

Brief Overview of the Vermont Mathematics Initiative (VMI)

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Dedication

This overview is dedicated to the memory of Dr. Marc E. Hull, the Vermont Commissioner of Education at the founding of the VMI, and my close personal friend and mentor. The VMI owes its existence to his dedication to the children of Vermont.

Whatever you do in education – teaching, professional development, administration, assessment ... – always keep the child in the foreground, especially the child who has no other champion.

The Marc Hull Doctrine

Preamble. The principle “one can not teach what one does not know” is nearly as secure as a law of nature. Yet, since the appearance of the National Council of Teachers of Mathematics “Standards” in 1989, elementary teachers have been asked to teach mathematics that they do not know at a level of depth to which they had never been exposed. The Vermont Mathematics Initiative (VMI) – a partnership of the University of Vermont with the Vermont State Department of Education – is founded on the belief that mathematics knowledge is prerequisite to enhanced pedagogy and higher student achievement.

Begun in 1999, the VMI is a statewide program designed to close the gap between insufficient mathematics training of elementary school teachers and the demands of the contemporary mathematics classroom. Formal program evaluation, begun in 2004, has shown that the VMI has had a profound impact on the teachers themselves, their classroom practice, and most importantly students in schools having VMI teachers.

Originally designed for K-6 teachers, the VMI has been found to be equally effective with middle school teachers. Thus, the VMI is currently structured as a K-8 program that enrolls both elementary and middle school teachers.

Mission. The Vermont Mathematics Initiative (VMI) is a comprehensive, statewide, mathematics professional development program for elementary and middle school teachers. The VMI is designed to train a cadre of mathematics teacher leaders across the elementary and middle schools of Vermont, who in turn serve as resources to all elementary and middle school teachers in their school or district in the teaching and learning of mathematics. Mathematics content knowledge is the cornerstone of the VMI.

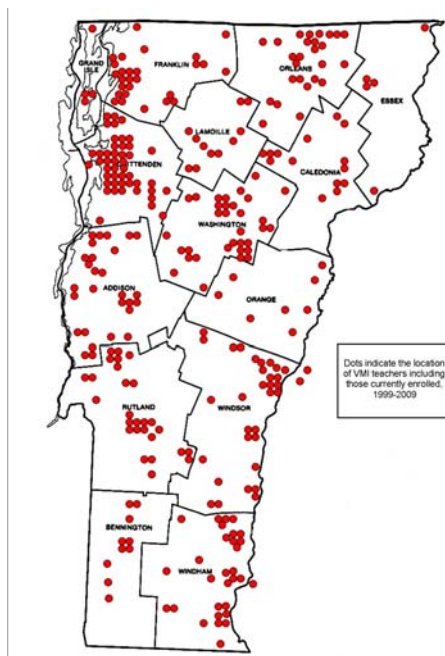
The design of the VMI has two components, referred to as “Phase I” and “Phase II.”

Phase I: The Master's Degree Program: Now in its eleventh year, Phase I is a three-year, 12 course, 36 credit master's degree granting program which develops mathematics teacher leaders.

Phase II: District Implementation: Begun in 2006, Phase II is designed to utilize the teacher leaders trained in Phase I to reach all K-8 teachers in the district.

To date, over 300 educators have completed the VMI Master's Degree program or are currently enrolled. These VMI trained teacher leaders represent over 90% of the school

districts in Vermont. The map below gives the geographical distribution of VMI teachers across Vermont



Including both Phase I and Phase II, VMI has reached over 600 Vermont teachers from roughly half the elementary schools in Vermont. In all, over 10,000 students annually are taught by teachers who have taken VMI courses.

The Master's Degree Program. For each of the three calendar years a teacher is enrolled, the VMI provides four courses, two during the summer and one each semester during the academic year. Each course awards three graduate credits. The two summer courses comprise a “Summer Institute” that runs for two weeks (10 days) at 8 hours per day. The two academic year courses each meet on three Friday-Saturday “VMI weekends” during the fall and spring semesters, again for 8 hours each day. Upon satisfactory completion of the three-year program, a teacher will have earned the 36 graduate credits required for the Master's Degree.

The Four VMI Goals. The VMI is guided by four goals. Through the required course work, classroom applications, mentoring by VMI staff, and leadership training, teachers in the VMI:

1. Build a strong and deep knowledge and understanding of mathematics content
2. Demonstrate effective mathematics instruction
3. Conduct action research that informs instructional decisions at the classroom level and beyond
4. Provide leadership that supports school-wide improvement of mathematics teaching and learning.

Goal 1, content knowledge, infuses all of the other goals, and Goals 2 through 4 are closely interrelated.

Graduates of the VMI provide evidence of the attainment of the above four goals through their coursework and completion of extensive homework assignments, a portfolio that documents their growth over the three years of the program in all four areas of responsibility, completion and presentation of their action research project, and a final oral examination and portfolio presentation.

No Mathematics Prerequisites. There are no prerequisite mathematics requirements for entry into the VMI. Teachers who enroll in the program are regular K-8 classroom teachers, the vast majority of whom enter the VMI with a weak mathematics background. Teacher retention, therefore, is a high priority, and the VMI includes multiple means of supporting teachers, both in their own learning of mathematics and in the transfer of mathematics knowledge to the K-8 classroom (see the section below on Support Structures).

Strong mathematics content knowledge is the foundation of the VMI. The VMI has three foundational underpinnings:

- Treat teachers well and with great respect.
- Engage teachers as adults with their own intellectual needs.
- Teach ‘serious mathematics.’

The phrase ‘serious mathematics’ implies that the extent of mathematical content and the depth and level of its presentation is not limited by immediate classroom needs. For if a teacher at any level, in any setting, and in any discipline is to be effective in transmitting knowledge, the teacher must know far more of the disciplinary content than is taught to students. In brief, mathematics content knowledge is at the heart of the VMI, mathematics content pervades all aspects of the VMI, and the program's overarching philosophy can be summarized by the adage “competence leads to confidence.”

Thus, in the VMI approach to mathematics professional development, VMI participants begin to view themselves as mathematicians, to view mathematics as part of their lives, and to see the world around them in a mathematical light. These transformations take place, in large part, through a VMI curriculum that is rich in mathematics content, and the impact of these transformations in the VMI teachers' classrooms and schools is far-reaching. As teachers feel more comfortable with mathematics, the more they are able to effectively communicate their knowledge and convey their enthusiasm to their own students and other teachers.

Because teachers come to the VMI from districts across the entire state, they are using a variety of different curricula and programs, depending on adoptions in their schools or districts. Hence, VMI mathematics courses are designed to transcend particular curricula and empower teachers with strong mathematics content irrespective of which curriculum program is being used in their classroom or its methodological philosophy.

Equity considerations. The VMI places a premium on helping Vermont achieve the educational equity demanded by its rural nature and widespread poverty. Thus, from its inception, the VMI has placed a high priority on admitting teachers from underperforming schools, from rural schools in general, from areas in the state in which there are larger than

normal concentrations of minority population, and from schools that do not currently have a VMI teacher on the faculty.

Materials to assist VMI participants and teachers in their schools. The VMI includes the development of high quality course materials – in topics such as algebra, number theory, probability, trigonometry, statistics, and calculus – which take teacher knowledge far beyond the elementary and middle school mathematics curriculum in a way that relates higher-level mathematics to the teacher's classroom. The written materials form a foundation for the VMI curriculum itself, and also serve as resource materials for the teacher leaders as they implement peer professional development in their schools and districts.

School implementation. The school implementation component of the VMI has been developed to assist teachers in transferring their deepened understanding of mathematics to the work they do in their classrooms and to the work they do as a leader within their school or district. This aspect of the VMI is quite comprehensive, is based in the teacher's content knowledge, and ties together the four VMI goals of content, classroom practice, action research, and leadership. In general, teachers are involved in various learning experiences designed to help each teacher apply her/his mathematics knowledge acquired through the VMI to improve instructional practice in the K-8 classroom.

Modeling effective pedagogy. VMI instruction engages the learner and maintains the learner's attention, concentration, and enthusiasm for the entire class day. Modes of instruction during the day include cooperative group work, mathematics learning generated through problem solving activities, and appropriate blending of inquiry based learning and direct instruction. Especially, all VMI courses model effective classroom pedagogy. They do so in many ways; for example, through:

- (1) formative assessment, which includes exit questions, daily evaluations, morning advisory/study groups, and much more;
- (2) effective questioning throughout all instruction, along with many other effective pedagogical approaches that are dictated by the content being taught;
- (3) an emphasis on the problem solving approach to teaching mathematics, which evaluation shows has been a powerful theme for our participants (participants learn that mathematics IS problem solving, which dispels the widely held myth that “problem solving is what we do on Fridays”);
- (4) instructional approaches that address the mathematics from deep conceptual understanding, rather than a set of rules to be memorized;
- (5) discussions that enrich the development of a concept. Teachers tell us repeatedly that the instruction experienced in VMI strongly influences their own pedagogical content knowledge.

The Partnership of Mathematicians and Educators. Professional mathematicians in higher education and master elementary and middle school teachers have worked hand-in-hand in developing and implementing the VMI. The partnership of mathematicians and K-

8 educators infuses all aspects of VMI and allows VMI to bring high-level mathematics and the classroom application of that mathematics together in an empowering way.

Evaluation of the VMI. The VMI has undergone annual formal evaluation since 2004. The evaluation has consistently revealed the following outcomes:

(1) *In cross-sectional analysis, comparisons of schools having VMI trained teacher leaders with control schools yielded an overall consistent pattern of students in the VMI schools exceeding the performance of students in the control schools.*

(2) *In longitudinal analysis, the schools having VMI trained teacher leaders showed a statistically significant advantage over the matched comparison group of schools when students are matched from grade 4 through grade 8 to grade 10.*

(3) *At grade 10, free or reduced lunch eligible students in the VMI schools significantly outscored their free or reduced lunch eligible peers, and they gained on students who are not eligible for free or reduced lunch in the matched schools.*

In other words, the studies indicate that the gap is narrowing between the free or reduced lunch eligible students in the VMI schools and their non-eligible peers in the matched schools.

A more detailed description of the evaluation can be found on the VMI website: www.uvm.edu/~vmi

National impact. The VMI is becoming a national model for delivering effective content-based professional development. Programs based upon the VMI model and utilizing VMI designed materials are running in Illinois, Massachusetts, Nebraska, New Mexico, the Little Rock (Arkansas) Public Schools, and the Cincinnati Public Schools; and the Intel Foundation chose VMI as the basis for their mathematics initiative called Intel Math.

Phase II of the VMI: District Implementation. With the Master's Degree program (Phase I) having produced sufficiently many teacher leaders to penetrate deeply into the schools and districts of the state, in 2006 VMI began to implement the next phase of the plan to improve student learning across the entire state. This phase of the plan, referred to as *Phase II of the VMI* or *the District Implementation Component*, is designed to reach all K-8 teachers in the state with a core set of mathematics content distilled from the current VMI curriculum, in which the learning and transfer to the classroom is sustained regionally and in districts through mentoring and other meaningful experiences led by the district's VMI-trained teacher leaders.

The Phase II content, written by Dr. Kenneth I. Gross, is drawn primarily from the VMI courses *Mathematics as a Second Language* and *Functions and Algebra*. The Phase II course is a six-credit experience, taught in local school districts following a schedule determined by the district. In keeping with the VMI philosophy, the course is co-taught by a VMI mathematician and the district's VMI trained teacher leaders. The title of this six-credit experience is *Mathematics for the PreK-8 Educator: Fundamentals of the Vermont Mathematics Initiative*.

Lessons learned. The VMI has a completion rate of over 95%. One can draw a number of inferences from this high rate. The first can be viewed as a foundational imperative:

Do not overestimate the mathematical knowledge with which an elementary or middle school teacher enters the program, but do not underestimate a teacher's intellectual capacity, motivation, and capability to excel in mathematics.

- With patient instruction and a supportive environment, K-8 teachers who are not strong in mathematics can learn demanding and rigorous higher mathematics.
- Elementary and middle school teachers want to be good at mathematics. If one sets the learning bar high and provides the necessary support, teachers will work hard to meet the challenge.
- Some of the teachers who enter knowing the least mathematics will be among those who three or fewer years later have the strongest understanding of mathematics, are among the best teachers of mathematics, and have become outstanding mathematics teacher leaders.
- Primary teachers (grades K-2) are often among the mathematically strongest graduates and most successful teacher leaders.
- Intense immersion in high level mathematics accompanied by strong support structures is a powerful model for sustained professional development. Once teachers become “hooked” on mathematics, they want to continually expand their knowledge.
- The bonding among teachers in a cohort, as well as the bonding of teachers with instructors, creates a stimulating learning community and extensive support network that remains intact “forever.”
- Teachers who enter the VMI afraid to go to the blackboard to present a solution, in a span of three years (or fewer) are presenting mathematics to their peers and reporting and interpreting assessment outcomes to their school boards.
- The sense of accomplishment that comes from gaining mathematics competence is a transforming personal experience, and the resulting self-confidence has an impact far beyond mathematics.

Leadership Roles Assumed by VMI Teachers. A substantial number of VMI graduates, estimated at over 90%, have assumed important mathematics leadership roles in their school or district, or statewide, which typically might include the following: becoming the school's ‘expert’ on evaluation and assessment including NCLB and state assessments, leading the school's portfolio efforts, assisting colleagues in implementation of the school's mathematics program, overseeing the administration of their school's (statewide) testing and interpreting the results, planning and delivering professional development for their school, serving as representatives on action planning and curriculum committees, and working on committees to improve mathematics statewide.

It is important to note that most of the VMI graduates perform the above leadership functions while still retaining classroom responsibilities, for in this model of school leadership one builds mathematics leadership capacity without removing effective teachers from their classrooms.

VMI graduates are also playing a significant leadership role at the statewide level. For example, VMI trained teachers make up an overwhelming majority of membership on any mathematics statewide committee, including the committee that established the state's Grade Expectations and committees that helped develop the assessments and expectations

for No Child Left Behind. In addition, the VMI Executive Director (Judi Laird), the Phase II Director for implementation of VMI in districts (Robert Laird), and Lead VMI Instructor (Susan Ojala) are graduates of the VMI, as is the current President (Mary Calder) of the Vermont Council of Teachers of Mathematics (VCTM).