

# Mathematics Teacher Leadership Center Strategic Plan March 2009

## Our Vision

The Mathematics Teacher Leadership Center (Math TLC) works to maximize K-12 student understanding of mathematics by developing mathematics teachers and teacher-leaders in Colorado and Wyoming with deep mathematics content knowledge that is culturally relevant and pedagogically effective, and to enhance the culturally competent pedagogical skills of university teacher-educators at the University of Wyoming and the University of Northern Colorado.

## Our Mission

Our purpose is to provide teachers and teacher-leaders with high-quality mathematics education within a collaborative climate that supports intellectual rigor, encourages innovation, fosters creativity and enhances cultural responsiveness in a way that results in self-confident K-12 students who understand important mathematics concepts and appreciate mathematics as a dynamic body of knowledge.

## Math TLC Structure

Math TLC, an integrated mathematics partnership of universities and school districts, weaves together current and new research, technology, mathematics expertise, and culturally responsive professional development in a *virtual master's degree program* (MP) for secondary teachers<sup>1</sup> and a *mathematics teacher-leader program* (TLP) for 4-12 grade teachers. Figure 1 depicts the project's organizational structure.

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<sup>1</sup> For our purposes, we define secondary to mean 7<sup>th</sup>-12<sup>th</sup> grade teachers.

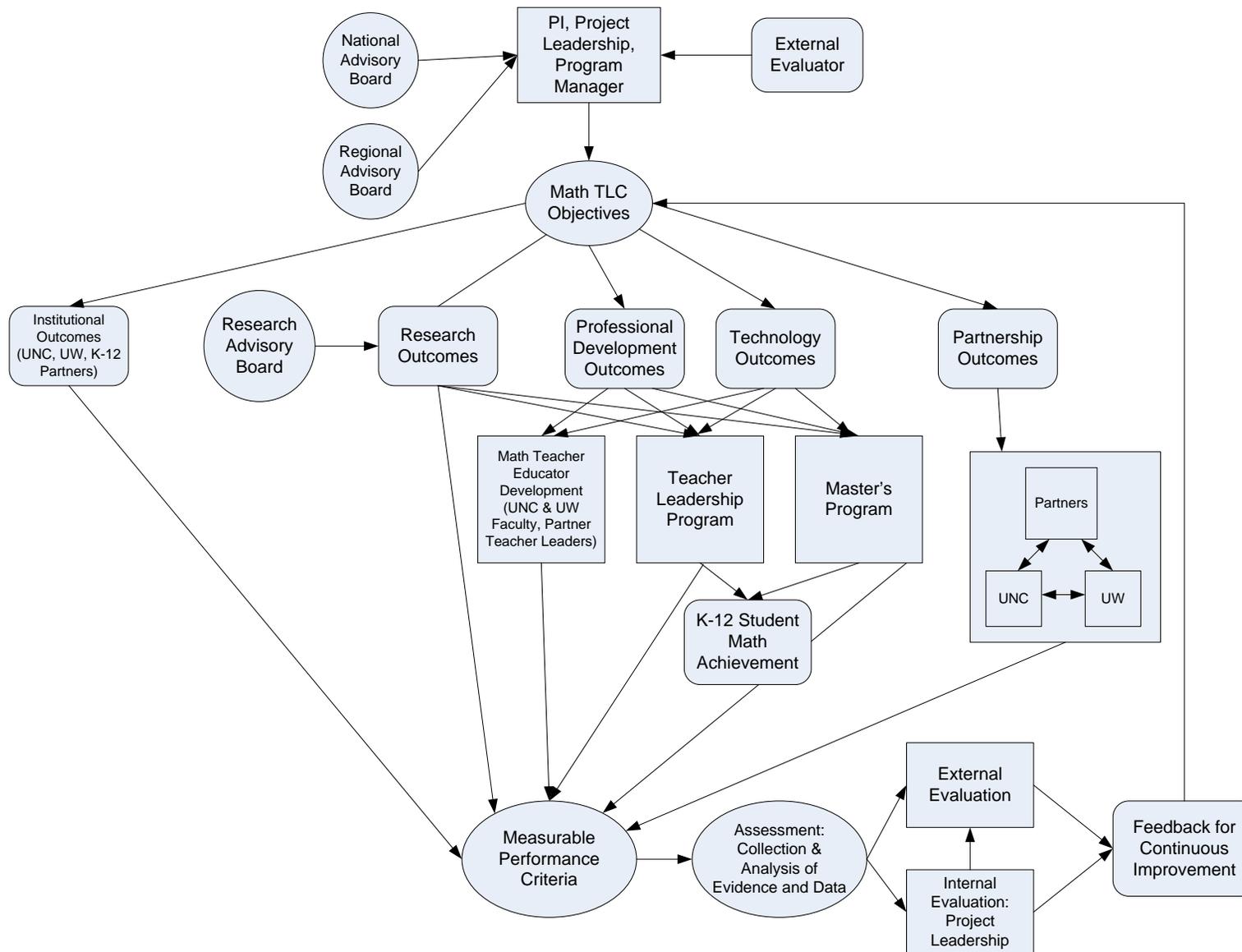


Figure 1. Math TLC Organization Chart.

## Overarching Goals and Anticipated Outcomes

*Math TLC's* ultimate purpose is to improve K-12 student mathematics learning. The project's primary strategy is to improve the effectiveness of mathematics teachers by focusing on content proficiency, cultural competence and pedagogical expertise.

<u>Math TLC Overarching Goals</u>	<u>Anticipated Overarching Outcomes</u>
<p>Goal 1: Develop a shared vision of mathematics as a culturally rich subject in which K-12 mathematics proficiency is defined by shared community standards (e.g., state, NCTM policies).</p> <p>Goal 2: Expand mathematical content knowledge in ways that broaden exposure to mathematical ideas and deepen understanding of topics that extend K-12 mathematics content.</p> <p>Goal 3: Increase pedagogical content knowledge by examination of how students think and learn about mathematics and, for teacher-leaders, about how teachers learn about teaching.</p> <p>Goal 4: Empower participants as lifelong professional learners who regularly reflect on themselves, students, and community context to improve teacher practice and student learning.</p> <p>Goal 5: Produce a research-based and tested model for master teacher and teacher-leader development based on the above goals that improves mathematical achievement for <u>all</u> students.</p>	<p>Outcome 1: A cadre of culturally competent mathematics master teachers and teacher-leaders equipped to work locally, regionally and nationally to improve teacher practice and student mathematics achievement.</p> <p>Outcome 2: A body of research that documents effective practices in developing master mathematics teachers and teacher-leaders.</p> <p>Outcome 3: A sustainable model for a virtual master's program and teacher leadership program offered jointly by the University of Northern Colorado and the University of Wyoming.</p>

The Math TLC, an integrated partnership of universities and school districts, serves the mathematical community by seeking to improve mathematics achievement in middle, secondary, and post-secondary education in Colorado and Wyoming. By weaving together existing and new research, teacher expertise, and culturally responsive professional development, we offer a *virtual master's degree program* for secondary teachers and a *mathematics teacher-leader program* for 4<sup>th</sup> through 12<sup>th</sup> grade teachers.

To be a successful project, we recognize the need to work together as a community, not as individuals. Program activities occur within all areas but much of the work is also between areas. For example, teachers in the master's program will be learning about culturally responsive mathematics instruction through activities developed by the mathematics teacher educators (who themselves learned about culturally responsive teaching through their involvement in the project) and then the teachers will be creating and implementing activities for the math students in their classroom. A teacher leader may be coaching the teacher on that lesson and helping them reflect on the impact of the instruction.

Our vision is focused on content proficiency, cultural competence and pedagogical expertise for all *Math TLC* participants<sup>2</sup> and our overarching goals guide us in achieving our vision.

- Mathematics Teacher Educators (MTE) are K-12 partner representatives, university faculty and graduate students who are involved in implementing the project.
- The Mathematics Teacher Educator Professional Development (MTE-PD) is the collection of activities designed to support the MTE.

<sup>2</sup> *Math TLC* participants include teachers in the master's program, teachers in the teacher leadership program, and K-12 partner representatives, university faculty and graduate students involved in the project.

Math TLC participants include MTE (Mathematics Teacher Educators) and 4-12 teachers participating in the TLP (Teacher Leader Program) or MP (Master's Program).

In this document, we articulate objectives for each goal and highlight how each goal applies to the components of the *Math TLC*. In other documents, we articulate specific goals and objectives for the virtual master's and the teacher leadership programs, often referencing back to these overarching goals. To be a successful project, we recognize the need to come to consensus on the *enduring understandings*<sup>3</sup> that are core to the *Math TLC*. We do this by framing the enduring understandings as *essential questions*. Each Overarching Goal addresses at least one essential question.

## **Goal 1: Interactions between Mathematics, Mathematics Proficiency and Culture**

Overarching Goal 1 addresses the essential questions: “What is mathematics?” and “What does it mean to be good at mathematics?”

When we talk about *mathematics as a culturally rich subject (MCRS)* we refer to several things. One is that mathematics is embedded in culture, even if the mathematics isn't initially obvious. For example, the complex kin system of the Warlpiri, in Australia's Northern Territory (Ascher, 1991) has the logical structure of a dihedral group of order 8. Another is that culture is embedded in mathematics. This contradicts the often stated belief that mathematics is culture-free. We need only look at the way we use symbols to realize that mathematics has its own culture; what symbols are appropriate to use is influenced by the context of the problem. For example, we have a variety of symbols to indicate division. If we want symbols to represent 2 divided by 4, we have several choices:

$$2 \div 4, 2/4, \frac{2}{4}, 4\overline{)2}.$$

What is considered the “best” choice is determined by the context in which the problem is being done. In some cases, the middle two representations give both the problem and the answer, but the first and last would be considered to represent only the problem and not the answer.

Current research and practice literature suggests five key areas of teacher learning that increase teaching effectiveness, particularly culturally and ethnically diverse students (Gay 2002): (1) developing a knowledge base about cultural diversity, (2) learning mathematical content from ethnically and culturally diverse origins, (3) participating in and building a caring community of learners – this includes developing ways to calibrate teacher intentions with student perceptions, (4) seeing personal communication patterns and using that awareness to learn to communicate effectively with diverse students, and (5) responding supportively to socio-economic, cultural, and ethnic diversity in the delivery of instruction. Offering academic knowledge and skills “situated within the lived experiences and frames of reference of students” (Gay, 2000) leads to more personally meaningful experience and more readily and thoroughly learned mathematics.

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<sup>3</sup> The MTE are currently reading and discussing *Understanding by Design*, 2<sup>nd</sup> Ed (G. Wiggins and J. McTighe, 2005, ASCD) in a weekly seminar to develop a shared vision of how to teach for enduring understanding. The italicized language here is from this book.

*Math TLC* university teacher educators, responsive to the professional worlds of the teachers in their classes, *model and teach* the five components in master's classroom instruction. Moreover, the teacher-leader program and *Math TLC* research plan are built around the five tenets.

**Overarching Goal 1:** Develop a shared vision of mathematics as a culturally rich subject in which K-12 mathematics proficiency is defined by shared community standards (e.g., state, NCTM policies).

**Objective 1.1:** Engage all *Math TLC* participants in collectively experiencing, analyzing, debating and exploring mathematics as a culturally rich subject through activities embedded in MTE-PD<sup>4</sup>, MP and TLP.

**Objective 1.2:** MTE will jointly develop and embed activities in the MP and TLP courses where participants collectively engage in experiencing, analyzing, debating and exploring mathematics as a culturally rich subject

**Objective 1.3:** Using the lesson experiment model<sup>5</sup>, MP and TLP teachers will jointly develop, implement and revise lessons for their students that treat mathematics as a culturally rich subject.

**Objective 1.4:** Engage all *Math TLC* participants in collectively analyzing, exploring and understanding culturally responsive mathematics pedagogy through activities embedded in MTE-PD, MP and TLP.

**Objective 1.5:** MTE jointly develop MP and TLP activities that engage teachers in collectively analyzing, exploring and understanding culturally responsive mathematics pedagogy.

**Objective 1.6:** Math TLC participants jointly develop, implement and revise lessons that implement culturally responsive teaching strategies in their classrooms.

**Objective 1.7:** Engage all *Math TLC* participants in analyzing and debating K-12 mathematics proficiency as defined by shared community standards (e.g., state, NCTM policies).

**Objective 1.8:** MTE will jointly develop activities for MP and TLP courses that ask teachers to read, analyze, synthesize and debate the shared community standards for K-12 mathematics proficiency.

**Objective 1.9:** Using the lesson experiment model, TLP and MP teachers will jointly develop, implement and revise lessons that address all aspects of mathematics proficiency and are aligned with state and NCTM standards.

In addition to data collected for evaluation purposes, data pertaining to research questions associated with Overarching Goal 1 will be collected by the project's researchers including pre/post classroom observations and participant feedback.

Process evaluation (benchmarks) and individuals responsible for data collection and analysis follow: EE represents External Evaluator and PM represents Program Manager. *Mathematics as a Culturally Rich Subject (MCRS)*, *Culturally Responsive Mathematics Pedagogy (CRMP)* and

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<sup>4</sup> MTE-Professional Development.

<sup>5</sup> Lesson Experiment is a form of small-scale action research that we are using to connect coursework with practice. It is a tool teachers can use to systematically examine their practice, improve their pedagogical content knowledge, and explore changes in student achievement.

*Shared Community Standards (SCS)* rubrics<sup>6</sup> for assessing the quality of assignments and lessons will be developed by the PI, co-PIs, the MP Team and the TLP Team.

Objective	Benchmarks	Data Source	Responsible for Data	
			Collection	Analysis
1.1, 1.4 and 1.7	MTE members participate in at least 75% of MTE-PD each project year.	Attendance logs	PM	EE
1.2	Quality of a sample of activities that address mathematics as a culturally rich subject will be assessed by MP Team and TLP Team: 75% will be at least Developing and 50% at least Proficient	MP Team, TLP Team reports	PI and PM	EE
1.2	All MP and TLP courses include at least one assignment (50% of courses will include two assignments) where teachers explore, analyze, and debate mathematics as culture.	Course notebooks	Co-PIs	Program Teams
1.2, 1.5, and 1.8	Activities assessed by MP and TLP participants	End of course survey	MPT, PM	EE
1.3	MP and TLP teachers develop, implement and revise at least 2 lessons that address mathematics as culture rich subject in their first year and 4 in their second year <sup>7</sup> .	Lessons	Course instructors, MPT, TLPT	PM
1.3, 1.6 and 1.9	All of the lessons will be at least Beginning, 50% at least Developing and 25% at least Proficient in the first year of participation and 100% will be at least Developing and 50% at least Proficient as assessed by both the <i>MCRS</i> , <i>CRMP</i> and <i>Shared Community Standards</i> rubrics.	Course report generated by instructors	PM, MPT, TLPT	EE
1.5	Quality of a sample of activities that address culturally responsive mathematics pedagogy will be assessed by MP Team and TLP Team: 75% will be at least Developing and 50% at least Proficient	MP Team, TLP Team reports	PI and PM	EE
1.5	All MP and TLP courses include at least one assignment (50% of courses will include two assignments) where teachers explore culturally responsive mathematics teaching strategies.	Course notebooks	Co-PIs	Program Teams
1.5 and 1.6	MTE, MP and TLP participants will document which culturally responsive teaching strategies they implemented in their classrooms along with student reactions.	Self-reports	Instructors and PM	Program Teams, PI and EE
1.6	MP and TLP teachers develop, implement and revise at least 2 lessons that implement culturally responsive teaching strategies in their classrooms in their first year and 4 in their second year.	Lessons	Course instructors, MPT, TLPT	PM
1.8	Quality of a sample of activities that address K-12 mathematics proficiency will be assessed by MPT	MP Team, TLP Team	PI and PM	EE

<sup>6</sup> Rubrics will address beginning, developing, proficient and advanced levels.

<sup>7</sup> The same lesson can address multiple aspects at a time.

Objective	Benchmarks	Data Source	Responsible for Data	
			Collection	Analysis
	and LPT: 75% will be at least Developing and 50% at least Proficient	reports		
1.8	All MP and TLP courses include at least one assignment (50% of courses will include two assignments) where teachers explore and analyze K-12 mathematics proficiency	Course notebooks	Co-PIs	Program Teams
1.9	MP and TLP teachers develop, implement and revise at least 2 lessons that address all aspects of mathematics proficiency and are aligned with state and NCTM standards in their first year and 4 in their second year.	Lessons	Course instructors, MPT, TLPT	PM

The External Evaluator is responsible for the administration, analysis and reporting of results associated with these outcome assessments. The Program Manager assists with some data collection (e.g., number of publications and presentations).

**Overarching Goal 1 Outcome Evaluation Measures:** [1] 90% of *Math TLC* participants will report increased knowledge of mathematics as a culturally rich subject (pre/post Culture Competence Survey). [2] The mean overall cultural relevant ratings of MP and TLP courses by participants will increase over the life of the project. [3] MP and TLP teachers will report pre, post (year 1) and post-post (year 2) increased implementation of culturally responsive teaching strategies in their classrooms. [4] MP and TLP teachers will report at ends of years 1 and 2 on a self-report assessment increased understand of K-12 mathematics proficiency as defined by shared community standards. [5] All Math TLC participants will report increased professional involvement locally, regionally or nationally in activities associated with improving teacher practice and student mathematics achievement (e.g., publications, presentations). [6] Increased student performance scores on the Wyoming and Colorado state NCLB assessments.

## Goal 2: Focus on Mathematics Content Knowledge

We want our teacher participants to continue as mathematical learners. The essential question here is: “What more should mathematics teachers and teacher leaders know about mathematics beyond what they teach and what they learned as undergraduates?” In line with our goals for culturally responsive teaching, we cannot say exactly what mathematical ideas will broaden their exposure without a sense of what they already know. So, we start with the assumption of undergraduate mathematics preparation for secondary mathematics teaching and build on and use the mathematical knowledge and sophistication garnered from teaching secondary mathematics to design courses and activities that challenge teachers to push their understanding of mathematics as a subject and as a process.

It is easy to say, as we do in overarching goal 2 below, that we will “expand mathematical content knowledge in ways that broaden exposure to mathematics ideas” but we want to do this in ways that are useful to secondary mathematics teachers. With this audience in mind, we develop activities that ask teachers to:

- Explore mathematics content outside the usual mathematics typically in programs that prepare secondary mathematics teachers.

- View mathematical ideas from the perspective of research mathematicians to help teachers appreciate the dynamic nature of mathematics as opposed to the static view offered in most secondary curricula.
- Experience interconnections between topics (e.g., look at symmetry from an algebraic perspective) to offset the separation of most secondary curriculum into algebra and geometry courses.
- Discover beauty, logical structure and applicability of mathematics.
- Relate to the historical and conceptual evolution of mathematics theory.

We also say that we will “deepen understanding of topics that extend K-12 mathematics.” For this, we develop activities that ask teachers to explore:

- The theoretical underpinnings of traditional algorithms (e.g., division of fractions) and how these algorithms are specific examples of more general mathematical ideas (e.g., division rings).
- Ways content in secondary mathematics can be extended through the use of technology.
- How secondary mathematical concepts are generalized and extended to provide a broader perspective of secondary content (e.g., exploring parallelism in non-Euclidean geometries).
- The applicability of mathematics in the real world so teachers can provide real answers when students ask “When will I ever use this?”

**Overarching Goal 2:** Expand mathematical content knowledge in ways that broaden exposure to mathematical ideas and deepen understanding of topics that extend K-12 mathematics content.<sup>8</sup>

**Objective 2.1:** MTE jointly develop activities that engage MP and TLP teachers in “doing” mathematics<sup>9</sup> that broadens their understanding of mathematics as a subject and a process by asking them to explore mathematics content outside the coursework they experienced as undergraduates.

**Objective 2.2:** MTE jointly develop activities that engage MP and TLP in broadening their exposure to mathematical ideas and

**Objective 2.3:** MTE jointly develop activities that engage MP and TLP teachers in expanding their mathematical content knowledge in ways that deepen their understanding of topics that extend K-12 mathematics content.

**Objective 2.4:** MP and TLP teachers complete course assignments and performance tasks requiring them to connect course content to the specific content they teach.

**Objective 2.5:** Using the lesson experiment model, MP and TLP teachers jointly develop, implement and revise lessons that reflect a broad and deep understanding of the content they teach.

*Quality of Course Activities, Quality of Completed Assignments and Quality of Content Lessons* rubrics for assessing activities will be developed by the PI, co-PIs, the MP Team and the TLP

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<sup>8</sup> This section draws heavily on language of Usiskin, et. al. in *Mathematics for High School Teachers: An Advanced Perspective*, 2003, Prentice Hall.

<sup>9</sup> “Doing” mathematics involves exploring mathematical ideas as mathematicians do (i.e., through making conjectures, testing and revising conjectures and eventually proving conjectures).

Team. The *Course Survey* will be developed by the External Evaluator and PI administered after all MP and TLP courses; results will be used to refine and improve courses.

Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
2.1 -2.3	At the end of each MP and TLP course, teachers will report positively on the <i>Course Survey</i> concerning the quality of activities, the extension of their understanding of mathematics content beyond their undergraduate mathematics and their knowledge of K-12 mathematics content (all will be 3.5 or higher on a 1 to 5 scale, 5 highest).	EE and PM	EE
2.1-2.3	<i>Quality of Course Activities</i> will be at least Developing in all courses and 50% will be at least proficient.	Program Teams	EE
2.1, 2.2 and 2.3	<i>Quality of Completed Assignments</i> will all be at least Developing and 50% at least proficient	Instructors	EE
2.4	<i>Quality of Content Lessons</i> will at be at least Beginning, 50% at least Developing and 25% at least Proficient in the first year of participation. The targets will be increased in the second year of participation: 90% Developing and 50% Proficient.	Instructors and Program Teams	EE
2.5	<i>Teachers will conduct a minimum of one lesson experiment per mathematics content/pedagogy course sequence.</i>	Research Team	EE

Data pertaining to research questions associated with Overarching Goal 2 (classroom observations of all teachers, interviews, etc.) will be collected by the project’s researchers including pre/post testing of teacher content knowledge.

**Overarching Goal 2 Outcome Evaluation Measures:** [1] 90% of the MP and TLP teachers will self-report increased appreciation for mathematics and knowledge of how K-12 mathematics fits into the larger mathematical picture. [2] External Evaluator observations of randomly selected teacher classrooms will show increases in overall ratings on the Horizon Research Classroom Observation protocol over time.

### Goal 3: Focus on Pedagogical Content Knowledge

We are addressing the mathematics content knowledge of teacher participants, so we ask: “How do we help them improve student achievement?” The syllabus for each course in the program will specifically identify mathematics Pedagogical Content Knowledge (PCK) outcomes. The MP and TLP courses will involve teachers in the exploration and development of:

- Mathematical PCK in conjunction with mathematics content knowledge in mathematics and mathematics education courses.
- Mathematical PCK through student thinking, including misconceptions and alternative concepts of K-12 topics
- A shared vision of mathematics PCK consistent with current learning theories.
- Research on PCK to improve understanding of how PCK impacts teaching.

TLP teachers will have an important role in helping teachers improve student achievement; they will:

- Complete performance tasks that require them to compare and contrast mathematics PCK as it pertains to school mathematics and to adult teachers as learners.

- Mentor inservice teacher in the master’s program or in a professional development setting and/or preservice teachers during preservice field experience in PCK and its impact on teaching.

**Overarching Goal 3:** Increase pedagogical content knowledge by examination of how students think and learn about mathematics and, for teacher leaders, about how teachers learn about teaching.

**Objective 3.1:** MTE will jointly develop PCK activities and outcomes for all MP and TLP courses including the 18 hours of mathematics courses and the 12-hours of mathematics education courses that will be developed.

**Objective 3.2:** Increase teacher mathematical PCK by examination of how students think and learn mathematics.

**Objective 3.3:** Increase teacher leaders and university faculty mathematical PCK of how teachers learn about teaching.

**Objective 3.4:** Teacher leaders will mentor MP and other teachers in mathematical PCK.

A *PCK Course Activities and Outcomes* and a *PCK Mentoring Ability* rubric (Beginning, Developing, Proficient, or Advanced) will be developed by the PI, co-PIs, the MP Team and the TLP Team to assess the quality of PCK activities and the PCK outcomes.

Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
3.1	80% of the mathematics PCK activities and outcomes will be Proficient or Advanced on the <i>PCK Course Activities and Outcomes</i> rubric.	PI	Team Leaders
3.2	At the end of each MP and TLP course, teachers will rate the quality of mathematical PCK assignments and performance tasks on the <i>Course Survey</i> (90% will be 4.0 or higher on a 1 to 5 scale, 5 highest).	EE and PM	EE
3.3	Teacher leaders and university faculty will be at the advanced or proficient levels on the <i>Mathematical PCK Understanding</i> rubric which will be developed by the researchers.	Research Team	Research Team
3.4	90% of teacher leaders with score at Advanced or Proficient level at the end of the second year of their participation.	Research Team	Research Team
3.4	90% teachers mentored by the teacher-leaders will rate the mentoring experience above Beginning on a <i>PCK Mentoring Rubric</i> developed by the External Evaluator and the PI.	EE and PM	EE
3.3 and 3.4	90% of the teacher leaders will document their mathematical PCK leadership activities.	PM and PI	EE

Research will be conducted on teacher participants’ understanding and ability to apply PCK. PCK data will be collected by the researchers through course observations and participant interviews and the level of commitment of teacher participants to mathematics PCK as an organizing principle.

**Overarching Goal 3 Outcome Evaluation Measures:** [1] Teachers will report at the end of each year on their knowledge, interest and understanding of mathematical PCK using an instrument developed by the External Evaluator and the PI. [2] Improved student performance scores on the Wyoming and Colorado state NCLB assessments.

### Goal 4: Becoming a Lifelong Learner

It’s not possible for mathematics teachers and teacher leaders to learn everything they need to know to be highly qualified, culturally competent, and pedagogically effective in the span of a two-year master’s or leadership program. And, it’s impossible to predict what they will need to know and learn over the life of their career. So, the essential question is: How do we prepare them for what’s coming up in their career?

MP and TLP teachers will:

- Develop and complete an action research project as a culminating thesis for the program.
- Complete assignments and performance tasks that require them to connect cultural competence, equity and diversity to their practice.
- Develop and practice reflective teaching through lesson experiments in each mathematics education course/seminar of the MP and TLP that includes a student and community reflection aspect.

**Overarching Goal 4:** Empower participants as lifelong professional learners who regularly reflect on themselves, students and community context to improve teacher practice and student learning.

**Objective 4.1:** Action research projects will empower participants as lifelong professional learners who regularly reflect on themselves to improve teacher practice and student learning.

**Objective 4.2:** Empower participants as lifelong professional learners who regularly reflect on students and community context to improve teacher practice and student learning.

Objectives	Benchmarks	Responsible for Data	
		Collection	Analysis
4.1 and 4.2	90% of teacher participants will complete a minimum of one lesson experiment per mathematics education course, will write a reflection on practice, and will develop an action research project as a culminating thesis for the program. 90% will be Proficient.	PI and PM	PI and Team Leaders

**Overarching Goal 4 Outcome Evaluation Measures:** [1] Action research project results will be used by the Research Team, and when possible, teachers will be included in Research Team publications and presentations. [2] Improved student performance scores on the Wyoming and Colorado state NCLB assessments.

### Goal 5: Research Driven

Finally, in creating this program, we want to build on what others have already learned and add to the knowledge in the field. The essential question here is, “How do we build a quality program that improves mathematics achievement for all students? An important anticipated

outcome is a sustainable model for a virtual master’s program and teacher leadership program offered jointly by the University of Northern Colorado and the University of Wyoming.

**Overarching Goal 5:** Produce a research-based and tested model for master teacher and teacher-leader development based on the above goals that improves mathematical achievement for *all* students.

**Objective 5.1:** Produce a research-based and tested model for master teacher development where research-based characteristics guide design (see table 1 page 6 of the proposal).

*For specific objectives and activities, see the Virtual Master’s Program Plan.*

**Objective 5.2:** Produce a research-based and tested model for teacher-leader development where research-based characteristics guide design (see table 1 page 6 of the proposal).

*For specific objectives and activities, see the Teacher Leadership Program Plan.*

**Objective 5.3:** Research will investigate Math TLC participant knowledge around two key institute themes: (1) examining and using students’ mathematical thinking to shape teaching and (2) strategies for generating culturally responsive teaching.

*For specific objectives and activities, see the Research Plan.*

**Objective 5.4:** Revise the models annually based on evaluation results and research outcomes.

*This revision process is specifically addressed in the Master’s Program Plan and the Teacher Leadership Program Plan.*

Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
5.1	The Virtual Master’s Program Plan and Implementation Plan will be used to ensure that the model is research-based and continually improved.	PI and PM	PI
5.2	The Teacher Leadership Program Plan and Implementation Plan will be used to ensure that the model is research-based and continually improved.	PI and PM	PI
5.3	The Research Plan and Implementation Plan will be used to ensure that the Research Team is conducting research as planned.	PI and PM	PI
5.4	The model will be presented at the annual Advisory Board meeting with Senior Personnel.	PI and UW co-PI	PI and UW co-PI

**Overarching Goal 5 Outcome Evaluation Measure:** The research-based virtual master’s program and teacher leadership program will be created and offered jointly by the University of Northern Colorado and the University of Wyoming.

## Expected 5-Year Math TLC Outcomes

While many 5-year expected outcomes are embedded throughout the strategic plan and the supporting documents in great detail, we highlight the four large scale 5-year expected outcomes here along with indicators of progress for each one.

**Outcome 1:** A cadre of culturally competent mathematics master teachers and teacher-leaders equipped to work locally, regionally and nationally to improve teacher practice and student mathematics achievement.

- 60 secondary mathematics teachers complete our 2-year, 32 credit hour Master's in Mathematics for Secondary Mathematics Teaching (15 a year in years 2-5).
- 30-36 mathematics teacher leaders complete our 2-year, 24 credit hour Teacher Leadership Program (10-12 teachers a year in years 3-5).

**Outcome 2:** A highly qualified, culturally competent, and pedagogically effective cadre of university mathematics teacher-educators at UNC and UW.

- 30 mathematics and mathematics education faculty will be involved in the Math TLC (at least 6 teaching a course in the Master's Program each year, at least 4 teaching in the Teacher Leadership Program each year, at least 4 involved in the research program each year).

**Outcome 3:** A body of research that documents effective practices in developing master mathematics teachers and teacher-leaders. See Strategic Plan for Research.

- Publications and presentations of research results each year.

**Outcome 4:** An institutionalized, sustainable model for a virtual master's program and teacher leadership program offered jointly by the University of Northern Colorado and the University of Wyoming. See Institutionalization and Sustainability Section of Strategic Plan.

- 15 master's courses developed by teams of mathematicians, mathematics educators, master teachers (5-6 each year with ongoing revisions)
- Affiliation agreement between UNC and UW (negotiated year 1, revised as needed in years 2-5)
- Institutionalization of master's program at both UNC and UW
- 2-year, 24 credit hour teacher leadership program developed (developed in years 1-3 and revised in 4 and 5)

**Outcome 5:** Strong partnership among UNC, UW and K-12 partners. See Partnership Section of Strategic Plan.

## MSP Key Features

We have chosen to weave the MSP Key Features throughout the many activities of the Math TLC. Here we identify how the key features are situated with respect to the project and provide additional goals and objectives as needed.

## Partnership-Driven

Our project is *Partnership-Driven*. At all grain sizes, from partnership level decisions to course development, mathematics and mathematics education faculty from UNC and UW work closely with representatives from our K-12 partners to create an active partnership to implement the Math TLC. In particular, our strategy is to create teams of IHE faculty and K-12 partner representatives to develop and implement project activities, thus ensuring that all partners have a voice at every level of decision making. See the Management Plan for specific team composition and data on roles, numbers and level of involvement of STEM faculty. As needed, teams will also include educational faculty and administrators from the IHEs and administrators from K-12 partner districts.

**P-Goal 1:** Develop and implement project activities by teams composed of mathematics and mathematics education faculty from both IHEs and representatives from our K-12 partners.

**P-Objective 1.1:** Through the master’s team and the teacher leadership team, IHE faculty and K-12 partner representatives oversee the development and delivery of the master’s program and the teacher leadership program.

**P-Objectives 1.2:** Through course development teams, IHE faculty work with representatives from the partner districts to develop courses and activities in the master’s program and the teacher leadership program.

**P-Objective 1.3:** District Math Team works with the PLT to ensure relevance of master’s program and teacher leadership program to K-12 mathematics teachers and to work for 1) sustainable change in mathematics instruction within their district; 2) increased student achievement in mathematics as measured by state standardized test scores and increased numbers in advanced mathematics courses; and 3) challenging courses and curricula for all math students in their district.

**P-Objective 1.4:** District Curriculum and Instruction Team works with the PLT and the District Math Team to provide increased responsibilities and support for the emerging master teachers and teacher leaders to use what they learned to support increased student achievement in mathematics.

P-Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
1.1-1.2	Teams are composed of math and math ed faculty from UNC and UW and K-12 partner representatives.	PM	EE
1.3-1.4	District Teams meet regularly with PLT and develop joint reports on efforts.	PM	EE

## Teacher Quality, Quantity and Diversity

Our project addresses *Teacher Quality, Quantity and Diversity* in a variety of ways. We work to improve *teacher quality* directly by deepening content knowledge and enhancing cultural competence in pedagogical content knowledge of the teacher participants through both the master’s and leadership program courses/activities. We address these aspects in detail in Strategic Objectives 1-3. Since *Math TLC* teacher-leaders will engage in leadership activities in their districts, we indirectly impact the quality of teachers and experiences of students across both states. Our research program will be investigating changes in these aspects in teacher participants.

We address *teacher quantity* not by recruiting more teachers into the workforce, but by working to retain those we have. First, we provide opportunities to deepen content knowledge and improve practice through participation in a master's program specifically designed for secondary mathematics teachers. Second, by preparing mathematics teacher-leaders, we provide support to new and continuing teachers with the research-based expectation that it will increase retention of the current workforce. Our evaluation plan will track retention rates of teacher participants and those impacted by working with teacher-leaders.

We address *diversity* through our attention to helping teachers gain cultural competence with diverse students, as our teacher population does not match the diversity of the student population in the region and our project is not about increasing the teacher workforce. We specifically address cultural competence in Strategic Objective 1 and our research program will be investigating changes in cultural competence in our teacher participants. In addition, we will actively recruit a diverse set of teacher participants and specifically include teachers from rural schools (40% of each cohort).

### **Challenging Courses and Curricula**

This project addresses *challenging courses and curricula*. See Overarching Goals 1-3 and the Master's Program Curriculum Framework and the Teacher Leadership Curriculum Framework. Both the external evaluator and the research team will be investigating impacts of the challenging courses and curricula on teacher knowledge.

### **Evidence-Based Outcomes**

The development and delivery of the *Math TLC* is based on research and its ongoing revisions will be based on research and evaluation of the evidence generated by the project. This is addressed in the evaluation plan, the research plan and Strategic Objective 5. Evaluation and research will investigate the effectiveness of *Math TLC* programs on teacher growth, impacts on student achievement, impacts on STEM faculty and institutional change.

### **Institutional Change and Sustainability**

Both UNCo and UWyo will undergo *institutional change* and address *sustainability* through negotiation and implementation of the *Math TLC* affiliation agreement. The outcome will be a true partnership offering a virtual master's and leadership program to teachers in their home regions. This will impact school district structures by creating/augmenting district leadership, supporting Lesson Experiment-based learning communities, and increasing teacher's knowledge of culturally relevant content and culturally competent pedagogy.

The *Math TLC* addresses *sustainability* at the district level by working with the District Curriculum and Instruction Team and the District Mathematics Curriculum Team to develop and implement strategies to sustain the partnership beyond the funding period.

The *Math TLC* will create institutional change through the creation of collaborative regional programs for culturally competent mathematics education. The UWyo and UNCo will enter into an affiliation agreement that institutes a virtual master's program and a leadership program. The affiliation will require that courses are accepted for credit towards a degree across institutions that teachers can take courses at in-state tuition rates, and that courses are team-developed by

mathematicians and mathematics educators across the two universities. Such an affiliation indicates an extraordinary institutional change as the universities move to becoming joint providers of a regional degree program. The *Math TLC* development of these mathematics programs will serve as a model for similar programs in secondary science education, including chemistry, biology, physics, and earth sciences. Expanding the model K-12 science teachers would require an expansion in the university partnership as well, with affiliations across multiple universities in the Rocky Mountain region.

The *Math TLC* also creates institutional change through the collaboration of mathematicians and mathematics educators who create and implement the courses in the programs. Their interaction with in-service mathematics teachers opens a dialogue around content and culturally relevant pedagogy issues that will have far reaching impacts on how mathematicians view their role in education. Offering mathematics courses online constitutes another instance of institutional change. This project provides support for their learning about alternate instructional techniques and a safe space to explore the use of powerful online tools to assist them. The long-term result of providing quality online STEM courses to teachers in the field will have a deep impact on professional development in local school districts.

The university affiliation and school partnership are the basis of sustaining the program, increasing faculty capacity to deliver the program and providing access to a pool of teachers. Recruiting across the region allows for large enough enrollments for programs to be self-sustaining. Tuition and fees flow to the university teaching the course; courses will be equally shared across institutions. The increased enrollments will offset accepting course credits from other institutions, making it a profitable model for all the institutional partners.

The corner stone of institutionalizing Math TLC is the affiliation agreement. In order for the MTLC programs to be a truly collaborative partnership between the University of Wyoming and the University of Northern Colorado, it is necessary to establish a strong affiliation between the two universities. The proposed affiliation for this project is based on the very successful model used in the NSF Center for Learning and Teaching ACCLAIM program (Robert Mayes, Co-PI). The affiliation developed in that program bound six universities together to offer an innovative Ph.D. program in Rural Mathematics Education.

A *Math TLC* Capacity Building Advisory Board (CBAB) will be formed and will consist of:

- *Math TLC* representatives PI Jodie Novak (UNC), Co-PI Robert Mayes UW)
- Provost's Office representative from UW and UNC
- Graduate School representatives from UW and UNC
- Registrar's Office representatives from UW and UNC
- Bursar's Office representatives from UW and UNC
- UNC College of Natural and Health Sciences representative
- UW College of Arts and Sciences and College of Education representative
- Other representatives of UNC and UW as needed

**Institutionalization Goal 1 (I-Goal 1):** An affiliation agreement between UW and UNC will be established which address issues of distribution of student revenues across partner institutions, agreement to accept courses in the program with course numbers established, registrar and

admissions agreements that avoid treatment of teachers in the program as exceptions that need special permissions and interventions on a routine basis, and institutionalization of the program in both universities.

**I-Objective 1.1** A draft affiliation agreement will be reviewed by the *Math TLC* Management Team and the CBAB

**I-Objective 1.2** The Letters of Affiliation is institutionalization of the *Math TLC* MP and TLP after expiration of the grant. It is crucial, therefore, that support from the grant be omitted from ongoing financial policies in this agreement. Grant support should probably appear in an addendum, and that addendum should specify the expected expiration date of the grant.

I-Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
1.1	By April 15, 2009 approval will be obtained from each institution.	Novak (PI) and Mayes (Co-PI)	
1.2	The Letters of Affiliation will be fully approved by May 1, 2009.		

**I-Goal 1 Outcome Evaluation Measure:** A budget that tracks the movement of the *Math TLC* programs from grant to tuition based funding will be produced and approved.

**I-Goal 2:** Establish collaboration across the partner universities of mathematicians, mathematics educators, and master K-12 teachers to create and implement the courses in the programs.

**I-Objective 2.1:** Create course teams consisting of a mathematician, mathematics educator, master teacher, and either a mathematician or mathematics educator from each of the partner university who is not designing or teaching the particular course to review the course.

**I-Objective 2.2:** Provide a dialogue for course teams through the *Math TLC* Seminar and face-to-face meetings that addresses characteristics of the courses they are developing that are required by *Math TLC*.

**I-Objective 2.3:** MP Team meets with the course development team to ensure *Math TLC* course characteristics are being met.

**I-Objective 2.4:** Offer mathematics courses online as a means of institutional change at both universities.

**I-Objective 2.5:** Review the virtual master's program and teacher leadership program at the end of each year to ensure that they are institutionalized and self-sustaining.

I-Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
2.1	Course teams established one semester in advance of the course being taught.	PI and PM	PI
2.2	Seminars begin in Spring 2009 and with face-to-face meetings in April 2009 and May 2009. A comparable schedule will be in place for subsequent years.	PI and PM	PI
2.3-2.4	Courses will be offered each semester and reviewed in the next semester.	PI and PM	PI
2.5	Enrollment will sustain the MP and TLP by the end of project funding.	PI and UW co-PI	PI and UW co-PI

**I-Goal 2 Outcome Evaluation Measure:** Courses will sustain and increase enrollment with high student satisfaction scores on university evaluation forms.

We convene the *Master’s Program Team* (pg 13, proposal) to establish course criteria and academic requirements/standards so courses will be acceptable to faculty at both institutions. The work of this committee will be guided by existing course development rules at both institutions and by the criteria outlined in the original proposal.<sup>10</sup> Course development activities include generating common syllabi, course materials, activities and assessments, and the online shell for distance delivery of courses. Each course will be jointly developed by a team of faculty from both institutions, further ensuring that courses will be acceptable at both institutions. The courses will be submitted to the Curriculum Committees of both universities for formal evaluation and approval. All courses will be assigned a permanent course number at each university. A course notebook will be created that collects all course artifacts to establish a permanent course record.

**Use and Support of Technology**

Using technology effectively and efficiently is an important goal for the success of the Math TLC which is not directly addressed in the five overarching goals for the project. Here we outline goals and objectives for the use and support of technology.

The Mathematics TLC will create a virtual mathematics education master’s program and mathematics leadership program that requires cutting edge technology and innovations. The MTLC Technology Team is lead by Robert Mayes, who served as NSF ACCLAIM technology leader, and Heng-Yu Ku, a technology education expert at UNC. The charge for the technology team is to research and establish a distance learning platform for the MTLC programs, support implementation of the program, and study impact of technology in the programs.

**T-Goal 1<sup>11</sup>:** Utilize research-based support to determine the best technology platform and pedagogy for the Math TLC programs.

**T-Objective 1.1:** Conduct a literature review of distance education to determine best platform and pedagogy for Math TLC programs, and provide recommendations for course format and pedagogy based on literature reviews

**T-Objective 1.2:** Provide recommendations for course format and pedagogy based on literature reviews

**T-Objective 1.3:** Continually update recommendations based on the literature and Math TLC experience concerning the technology needed for sustaining an up-to-date delivery system for the virtual MP and TLP.

T-Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
1.1-1.2	Complete and present the technology review and recommendations for course format/pedagogy by May 1, 2009 and update the literature review annually.	Mayes & Heng-Yu Ku	Mayes & Heng-Yu Ku

<sup>10</sup> In the original proposal, see Table 1 for research-based course design characteristics guiding master’s and teacher-leader program offerings, pg.6; culturally responsive teaching criteria, pg. 3; goals of master’s program, pg. 7

<sup>11</sup> T-Goal represents Technology Goal 1, and T-Objective 1.1 is objective 1 associated with T-Goal 1.

T-Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
1.3	Assess the platform and continue to update the online courses.	Mayes & Heng-Yu Ku	Mayes & Heng-Yu Ku

**T-Goal 1 Outcome Evaluation Measure:** Online courses will be delivered and course participants will rate the courses Proficient or above on the Universities' course evaluation forms.

The focus of Technology Goal 2 (T-Goal 2) is on the first project year. Because technology changes rapidly and the online courses will need to be updated continually, a new T-Goal 2 will be written each year. This will ensure the flexibility needed for the institutionalization of the virtual MP and TLP as well as a way to utilize information gained through research and evaluation to refine and improve the online project components.

**T-Goal 2:** Select a common technology platform to support summer hybrid courses and provide academic year online courses.

**T-Objective 2.1:** Select videoconferencing package for summer programs supporting broadcasting courses between UNC and UW.

**T-Objective 2.2:** Select software for transfer of homework assignments/assessments for summer and online courses.

**T-Objective 2.3:** Determine equipment (eyeball camera, headset, writing tablet, text) that Math TLC will supply for teacher participants and faculty teaching online courses.

**T-Objective 2.4:** Recommend course management (asynchronous), course conferencing (synchronous), and video production (video vignette) software for online courses.

**T-Objective 2.5:** Offer expo on technology for distance classes for Math TLC leadership group.

**T-Objective 2.6:** Design project website for Math TLC and make recommendations on transparency issues such as what is posted for open web access and what is password protected (posting products of courses, grant products, teacher products such as action research or performance tasks). Address accountability issues related to this issue.

**T-Objective 2.7:** Determine support needed in teaching with the selected technology for faculty teaching the courses and for learning in the technology environment for teacher participants. Coordinate the efforts to provide technology support.

**T-Objective 2.8:** Consult on the use of technology to support management aspects of the program, including online applications and data bases associated with Math TLC.

T-Objective	Benchmarks	Responsible for Data	
		Collection	Analysis
2.1-2.4	Selection of technology to support the summer courses by March 31, 2009 and fall semester courses by May 31, 2009	Mayes & Heng-Yu Ku	Mayes & Heng-Yu Ku
2.5	Offer expo on technology for faculty and teacher participants by July 31, 2009		
2.6	Finalize project website by June 1, 2009		
2.7-2.8	Determine technology needs for supporting the management aspects of the program by June 1, 2009.		

**T-Goal 2 Outcome Evaluation Measure:** The first online course will be delivered fall semester 2009. Online course participants will rate the courses Proficient or above on the Universities' course evaluation forms.