The Rice University Robert Noyce Master Teaching Fellowship Program (RU-MTF)
Case Study Evaluation Report 2019

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

This report concerns the fourth year of the RU-MTF (spring 2019 and fall 2019). This was the first year that the RU-MTF did not participate in a summer program with assessments or surveys measuring their mathematical knowledge. They engaged in leadership activities and developed first-hand a greater understanding of diversity and equity issues. This report presents data collected through a focus group conducted with MTFs in spring 2019 and in-depth interviews conducted with MTFs and their campus colleagues in fall 2019.

In determining the extent to which the program's goals were met, qualitative data were collected to gain a more detailed understanding of MTFs' on-campus support from colleagues and administrators, efforts to implement effective precollege mathematics curriculum, advocacy of equity and diversity issues in mathematics, actions to motivate and encourage students to persist and achieve in mathematics, and assistance to their on-campus colleagues.

The first section of this report presents focus group findings. The second section presents results from in-depth interviews conducted with MTFs and their on-campus colleagues. Finally, the third section presents a discussion of the results.

I. Focus Group

The focus group conducted during the spring of 2019 was the first time that MTFs were brought together for the express purpose of hearing their views on mathematics instruction, how RU-MTF influenced their perceptions of diversity and equity, their campus leadership roles, and community connectedness. MTFs were very forthcoming and engaged throughout the 45-minute focus group. Their responses to the 6 questions they were asked are presented below.

MTFs were first asked, "what does effective mathematics instruction look like?" Their responses highlighted the importance of teachers encouraging students' learning through discovery and included the following statements: *"students engaged…hands-on…teacher lead facts and students discover…teacher-lead instruction followed by students working in groups and explain[ing] things to each other…percentage of what they [students] learn from [the] teacher should be as small as possible…students depending on teacher a lot is a sign of ineffective teaching."*

This question was followed by asking MTFs, "How well do your colleagues understand [what effective instruction looks like]?" MTFs responses focused on the misuse of testing to penalize both students and teachers and included the following statements: "*poorly…teachers are judged by their students' current performance not by their future performance…making students miserable + make them hate math but teach[ing] them how to pass the test is perceived as a good teacher but this would be a complete failure…external measurement is a big pressure…testing is not bad but relying only on that is bad…testing is bad...how teachers teach does not matter."*

This question was followed by asking MTFs, "how well do administrators at your school understand [what effective instruction looks like?" MTFs reported that "*[it]* d*epends on what content background they* [administrators] *have...administrators with math backgrounds are more helpful and understanding and more interested in a more meaningful way…no focus on content…no training in content…administrators do not value teachers sharing and collaborating…less and less time to interact with other teachers (both in and outside the content [area])…background of administrators matter…[those without] math backgrounds*

tend to micromanage… if no one complains, administrators do not even interfere (good and bad!)…[what's] most important is that a certain # [of] students pass the STAAR, if yes, administrators [are] hands off."

Next MTFs were asked, "in what ways has the RU-MTF program affected your beliefs about equity and diversity issues in mathematics?" According to the MTFs, the summer campus program's focus on these issues "*made [me] less happy…some students labeled as failure[s] by [the] system…made look for things that are not appealing (reality but hurts)…made more attentive to equity issues/stereotypes, gave different perspective, better communication skills gained, more understanding of diverse students…eye-opening experience to understand diverse students, trying to help more with students from different backgrounds…helped a lot. different experience, [now use] different methods, let [students do] more group work, student-center teaching…writing reflections led [to] more honest look into one's own teaching, realization of treating students differently…reflecting a lot, started looking at things differently…takes time to adjust different things…way of thinking changed."*

MTFs were then asked, "what other leadership roles have you assumed on your campus, in your community?" MTFs responses varied, some stated "a*dministrators do not ever value teachers and what they know…administrators see teachers as easily replaceable, do not show respect."* Others reported that, *"[I] used to be more closed and individual at work. RU-MTF encouraged sharing and now I am volunteering more to help others…every aspect of putting a program/workshop together (planning etc.)…collateral effect. R-UMTF provided credibility to our work. We are now more appreciated and receive more respect. I can now mentor more effectively. Just being part of RU-MTF gave me more credibility on campus."*

Finally, MTFs were asked, "how important is community connectedness for your work?" While acknowledging the value of community and school connections, MTFs' responses suggested that this was long-term work that might be beyond their ability to influence. They stated that *"community support and buy-in is important…TEA* [Texas Education Agency] *dictates what we teach. There isn't much voice of the community in what to teach…community engagement takes a lot of work. It needs 2-way work, community has to help…hard work/lots of coordination among teachers, parents, and students."*

II. In-Depth Interviews

The in-depth interviews were conducted to describe how MTFs influenced the perception, presentation, and teaching of mathematics on their campuses. The MTFs participating in these interviews were chosen for several reasons including their on-campus tenure, changes taking place on their campuses, and the breadth of their mathematics knowledge.

In keeping with the RU-MTF Program's overarching goal of "developing exceptional mathematics teachers into leaders deeply grounded in sound mathematical content," these interviews present the insights and experiences of three MTFs as they work on their campuses to implement pre-college mathematics curricula, share learning strategies and experiences with their campus colleagues, and motivate students to persist in mathematics courses. Also included here are the perspectives of teachers who work with the MTFs on the same campus.

Campus Profiles

Brief profiles of the high schools where the interview participants teach are presented below. These profiles provide a general overview of the contexts in which the MTFs and their colleagues work. Although separate profiles are presented for each campus, information obtained from interview participants and their colleagues will be presented by themes explored through the interviews rather than by high school. Presenting the information in this manner also preserves the privacy of the participants.

High School A

The 2017-18 academic year is the most recent year for which demographic data are available for High School A. At that time, the total student enrollment was 3,330 students of whom 30 percent were in the International Baccalaureate Program. Approximately, 46 percent of students were economically disadvantaged. The ethnic breakdown of the student body was—32 percent African American, 5 percent Asian, 36 percent Latino, and 25 percent Anglo. There were 152 faculty members. The ethnic breakdown of the faculty was—19 percent African American, 7 percent Asian, 20 percent Latino, and 50 percent Anglo. Faculty members' years of teaching experience were distributed as follows—5 or fewer years, 51 percent; 6-10 years, 16 percent; and 11 years or more, 33 percent.

High School A offers both a traditional high school curriculum as well as the International Baccalaureate World School curriculum. The school's on-going remodel includes both a new building and a redesign of both its curriculum and instructional approach. The new building uses an open concept approach described as "flexible learning areas with moveable walls" and students' sit in desks that roll and swivel. Over the past few years, High School A's faculty members redesigned the curriculum to make it more interdisciplinary. In addition, all academic disciplines at High School A use Flipped Lessons (that is, students learn new material outside of class through short on-line lessons and use class time to practice and explore the new content with their teachers), Project-based Learning (that is, students working together to learn about, explore and solve real world problems), and Kagan Cooperative Learning Strategies as the primary instructional strategies.

High School B

The 2017-18 academic year is the most recent year for which demographic data are available for High School B. At that time, the total student enrollment was 1,696 students. Approximately, 86 percent of students were economically disadvantaged. The ethnic breakdown of the student body was—5 percent African American, <1 percent Asian, 93 percent Latino, and <1 percent Anglo. There were 99 faculty members. The ethnic breakdown of the faculty was—41 percent African American, 5 percent Asian, 26 percent Latino, and 26 percent Anglo. Faculty members' years of teaching experience were distributed as follows—5 or fewer years, 31 percent; 6-10 years, 18 percent; and 11 years or more, 51 percent.

High School B offers both a traditional high school curriculum as well as various Science, Technology, Engineering, and Mathematics (STEM) career and college preparatory programs. The school's STEM Magnet Program strands—Applied Science and Health Professions, Computer Science, and Petroleum Exploration and Engineering—combined with its traditional academic curriculum prepares students for college and career opportunities. Through the program strands students shadow professionals, attend

industry conferences, gain work experience through externships, and earn entry–level industry certifications.

High School C

The 2017-18 academic year is the most recent year for which demographic data are available for High School C. At that time, the total student enrollment was 2,870 students. Approximately, 50 percent of students were economically disadvantaged. The ethnic breakdown of the student body was—30 percent African American, 7 percent Asian, 42 percent Latino, and 19 percent Anglo. There were 162 faculty members. The ethnic breakdown of the faculty was—20 percent African American, 9 percent Asian, 18 percent Latino, and 51 percent Anglo. Faculty members' years of teaching experience were distributed as follows—5 or fewer years, 48 percent; 6-10 years, 17 percent; and 11 years or more, 36 percent.

High School C offers both a traditional high school curriculum as well as an Integrated Technology through Career Pathways Magnet Program. Students can explore career pathways in—Applied Science and Health Professions, Media Relations, Computing Sciences and Engineering, Performing and Visual Arts, and Business and Entrepreneurship. High School C's traditional high school curriculum includes an Advanced Placement program that offers 62 Pre-AP and AP courses.

MTFs Interviews

The interviews served as a means of obtaining information to better understand MTFs' as mathematics experts, mentors, and collaborators. Themes explored through the interviews with MTFs were secondary and university-level mathematics, shared professional learning experiences, obstacles encountered, AVID, and students' mathematics persistence and motivation.

Secondary and University-Level Mathematics Connections

When asked how their knowledge of secondary and university-level mathematics content changed as a result of their RU-MTF experiences MTFs reported that PI Papakonstantinou and Co-PI Parr's training, discovery learning experiences, and exploration of college level mathematics content opened the door to a different perspective on the secondary mathematics curriculum that helped them understand the reasons for certain secondary curriculum requirements and their connection to success in college level mathematics courses. MTFs also reported that they see the bigger picture of mathematics and understand when concepts students need to know and why. They work with students to develop the ability to think algebraically. Additionally, MTFs stated that they can look at mathematics topics not tested in the curriculum and understand where those topics can lead students beyond calculus.

Shared Professional Learning Experiences

MTFs used their experiences in the RU-MTF to implement and enhance the precollege mathematics curriculum both in their classrooms and on their campuses. The activities MTFs reported undertaking included creating a pre-College Math course with the mathematics department chairperson as well as a new math course—Business Calculus—for dual credit students and students who did not do well in Calculus AB.

MTFs reported that their RU-MTF experiences helped them grow professionally and now they are more comfortable helping colleagues and sharing what they know. MTFs also used their experiences in the RU-MTF to respond to the needs of teachers and students on their campuses.

For example, one MTF was inspired to create a series of YouTube instructional videos[1]. These videos include not only the content of the courses that the MTF teaches but also instructional videos for Pre-Calculus, PSAT, SAT, ACT, and the TSI placement test. (Changes in the ACT prompted some students to request that the MTF update those videos.) In addition, the MTF also produced on-line video content for students who failed Geometry, Algebra I, Algebra II or Pre-Calculus, to help them understand the content necessary to pass the course. Additionally, some of the MTF's campus colleagues who teach Pre-Calculus also use these videos. Because these instructional videos are available on the internet, the MTF also receives math questions from students at other schools.

Obstacles Encountered

When asked about obstacles they encountered to implementing or enhancing the precollege mathematics curriculum on their campuses MTFs identified several. No longer being department chair was an indirect obstacle to enhancing the precollege mathematics curriculum for one MTF who was demoted after new administrators were assigned to the campus. However, the MTF continued to support faculty members through professional learning community presentations and keeping an open door.

Other obstacles identified by MTFs were getting students to enroll in and persist in Calculus; many students do not stay with the course and "want an easy way out." In addition, the academic deans do not push advanced mathematics courses but refer students to APEX, an online program that provides credit-bearing courses. The lack of physical proximity to mathematics colleagues on campus was another obstacle that made it difficult for mathematics teachers to meet, discuss, and plan instruction.

AVID

When asked how they use AVID's Writing, Inquiry, Collaboration, Organization, and Reading in their mathematics classroom, MTFs reported that they incorporate AVID strategies into instruction by requiring that students write out their explanations; causing some students to complain that "this is not an English class."

For other MTFs, AVID prompted them to think of different ways to assess students. Recognizing that many students are not proficient writers, one MTF asks students to give their answers orally or lets students complete tests at home because it is important that "students experience small victories" and teachers can choose to be more flexible when working with students.

MTFs also shared AVID strategies as part of their group planning for students enrolled in higher-level mathematics courses; and encouraged their colleagues to be more flexible when how the assessing students' performance because it is important that such evaluations be balanced against getting students to persist in mathematics.

[1] The YouTube Channel created in September 2017 has 347 subscribers and 93,095 views. The approximately 324 videos run from 2 to 25 minutes and cover topics ranging from Factoring Quadratics to the Power Rule of Derivatives.

Students' Mathematics Persistence and Motivation

When asked what makes it difficult for students to persist in mathematics MTFs identified working full-time jobs that deprive students of study time and lack of prior knowledge as factors that adversely affects students' persistence in mathematics courses.

Lack of motivation and not being told that they can do mathematics well early-on also makes it difficult for students to persist in mathematics. Students' prior negative experiences with math teachers leads many to believe that they cannot be successful in mathematics. MTFs described the long-term effects of negative experiences with mathematics teachers as "sad" and "an injustice" because it is difficult to get students to let go of their math fears in high school.

For example, during the 2018-19 school year, a MTF taught low performing Algebra I students who failed the state mandated STAAR test the previous year. The MTF's goal was to build students' confidence over the course of the school year. As the MTF's students' confidence increased, their mathematics performance improved; by the end of the school year, 55 percent achieved passing scores on the STAAR test.

MTFs also connected students' mathematics persistence to teachers' not understanding the mathematics curriculum. They reported that many math teachers do not understand the connection between lower and higher-level mathematics; and that HISD needed more vertical alignment across the district and more vertical planning among teachers on the same campus. An example given was that knowledge of quadratic functions and inequalities as a topic is not taught in the district but is necessary for students to know when solving problems (on the SAT, IB Exams, and in advanced math courses) that require predicting the shape of a graph.

When asked how the strategies they use to motivate and encourage students to persist in mathematics changed as a result of their MTF experiences, MTFs reported that they now know more ways to motivate students and strive to meet all students where they are. MTFs talk to their students to understand their backgrounds, ask students about their post-high school plans and whether they have researched the mathematics requirements for their chosen fields, and educates students about the difference in earnings between those who go to college compared to those who do not.

The MTF's emphasis on equity in education helped MTFs understand the importance of getting to know their students' backgrounds. Although talking to students about cultural issues is not encouraged on some campuses, MTFs learned that students feel more respected and understood when they can talk about their lives with their teachers. MTFs reported that Co-PI Tapia's seminars and the presentation from the Center for the Healing of Racism were beneficial because they influenced how MTFs prepare their lessons and interact with their students.

Colleague Interviews

These interviews served as a means of obtaining other teachers' perceptions of MTFs. Themes explored through the interviews with MTFs' colleagues were mathematics advocacy, secondary and university-level mathematics content connection, obstacles encountered, AVID, and assistance needed by teachers.

Mathematics Advocacy by MTFs

When asked about the ways MTFs advocated for mathematics on their campuses, their colleagues reported that MTFs helped them see the vertical alignment throughout the high school mathematics curriculum; and taught them how to maintain classroom discipline, present mathematics content, and have students work problems in small groups that include both high and low performing students.

Their colleagues also noted that MTFs encouraged them to help students get small victories and increase their mathematics understanding by focusing on one idea at a time and minimizing the likelihood that students would become overwhelmed or frustrated.

In addition, MTFs helped their colleagues look beyond the district's emphasis on the STAAR exam and appreciate the importance of understanding what students are thinking, asking them questions, and pushing for students to complete assignments which required that they demonstrate their work step by step instead of completing computer-based assignments.

Secondary and University-Level Mathematics Content Connection

MTF's colleagues reported that it was very important for teachers to understand the connection between secondary and university-level mathematics content especially when significant numbers of students enroll in Calculus. Among some MTFs' colleagues, understanding this connection came as a direct result of working with the MTF and represented a "huge" step forward in their development as teachers. This knowledge helped MTFs' colleagues talk students about how pre-Calculus fits in with Calculus and other advanced mathematics courses; something that they did not know and could not do previously.

AVID

Although MTFs reported using AVID strategies as part of their instruction, AVID was not used widely on their campuses or by their colleagues.

Assistance Needed by Teachers

When asked about additional assistance needed by high school mathematics teachers MTFs' colleagues reported that teachers need more resources (HISD's loss in a recent copyright case limited teachers' access to resources) and time because it is difficult to create new lessons.

They also identified the need for "really good staff development specific to mathematics" and more time to cover topics in-depth; because teachers rush through topics to insure that they cover the material listed in the Texas Essential Knowledge and Skills (TEKS) even though students want to spend more time on some topics.

Teachers also reported needing additional on-line programs to reinforce student learning. In addition, MTFs' colleagues on some campuses reported that teachers need support from administrators for smaller class sizes and providing projectors and document cameras (or allowing teachers to purchase them) to use as instructional aids.

III. Discussion

MTFs on-line portfolio entries and reflections highlighted in the 2017 and 2018 evaluation reports pointed out the challenges they encountered as they worked to improve their professional learning communities and nurture students' curiosity about mathematics. The 2019 evaluation looked more closely at MTFs' on-campus experiences through a 45-minute focus group and in-depth interviews with MTFs and their campus colleagues.

The focus group revealed that MTFs view effective mathematics instruction as active teacher facilitated and student focused experiences. However, MTFs recognized that many of their colleagues do not know what effective instruction looks like and instead focus on students' test results because that is prioritized by administrators. Similarly, MTFs noted that unless campus administrators have mathematics backgrounds, they do not appreciate what effective mathematics instruction looks like and tend to take a hands-off approach as long as students achieve high passing rates on the STAAR test.

MTFs reported that the equity and inclusion components of the summer program caused them to reflect and reconsider how they think about and interact with their students; which caused them to change their teaching strategies. Participating in the RU-MTF increased the credibility of some MTFs on their campuses; while others reported that teachers were not valued by their school administrations which limited their ability to assume leadership roles on campus. Finally, during the focus group, MTFs expressed an appreciation of community connectedness but did not appear to embrace the work that it required as they needed the support and commitment of the community stakeholders.

The in-depth interviews provided more detailed pictures of MTFs' work their on-campuses and with their colleagues. Their understanding of the connection between the high school mathematics curriculum and college-level mathematics shifted their perspectives and changed how the approach content, teach students, and emphasize these connections with colleagues. MTFs' connections with their colleagues were strengthened by sharing professional learning experiences which included designing new courses, creating on-line instructional videos for students and teachers, and modeling effective instructional strategies.

Obstacles MTFs encountered included demotion within their department and administrators who did not encourage students to persist in advanced mathematics courses. However, MTFs continued to help their colleagues and encourage students' mathematics persistence through new course offerings. MTFs recognized that students' mathematics persistence was undermined when they lacked prior mathematics knowledge and confidence in their mathematics abilities. According to MTFs, teachers' failure to understand the vertical alignment of the high school mathematics curriculum also contributes to students' lack of persistence in mathematics. MTFs work with both their students and colleagues to develop connections that will facilitate effective instruction and student success.

MTFs continue to do the hard work of making incremental improvements in high school mathematics instruction and student achievement. Their efforts are recognized by the colleagues with whom they work and appreciated by the students they teach. All of this work is in keeping with and supportive of the RU-MTF's overall goals.