Community Impact with Teacher Leaders in Data Science and Mathematical Modeling

Introduction

A group of USU Mathematics and Statistics Educators has been awarded a National Scienced Foundation Noyce Track 3 Master Teacher Fellows (MTFs) Grant. Henceforth, the project will be known as **Data science in Rural Utah with Mathematical Modeling (DRUMM)**.

Master Teacher Fellows will be supported with stipends and coursework costs (tuition, materials, etc.) to engage in a series of courses and professional development workshops. The MTFs (selected from rural and Native American communities in Utah) will develop teaching excellence in data science and mathematical modeling.
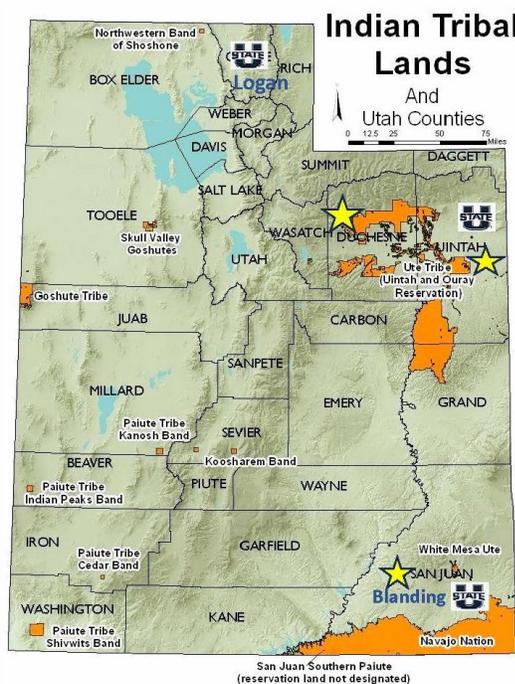
This project will pair MTFs in high-need LEAs with USU faculty experts in Math Education, Applied Mathematics, and Statistics. These collaborations will develop rich mathematics and data science lessons for engaging secondary school students in ways that are relevant to their lived experiences and identities. The program design features the direct and practical application of research in mathematical modeling and data science education, professional development, culturally relevant pedagogy, and community engaged learning.

Collaboration

The project directly engages three high-need rural school districts including Uintah, Duchesne, and San Juan, along with the Ute Tribe Department of Education. Teachers in these and other rural Utah high-need local education agencies (LEAs) are encouraged to apply to the program. These school districts were selected because they contain substantial proportions of rural and Native American (Native) students, which are two groups that are often overlooked in STEM education. It is anticipated that there will be openings for MTFs in other rural Utah School Districts, so teachers from any rural school district in USU's service area are encouraged to apply.

Figure 1. Map of Tribal Lands and Utah counties, retrieved from https://indian.utah.gov/tribal-nations/

Utah State University is uniquely positioned to engage with these school districts due to its extensive network of regional campuses and ongoing work in these communities.

The DRUMM team already has experience with regular outreach in San Juan County, via the USU Blanding STEAM Expo. At this annual event, we have hosted several teacher workshops and led hands-on activities and events for schoolchildren, teachers, and USU faculty from our main campus. These activities included cultural exchange, excursions to visit geological and historical sites, and exhibitions of Native arts and traditions. Additionally, reflections and artifacts from these events show that incorporating cultural exchange opportunities with relevant modeling contexts corresponds with a strong sense of belonging and connection to the learning community, and high motivation to incorporate mathematical modeling into.

The proposed program also involves partnerships with many university, state, and non-profit organizations, including the

USU College of Science, the USU College of Education and Human Services, the Utah State Department of Education, and the Utah Division of Indian Affairs. The project will also establish and maintain collaboration with Data Trail, a non-profit organization that has previously provided data science opportunities to students in urban areas.

Program Components and Design

The DRUMM project will provide MTFs with financial, intellectual, and community support to (a) earn a Master's of Mathematics (MMath) – this only applies to MTFs who don't already have a master's degree, (b) receive a mathematical modeling (MM) and data science (DS) teaching leadership credential, (c) gain proficiency in industry-standard technology for teaching and coding (such as R, Python, or MATLAB), (d) engage in professional development immersion experiences and outreach opportunities in rural and Native communities, (e) collaborate with USU faculty and peer MTFs to co-design and implement culturally relevant DS and MM lessons in their own classrooms, and (f) create scholarly products to disseminate their co-designed lessons at teacher workshops across Utah and the Four Corner's region, conferences, or practitioner journals.

Scope

A total of 24 MTFs will be selected from the applicant pool to participate in DRUMM. The MTFs will be selected from our target school districts first, and then remaining openings will be filled with MTFs from other USU service areas who teach in high-need schools. We will recruit two cohorts: (1) MTFs already holding a master's degree and (2) MTFs who enroll in our Master of Math (MMath) program while teaching.

MTFs in the first cohort will receive a stipend of $14,000 per year for each of the 5 years of the program. MTFs in the second cohort will receive cost of attendance (i.e., tuition, etc.) in their last 14 months of the MMath program, and $14,000 stipends for 4 years after their degree completion. All MTFs will be required to meet the stipulations of these stipends during their five years of participation.

Degree Preparation and Teacher Development Program, Project Activities, and Support

The DRUMM program consists of two major components that serve the needs of the two cohorts: (1) The Master of Mathematics (MMath) Degree and (2) The Data Science and Mathematical Modeling (DSMM) Leadership Credential. The design of the program provides unique opportunities for MTFs to engage in intensive, sustained, collaborative, and research-based experiences to become inclusive teacher leaders in rural and Native communities and teacher leaders of data science and mathematical modeling.

The MMath Degree: The MMath degree is a professional master's degree designed to serve mathematics educators at the secondary and sometimes tertiary levels. The MMath program is primarily designed for secondary mathematics teachers already holding a secondary teaching license and mathematics endorsement in the state of Utah.

The program requires the completion of 36 credits; at least 21 credits must be from courses offered by the Department of Mathematics and Statistics, while remaining credits may come from the College of Education and Human Services as approved by an advisory committee. Students may take courses from a broad array of topics in applied mathematics, pure mathematics, statistics, mathematics education, and pedagogy. The DSMM Leadership Credential courses can be used to fulfill requirements for the MMath Degree.

Individualized plans of courses will be created by project team members to fit the needs of MTFs (one possible example plan of courses is shown in Table 1). As part of the MMath degree requirements, the MTFs must pass a qualifying exam consisting of two parts: (1) A written take-home exam in mathematics teaching, and (2) A learning project that demonstrates coding proficiency.

The DSMM Leadership Credential: Both our cohorts will be required to participate in the DSMM leadership credential program. The DSMM Leadership credential is designed to foster MTFs skills in teaching mathematical modeling and data science at the secondary level by creating lessons that incorporate computer programming in culturally relevant contexts. In addition, the DSMM leadership credential also supports MTFs in advancing as teacher-leaders of mathematical modeling and data science in rural and Native communities through community engagement, collaboration with faculty, and scholarly engagement. To accomplish this, the DSMM leadership credential consists of course work and activities that are designed to attain specific goals outlined below (see Table 1 for timeline of the activities).

1. <u>Orientation-Community Engaged Learning:</u> Both cohorts of MTFs will start the program with a three-day orientation. The orientation will focus on team building between the MTFs and project leaders, and will build synergy toward the overarching goals of the project.

2. <u>Technology Workshops*:*</u> MTFs will engage in a week-long technology workshop every summer for 3 years. Themes include data wrangling, modeling using computer programming, and using technology in classrooms, among other technology skills. These workshops will advance MTFs' technology competencies for coding simple models and using simulations and other technological tools for instruction. This workshop will be instrumental for supporting MTFs to be prepared to learn mathematical modeling and data science.

3. <u>Culturally Relevant Pedagogy Online Module:</u> MTFs will complete a culturally relevant pedagogy (CRP) module during their first year of the program that combines the TEACH for cultural competence course, developed as part of the Mentoring & Encouraging Student Academic Success (MESAS) program at USU, with supplemental focus group activities. MTFs focus group activities include reading and discussing CRP literature, engaging with invited speakers in the mathematics education community that specialize in CRP, and analyzing audio-video of publicly available lessons using the culturally responsive mathematics teaching (CRMT) observation rubric. The CRP course will support the MTFs in becoming culturally responsive teachers.

4. <u>Mathematical Modeling for Secondary Teachers (MATH 6810-A) & Data Science for Secondary Teachers (MATH 6810-B):</u> The program will foster MTFs' mathematical knowledge for teaching data science and mathematical modeling by incorporating two courses (3 credits each) that all MTFs will be required to take: Mathematical Modeling for Teachers and Data Science for Teachers.

5. <u>MTF-Faculty Paired Co-teaching and Mentorship:</u> Throughout the six years of the project, each MTF will be paired with a university faculty member. The university faculty member will mentor the MTF throughout the project, providing feedback and support on implementing data science and mathematical modeling in their classrooms. Furthermore, faculty will co-teach at least one data science/mathematical modeling lesson with each MTF at their school to demonstrate

teaching approaches in real-time tailored to their classroom setting. Co-teaching will be primarily facilitated through the Lesson/Curriculum Creation course (M6910).

6. Regional STEAM Expo: MTFs will be required to participate in the regional STEAM Expos held in Blanding (in Spring) and Uintah (in Fall). The STEAM Expo is an event highlighting Science, Technology, Engineering, Arts, and Mathematics in the rural and Native communities of Southeastern Utah that USU faculty have facilitated for many years. We strive to make this event inclusive and accessible for all and many in-service teachers not enrolled at USU also may attend.

    MTFs are required to participate in four STEAM Expos throughout the five years of the program. In the first two years, MTFs will participate as learners and network with other in-service teachers. In the last 3 years MTFs will participate as teacher-leaders by presenting scholarly projects that they complete in their MATH 6910 course and facilitating other workshops (collaboratively or individually) on data science, mathematical modeling, and culturally relevant pedagogy.

7. Scholarly Projects (MATH 6910-A & MATH 6910-B): Following MTF-Faculty collaboration developments, these course will provide MTF-Faculty pairs with support to turn their co-created MM and DS lessons into scholarly publications. The MTFs will be introduced to action research for teacher candidates and provide IRB/data collection along with writing support. Instruction guides will be created for MTFs to transform their co-created MM and DS lessons and ideas into lesson analysis manuscripts submitted to practitioner journals, conference presentations, or workshops.

8. Teacher Leadership Activities (TLA): After the completion of the M6910 Scholarly Projects, MTFs are required to engage in at least 3 TLAs for the remaining years. The MTFs can select TLAs from the following list: Conference presentation (e.g., AMTE, NCTM, TODOS), conduct a technology-oriented summer camp for kids, mentor other teachers to become teacher leaders of MMDS, engage in research experience with faculty, develop a unit on DS & MM to be shared in a publicly available repository, or another TLA that is mutually agreed-upon by the faculty mentor and MTF pair. The goal of the TLAs is to promote persistence to stay in profession and advance professional competencies in teaching DS & MM.

9. Planning to Stay Book Study: Both cohorts will participate in a year-long book study centered around *Planning to Stay* (Cleeves, 2023). This book focuses on teacher burnout, and it will allow MTFs to have critical conversations about persisting through challenges within education. MTFs will engage in monthly readings and quarterly discussions, which will be facilitated by USU faculty.

10. Online Support Community: Throughout the program, MTFs will receive support/mentorship through an online support community (created in Canvas) formed by MTFs and USU faculty. The purpose of the online community is to create a repository to share lesson materials, share experiences in development and implementation of curricular materials, ask support questions, and express any concerns as MTFs navigate the demands to teaching, learning, and service to profession.

Table 1. Six Year Design of the Program

Year (semester)		MTFs with Master's Degree		MTFs earning the MMath	
		Course	**Other Activities**	**Course**	**Other Activities**
1	Su24		Orientation Technology Workshop Annual Survey	Self-funded coursework (optional)	
	Fa24	Math 6810 Math Modeling	STEAM Expo: MM workshop (Uintah)-MTF as Learners	Math 6810 Math Modeling	
	Sp25	Math 6910 Curriculum Development: MM	STEAM Expo: MM workshop (Blanding) -MTF as Learners CRP online course	Math 6910 Curriculum Development: MM	
2	Su25		Technology workshop *Planning to Stay* Book Study starts Annual Survey	Math 5810: Geometry Stat 5010, Math 5020 Mathematical Cognition and Assessment 1 Additional Stat course	Orientation Technology Workshop Annual Survey
	Fa25	Math 6810 Data Science	STEAM Expo: DS workshop (Uintah) MTF as Learners	Math 6810 Data Science	STEAM Expo: DS workshop (Uintah) MTF as Learners
	Sp26	Math 6910 Curriculum Development: DS Demonstrate coding Proficiency	STEAM Expo: DS workshop (Blanding) MTF as Learners *Planning to Stay* Book Study Ends	Math 6910 Curriculum Development: DS Demonstrate coding Proficiency	STEAM Expo: DS workshop (Blanding) MTF as Learners CRP online course
3	Su26	Math 6910 Scholarly Project	Technology workshop Annual Survey	Math 5010 Technology Math 6910 Scholarly Project 2 TEAL courses Qualifying Exam **MTFs Graduate	Technology workshop *Planning to Stay* Book Study starts Annual Survey
	Fa26		TLA STEAM Expo: (Uintah) MTF as Teacher Leaders		**MTF stipends start STEAM Expo: MM workshop

					(Uintah)-MTF as Learners
	Sp27		TLA STEAM Expo: (Blanding) MTF as Teacher Leaders		STEAM Expo: MM workshop (Blanding) -MTF as Learners *Planning to Stay* Book Study Ends
4	Su27	Math 6910 Scholarly Project	Annual Survey	Math 6910 Scholarly Project	Technology workshop Annual Survey
	Fa27		TLA STEAM Expo: (Uintah) MTF as Teacher Leaders		TLA STEAM Expo: (Uintah) MTF as Teacher Leaders
	Sp28		TLA STEAM Expo: (Blanding) MTF as Teacher Leaders		TLA STEAM Expo: (Blanding) MTF as Teacher Leaders
5	Su28		TLA Annual Survey		Annual Survey
	Fa28		TLA STEAM Expo: (Uintah) MTF as Teacher Leaders		TLA STEAM Expo: (Uintah) MTF as Teacher Leaders
	Sp29		TLA STEAM Expo: (Blanding) MTF as Teacher Leaders Final Survey		TLA STEAM Expo: (Blanding) MTF as Teacher Leaders
6	Su29				TLA Annual Survey
	Fa29				TLA STEAM Expo: (Uintah) MTF as Teacher Leaders
	Sp30				TLA STEAM Expo: (Blanding) MTF as Teacher Leaders Final Survey