The U.S. faces a significant shortage of well-prepared secondary mathematics teachers who can support their students in achieving the Common Core State Standards for Mathematics. More than 1 in 6 secondary schools report “serious difficulties” in filling vacant mathematics teaching positions (Ingersoll & Perda, 2010). And, according to the National Center for Educational Statistics (NCES) (2011), 1 in 12 mathematics teachers leave the profession every year, with another 1 in 16 changing schools. The attrition rate is particularly high for teachers with 3 years or less of experience. Of practicing secondary mathematics teachers, only about half report using instructional practices and goals that would promote the Common Core (Banilower et al., 2013; Markow et al., 2013).

The implications are unsettling, given that mathematics is foundational to the national priority of improving participation in Science, Technology, Engineering, and Mathematics (STEM) fields (President’s Council of Advisors on Science and Technology, 2010). Indeed, only about 1 in 4 twelfth-graders are proficient in mathematics, and more than 1 in 3 do not possess a basic knowledge of mathematics, according to the latest National Assessment of Educational Progress (NCES, 2010). Performance of U.S. 15 year-old students continues to lag behind the average for industrialized societies on the Program for International Student Assessment (PISA) (Fleischman et al., 2010), which measures students’ ability to apply mathematics (although some analyses are a little less gloomy; cf. Carnoy et al., 2013). Improving the quality and quantity of beginning secondary mathematics teachers is of paramount importance in addressing this challenge.

The MTE-Partnership was established to “transform secondary mathematics teacher preparation”¹ to ensure an adequate supply of teacher candidates who can promote mathematical excellence in their future students, leading to college and career readiness in accordance with documents such as the Common Core State Standards for Mathematics (CCSSM) and the Mathematics Education of Teachers II (METII). The Partnership also strives to ensure teacher candidates who graduate from partnership programs successfully, enter and remain in the profession, and continue their professional growth as effective secondary mathematics teachers.

The MTE-Partnership is part of the Science and Mathematics Teacher Imperative (SMTI) of the Association of Public and Land-grant Universities (APLU) and includes 38 partnership teams of universities, community colleges, and K-12 districts and schools across 30 states. Together, these teams currently produce more than 1,100 new secondary mathematics teachers each year and are influential “thought leaders” in their states and nationally as the Partnership collaborates to create national models for improving secondary mathematics teacher preparation.

Aims of MTE-Partnership Programs:

- **Creating a “gold standard”** → To document that secondary mathematics teacher candidates are prepared to help their students reach the requirements of the CCSSM, based on benchmarks to be developed by the MTE-Partnership.

- **More (as well as better) teachers** → To increase the number of graduating secondary mathematics teachers by a target percentage with an emphasis on increasing diversity.

¹ Note that we define secondary mathematics teacher programs to include programs specifically focused on preparing mathematics teachers, including those certified to teach at the middle school level, at the high school level, or across the secondary school grades.
Long-term Objectives of the MTE-Partnership:

1. To build a national consensus on guiding principles for secondary mathematics teacher preparation
2. To enlist a committed set of school-university partnership teams who will ensure their graduating mathematics teacher candidates meet benchmarks for excellence established by the MTE-Partnership and who will increase the number of mathematics teachers they prepare
3. To develop model approaches, practices, and materials using a rigorous research, development, and implementation design that addresses some of the most challenging issues facing secondary mathematics teacher preparation
4. To support national scale-up of effective methods for secondary mathematics teacher preparation developed by the partnership, its partnership teams, and others involved in mathematics teacher preparation
5. To work in close alignment with other national efforts to build a national consensus around the transformation of secondary mathematics education, particularly secondary mathematics teacher preparation, to ensure the vision of career and college readiness for all students.

MTE-Partnership Design

In developing its project design, the MTE-Partnership leadership sought an approach that drives implementation of transformative program improvement at scale, based on our common vision and harnessing the power of our network. Our diverse membership -- which includes education practitioners, leaders, and researchers -- requires a focus beyond advancing scholarly knowledge to demonstrating broad impact and results, setting a bar for others to follow. On the other hand, achieving this goal requires that the design be evidence-based and scientifically rigorous.

The Partnership believes our design needs are particularly well served by the rapidly evolving “Networked Improvement Community” (NIC) model developed by the Carnegie Foundation for the Advancement of Teaching (cf. Bryk et al., 2010). NICs are scientific learning communities distinguished by four essential characteristics:

- **focused** on a well specified common aim,
- **guided** by a deep understanding of the problem and the system that produces it,
- **disciplined** by the rigor of improvement science, and
- **networked** to accelerate the development, testing, and refinement of interventions and their effective integration into varied educational contexts.

The NIC’s emphasis on rapidly prototyping, testing, and refining strategies for improvement is designed to create timely solutions to important problems and directly supports the Partnership’s design objectives. Moreover, the NIC’s networked nature means that interventions are tested in a variety of contexts. Rather than trying to “control” variation, as is common in educational research, we embrace variation to study how interventions might be responsive to differing conditions under which they might be used. By marrying precepts of design science and networked improvement, we can thus mobilize the capacity of our partners to work in a parallel and coordinated manner to address various sub-problems – providing the capacity to build a variety of products and approaches demonstrated to be successful, but also sensitive to the conditions affecting their success. With this model, local efforts can be linked to form large-scale understandings.

Ultimately, these solutions will be disseminated as national models for effective secondary mathematics teacher preparation. The diversity of populations served by our partners (rural/suburban/urban, geographical, large and small districts, high-needs) implies our ability to address a wide range of contexts. Moreover, our adaptation of the NIC model may provide a useful perspective for other school-university partnerships addressing areas of need in mathematics education and beyond. The MTE-Partnership is particularly pleased to be an early adopter of this model and to have the Carnegie Foundation as a “design partner.”

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2 The MTE-Partnership was chosen as one of two outside projects included in the Carnegie Foundation’s study of the Genesis of Improvement Networks project funded by the W.T. Grant Foundation.
Formative Work (Supported by funding from the National Science Foundation)

- Created leadership structures to guide the development of the Partnership.
  - An Advisory Board of national standing provides direction for the Partnership and ensures it is appropriately connected to other leading organizations undertaking related work in improving mathematics education.
  - A Planning Committee of national leaders directly engaged in mathematics teacher preparation guides the specific actions and strategies used by the Partnership.
- Recruited partnership teams – each anchored by an APLU/SMTI institution, including at least one school district (or other K-12 entity), and at least one more college or university, school district, or other entity (December 2011-January 2012).
- Convened a first conference to establish mutual goals and priorities (March 2012).
- Produced a draft report, Guiding Principles for Secondary Mathematics Teacher Preparation Programs addressing key challenges of secondary mathematics teacher preparation programs (July 2012).
- Established Working Groups involving 130 mathematicians, mathematics teacher educators, and K-12 personnel to address four priorities for action – see primary drivers in diagram below (August 2012).
- Developed the initial NIC design, with partial support of a planning grant from 100Kin10.

Developing an Action Agenda: “Driver diagrams” are primary tools used by NICs for analyzing problems and explicating ideas for specific work to address them. Primary drivers are the major causal explanations hypothesized to produce currently observed results. Secondary drivers are interventions aimed at advancing improvement toward targets. We have identified four primary drivers to attain our aim, along with preliminary secondary drivers that might address these primary drivers, as shown in the following diagram.

<table>
<thead>
<tr>
<th>Primary Drivers (contributing problems)</th>
<th>Secondary Drivers (proposed strategies)</th>
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<tbody>
<tr>
<td>Stakeholders do not hold a common vision of and commitment to secondary mathematics teacher preparation – what graduates look like and what the program looks like.</td>
<td>• Articulation of and agreement on a common vision and developing shared responsibility within and across teams.</td>
</tr>
<tr>
<td>Teacher candidates are not receiving adequate clinical preparation (practica and internships) to support student learning of the CCSSM.</td>
<td>• Preparation and support structures for mentor teachers.</td>
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<tr>
<td>Teacher candidates do not have the necessary knowledge of mathematics to support student learning of the CCSSM content and practices.</td>
<td>• Development of Professional Learning Communities including universities and K-12 teachers.</td>
</tr>
<tr>
<td>MTE-Partnership teams are not preparing, attracting, and maintaining an adequate supply of secondary mathematics teacher candidates.</td>
<td>• Development or identification of mathematics courses or units in alignment with the MET II recommendations pertaining to teachers’ mathematical knowledge.</td>
</tr>
<tr>
<td>• Strategies for recruitment of candidates and retaining them in the program.</td>
<td></td>
</tr>
<tr>
<td>• Procedures for matching candidates with partnership schools as they begin their careers.</td>
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<tr>
<td>• Joint responsibility for induction programs by K-12 schools and universities.</td>
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</tbody>
</table>

Measures of Success: In addition, the Partnership aims to establish benchmarks by which partner institutions can determine that their graduates are prepared to help their future students reach the requirements of the Common Core State Standards for Mathematics, as well as measure the overall effectiveness of their programs. An initial inventory of the measures used nationally, as well as the measures used by Partnership teams, reveal a tremendous range in the kinds of measures used, with little commonality across programs.
Moreover, each state has its own requirements for certification that programs must meet, adding to the difficulty of the challenge. Our plan is to identify immediate proxy measures that can be used as interim measures while embarking on a program of development to establish more valid benchmarks. A white paper on measures is currently in development, and a plan for engaging expert advice as well as input from partnership teams will be launched beginning with the Partnership conference in June 2013.

**Action Plan**

**January-June 2013 - Project Planning and Conference** (Funded by the Helmsley Charitable Trust)

- Complete design phase, including defining high priority challenges (primary drivers) of partnership teams and formalizing partnership organization.
- Increase member understanding of NIC approach – its benefits and application to the Partnership.
- Define potential priorities for action plans for secondary drivers leading to prototyping and testing interventions.
- Identify other key national efforts; determine areas of potential alignment and collaboration.
- Hold a partnership conference to finalize planning, including developing “white papers” summarizing the four primary drivers, including several members of Advisory Board as reflectors.
- Develop a white paper on measures for success; provide opportunity for initial input at the conference.
- Establish a formal Hub for MTE-Partnership to manage overall communications (both internal and external), data, analytics, advisory and leadership groups, and support work across the network as we move towards research, development, piloting, and implementation.

**July 2013-June 2014 - Transition to Action**

- Develop and seek agreement on a NIC Charter, incorporating definitions of the roles and functions of participating teams; recruit teams to agree to the Charter as a requirement to join in the intensive research and development effort.
  - The charter will include operational definitions of Research Action Clusters (RACs) that will begin to devise and test interventions addressing specific problems, Working Groups, and other organizational structures.
- Convene an additional Working Group on developing measures, including representative team leaders and others in the field working on this issue, including appropriate Advisory Board members.
- Provide opportunities for partnership teams to coalesce into RACs that prototype and test particular interventions based on the analysis of the Working Groups. These groups will engage in the rapid prototyping and testing characteristic of NICs, as exemplified in “Plan-Do-Study-Act” (PDSA) cycles.
  - We will establish an application process to form a RAC, including participation and leadership structures, the development process, data to be collected, targets to be met, and mechanisms for sharing progress with other member teams.
  - Approximately 4 RACs, each consisting of 4-6 membership teams, will be launched to begin improvement. Seed funding will be provided by the Partnership (depending on available resources and level of need) – assuming significant in-kind effort across partnership teams. RACs will be encouraged to seek additional outside funding to support the work as it progresses, as needed.
  - Intensive support will be provided by the Hub and by consultants from the Carnegie Foundation as the RACs launch their efforts.
  - RACs will report every six months and need to demonstrate progress as a requirement for continuing support.
- Redefine the role of the Working Groups to track progress across RACs as well as to consider the formation of additional RACs.
  - Establish a mechanism for creating Special Interest Groups (SIGs) focusing on particular issues. SIGs might evolve into Working Groups or RACs depending on their progress.
- Work on establishing interim measures of quality; devise a plan for the development of the Partnership candidate benchmarks.
- Continue to establish Hub and planning structures for the overall communications, data functions, and organization of the Partnership.
• A data architecture will be built to track the on-going work of the Partnership based on interim measures of quality, as well as measures identified by the RACs to track their progress.
• The Advisory Board and Planning Committee will receive periodic updates: Partnership representatives will address their meetings, and individual members will be engaged with efforts of specific RACs as appropriate to their roles and expertise.
• Establish appropriate methods of closely communicating and working with aligned/collaborating external groups – through a Working Group, RAC, or the Hub as appropriate.

 %- MILESTONE: Establish targets for number of teacher candidates to be produced.

- Continuing activities for 2013-2014 and following years:
  • Existing RACs will be monitored by the Working Groups and Hub to ensure progress.
  • An application for formation of additional RACs will be issued periodically, with approximately 3-4 additional RACs selected each year, again depending on availability of resources.
  • The Hub and planning structures will continue to undertake the overall communications, data functions, alignment with other groups (as appropriate), and organization of the Partnership.
  • An annual conference will be held to assess what we have learned, how our effort relates to efforts by others, and facilitate communication across the Partnership.
  • An invitation will be extended to other SMTI and APLU institutions to form a team that could join the Partnership; eventually this invitation might extend to institutions outside of APLU/SMTI.
  • The progress of the Partnership towards reaching targeted output of teacher candidates will be monitored.

July 2014-June 2015 – Scaling Up

• Continuing activities above.
• Continue development of benchmarks for candidate success.
• The NIC design will be scaled up to support a range of RACs across the primary drivers. In aggregate, the Partnership will be making significant progress in identifying potential interventions to reach project goals.

July 2015-June 2016 – Spreading the Word

• Continuing activities above.
• As RACs meet their targets, they will transition to extending the implementation of the interventions they have developed with Partnership teams not in the RAC in order to further validate those interventions and to move the partnership as a whole towards its objectives.
• As interventions are validated, they will be promoted to others involved in secondary mathematics teacher preparation through SMTI meetings and across the leadership of APLU institutions.
  • Note that this transition may occur prior to July 2015 for a small number of RACs.
• MILESTONE: Finalize development of benchmarks for the MTE-Partnership for candidate success.

July 2016-June 2017 (and beyond) – Building a Movement

• Continuing activities above.
• As success of the RAC methods are established across the Partnership, they will be packaged for dissemination across the nation.
• Our goal is to have Partnership teams from all 50 states and to become a leading voice for effective secondary mathematics teacher preparation.
• MILESTONE: Ensure that targets are being met at an appropriate level of candidate quality in compliance with established benchmarks. As necessary, new targets will be established.

Impact

In terms of direct impact, the 38 lead APLU/SMTI institutions for the partnership teams have produced over 3,800 secondary mathematics teachers over the past 5 years, and partner institutions have produced another 1,400 for an average of over 1,100 per year. As the quality and quantity of this pool of candidates increase, this will have an appreciable impact on the quality of mathematics teaching in the regions they serve. Moreover,
the Partnership collaboration will result in approaches to improving secondary mathematics teacher preparation that can be adopted across the nation. In particular, the partnership will employ a “spread” strategy to reach additional institutions among SMTI members, both to join the Partnership and to use the approaches designed by the Partnership – these 132 institutions and 13 systems together produce 37% of the nation’s new secondary mathematics teachers each year. A further circle of influence can be found among the 217 member institutions of APLU -- when combined with all Partnership institutions, these institutions prepare some 43% of secondary mathematics teachers annually. The MTE-Partnership/SMTI/APLU institutions are influential “thought leaders” in their states and nationally, leading to increased visibility for the partnership and its efforts. Finally, the Partnership Hub will orchestrate a communications and dissemination plan to ensure wide visibility for the results of the project; RACs, Working Groups, and member teams will also be encouraged to communicate their findings in national journals and at national conferences that would be relevant to those engaged in secondary mathematics teacher preparation.

Moreover, we will work to establish the MTE-Partnership as the leading voice for advancing effective secondary mathematics teacher preparation. As our stature grows, we will consider extending our effort, or working to create parallel efforts, addressing closely related problems, including the preparation of elementary mathematics teachers as well as the preparation of science teachers.

**We welcome your comments or requests for further information.** Please contact the project co-directors:

Howard Gobstein  
Executive Vice President  
Association of Public and Land-grant Universities  
hgobstein@aplu.org  
202-478-6077

W. Gary Martin  
Leischuck Distinguished Professor of Mathematics Education  
Auburn University  
wgarymartin@auburn.edu