fellows (MTFs) in sound mathematical content and research-based pedagogy, leadership, adult education, and mathematics advocacy skills. Reform-based mathematics teaching strategies, a central focus of the RU-MTF, emphasizes problem-solving and motivational strategies, classroom assessment, differentiated instruction, questioning strategies (National Council of Teachers of Mathematics, 2000), and mathematical knowledge for teaching (Hill, Ball, & Schilling, 2008) through sustained professional development that will encompass high-quality instructional methods deemed effective in past research (e.g., Desimone, 2009; Learning Forward, 2011).

By sharing their mathematics content knowledge and pedagogical techniques, MTFs will gain experience in developing meaningful professional learning experiences for teachers at their schools and across the district.

HISD is fortunate to have a racially and ethnically diverse student body, MTFs serve as advocates for equitable mathematics excellence among all students also.

RU-MTF Goal and Objectives

The overarching goal of RU-MTF is to develop exceptional secondary mathematics teachers into leaders who are deeply grounded in sound mathematical content and research-based pedagogical, leadership, adult education, and mathematics advocacy skills. RU-MTF objectives are to develop MTFs who have:

1. a strong knowledge base in both university-level and secondary mathematics and a solid understanding of the connection between the two;
2. a deep understanding of and skills to implement effective precollege mathematics curriculum, instruction, and assessment;
3. exceptional leadership, mentoring, and adult education skills;
4. a robust understanding of equity and diversity issues in STEM, in particular mathematics; and
5. a repertoire of research-based methods for motivating and supporting *all* students to persist and achieve in mathematics with a special focus on motivating URMs.

Evaluation Design

Original plans for the fifth-year evaluation of the RU-MTF changed to reflect how the emergence of the SARS-CoV-2 coronavirus, its resulting COVID-19 diseases, and efforts to mitigate its transmission affected MTFs. In a matter of weeks, education in public schools changed. MTFs began educating students virtually after HISD's 2020 Spring Break. The 2020 Fall Semester began with MTFs teaching virtually from their homes. After the first six-weeks, they were expected to simultaneously provide instruction both in-person and virtually on their campuses.

The worldwide pandemic influenced MTFs, their working environments, and students. This evaluation serves to document the levels of stress MTFs experienced; their perspectives of the Noyce Fellowship, campus and district support, stress and student anxiety, and teaching during the pandemic; and the lessons MTFs provided students. Data were collected through responses to the Perceived Stress Scale, responses to in-depth interview questions answered by all MTFs in fall 2020; and recorded lessons provided by three MTFs.

Although these were not the data originally planned for collection, the data presented here remain relevant to determining the extent to which the program’s goals were met. These data provide a detailed understanding of MTFs’ on-campus support to colleagues and from administrators, efforts to implement effective precollege mathematics curriculum, advocacy of equity and diversity issues in mathematics, and actions to motivate and encourage students to persist and achieve in mathematics.

The first section of this report presents results of the Perceived Stress Scale. The second section presents results from in-depth interviews conducted with MTFs. The third section describes lessons via videos submitted by three MTFs. Finally, the fourth section presents a discussion of the results.

I. Perceived Stress Scale

In November 2020, the fourteen MTFs (originally 16 MTFs joined the grant, two are now deceased) were asked to complete the Perceived Stress Scale¹ (PSS), a general measure of stress perception with which respondents retrospectively appraise how much their lives were unpredictable, overloaded or uncontrollable within the last month. The overall mean score for MTFs on the PSS was 19.43 (SD = 8.2342). Among the norm groups for the PSS, mean scores ranged from 11.9 - 14.7 (SD = 5.0 – 7.2). MTFs’ mean score suggest that current environmental demands are taxing their adaptive capacities causing many of them to experience elevated stress levels.

Table 1 presents MTFs’ responses for each item of the PSS. The notable responses include that in the past month, over 50 percent of MTFs had sometimes, fairly often or very often—

- been upset because of something that happened unexpectedly,
- felt they were unable to control the important things in their lives,
- felt nervous and “stressed,”
- found that they could not cope with all of the things they had to do,
- been angered because of things that were outside of their control, and
- felt difficulties were piling up so high that they could not overcome them.

Simultaneously, over 70 percent of MTFs reported that sometimes, fairly often, and very often they also—

- felt confident about their ability to handle personal problems,
- felt that things were going their way,
- were able to control irritations in their lives, and
- felt they were on top of things.

Table 1. MTFs Perceived Stress Scale

1. In the last month, how often have you been upset because of something that happened unexpectedly?				
	N	Percent	Mean	Std Deviation
Never	0	0.00%	2.00	0.535
Almost Never	2	14.29%		
Sometimes	10	71.43%		

¹ Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 24, 386-396.

Cohen, S. and Williamson, G. Perceived Stress in a Probability Sample of the United States. Spacapan, S. and Oskamp, S. (Eds.) *The Social Psychology of Health*. Newbury Park, CA: Sage, 1988

Fairly Often	2	14.29%
Very Often	0	0.00%

2. In the last month, how often have you felt that you were unable to control the important things in your life?

	N	Percent	Mean	Std Deviation
Never	1	7.14%	2.29	1.16
Almost Never	3	21.43%		
Sometimes	3	21.43%		
Fairly Often	5	35.71%		
Very Often	2	14.29%		

3. In the last month, how often have you felt nervous and "stressed"?

	N	Percent	Mean	Std Deviation
Never	0	0.00%	2.50	0.91
Almost Never	2	14.29%		
Sometimes	5	35.71%		
Fairly Often	5	35.71%		
Very Often	2	14.29%		

4. In the last month, how often have you felt confident about your ability to handle your personal problems?

	N	Percent	Mean	Std Deviation
Never	0	0.00%	1.50	0.98
Almost Never	3	21.43%		
Sometimes	3	21.43%		
Fairly Often	6	42.86%		
Very Often	2	14.29%		

5. In the last month, how often have you felt that things were going your way?

	N	Percent	Mean	Std Deviation
Never	0	0.00%	1.86	1.03
Almost Never	4	28.57%		
Sometimes	6	42.86%		
Fairly Often	2	14.29%		
Very Often	2	14.29%		

Table 1. MTFs Perceived Stress Scale Results (cont'd)

6. In the last month, how often have you found that you could not cope with all the things that you had to do?				
	N	Percent	Mean	Std Deviation
Never	2	14.29%	2.00	1.31
Almost Never	3	21.43%		
Sometimes	5	35.71%		
Fairly Often	1	7.14%		
Very Often	3	21.43%		
7. In the last month, how often have you been able to control irritations in your life?				
	N	Percent	Mean	Std Deviation
Never	0	0.00%	1.50	0.85
Almost Never	1	7.14%		
Sometimes	7	50.00%		
Fairly Often	4	28.57%		
Very Often	2	14.29%		
8. In the last month, how often have you felt that you were on top of things?				
	N	Percent	Mean	Std Deviation
Never	1	7.14%	2.00	1.04
Almost Never	3	21.43%		
Sometimes	6	42.86%		
Fairly Often	3	21.43%		
Very Often	1	7.14%		
9. In the last month, how often have you been angered because of things that were outside of your control?				
	N	Percent	Mean	Std Deviation
Never	0	0.00%	1.93	0.88
Almost Never	5	35.71%		
Sometimes	6	42.86%		
Fairly Often	2	14.29%		
Very Often	1	7.14%		
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?				
	N	Percent	Mean	Std Deviation
Never	3	21.43%	1.85	1.41
Almost Never	3	21.43%		
Sometimes	3	21.43%		
Fairly Often	3	21.43%		
Very Often	2	14.29%		

Note: 0 = Never, 1 = Almost, 2 = Sometimes, 3 = Fairly Often, 4 = Very Often; Reverse code items 4, 5, 7, and 8.

While it appears that MTFs are coping with the extraordinary stress of the present moment, their vulnerability to depression, anxiety, and other physiological illnesses must be addressed by HISD administrators.

II. MTFs' Interview Responses

Noyce MTFs were invited to respond to interview questions either by telephone or in writing. One MTF completed the interview questions via telephone interview; the remaining MTFs provided written responses to the questions. They were asked 16 questions in four topic areas—Noyce Experience, Campus and District Support, Stress and COVID-19, and Teaching during COVID-19. During the 2020 Fall Semester, only two of the 14 MTFs were working entirely on-line. The other 12 were required to provide instruction in-person while students attended classes either in-person or on-line.

Noyce Experience

Benefits of the Noyce Fellowship

When asked whether and how they benefited from participating in the National Science Foundation Rice University Robert Noyce Master Teaching Fellowship, fellows were unanimous in stating that they had benefited from the program. The benefits they identified included attending conferences, personal and professional growth, developing relationships with each other, and giving them “*greater credibility among colleagues and administrators.*” Below are a few of the fellows’ responses—

- *Absolutely!! Participating in the NSF/[Rice] Robert Noyce MTF, has contributed to my mathematical, professional, pedagogical, and personal growth. Having designated time during the summer seminars to work in math problems individually and collectively, allowed me to re-activate my mathematical knowledge, to review mathematical concepts that I had forgotten, and to learn new ones, experiencing what “doing math” means...At a professional level, the AVID activities, the conferences from the experts, the discussions and the reflections about sensitive topics we face in our daily practice as teachers, made me aware of cultural and social realities in my community...Being part of this initiative, having the opportunity to reflect, discuss, exchange experiences, conceptions, and knowledge with a great group of people and great math educators has been extremely rich and positive. I felt alive, happy and excited every time I knew we had to meet.*
- *I feel like the Noyce program has made me blossom as a teacher and gave me the courage to be the leader I have always wanted to be. I developed my voice and grew not only as an educator but as a person. I have also made friends with a group of people that support me and guide me. I do not feel alone in this journey. I have enjoyed every opportunity I was provided and will continue to be involved with my Rice family.*
- *Yes, I feel like I have...It is similar to the experience that I had when I attended the RUSMP summer campus program, except the Noyce program has gone on for much longer, and so I feel like the bonds that have formed have been deeper.*

Support among MTFs

MTFs were asked about the extent to which members of their cohort have been a source of support. Their responses spoke to the camaraderie this group shares “*the Fellows of our group...are always willing to share and instruct and prod one another to excellence*” and suggests that these relationships will continue beyond the fellowship. Many noted how they benefited from on-going professional and personal relationships with other MTFs—“*sharing common struggles makes me feel that I am not alone and hearing people’s successes and creative ways of reaching out to the students has motivated me to try new things.*” As these quotations and those below illustrate, MTFs both support and challenge one another to create and provide instructional approaches to better meet their students’ needs. MTFs said the following about their colleagues:

- *A lot has happened to members of our group in the last few years, and we all know that other MTF’s are there for us...even if it’s a small gesture, you can feel that they are looking out for each other.*

- *I have learned so much from them...I have a good outside relationship with at least 3 of the others. I enjoy their stories and learning so much from them and about them. I really like our group. I always feel like I have people to lean on when education throws me a curveball.*
- *Mainly, they are a source of reason, and in that way they are a source of support. My Noyce colleagues, from what I have seen, are both open to new ideas while still being skeptical of fads. They have enough experience and sense to decide what is appropriate in a curriculum rather than rely on a strict reading of the TEKS [Texas Essential Knowledge and Skills]. And they are not afraid or too arrogant to modify or even radically change what they are doing in the classroom in order to best serve their students.*
- *Each one of the members posses[s] a high math and pedagogical knowledge, and in that sense, everybody is a source of support. More specifically, [Name of MTF] has been a great support. We work at the same school and we've been working as a team promoting and developing math activities that involve the whole school. We also have had opportunities to discuss[s] math topics, to share pedagogical strategies, and to share with other teachers.*
- *Professionally, we discuss issues in mathematics education and try and come up with resolutions to those issues so that we can better serv[e] our students and for added professional growth. We have established both professional and personal connections to challenge ourselves to be the best mathematics educators we can be, so that in turn, our students can have the best experience possible in learning mathematics.*

Supporting Campus Colleagues

To understand the extent to which they disseminated what they learned through the fellowship to other teachers, MTFs were asked how they supported their campus colleagues. They said, *"the Noyce experience promotes collaboration and sharing of ideas with your colleagues on campus, therefore I am always looking for ways to support and help out my fellow colleagues"* and *"I have supported my campus colleagues helping them with the use of technological tools (Geogebra, One Note, Desmos) to enhance their student's math learning."* As the quotations below indicate, MTFs felt a responsibility to both share what they learned with other mathematics teachers and help those teachers enhance the mathematics learning of their students. They said the following:

- *I have been more active in my support of colleagues on my campus. I went from new teacher to veteran teacher in a blink of an eye, and so I feel as if I didn't actively seek to be that support. Going through the program I felt a greater responsibility and motivation to do so.*
- *I've become more open to reach out and see what others are doing and sharing my newfound expertise. This year has been a complete challenge since everyone is virtual, but I am trying to send out ideas of what I am trying to do to improve student learning.*
- *As part of my responsibilities with Noyce, I have been provided additional opportunities to work with and support colleagues at my campus. I find that I am given additional latitude to develop and plan with them. We meet frequently and strive to further the development of an even-better experience of mathematics for our students. As we interact, we foster an open exchange of ideas for the betterment of us all and of our students.*
- *As a result of my Noyce experience I have supported my campus colleagues since 2006, which is over 14 years of Noyce experience support. I have been a mentor to other teachers...I shared with other teachers my knowledge of what I learned from the many professional development opportunities that I have been a part of.*

As the quotation below illustrates, other MTFs experienced resistance from teachers on their campuses to using technology as part of instruction as well as disagreements regarding the rationale for including specific content in the curriculum.

- *I have made several instructional videos. There are a few teachers at [name of high school] that seem willing or able to make videos, and then there are many teachers that either do not have the resources or do not have the ability to do that. So we rely on each other. I have noticed a particular difference in style of teaching that seems to have been highlighted by our particular videos. For a while I have disagreed with the majority of my [name of high school] colleagues about the importance of proof. To me, one of the most important things that students get out of their math education is the habit of asking themselves “How do I know that?” In a math class, if you know something, then either you have assumed it to be true (in the case of axioms or postulates), or you have proven it to be true (in the case of theorems, identities, corollaries, etc.). New algebras and geometries can be formed by changing our basic assumptions...What I see in a lot of my colleagues’ videos (the same colleagues that think that I waste time by insisting upon proving every theorem in class) is the lack of distinction between math and convention by using the message: Do it this way because that’s what I’m telling you to do, and I’m the one grading your work. It’s a very authoritarian message, and I don’t think it’s a good one for the students. I have tried to have conversations about this with my colleagues, but [name of high school] is very fixed in its habits. The mindset here is that we are successful, therefore we don’t need to change what we are doing.*

Interactions with the Community and Parents

In addition to being asked about supporting their campus colleagues, MTFs were also asked how they interacted with their communities and parents as a result of their Noyce experience. MTFs noted that the fellowship helped them work with parents, they reported that *“Through this experience, I was able to help out with tutoring students and parents in upper level math.”* and *“I have reached out more to parents, especially this year because of the pandemic. Overall, I tried to communicate with parents of my students about opportunities that are available for their child that could help them mathematically besides what is available at the school.”* As can be seen from their responses below, MTFs also connected their campuses with national organizations, initiatives, and experts, created resources used by students beyond their campuses, and had greater credibility with parents.

- *As a result of my RUSMP and Noyce experiences, I have supported my community since 2007. In 2007, I began participating with the National Society of Black Engineers South Houston Junior Chapter. I helped students with math, science and engineering projects. I helped parents with educational opportunities for their children and scholarship information.*
- *I’ve overseen the logistics of the Hour of Code event for four years, inviting experts in the computer science field, and motivating the participation of the whole school, teachers and students.*
- *The NSF/Rice Robert Noyce MTF motivated me to make [an] IB Math YouTube channel, which help IB students from other school.*
- *Many of my students are from families with well-educated parents. Sometimes they don’t hold high our decision to teach rather than to pursue other, more lucrative, careers. The status conveyed by the Noyce designation and affiliation with Rice University and the NSF helps to cut through their pre-conceived notions and paves the way for a better working relationship with parents, facilitating better overall learning opportunity for the students.*

Campus and District Support

Campus Support

MTFs responses to a question about the level of support they received from the leadership on their campuses elicited responses that reflected varied administrative reinforcement of their efforts. MTFs on campuses with supportive leadership reported that their *“school gives [me] opportunities to represent my ideas and information during staff meetings and include it in IPDP individual plan,”* and *“our campus is one that fosters innovation and excellence. The administration is always pleased to provide opportunities and resources for us. We hosted a*

delegation of Noyce Fellows from Louisiana. My principal and administrators were most helpful in facilitating, providing space and opportunity for us, and buying everyone lunch.” Other MTFs on campuses with supportive administrators reported that “I have received plenty of support from the leadership at my school. The principal makes sure he is up to date on technology and tries to answer our questions” and “the school leaders are always willing to support any initiat[ives] that favor students learning, providing the resources and time.” And during the pandemic, another MTFs noted that “the school has provided support on how to reach students and provide strategies that could enhance student learning in a virtual setting.”

MTFs on campuses where the leadership sent mixed-messages regarding support reported that “I do have one extra off-period, but this is really for being the department chair. Otherwise I’m not aware of real support for my Noyce work” another MTF stated, “though they have not let me teach math, I have pushed the math curriculum in science and shown the students that math is not only in math class. The students can see my love for math shine and the passion that I have is contagious. My principal has also let me attend CAMPT one summer and the National Conference in Portland last February which I am extremely grateful for. I gained so much independence and knowledge through these two activities.”

MTFs who took a dimmer view of their campus leadership’s support described the leadership as “limited” or said, “...administrators have never treated teachers very well...the principal not interested in supporting the faculty at all...school is a tool for social advancement and uninterested in promoting students...” Another MTF described the campus leadership this way, “I have been quite disappointed with the leadership at my school this year. My principal has been largely invisible, except to send out form emails about how someone at the school tested positive, and the school will undergo a “deep clean” (that phrase has never really been defined) overnight, and how our safety is important to him...My opinion of his integrity has taken a big hit, as has my morale and my loyalty to the school.”

School District Support

When asked about the type of support they received from the HISD leadership, MTFs’ again offered differing perspectives and experiences as reflected in their responses. Among MTFs who experienced support from the district, they said, “the district has been great by providing many different professional development opportunities,” noted that “the district provided [name of MTF] and I the opportunity to assist with the New Teacher Academy last year which I really appreciated. I know my calling is to lead” and reported both “[a] good working relationship with HISD’s head of the math department” and “supportive. Participation [in] facilitate[ing] workshops face to face before virus and online after virus.”

Other MTFs described HISD’s support as “very little” and “not really support, but they did give me opportunities to write curriculum for Algebra 2, AQR, and Pre-Calculus for the district.” One noted that, “I have never really looked for leadership from the district. I know that that sounds cynical, but I find that the district is much more concerned with compliance than they are with excellence.”

The mix of support MTFs experienced from campus and district administrators suggests that the benefits derived from their fellowships may not be shared as broadly as possible among teachers who could use the expertise of MTFs. However, MTFs on campuses that foster innovation and support their efforts will likely create more opportunities for both teachers and students.

Stress and COVID-19

The virtual instruction and learning necessitated by the current public health crisis created new stressors for both teachers and students. MTFs were asked about these pandemic induced stressors to gain an understanding of their influence on teaching and students’ learning.

Remote Learning

When asked how they were managing the stress associated with remote learning MTFs' responses included the importance of self-care. MTFs' descriptions of their self-care included *"I walk my dog twice a day. I try to exercise between the virtual classes. I try to keep 1 day a week (Saturday) without any work on the computer"; "I'm walking and taking care of myself when I do have the time (this includes not answering calls or messages from students or parents after 8pm). It is more work, but I think I found a way to make it less-stress-full for myself by developing routines.";* and, *"[I am] trying to see the good things out the difficult circumstances. Communicating with my family and friends. Listening to music Walking outside Reading Meditating."* Another MTF said, *"I always told myself this is [a] special time not only for me but also for anyone else. Understanding, patience and flexibility are the key to the stress."*

One MTF also reported, *"I think I am managing okay. I felt more stressed working from home because I could not separate my personal and professional life and was constantly thinking of work while at home. I like to separate these two as much as possible, especially with having two kids of my own going through their own struggles."*

Unlike most MTFs, another MTF reported, *"physically or psychologically I do not feel stress with remote learning but I had and still have many concerns how to keep the bar at the high level and teach the same amount of material from the curriculum of the subject I teach (Geometry)."*

Many MTFs also reported feeling frustrated and poorly supported by their campus leadership as well as experiencing personal losses and illness. They described their struggles saying, *"the stress of remote learning was extremely hard at first. I had internet issues, wasn't sleeping, slept through class, marriage strained then crumbled"; "it has been hectic and scary. It's beginning to be a bit better. Everyone's trying to be helpful, but it has mostly felt like they're just throwing a zillion things at me and expecting me to catch them all and thrive. It has seemed like no one knows what they're doing – perhaps because they don't, [and] we're all just fellow travelers. Challenging and problematic. I was also ill for about a month, all the while continuing to teach. It was hard. It's getting better now";* and, *"remote learning/teaching is difficult, but not impossible. During the first 6 weeks, I found that my biggest problem was that since my desk and work were always just a few feet away, I rarely stopped working. But I managed to get my work done, and I felt like, given the situation, I was doing a decent job. And I was helping out my colleagues as well. During the second six weeks, things changed significantly. My ability to manage any kind of stress dropped significantly with the death of my mother—I expected the grief, but I had underestimated how intense and debilitating it would be. And then within the first few days after reporting back to school, I was told that someone that had been in my class during the SAT—a test that required me to be in a poorly ventilated room for several hours with the same students—was presumed to have COVID-19. I was sent home and told to quarantine for 14 days. My principal assured me that once he had any further information, he would let me know. However, he has not communicated with me at all in the two months since then. I was (and still am) angry that the school had us all in the same room for such a long time—it was extremely irresponsible of them."*

Students' Stress and Anxiety

In addition to experiencing their own stressors, MTFs also vicariously experienced their students' stress. When asked how they helped students manage their stress and anxiety MTFs reported being more lenient when students submitted assignments late, *"I allow my students to turn in assignments late without dropping the grade too much (5 or 10 points off total vs. 20 points off per day late like [son's name] experiences at his school for a few classes), I do allow kids to work on paper and send me a picture rather than forcing them to work online the whole time, I update grades regularly so that students know their actual standing, and I'm approachable if they need help (did a college advise talk with several students...)." They used greater flexibility in their instructional approaches and viewed students more holistically, one MTF described it this way, "First thing I am focusing on is the student's well-being. Grades, understanding of a concept will be taken care of when the student feels comfortable. Too many of my students are losing loved ones or loved ones of friends."*

Other MTFs reported reaching out to students and parents more frequently saying *“I have been making personal phone calls to many of my students checking on their well-being and their families. Opportunities to be able [to] talk to them helped [me] understand each situation. I felt that many of my students felt supported by me.”* MTFs also referred students for counseling saying, *“if there is some serious anxiety and stress, I normally refer them to the counselor”* and *“we have a large variety of support systems on our campus to help students with problems that they may encounter on or off campus. This now includes helping them cope with the challenges that virtual learning comes with. We offer a variety of Socio and Emotional Learning (SEL) services and Wrap Around Services to help not only the students, but also their families.”*

Another, MTF summed up all of their efforts to help students manage stress and anxiety saying, *“I want to treat my students with respect, and with trust. I give them the benefit of the doubt. I am letting them reschedule tests, turn in work late, and recording every class so that they can watch it later in case they miss it. I am positive that some of them are taking advantage of the trust that I am placing in them, but I am not going to worry about that. I am also trying to be lenient with their grades, while also being as accurate as I can about their preparedness for the next level (calculus). I think that in stressful times like these, students (really everyone) need to be shown compassion, trust, kindness and forgiveness.”*

Growth

Crises are often viewed as catalysts for personal growth. Our on-going public health crisis represents an opportunity for such growth. MTFs were asked how they have grown during this period. The growth some MTFs identified included broadening their instructional skills, *“I learned to be more laid-back, using new apps and programs to deliver my lessons, and learned to really dissect the curriculum to determine the most important parts to give students time after the explanation to practice”* and *“I feel like a new teacher learning how to teach. This year I had to learn how to reach and teach my students differently than I had to in the past. I must say, this has definitely made me grow as a teacher and as a professional.”*

One MTF said, *“this experience has been humbling. It shows me that I do know what I am doing and can adjust to anything. I feel like the accountability for me is increased.”*

Another said, *“I have always been an emphatic person and try to remain calm in all situations. This calmness relies from my belief that all students can learn math and grow their understanding. How I have grown is that this concept of growth has extended beyond math for me. My students are experiencing so many struggles, like what I am dealing with and to be going through similar situations has made me see my students as more than students because I could be in their situation too.”*

Other MTFs reported growing in their appreciation of life, family, and friends, saying, *“In many ways. I appreciate more my family and my friends, and I enjoy the time we can be together. I appreciate every second I am healthy, and I am more sensitive to other’s needs”* and *“I have learned to appreciate life even more. It was not easy to see how many families were affected by the pandemic in my school community.”*

MTFs also reported that their views of the education system and their place in it have changed during the pandemic. One observed, *“I am more independent in my thinking...and have a growing feeling of self-reliance—if you want to trust somebody trust yourself...didn't get upset when told I had to teach in person...comfortable with that...I am a little more self-reliant and less pushed around by the system...”* Another MTF said, *“I’m not sure that “grown” is the right word though, because I am not completely happy with how I have changed. I no longer have faith in my school’s leadership. I miss that feeling—I miss believing what my principal says, rather than thinking that he is just covering his backside and giving us feel-good lip service. But I have learned from experience, and that experience keeps me from believing that the teachers’ well being is at or near the top of his priority list. Some of my misgivings and doubts about the effectiveness of our entire school system have been amplified during the pandemic. Again, I’m not sure this is “growth”, but it is an evolution of a belief about education.”*

Impact of COVID-19

The final set of questions asked MTFs about teaching during the pandemic. These questions focused on inequities associated with remote learning; the personal effects of teaching during the pandemic; changes in their approach to teaching; what they want students to gain during the academic year; advocating for and motivating students; and, changes they would like to see in education as a result of the pandemic.

Inequities and Remote Learning

Several MTFs identified lack of access to reliable wi-fi and poverty as inequities that are more visible during the pandemic saying, *“students not having reliable internet, being called in to work during school hours, having to work because they are the only breadwinner for the family now, increase in homelessness, learning disabilities not being accounted for (modifications), family members becoming gravely ill and dying while we expect the kids to concentrate on their work, kids having to go with their family to pick up food from a distribution center (and participating on the phone in class)”* and *“not all students had high speed internet connection to participate fully during the class. A lot of students have family situations where participation in a class is not today's priority: taking care younger siblings during the class, taking small jobs to support the family, or taking care [of] the parents that are not well.”*

Other MTFs described situations involving specific groups of students or individual students. The following vignettes from MTFs illustrate how the pandemic revealed and reinforced existing inequities.

- *A lot of our kids are not tech savvy. They lack basic skills for effectively using technology, and don't have any help from their parents. My own children have run into a ton of problems, and have either managed to figure it out themselves, or I have fixed it for them. That's the difference between a middle-class college educated household and [T]itle 1 kids.*
- *Due to lower numbers, I am now working with other teachers to teach students who are house[d] at the Harris County Jail for offenses committed against other[s] in the community. To work online and see young people age[s] 15-21 who are there for assault, kidnapping, stealing and other offenses housed in cages with orange jumpsuits in a COVID-19 environment because they are unable to make bail which could be from \$50 to \$200 reminds me of the inequalities in this country in wages, housing and accessibility to technology, health care and unnecessary persecutions to minorities.*
- *Where to start...I feel that COVID-19 has done to American society, and to our education system in particular, what Katrina did to New Orleans: put a microscope on not just what is wrong now, but what has been wrong for a long time. There are some students in my class that are either barely there, or not there at all... There are several possible good reasons why this is so...Here's a story that really affected me last year: I had a student that was just wonderful. She was not the best math student (high-B to low-A average), but she was good, and it was obvious that it was not her favorite subject but she gave it her best anyway. And she was a really nice and thoughtful kid, who enjoyed talking with adults and learning from them. After school was closed and we went to distance education, she missed some classes, but was always very responsible in making up her work. She explained to me that she was working more hours than usual at her fast-food job, both because she was getting pressure at work to increase her hours, and because her family really needed the money. She had no car, so she was taking the bus to work. Metro, during the pandemic, had reduced the number of buses so that even during the week they were operating on weekend schedules. So rather than fewer people on the bus, there were more. This meant that she often had to sit right next to someone, and frequently that someone was not wearing a mask. So every single day she was at very high risk of being exposed to [COVID-19], just so she could earn her minimum wage and try to claw her way out of poverty. This is one of my most responsible and promising students, one of the most eloquent 17-year-olds I have ever met. Her health was constantly in danger, and there was not a thing she could do about it. The “inequities associate with remote learning” are just a reflection of the gross financial inequities that we have in our communities...Our schools try so hard to fix problems that are so*

much bigger than just education. The inequity that exists in our society today is staggering, and while it's on full display in the classrooms, it doesn't originate in the classrooms. Outside of the classrooms, our unregulated dog-eat-dog capitalism just exacerbates the situation.

Teaching during COVID-19

When asked how teaching during COVID-19 was affecting them MTFs' expressed concerns about their health and safety and spreading the virus to family members saying, *"I am very concerned for my personal health so it's hard to come every day. We haven't seen widespread infection at school, but as close as these kids sit at lunch every day, with no masks on, we are just counting the days"; "more stress, longer hours, everything due at the same time, kids being sick, kids losing family members, kids absent from f2f [face to face] for a few days and then returning without telling us if they were sick or not makes me wonder how often I was exposed to the virus already, worrying that I might bring the virus home and get my son sick or I might get sick and then what would happen to [my son]?"*; and, *"I have worked harder in this school year than I have in the past 12 years of teaching. Being in person, we are all nervous about the germs. I am sanitizing all the time and make sure everyone has their mask and their area is clean...I go home every day and immediately take a bath and put my clothes in the dirty clothes; I live with my elderly parents and my 4 year old son so I cannot risk it. The first week back, one of my students had [COVID-19] leaked out. They couldn't confirm it but he did. Everyone that sat around him was quarantined but us teachers were not."*

MTFs described teaching during the pandemic as *"disheartening and demoralizing."* And, expressed concerns about the inability to interact with students remotely and how this influenced their effectiveness as teachers saying, *"it is extremely difficult to stay in front of the computer ALL day. It has been affecting my health in a negative way. It is very frustrating to have poor student feedback during class discussions in a virtual class. Very few students are willing to respond and participate. It is very difficult to make a realistic picture [of] what students really know and understand"; "I am more efficient with the use of technological tools. But in terms of my students' learning I have an ambiguous feeling...As much as I believe making connections and having a positive interaction with the students [to] have a positive effect in their learning, it has been difficult to have this interaction with some of my students. Sometimes I feel frustrated. I feel that I work harder but I am less effective";* and, *"it's very difficult...The interaction is completely different now—because we are communicating through a laptop, it is far less personal than it was earlier, and I get lots less feedback from the students than I used to...In short, I just don't like my job nearly as much as I used to, and I am thinking about retirement much more than I used to...this year I have lost some of my spark, and I feel like I'm just not as effective as I was before. I have no idea how much of that is due to grief or depression due to [COVID-19], or what, but it is very troubling."*

Changes in Teaching during 2020

When asked how their approach to teaching differed this year, MTFs reported that they *"had to adjust how to teach – what is really important to know, how to make it still interesting and maybe fun, how do you explore a concept? Grading has gotten more challenging since some kids will turn in assignments really late due to work, internet issues etc. ...also had to adjust how to praise and motivate kids to continue trying"; "I am endeavoring to recast my instruction in ways amenable to home-based learning. I've lightened-up on grading and timelines. So far, the students are acclimating well to the different expectations. For the most part, they are stepping up and attaining the maturity of viewpoint necessary to learn in the midst of less supervision";* and, *"some topics from the curriculum have to be reduced or skipped because I have no opportunities to teach them and I am not sur[e] students are able to learn them on-line without the teacher...I have to check/find web-sites with more adequate and understandable supplementary content."*

Other MTFs incorporated more technology in teaching, *"this year has had to be much more lecture on my part and self study on their part. I have spent a lot of time making videos of lectures, and in a way it makes me concentrate harder on my sequencing of topics, and the best way to present";* and, *"I am teaching three new courses this year. Two are college level course[s]. I used more technologies to engage my students in the activity, but it is not very successful so far."*

Student Learning in 2020

Given that they are teaching during an unusual time under difficult circumstances, MTFs were asked what they wanted students to gain from their instruction this year and whether that differed from previous years. MTFs' goals regarding what they wanted students to learn remained unchanged. However, they realized that students' learning environments were not optimal and adapted their instructional methods accordingly. MTFs described their approaches to instruction saying, *"I set the same goal as before because my students have to take [the] IB exam by the end of May...but I slowed down the pace and give more scaffolding when I teach the new concept. But in this way, I do not have time for my students to review before they take IB exam"; "I want them to learn the same math and at least at the same level of comprehension. This differs from previous years in that we are all in it together, adapting and attempting to find new modalities to accomplish the goal"; "I continue to want students to learn the math. That will not change. I also want students to realize that we are in an ever-changing world and sometimes adjustments must be made"; and, "what I want them to gain has not changed...I teach geometry to teach the art of thinking...few people need to understand geometry but everyone needs to understand deductive and inductive reasoning..."*

However, many MTFs wanted students to become independent learners, develop life skills, and apply what they learn. They said, *"I want them to gain life skills: time management, independence, responsibility. From previous years I was more focus in terms of their academic growth" and "I wished they could see this as an exercise in learning to be self-motivated and independent."* Another MTF wanted students to become self-regulated learners saying, *"I want them to realize that they are pretty good at teaching themselves. This year they have had to teach themselves a lot, and they've done pretty well. How good an education they get is affected somewhat by their teachers and their schools, but it's affected mainly by their own attitude toward learning...I'm not saying that school isn't important, but it is not the only way to learn. I want my students to leave my class thinking that they are capable of learning on their own, and to feel confident in their ability to learn. I am here to help them think logically, and to help them communicate their thoughts, but they are the ones that are in charge of their learning."*

Advocating for Students

When asked how they advocated for students this year MTFs reported being more lenient with students with one reporting, *"I am always the one saying that we need to give parents and students a break. We have no idea what is going on at home with our virtual students or even our in-person students. Building relationships is important right now because the students will tell you for the most part what is happening at home. This is a difficult time for us all."*

MTFs also reported that they contacted students to learn what was happening in their lives and shared the information with appropriate colleagues. One MTF said, *"I had for example a student who missed class one day because her brother died that day – [I] submitted her name to our counseling staff and talked to one of her other teachers to excuse her from the work for that day to not receive a failing grade."*

Another MTF reported talking to administrators about policies that did not serve students well saying, *"I have tried to get them [administrators] to realize what teachers and students are actually facing in real life distance learning classes, so that they can make changes that can help students learn. There are many policies that are making our kids opt out of participation, and we need to do something about it."*

Motivating Students

When asked how they motivated students to persist with remote learning MTFs reported that they talked to students and encouraged them to think about their futures. MTFs described their efforts to motivate students saying, *"during my lessons I talk to my students [about] many aspects of their online education – organization, submitting assignments, motivation to learn, attendance classes and so on"; "I have been making phone calls to some of my students or talk to them in my virtual classes, I always keep motivating them and providing them with any help, advice, and support they might need for my class"; and, telling students that "IB college credit will save them more money."*

Another MTF motivated students by giving them *“opportunities for extra credit, grading for effort and improvement, option[s] for assignments based on students’ interest.”*

Other MTFs communicated with students individually by *“asking question about students’ feelings, problems, needs”*; holding *“a few tutorial meetings outside of school hours and most just needed a little reassurance that they are on the right track”*; and, *“sending chats to students asking where they are and about their wellbeing. If students are missing too much, I let them know that I am thinking about them and that they are missed. Since I teach a lot of 12th graders I congratulate them for making it this far and [encourage them] to not give up.”*

Changes in Education as a Result of COVID-19

Finally, MTFs were asked about the changes they would like to see in education as a result of COVID-19. The list below includes several systemic changes and education alternatives that address the needs of students and teachers. MTFs recommended the following changes to education in the aftermath of the pandemic:

- change the mathematics curriculum *“in mathematics, create a sequence of learning starting in Kindergarten that ends with advanced mathematics in high school that allows students to go as far as they can on their own...technology allows students to work at their own pace...”*
- increase students’ access to technology *“I think it would be a great idea to make all schools one to one, so that all student can have access to the technology needed for learning”*
- give *“students [the] ability to choose how they want to learn, students’ choice if they want to work on paper or online (pear deck), hybrid schedule – where students attend school 3 days and have 2 days to complete assignments at home or work together as a small group to complete assignments”*
- improve the quality of remote learning because *“virtual classes must be engaging, productive, and self-reflective for the learner. Differentiated instruction where students in need get more instructor time and students that are already successful could accelerate on more topics”*
- improve teaching conditions so that *“teachers [are] paid more and better programs [are] in place to help teachers feel safe so that they can stay in the teaching field”*
- make available *“a constant supply of soap and sanitizer...for the kids because here the students were going all day without washing their hands and teachers were made to buy sanitizer if they wanted it. It was disgusting”*
- take *“care of the [students’] behavioral and socio-emotional skills. Digital skills need to be taught at school. Parents [need to be] more involved in school.”*
- *“My colleagues and I have been told by our administrators that these are extraordinary times, and that we should give the students a bit more leeway, and be more flexible in our expectations. I would like us to learn that there are always students who are living through extraordinary times, and this flexibility needs to be our default reaction...Here are some ideas:*
 - 1) *Fewer required courses...Require three math classes, but offer a wider variety, including classes on handling data. Offer an English class that specializes in technical writing.*
 - 2) *Allow students to take a course twice. If I got a 70 in biology, but I had a nightmare of a semester and I know I could do better, then let me try. Maybe I’ll make a 95 this time. If I do, then change the grade from a 70 to a 95. Don’t give me two credits (I didn’t earn that), just give me the more recent of the grades, since that accurately reflects my level of knowledge.*
 - 3) *Don’t include failing grades in a students’ GPA. They already wasted their time and didn’t get credit for the class. They will have to either retake the class or take something else now to get that credit. Taking a hit to the GPA is just getting punished twice.*
 - 4) *Allow some students to take some courses pass/fail. This would encourage a student to dabble in something in a lower-stress situation. It would encourage risk-taking in school, which is currently highly discouraged.*
 - 5) *Bring back some vocational classes. Every student in the building would benefit if [name of high school] had vocational classes again...*

- *“Our kids are clueless when it comes to technology. We need to do better for our kids, when it comes to technology. We need to start in elementary and we need to force them to be independent problem solvers with technology. They get on pop-up and they don’t know what to do!!!”*

III. Lessons Created by MTFs

Three MTFs submitted links to virtual lessons they taught. All were teaching blended classes in which MTFs were in their classrooms and students attended either in person or virtually. MTFs used Pear Deck and Geogebra to increase students’ opportunities to participate in the lessons. During classes, students both posted questions in the chat feature and asked questions aloud.

The lessons MTFs shared demonstrated their careful lesson development, proper use of mathematics terms, clear explanations, notations, and examples. MTFs gave students time to think, contribute, and ask questions and gently corrected incorrect answers to problems.

They were relaxed and calm as they developed and presented difficult material. MTFs’ interest in students’ learning was demonstrated by their prodding of students to join the class, asking them to explain their reasoning, and thanking students for participating in class.

Although MTFs’ virtual teaching is a work in progress. They are using and adapting the skills they have acquired through the Noyce Fellowship to create meaningful learning opportunities for their students.

IV. Discussion

The emergence of the SARS Co-2 virus and its associated COVID-19 diseases created both a crisis and an opportunity in education. Noyce MTFs upheld the goal and objectives of the RU-MTF. Although teaching is a stressful occupation under the best conditions, MTFs continued to teach during the pandemic in environments that endangered their health, safety, and well-being. Their results on the PSS attest to the group’s elevated stress levels. Nevertheless, MTFs continued use their deep mathematics knowledge base and skills to provide thoughtful secondary mathematics instruction both virtually and in-person.

Teaching during the pandemic presented MTFs with a unique opportunity to mentor other teachers in the use of technology for virtual learning. With or without the support of campus and district leadership, MTFs shared what they knew with colleagues to provide enriching mathematics lessons for students who may or may not have been able to focus on the lessons. They also expressed the hope that through this experience students would become independent learners. MTFs’ descriptions of how they advocated for and motivated students suggests that their approaches were flexible, kind, and meant to encourage students’ perseverance.

Teaching during 2020 also gave MTFs multiple vantage points to see the inequities their students live. The pictures MTFs painted of these inequities were poignant.

It remains to be seen whether education administrators and policy makers will recognize the opportunities presented by the pandemic to improve public education. Many of the MTFs’ recommended changes in education appear to be informed by their teaching experiences and by their support for colleagues and the community during the pandemic and are worthy of serious consideration for improving the education outcomes and experiences of both students and teachers.