

**Abstract Title: The Role of STEM Teacher-Leaders in Student Success**

**MSP Project Name: Texas Middle and Secondary Mathematics Project**

**Author(s): Kimberly Childs, Keith Hubbard, Lesa Beverly, Thomas Judson, Meagan Hensley**

**Presenter(s): Kimberly Childs, Keith Hubbard**

**120 word summary:**

Our goal is to equip teachers in STEM disciplines, via teacher-leaders, to optimize student success through pedagogical content knowledge and a more fully developed support structure. From our perspective, student success is graduation and passing high stakes tests, but also perceiving a supportive classroom environment which communicates the applicability of mathematics to life.

1. We developed a long-term data set measuring direct teacher content knowledge (which has a well-established correlation to student success).
2. We studied how teacher-leaders providing professional development interpret and respond to the pedagogical needs of recipients.
3. We developed a case study to investigate horizontal curricular integration in an alternate cultural setting to better inform curriculum innovation for future teacher-leader training.

**Section 1: Questions for dialogue at the MSP LNC.**

How can data sets of teacher content knowledge most meaningfully be correlated with actual student success? Specifically, when states change their high states testing formats how should continuity be measured?

How can issues of teacher success, like teacher longevity, quantifiably be linked with improved learning environment?

How is qualitative data, such as interviews and surveys, most effectively preserved from overlapping projects to inform future research endeavors?

After identifying cultural, ethnic, or socio-economic stratification in best pedagogical practices, what approaches are optimum to educate teachers about these differences and maximize teacher buy-in for addressing them?

**Section 2: Conceptual framework**

Stephen F. Austin State University has a history of involvement with teacher preparation in STEM disciplines, particularly in mathematics. We have received funding and have a pre and post assessment protocol for the following programs. Our 2-year TxMSMP program has trained five cohorts of teachers – three middle school and two high school cohorts. We have also trained two cohorts in our 2-year MST academies. We currently have one middle school and one high school cohort progressing through our 5-year Texas LIMIT program. Finally, we have recently begun working with both middle school and high school teacher-leaders through our Texas Leadership program.

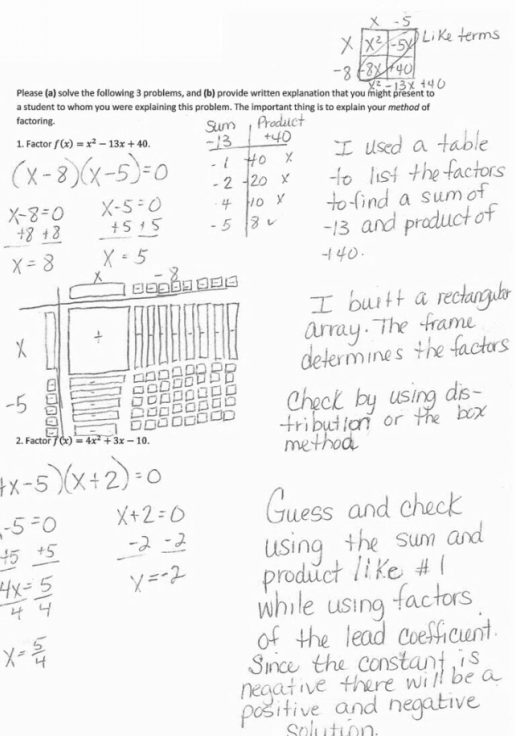
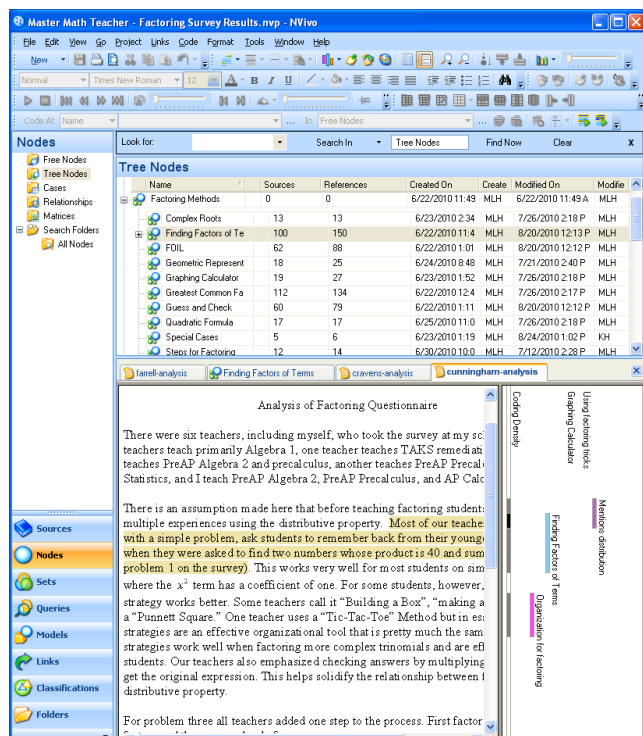
Macroscopically, we believe student success to be successfully graduating high school (including passing the TAKS test/end-of-course exams – Texas' high stakes tests) and matriculating at high percentages into higher education, college ready. Further, success for students of mathematics connotes that students

believe the mathematics classroom to be a supportive environment and perceive mathematics to be a discipline integrally tied to their everyday lives. Since the link between having qualified teachers and student success (as defined by graduation and improved performance on standardized tests) is well established, much of our efforts are on measuring teachers' pedagogical content knowledge. Of particular interest to us is not merely whether content knowledge improves from pre assessment to post assessment (it does). Since a primary concern in our state is the retention of successful STEM teachers, we would like to establish a correlation between specific gains in content knowledge, as well as participation in professional development founded upon the cohort philosophy, and longevity in the classroom. We hope our research will show that participation in MSP funded programs not only improves teacher quality, but also teacher quantity. Our end goal is to extend these finding to the development of teacher-leaders, and perhaps even the longevity and success of non-participating teachers at schools with participants in MSP funded programs.

Although our primary research subjects are in fact the teachers involved in content delivery, we also hope to establish student success as measured in terms of retention and standardized tests, and demonstrate an environment supportive of student inquiry, educating students as to the importance, not just the computation, or mathematics. Since these are truly measures of student perception, surveying students and interviewing students will serve as direct measures or success.

Our second major research endeavor is to illuminate more subtle aspects of STEM teacher-leader training leading to successful collaboration on site in the public schools using qualitative analysis techniques. Our first systematic investigation in this direction has been motivated by the research question: How do mathematics educators providing professional development to middle and secondary mathematics teachers interpret and respond to the pedagogical needs of those teachers?

We asked participants in the Texas LIMIT and Texas Leadership programs to each seek out 5 colleagues at their school site and ask them to take a short survey of factoring techniques. We then asked the teacher-leaders in training to identify themes in their colleagues' work that could lead to potential professional development sessions at their school site. We collected copies of the colleagues' work samples (see sample - below right) and paired them with the analyses of the teacher leaders. We integrated all of these artifacts into the qualitative data analysis software package NVivo. Inside NVivo, we were able to link themes between the factoring surveys and the teacher-leaders' analyses (see sample below left).



Third, if we are to perpetuate teacher-leaders' training in pedagogical content knowledge, we must also be modeling active development of new pedagogical content techniques. In addressing different student success rates due to cultural incongruities, we chose a different approach with the hope of shedding light on a contemporary content issue: radically different learning styles linked to different cultural backgrounds. Here, we opted for a highly microscopic definition of student success appropriate for such a case study: a successful student measurably improves performance on a specific battery of questions after one treatment.

In this project, our lead researcher presented a series of lessons on mathematics to secondary students in Niger, Africa. She decided to focus on the marriage of algebra and geometry, furthering comprehension in both areas. Assessment was performed in pre-test, post-test format and qualitative exit interviews were also obtained.

### **Section 3: Explanatory framework**

Each of our three different research emphases has a slightly different explanatory framework.

Our long-term data set on teachers' pedagogical content knowledge has already been used to validate and refine our use of the cohort model for teacher-leader training. We hope to also quantify the effects of increased content knowledge on teacher retention, student persistence to graduation and higher education, and finally to changes in specific class test scores. Much of this analysis must, by its nature take place several years after the original treatment; but we are now in the window of opportunity for this work.

On the topic of teacher-leader adaption to content needs of peer teachers, certain patterns emerged from the qualitative analysis. For instance, multiple surveys revealed a leaning toward the use of mathematically unmotivated acronyms for factoring (such as the MUSTANG method). The teacher leaders recognized these faulty methods, but did not seem to have a clear idea of how to convince colleagues these methods were inappropriate. This analysis has fed a collaborative effort between university STEM faculty and grad students attempting to write accessible literature explaining these 'variant' factoring methods, and also presenting a geometrically motivated alternative.

Since this step in the treatment process is only happening now, our hope is to demonstrate an effect on students within STEM districts and possibly see measurable improvements on standardized tests. This type of improvement is unlikely to be observable from the level of test scores for some time, however, as the method of dissemination is intended to be organic.

Our efforts in culturally aware content development not only produced high student success, but intriguing cultural patterns emerged as well. For instance, native Africans tended to excel at geometric problem solving approaches to algebraic problems over purely algebraic ones. We hope to further this investigation into the interplay between culture and the learning of mathematics, and possibly augment it with experiences from other diverse cultures. We plan to bring these findings back to our teacher-leaders, hopefully sensitizing them to the value of questioning whether specific pedagogical techniques are equally effective between different student groups.