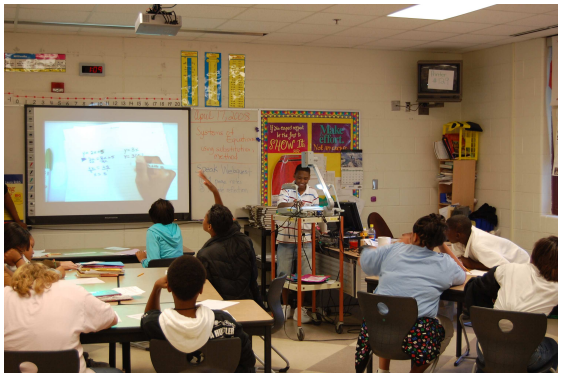
Developing Mathematical Literacy:
Improving Mathematics Achievement in Livingston and Washtenaw Counties






A Final Report of the Livingston and Washtenaw Mathematics Steering Committee

May 2008

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Introduction

This document represents two years of work and is the product of the Math Steering Committee of the Effective Practices/Assessment Work Group. More than fifty people have come together during this time of study from Washtenaw and Livingston County local school districts, Eastern Michigan University, the University of Michigan, and Washtenaw Intermediate School District (WISD). This document represents a synthesis of their thinking as they dealt with the complex process of mathematical literacy and its impact on all of today's youth in being knowledgeable, productive citizens in the 21st century.

The committee was originally formed to identify a professional development sequence for improving mathematics achievement. We reviewed the literature, examined mathematics achievement patterns in Washtenaw and Livingston counties, dialogued and discussed the purpose of mathematical literacy, and reviewed current effective mathematics and professional development practices within our counties and state. Based on this work, it was determined that there is not just one professional development strategy expansive enough to improve mathematics achievement. A more holistic approach focusing on: mathematics literacy and problem solving; teacher and student attitudes; thinking about what it means to be a learner; and frequent and varying formative assessment strategies are at the heart of the professional development plan offered in this document.

The plan also takes into consideration The Michigan School Improvement Framework, Strand I: Teaching for Learning and Strand III: Personnel and Professional Learning. The Benchmarks in Strand III are all critical pieces in the Professional Development Plan contained within this document.

In order to address the complex issues that affect student learning of mathematics, a three-part professional development program was developed. First, teachers study what it means to be a learner of mathematics and what supports are necessary to help students to develop as learners. Next, teachers become part of a professional learning community focused on practicing strategies that work to support student learning. Finally, teachers apply their skills and work through a modified lesson study process through a summer camp for students. This program will be expanded throughout three phases with opportunities for teachers, administrators, and teacher leaders. An outline of the offerings is shown in Table 1. This document provides a more detailed explanation of the program and research supporting this work.

This document is organized in five sections, each addressing critical questions.

1. **Rationale:** Why is the development of a mathematics professional development plan an important focus at this time? What do the data from our two counties show us? What do we know about the future success of students who do not have appropriate mathematics skills and understanding?
2. **Research:** What have we learned about what is necessary to give students the requisite skills needed to be successful?

3. **Vital Instructional and Infrastructure Components:** What do we know that has to be a part of any professional development plan for teachers and students and what are the necessary structures that must be in place to sustain it?
4. **Professional Development Plan:** What precisely is being recommended over a three-year time frame to build a strong foundation and allow for incremental growth?
5. **Appendices:** What was done at each of the math steering committee meetings and who was involved? How has the information collected at each meeting fed into the final plan?

Our math steering committee goal is that the reader will understand the wisdom of this approach in looking at the broader issues uncovered and find validation for dynamic paradigm changes toward mathematics professional development.

	Phase 1: 2007-2008	Phase 2	Phase 3
Planning	• Steering Committee expands professional development plan • Dissemination of plan	Develop phase 3 program at school level	Use of data to make modifications
Teacher Facilitators		• Identify teacher facilitators • Provide summer professional development • Engage in monthly networking meetings • Optional facilitation of summer camp • Participate in program evaluation	• Facilitate work at home district • Attend monthly meetings to plan for building-level meetings • Plan/facilitate summer camp • Participate in program evaluation
Administrators	K-8 Lenses on Learning	• Continue K-8 Lenses on Learning • Offer 9-12 Lenses on Learning	• Participate in program evaluation • Allocate and align building resources
Teachers	Elementary/Middle School/High School Math Institutes	• K-6 Summer Lab Class • K-12 Summer Program • Additional supplementary offerings	• Participate in building-level meetings • Implement strategies learned • Participate in program evaluation
Student Summer Camps		Optional in June 2009 (Modified Lesson Study format)	Modified Lesson Study through Summer Camp program
Program Evaluation	Begin development of program evaluation	Implement program evaluation	Use data to make modifications

Table 1

Rationale

The Michigan School Improvement Framework stresses the importance of teachers' professional learning. Strand III Standard 2 focuses on this professional learning stating that "Educators in schools/districts acquire or enhance the knowledge, skills, attitudes, and beliefs necessary to create high levels of learning for all students (National Staff Development Council)" (pp. 10). We know that the knowledge necessary for teaching mathematics includes how to teach for mathematical literacy for all students.

Numeracy, one of the essential pieces of mathematical literacy, is recognized as an essential skill for competent, responsible citizens. Adolescents who have solid numeracy skills are prepared to be successful adults who can interpret and analyze the numerical information that surrounds them in daily life. From making appropriate financial decisions to interpreting a chart found in the newspaper, mathematical literacy is a key component to success in navigating the world, the job market and school.

> ***"Mathematically literate individuals are informed citizens and intelligent consumers. They have the ability to interpret and analyze the vast amount of information they are inundated with daily in newspapers, on television, and on the Internet" (Martin, Hope 2007).***
>
> ***"…the idea of citizenship now requires not only literacy in reading and writing but literacy in math and science. … So Algebra … now is the gatekeeper for citizenship; and people who don't have it are like people who couldn't read or write in the industrial age" (Moses, 2001).***

Mathematical Literacy

The steering committee determined that ***mathematical literacy*** is a key framing concept. Students can be thought of being "mathematically literate" when they have mastered essential understandings of mathematics and can apply them to situations in their life. Using the research literature, the following definition of mathematical literacy was developed by the committee:

Mathematical literacy **is the inclination to see math as accessible, sensible, useful and worthwhile to meet a person's life needs. It should be demonstrated by communicating, reasoning, analyzing, and formulating and solving problems. The guiding principles of mathematical literacy are:**

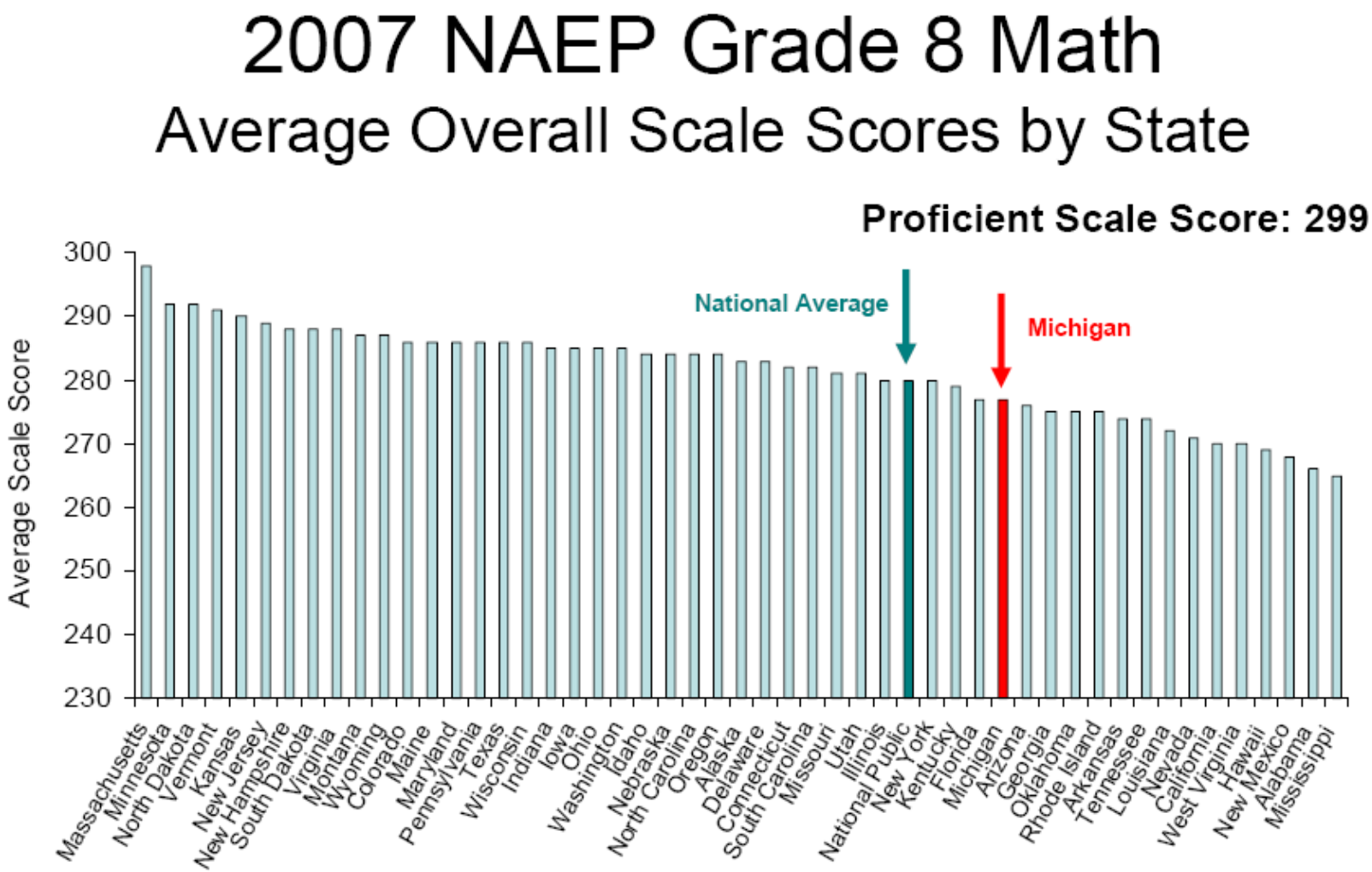
- **Coherent, integrated and functional understanding of concepts, operations and relations**
- **The ability to carry out procedures flexibly, accurately, efficiently and appropriately**
- **The capacity for logical thought, reflection, explanation and justification**
- **The ability to use mathematics to meet a person's life needs**
- **To see mathematics as an integral part of a global society.**

Michigan's new graduation requirements require all students to demonstrate proficiency in mathematics equivalent to the skills traditionally taught in a second year Algebra course. These recent changes highlight the belief by Michigan leaders and policymakers that higher-level mathematics can be mastered by all students and that being skilled in mathematics will be a critical literacy for the 21st century workforce. These workforce skills are incredibly important. According to Dave Murray of the Grand Rapids Press (November 30, 2007), an employer survey showed that while the job market is growing in Michigan "70 percent of the people who apply aren't qualified." Many of these jobs require a college education of some level, whether it be a certificate from a community college or an advanced university degree. Research has shown that most students who do not take coursework past second year Algebra as high school students require remediation in college, and that remediation in mathematics lowers the likelihood of graduation from college with an associate or bachelor's degree by 63% (NCES, 2004). In fact, college instructors and employers estimate that more than 40% of students they receive after graduation from high school are not prepared (Achieve Inc, 2005).

Moving from a system that has traditionally used mathematics as a way to weed students out of higher-level coursework to one where mastery of Algebra, Geometry, Statistics and quantitative literacy standards is an expectation for all students will require significant changes in the way we think about and teach mathematics in not only our high schools, but in our K-8 schools as well. We know from collected data that students are falling farther behind in their mastery of mathematics as they progress through school. In order to accomplish our goal of all students being successful in mathematics, we believe that sustained professional development must be in place to help teachers deepen their understanding of both mathematics as a discipline and the mathematics they teach, use effective practices for teaching mathematics in order to reach all students and believe that ALL students are capable of learning mathematics.

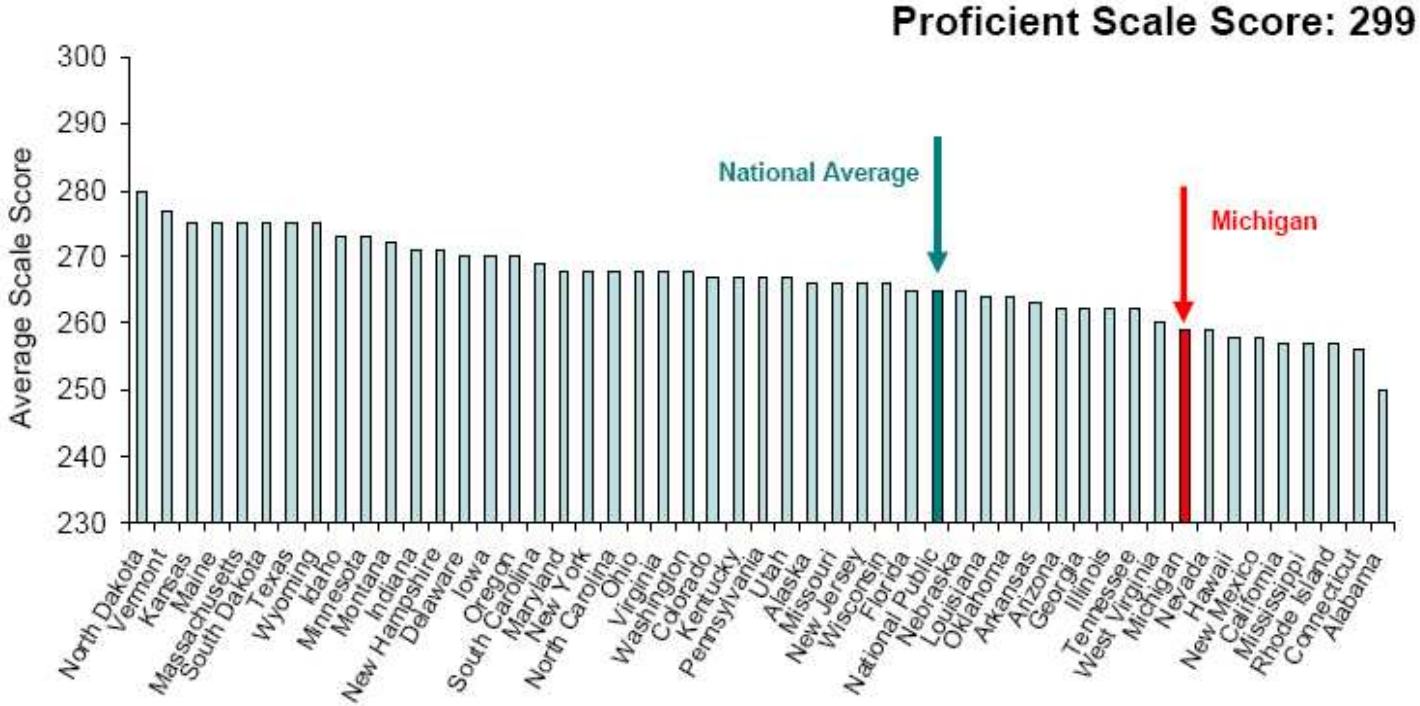
Urgency

Data collected on student achievement suggest that we have far to go before we can achieve the goal of mathematical literacy for all students. At a national level the NAEP data (available at nces.ed.gov/nationsreportcard/states/profile.asp), while showing statewide improvement in proficiency since 1992 at both the fourth- and eighth-grade levels, show that there has been no statistically significant change in the achievement gap between economically disadvantaged students and the remainder of the population or between ethnic groups in Michigan (see appendix A for summary data tables). If our goal is indeed to promote success for all students, this gap must be closed. Below, charts from EdTrust show unacceptable patterns in the NAEP scores in our state compared to the nation.

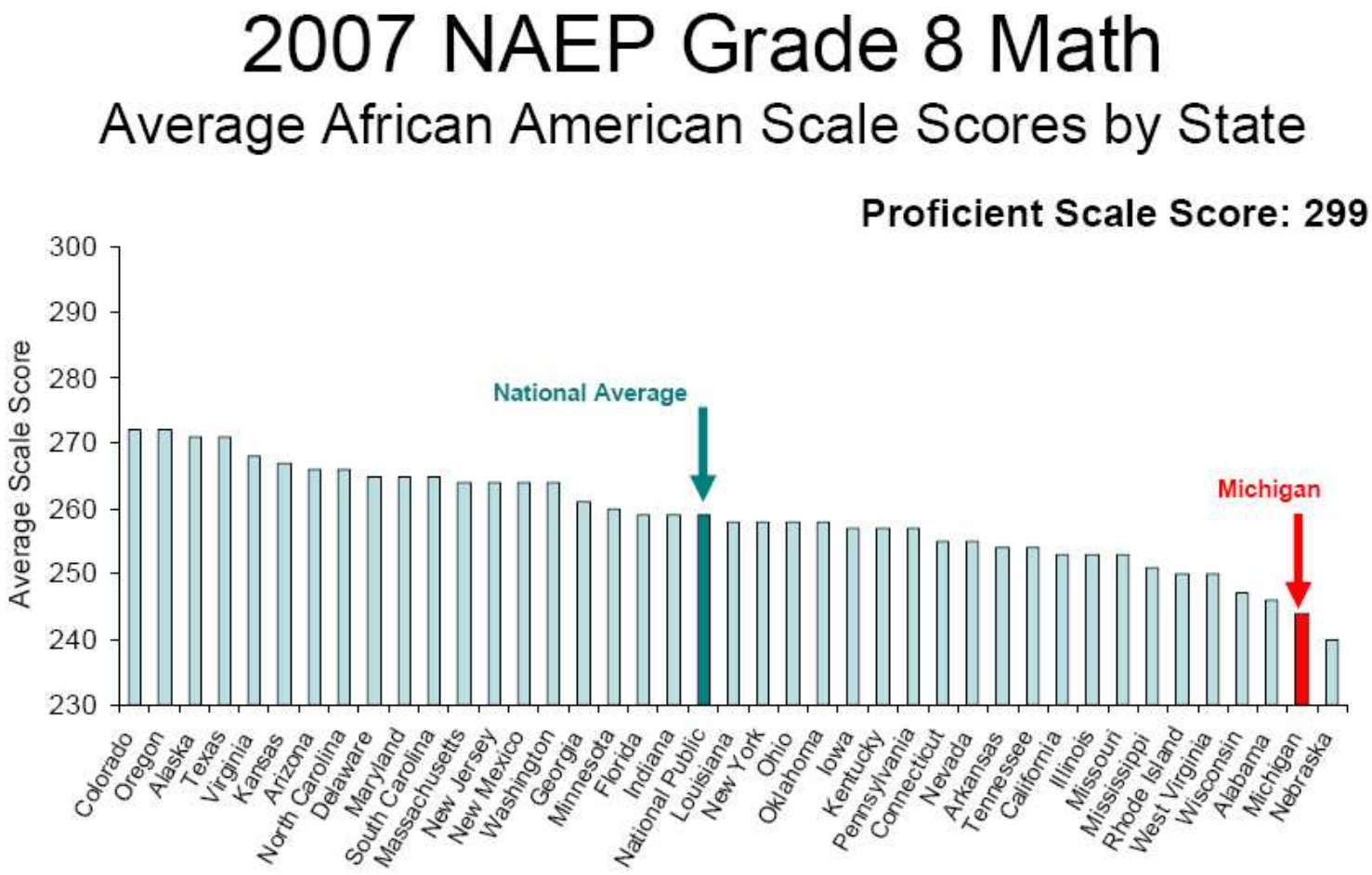

2007 NAEP Grade 8 Math
Average Overall Scale Scores by State
Proficient Scale Score: 299
National Average
Michigan
Average Scale Score
300
290
280
270
260
250
240
230
Massachusetts
Minnesota
North Dakota
Vermont
Kansas
New Jersey
New Hampshire
South Dakota
Virginia
Montana
Wyoming
Colorado
Maine
Maryland
Pennsylvania
Texas
Wisconsin
Indiana
Iowa
Ohio
Washington
Idaho
Nebraska
North Carolina
Oregon
Alaska
Delaware
Connecticut
South Carolina
Missouri
Utah
Illinois
National Public
New York
Kentucky
Florida
Michigan
Arizona
Georgia
Oklahoma
Rhode Island
Arkansas
Tennessee
Louisiana
Nevada
California
West Virginia
Hawaii
New Mexico
Alabama
Mississippi

2007 NAEP Grade 8 Math

Average Poor Scale Scores by State



Source: National Center for Education Statistics, NAEP Data Explorer, http://nces.ed.gov/nationsreportcard/nde/


2007 NAEP Grade 8 Math
Average African American Scale Scores by State
Proficient Scale Score: 299
Average Scale Score
300
290
280
270
260
250
240
230
National Average
Michigan
Colorado
Oregon
Alaska
Texas
Virginia
Kansas
Arizona
North Carolina
Delaware
Maryland
South Carolina
Massachusetts
New Jersey
New Mexico
Washington
Georgia
Minnesota
Florida
Indiana
National Public
Louisiana
New York
Ohio
Oklahoma
Iowa
Kentucky
Pennsylvania
Connecticut
Nevada
Arkansas
Tennessee
California
Illinois
Missouri
Mississippi
Rhode Island
West Virginia
Wisconsin
Alabama
Michigan
Nebraska

While expectations of students' mathematical skills increase at each grade level, student performance on many standardized measures does not. An examination of Washtenaw and Livingston County MEAP data from grades 3 – 11 in the 2005/2006 school year show a dramatic drop in the percent of proficient students as grade levels increase. By 11th grade, less than 65% of students are considered proficient in mathematics – down from 90% in the third grade. This decline in proficiency is fairly steady in elementary school but levels out in middle school at approximately 70%. The third- and eleventh-grade scores held in the 2007/2008 school year with a rise to 80% proficiency in the middle school scores. With a focus on professional development for middle school mathematics teachers in the past three years, these results may indicate that instructional support is necessary and useful at all grades in addition to the support that is called for by secondary educators who are expected to meet increasingly high standards.

Why Professional Development?

This decrease in proficiency coupled with the recent increase in standards creates a situation that requires the attention of educators, administrators, parents and community members. Fortunately, Livingston and Washtenaw counties are uniquely positioned to take advantage of key resources such as leading researchers in the field of mathematics who have investigated data-supported best practices, a set of common, agreed upon goals to frame the work, and access to key research and innovative practices that have been tested within Washtenaw County. A bi-county professional development plan will provide the opportunity to align these resources in support of effective teaching and learning around mathematical literacy and to ensure on-going instructional improvement.

The classroom is the one environment over which teachers have direct control. They may not be positioned to easily address the outside factors that affect student achievement, but we know that changes at the classroom level have the greatest impact on student learning. One way to affect change at that level is through sustained professional development that addresses the areas of teaching that have the greatest impact on student achievement. These areas are identified in the following section and have been addressed in the professional development plan.

"Research on the relationship between teachers' mathematical knowledge and students' achievement confirms the importance of teachers' content knowledge. … Direct assessment of teachers' actual mathematical knowledge provide the strongest indication of a relation between teachers' content knowledge and their students' achievement." (National Mathematics Advisory Panel, 2008, pp xxi)

"Teaching well requires substantial knowledge and skill" (National Mathematics Advisory Panel, 2008, pp xxi).

Research

An examination of relevant research indicates there are several important variables that affect literacy and student achievement in mathematics. The attitudes and beliefs of teachers, administrators, parents and students, instructor content knowledge, and instructor pedagogical knowledge/practices are the major variables involved in student success. Each of these major variables is addressed in our professional development plan.

Student Achievement

Teacher attitudes and beliefs about mathematics have been found to affect the way teachers interpret and teach curricula. According to Barlow and Reddish, "Beliefs impact practices because beliefs affect how teachers see their students, how they view the practices of other teachers, and how they accept the ideas given to them to develop their practice – whether those ideas are introduced through staff development, content courses, or pedagogy courses" (pp 145). Unfortunately, many teachers in their study held the unfounded beliefs that: only some people have the ability to do mathematics; mathematics involves much memorization; and that inability to demonstrate meta-cognition indicates a lack of mathematical knowledge (Barlow and Reddish, 2006). These beliefs must be addressed with all teachers before we can expect improvement in student mathematics achievement.

Instructor content knowledge and pedagogical knowledge have also been shown to have a profound effect on student mathematics learning. Not only is a teacher's deep understanding of mathematical content important, but his/her pedagogical knowledge also plays a key role in student learning. Koency and Swanson (2000) found that studies in classrooms with high expectations and challenging mathematics suggest that "teacher knowledge of mathematical content is a key factor that underlies the quality of classroom instruction" (pp 3). Hill, Rowan and Ball investigated both specialized content knowledge and skills used in teaching and found that "teachers' mathematical knowledge was significantly related to student achievement gains in both first and third grades" (pp 1, 2005). Given the extensive research supporting the importance of instructor knowledge, it is clear that the professional development plan must address the issue of content and pedagogical knowledge for all mathematics teachers.

Building upon the definition of mathematical literacy and educational research, the committee worked to construct a framework that would support mathematical literacy. The details of this framework are outlined in the next section.

Vital Instructional Components

Embedded in this plan is the belief that there are specific strategies coupled with a supportive classroom environment and deep connections that help students understand math content and processes more effectively. The idea is to get students to read, write, talk, and think mathematically. No one can do this better than the math teacher with his/her knowledge of the content and pedagogy in that specific math area. The teacher's own metacognitive awareness is critical in explaining his/her own thought processes comprehending the mathematical work. By modeling "think alouds" the teacher puts himself/herself in a position of being a learner with the students. Students can gradually feel safe in practicing these same skills until it becomes the routine way of delving into math work that, heretofore, would have been beyond their scope of understanding.

In developing math literacy, we look to the framework clearly outlined in the Reading Apprenticeship Program[1] which supports earlier literacy research. This framework outlines four interactive dimensions which, if melded carefully through metacognitive discussions, promote all literacy development. These dimensions also encompass the class environment and additional mathematics-specific teaching strategies. A description of each of these dimensions follow.

Social Dimension

Here is the recognition that math literacy learning requires social interaction. This helps students to feel greater safety in knowing that they can share mathematical processes, problems, and solutions to gain understanding. Students widen their perspectives as they begin to notice and appropriate multiple ways of gaining meaning and solving problems. They learn to ask critical questions as these conversations progress, moving their thinking to a much higher level.

Personal Dimension

In this dimension, students begin to think of themselves as mathematicians. They develop metacognitive skills, mathematical persistence and perseverance, confidence and curiosity. As students build their mathematics identity, they become much more able to assess their own performance and set personal goals.

Cognitive Dimension

Here students learn various comprehension and problem-solving strategies specific to mathematics and develop an approach for what to do when they don't understand.

Knowledge-Building Dimension

In this dimension there is direct correlation to the math content, text, and discourse. Students identify what they bring to the math context and expand this knowledge. This

[1] Reading Apprenticeship is an approach to reading instruction that helps young people develop the knowledge, strategies, and dispositions they need to become more powerful readers. It is at heart a partnership of expertise, drawing on what teachers know and do as discipline-based readers, and on adolescents' unique and often underestimated strengths as learners. (http://www.wested.org/cs/sli/print/docs/sli/ra_framework.htm)

includes content/topic knowledge, mathematical word construction and vocabulary, specific text structures, and discipline- and discourse- specific knowledge.

Mathematical Knowledge for Teaching

In order for these four dimensions to work effectively in building mathematics literacy, teachers must have a strong understanding of Subject Matter Knowledge and Pedagogical Content Knowledge (Ball, 2006).

Subject Matter Knowledge

- The sequence of math content; what comes before and after
- The new things that have relevance to our field
- The big ideas in any given area of math

Pedagogical Content Knowledge

- Who are we teaching and how will they relate best to the content?
- What are the instructional decisions that must be made that will be most helpful in any given context?
- What are the ways that we must understand the content to be able to apply it in various situations?

Ongoing Formative Assessment

Current research supports continuous, daily assessment that is embedded in classroom instruction. This formative assessment informs decisions made by teachers and students about what is understood and what needs to be done to increase understanding and help students acquire necessary skills. Rick Stiggins and his colleagues (2006) cite several expansive bodies of research indicating that formative assessment strategies, when used consistently and correctly, can result in achievement gains of one or more standard deviations and can close the gap between low-achieving and high-achieving students.

Vital Infrastructure Components

Professional Development
Research around professional development generally and more specifically around mathematics indicates that it must be ongoing, job-embedded and involve a community of learners. Effective professional development should use data and reflection to guide instruction. This learning should be integrated into the school schedule and allow support to practice new instructional strategies.

According to the *What Works* documents published by National Staff Development Council (NSDC) / National Education Association (NEA), mathematics professional development should:

Focus On	Include these tasks
• key mathematical concepts & problem solving skills	• summer intensive work for teachers
• instructional strategies	• demonstration of lessons
• multiple representations	• observation/examination of teaching videos
• lesson design	• school-based support
• class organization and management	• planning for instruction collaboratively
• leadership skills	• develop master/lead teachers
• children's thinking	• leadership development
• technology integration	• principal development

Teacher Teams
In order to support the work of teachers at the building level, it is recommended that teacher teams be allowed time to plan, align work and resources, and build supportive relationships. The support of colleagues increases the likelihood of effective implementation of strategies and methods learned during professional development; it is also a means of feedback and reflection on the teaching process.

Summative Assessment of Students and Programs
Norm/criterion-referenced assessments monitor student progress over time relative to their journey to mathematical literacy. These assessments provide data for internal and external evaluation of the instructional strategies being implemented. Assessments may also be used to evaluate the level at which the strategies are being implemented and/or program fidelity.

Teacher Leadership
In order to provide necessary support for teachers working to implement new strategies and processes, it is necessary to have leadership from teachers. These teachers will become more knowledgeable in mathematics content, pedagogical content and pedagogy and will then support the growth of other teachers in their building in these areas. These teachers are not necessarily the expert, rather, someone willing to take the lead in facilitating the work, someone willing to lead through example by using their knowledge

and skills to sustain a partnership with other teachers of mathematics. More critical still is the concept of creating change from within versus external mandates. Committed teacher leaders working with a small group of supporters will bring the kinds of instructional and achievement changes needed in a way that is participatory and sustainable rather than coerced and ephemeral.

Opportunity for Cross-District Conversation

Teachers will be provided the opportunity to share their successes and challenges with colleagues. The research on Washtenaw County's Reading Apprenticeship (RA) program strategies applied by teachers of mathematics cited successful opportunities reflective of best practice methodologies. Interviews and surveys identified structured time for formal sharing as the key factor in program success. Structured by formal protocols, discussions were focused, developed collegiality and validated professionalism, all of which sustained teachers as they worked toward reaching more and more students. Opportunities for formal sharing among teachers also contributed significantly to program implementation, fidelity, and to goals and accountability among teacher peers.

Professional Development Plan

This implementation plan has the goal of improving mathematical literacy of students and teachers in Livingston and Washtenaw Counties and supporting teachers in their efforts with students.

The purpose of the plan is to:

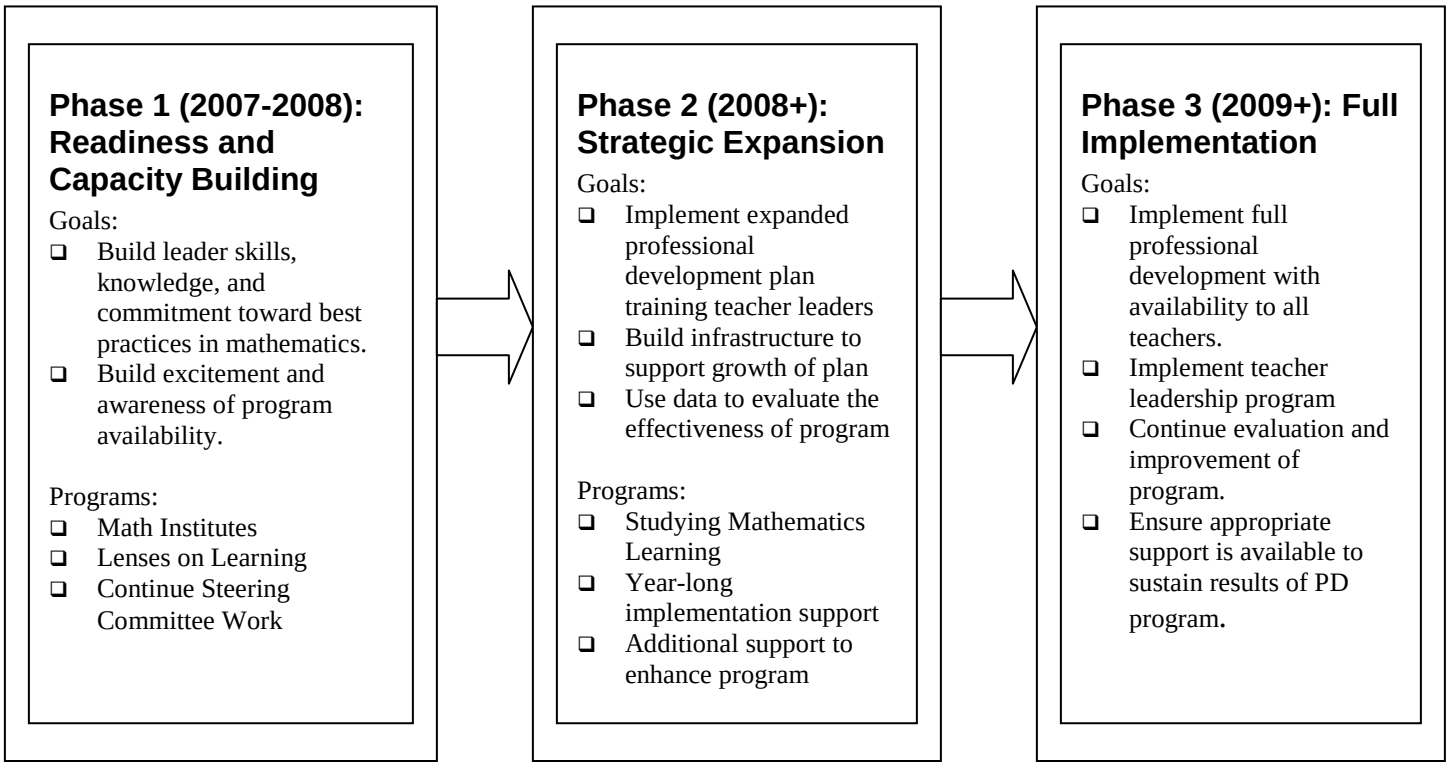
- strengthen student, teacher and systems capabilities to develop mathematically literate thinkers
- build a strong, systemic, collaborative process
- utilize proven strategies to build student thinking skills, support procedural flexibility and fluency, and build capacity for logical thought, reflection, explanation and justification.

The approach to learning these teaching strategies noted in the implementation plan reflect the research of Joyce and Showers (1980, see appendix A). Their work demonstrates the need for modeling, guided practice and supervision during application in order to reach full implementation of desired strategies. Each of these activities is embedded in Phase 2 of the plan.

The professional development plan is also aligned with the NSDC model, upon which the Michigan School Improvement Framework was structured. The opportunities for teachers are built around learning communities, teacher leaders guiding improvement within their buildings, creating a positive classroom environment and building pedagogical and content knowledge.

Multi-phase Professional Development Plan

The Mathematics Steering Committee is recommending the continuation of a three-phase implementation of the bi-county professional development plan to address the concerns outlined in previous portions of this document. Using a phase model rather than a time-centric model allows us to guarantee that each portion of the plan is well researched, tested and put into practice to ensure the success and longevity of mathematics professional development in Washtenaw and Livingston Counties.



Phase 1: Readiness and Capacity Building

We termed the first phase "Readiness" because we felt that we needed to raise awareness with all teachers of the mathematical challenges with which we are struggling in our counties. In phase one, we worked with voluntary teachers and administrative leaders on building both their leadership skills and their mathematical knowledge. We used these participants to build excitement about the programs within their own districts and to communicate the issues and possible solutions with fellow educators. In addition, we worked toward creating sustainable relationships with the community and the universities that support the work of the professional development program.

The two programs provided in phase one were Math Institutes and Lenses on Learning. The Steering Committee initially viewed presentations from fellow mathematics educators who were involved in these programs and determined that the programs would be extremely valuable for the entire county. We were able to offer six Mathematics Institutes, two at the Elementary level, two at the Middle School level, and two at the High School Algebra level. Participating districts included Ann Arbor, Brighton, Dexter, Fowlerville, Hartland, Lincoln, Manchester, Pinckney and Ypsilanti. We were also able to offer Lenses on Learning at the K-8 level and had almost all of Ann Arbor Public School administrators attend.

Phase 2: Strategic Expansion
The second phase will allow us to implement an expanded professional development plan and the selected evaluation tools with groups of teachers and administrators. Educators will begin training as teacher leaders in this phase. This will give a larger support base for the final phase. Teacher facilitators will also be provided with additional training opportunities as determined by the group.

During this phase we will continue to work with administration to help them create the infrastructure necessary to support this type of professional development within their buildings. We will also ask them to participate in data collection and communication with the instructors in their district.

Teachers participating in the program will be part of a year-long cohort supporting their work. The initial program provides two choices for teachers focused on studying how students learn mathematics and what structures/strategies must be in place to support that learning. Teachers then attend monthly meetings to learn new strategies, share their experiences with implementing what they have learned and participate in peer observation and sharing. The culmination of the year takes place when members of the cohort participate in a modified lesson study program by designing and teaching a summer opportunity for struggling students at transition points (either from elementary to middle school or middle to high school).

	Participants	Objective(s)	Activities	Timeline	Facilitator
Teachers Choose One Opportunity	Teams of K-6 math teachers		Studying Teaching Moves: Making the Math Curriculum Accessible to all Learners	July 21-August 1, 2008	University of Michigan
	Teams of K-12 math teachers	• Learn mathematical problem solving processes. • Reflect on what it takes to be a learner of mathematics. • Plan for the following aspects of the upcoming school year: classroom culture, classroom expectations, logistics, lesson planning, and intentional teaching of social expectations.	Studying Mathematics Learning from the Student Perspective	August 18-22, 2008	Mathematics Coordinator
All Teacher Participants	Teacher Facilitators	• Build understanding of five domains of learning. • Build and refine teachers' repertoire of strategies. • Reflect on the practice of teaching and implementation of strategies. • Build and refine formative assessment skills	Meet monthly as a team to reflect on implementation, learn strategies, examine lessons/student work, peer observations, and journal entries	Year-long 2008-2009 School Year	Mathematics Coordinator, Assessment Supervisor
Principals	Building Principals	• Build shared understanding of mathematics teaching. • Build capacity for supporting mathematics teaching.	Lenses on Learning	Year-long 2008-2009 School Year	Lenses on Learning Facilitators
Optional	Teacher Facilitators (Optional)	• Experience the Lesson Study process. • Reflect on the teaching practice. • Examine a course structure through the lens of the framework and strategies learned throughout the year.	Modified Lesson Study process using transition course for students	End of June 2009	University of Michigan and Mathematics Coordinator
Facilitators/ Principals	Teacher Facilitators and Principal		Develop and schedule school-wide training plan for Phase 3	June 2009	Mathematics Coordinator

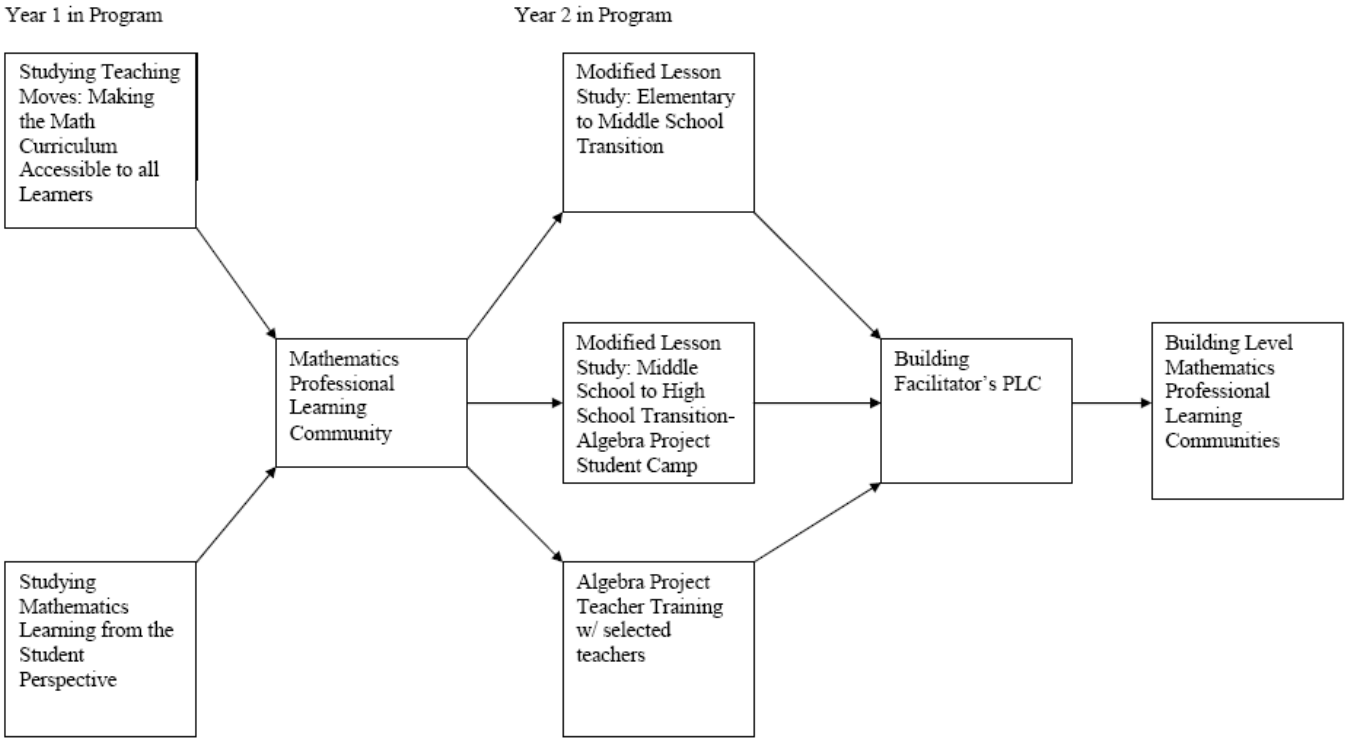
Phase 3: Full Implementation

The final phase will allow for implementation with all teachers in all districts. The same instructional and evaluation protocols will be followed as in phase 2. The focus of this phase will be to ensure that proper support is given for successful and sustainable implementation.

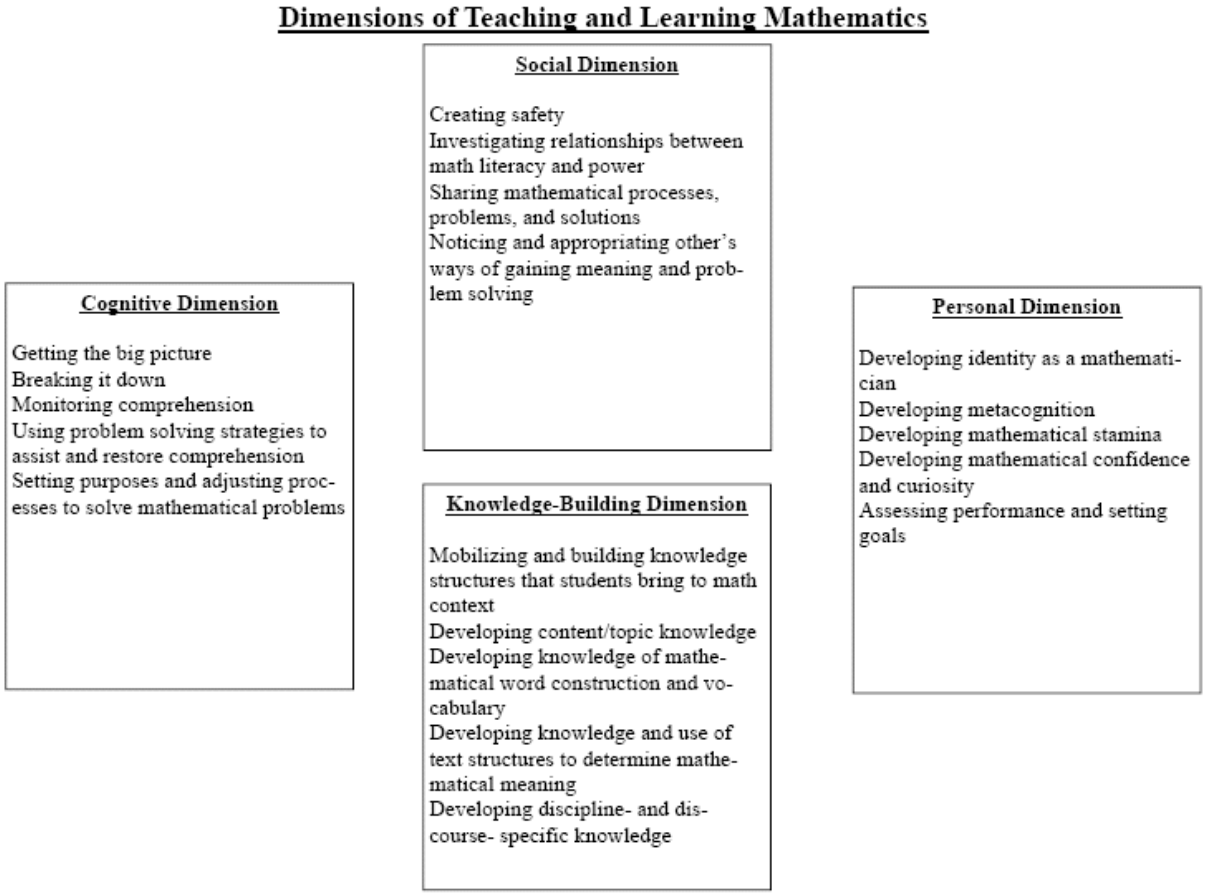
	Participants	Objective(s)	Activities	Timeline	Facilitator
Teachers Choose One Opportunity	Building-level groups of K-6 math teachers		Studying Teaching Moves: Making the Math Curriculum Accessible to all Learners	July -August	University of Michigan
	Building-level groups of K-12 math teachers	• Learn mathematical problem-solving processes. • Reflect on what it takes to be a learner of mathematics. • Plan for the following aspects of the upcoming school year: classroom culture, classroom expectations, logistics, lesson planning, and intentional teaching of social expectations.	Studying Mathematics Learning from the Student Perspective	August	Mathematics Coordinator
	Selected high school math teachers from phase 1	• Learn mathematical problem-solving processes. • Reflect on what it takes to be a learner of mathematics. • Plan for implementing the Algebra Project curriculum with struggling students	Algebra Project Teacher Training	July-August	Algebra Project Trainers
Teacher Facilitators	Teacher Facilitators	• Build facilitation and professional community skills. • Network with other facilitators to create a supportive community.	Planning for building-level training and facilitation	August intensive, year-long meeting schedule	Mathematics Coordinator
	Building-level Groups (facilitators + teachers in building)	• Build understanding of five domains of learning • Build and refine teachers' repertoire of strategies. • Reflect on the practice of teaching and implementation of strategies.	Meet monthly as a team to reflect on implementation, learn strategies, examine lessons/student work, peer observations, and journal	Year-long	Teacher Facilitators

Optional	Teacher Facilitators (Optional)	• Experience the Lesson Study process. • Reflect on the teaching practice. • Examine a course structure through the lens of the framework and strategies learned throughout the year.	Modified Lesson Study process using transition course for students	End of June	University of Michigan, Algebra Project Trainers, Mathematics Coordinator and Teacher Facilitators
Facilitators/ Principals	Teacher Facilitators and Principal		• Develop and schedule school-wide training plan for Phase 3 • Align building resources to sustain work		Mathematics Coordinator

Teacher Professional Development Program Pathway



Appendix A: Supporting Documents



Adapted from The Reading Apprenticeship Framework

Training Methods & Levels of Impact

Joyce & Showers (1980)

Training Method	Level of Impact	Evidence of Impact *What does this look like?*
Didactic presentation of theory & concepts	Awareness	Participant can articulate general concept & identify problems.
Modeling/ demonstration (i.e. live, video)	Conceptual Understanding	Participant can articulate concepts clearly & describe appropriate actions.
Practice in simulated situations with feedback (i.e. role play, written exercises)	Skill Acquisition	Participant can begin to use skills in structured or simulated situations.
Coaching & supervision during application	Application of Skills	Participant can use skills flexibly in actual settings.

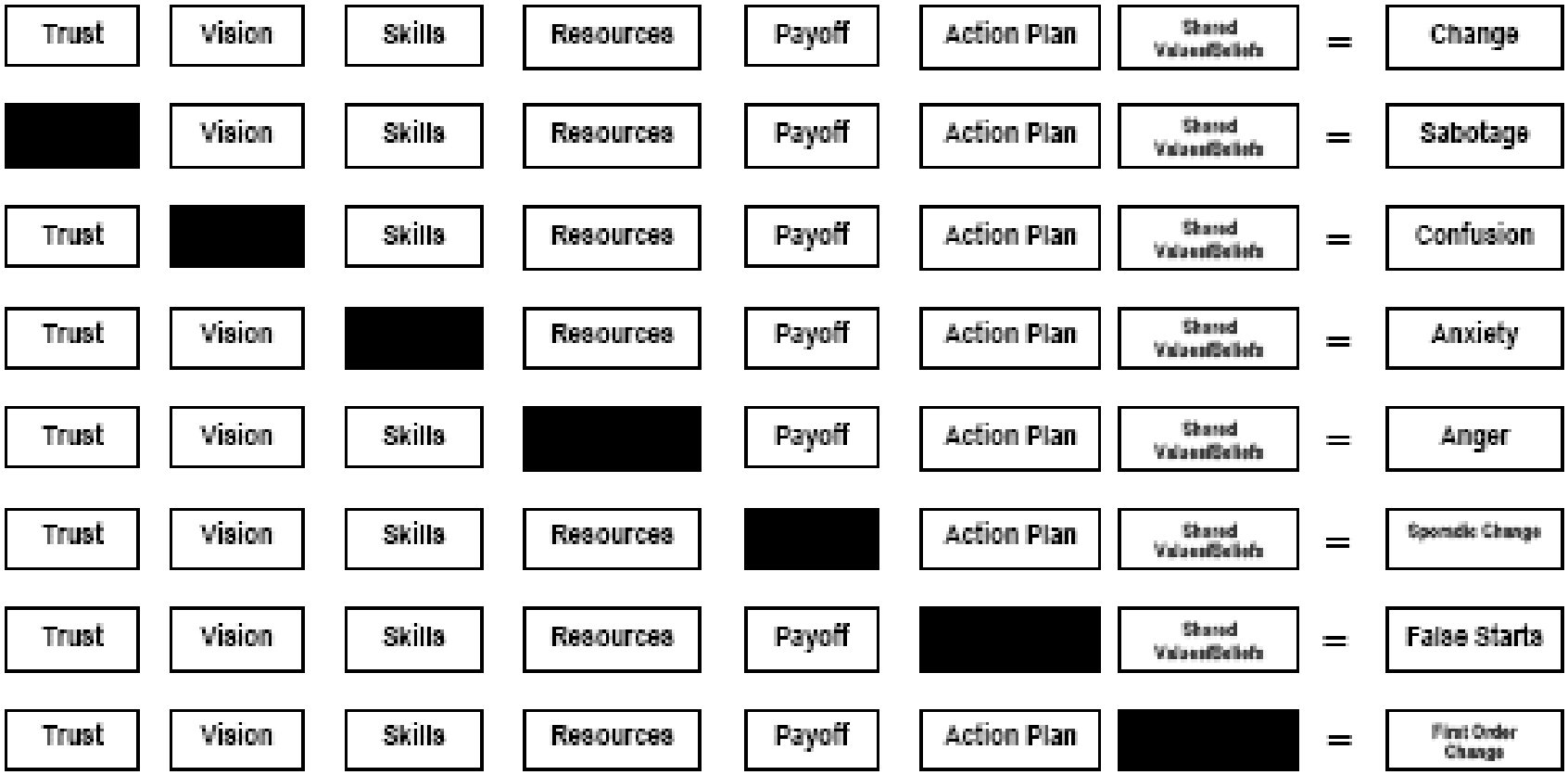
Educational Change Process

Hall & Hord (1987)

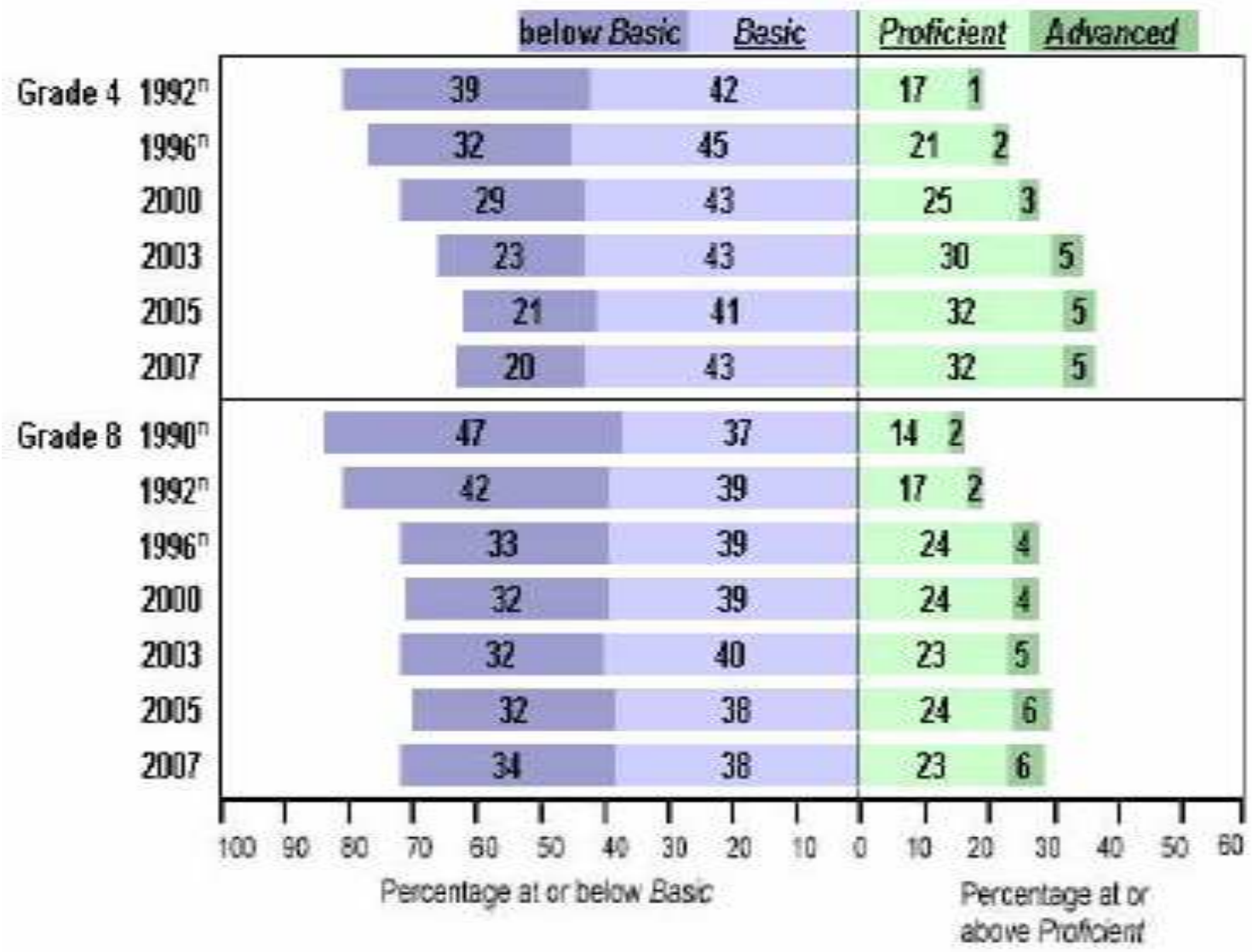
Initiation: process leading to the decision to implement change
Implementation: process of putting the change into action
Institutionalization: process of stabilizing/continuing change (Fullan, 1991)

	Stages of Concern
0-Awareness	Little concern about or involvement in the innovation is indicated
1- Informational	There is general awareness of the innovation and increased interest in details.
2- Personal	Uncertain of demands of innovation; concerns regarding how innovation will affect self.
3- Management	Attention is focused on process and task of using innovation and most efficient use of time, resources, etc.
4-Consequence	Focus is on impact innovation will have on students.
5-Collaboration	Concern about coordinating and collaborating with others regarding innovation.
6-Refocusing	Exploration of additional benefits for students, including modifying or replacing innovation.

UNDERSTANDING CHANGE



NAEP Achievement Levels



NAEP Mathematics Grade 8 2007, 2005, 2003, 2000, 2000, 1996, 1992 and 1990
Average Scale Score (with Standard Errors in Parentheses), Mathematics
Gaps and changes in gaps for selected subgroups - Michigan

	Male		Female		Gap between Male and Female	
	Average Scale Score		Average Scale Score		Difference	
2007	278.2970956	1.48641698	275.2354584	1.62886404	3.06163717	2.205137977
2005	279.4385813	1.71470465	275.2618138	1.76366895	4.17676755	2.459825238
2003	276.9254419	2.25033246	275.9709816	1.97554498	0.95446033	2.994457238
2000	277.588948	1.90284053	276.9503029	2.21913345	0.63864512	2.923243977
2000 [1]	279.0590125	1.84755653	277.863207	1.78485274	1.19580551	2.568883889
1996 [1]	278.7893171	2.02943236	274.9474631	1.97586548	3.84185396	2.832426539
1992 [1]	269.8658368	1.6160101	265.0181303	1.52197612	4.84770646	2.219887374
1990 [1]	265.0933422	1.43884794	263.6326709	1.25745927	1.46067133	1.910886499

From 2005 to 2007, the change in the gap was 1(3.3), which does not represent a significant difference between the two years.
From 2003 to 2007, the change in the gap was 2(3.7), which does not represent a significant difference between the two years.
From 2000 to 2007, the change in the gap was 2(3.7), which does not represent a significant difference between the two years.
From 2000 [1] to 2007, the change in the gap was 2(3.4), which does not represent a significant difference between the two years.
From 1996 [1] to 2007, the change in the gap was 1(3.6), which does not represent a significant difference between the two years.
From 1992 [1] to 2007, the change in the gap was 2(3.1), which does not represent a significant difference between the two years.
From 1990 [1] to 2007, the change in the gap was 2(2.9), which does not represent a significant difference between the two years.

Gap between White and Black (Race/ethnicity used in NAEP reports after 2001)

	White		Black		Difference	
	Average Scale Score		Average Scale Score			
2007	284.983429	1.09075196	243.8918449	2.19525799	41.0915841	2.451305261
2005	285.4627497	1.62490915	247.4975416	2.02147452	37.96520801	2.593586124
2003	286.1518943	1.34182048	244.9445747	3.45342666	41.2073196	3.704947759
2000	284.9118759	1.53287092	239.4476208	3.25999529	45.46425501	3.602396778
2000 [1]	285.7909531	1.44506398	241.9733152	2.68656492	43.81763794	3.050547652
1996 [1]	283.9082191	1.61810879	244.8155325	3.73397794	39.09268667	4.069504554
1992 [1]	276.4263204	1.44946827	232.7418683	1.75374103	43.68445206	2.275206774
1990 [1]	269.9040468	1.06882974	230.8805192	1.53631343	39.02352758	1.871538396

From 2005 to 2007, the change in the gap was 3(3.6), which does not represent a significant difference between the two years.
From 2003 to 2007, the change in the gap was 0(4.4), which does not represent a significant difference between the two years.
From 2000 to 2007, the change in the gap was 4(4.4), which does not represent a significant difference between the two years.
From 2000 [1] to 2007, the change in the gap was 3(3.9), which does not represent a significant difference between the two years.
From 1996 [1] to 2007, the change in the gap was 2(4.8), which does not represent a significant difference between the two years.
From 1992 [1] to 2007, the change in the gap was 3(3.3), which does not represent a significant difference between the two years.
From 1990 [1] to 2007, the change in the gap was 2(3.1), which does not represent a significant difference between the two years.

Gap between White and Hispanic (Race/ethnicity used in NAEP reports after 2001)

	White		Hispanic		Difference	
	Average Scale Score		Average Scale Score			
2007	284.983429	1.09075196	258.8407039	3.82155722	26.14272511	3.974171539
2005	285.4627497	1.62490915	265.0248575	3.7840017	20.43789211	4.118130475
2003	286.1518943	1.34182048	266.8330286	4.21913436	19.31886573	4.427366819
1992 [1]	276.4263204	1.44946827	251.9262071	8.14653879	24.50011328	8.274482009

From 2005 to 2007, the change in the gap was 6(5.7), which does not represent a significant difference between the two years.
From 2003 to 2007, the change in the gap was 7(5.9), which does not represent a significant difference between the two years.
From 1992 [1] to 2007, the change in the gap was 2(9.2), which does not represent a significant difference between the two years.

Gap between Not eligible and Eligible for Free/Reduced-Price Lunch

	Not eligible		Eligible		Difference	
	Average Scale Score		Average Scale Score			
2007	285.3667994	1.25445465	259.3456719	2.16408347	26.02112747	2.501382365
2005	284.7521452	1.6417063	258.360005	1.98371306	26.39214022	2.574940209
2003	284.5940461	1.78513613	257.1098328	3.24068883	27.48421325	3.699834469
2000	284.2984033	1.99486011	255.9773992	2.15090843	28.3210041	2.933576986
2000 [1]	286.3255513	1.65242297	255.6201825	2.23499561	30.70536884	2.779515614
1996 [1]	283.8503439	1.74802535	257.0160751	2.68725087	26.83426876	3.205761978

From 2005 to 2007, the change in the gap was 0(3.6), which does not represent a significant difference between the two years.
From 2003 to 2007, the change in the gap was 1(4.5), which does not represent a significant difference between the two years.
From 2000 to 2007, the change in the gap was 2(3.9), which does not represent a significant difference between the two years.
From 2000 [1] to 2007, the change in the gap was 5(3.7), which does not represent a significant difference between the two years.
From 1996 [1] to 2007, the change in the gap was 1(4.1), which does not represent a significant difference between the two years.

Gap between 75th and 25th Percentile

	75th Scale Score		25th Percentile Scale Score		Difference	
2007	303.0679993	1.23460057	252.2400024	2.39964799	50.82799683	2.69861984
2005	303.1959961	1.93766731	253.2660004	1.83964148	49.92999572	2.67185991
2003	302.1219971	2.22595983	253.5579987	3.08371058	48.56399841	3.803178684
2000	302.3420044	1.96955202	254.5700012	2.00930698	47.77200317	2.813618613
2000 [1]	302.8059998	1.63620084	255.9439972	2.62595271	46.86200257	3.093991083
1996 [1]	302.2299988	0.94877702	253.2040009	2.34500776	49.02599793	2.529671763
1992 [1]	292.2679932	2.22771806	244.0200012	2.15685349	48.24799194	3.100765185
1990 [1]	287.8119934	1.72471171	241.2819977	1.32507777	46.52999573	2.174962432

From 2005 to 2007, the change in the gap was 1(3.8), which does not represent a significant difference between the two years.
From 2003 to 2007, the change in the gap was 2(4.7), which does not represent a significant difference between the two years.
From 2000 to 2007, the change in the gap was 3(3.9), which does not represent a significant difference between the two years.
From 2000 [1] to 2007, the change in the gap was 4(4.1), which does not represent a significant difference between the two years.
From 1996 [1] to 2007, the change in the gap was 2(3.7), which does not represent a significant difference between the two years.
From 1992 [1] to 2007, the change in the gap was 3(4.1), which does not represent a significant difference between the two years.
From 1990 [1] to 2007, the change in the gap was 4(3.5), which does not represent a significant difference between the two years.
--- Sample size is insufficient to permit a reliable estimate.
[1] Accommodations were not permitted for this assessment.
Note: Score differences are calculated based on differences between unrounded average scale scores. In this table, significance tests were carried out for all changes in gaps. All other observed differences are not necessarily statistically significant.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2007, 2005, 2003, 2000, 2000, 1996, 1992 and 1990 Mathematics Assessments.

Program Descriptions:
Mathematics Institutes are a sequence of courses that focus on the mathematics that teachers teach and on the best practices for teaching mathematics with the goal of reaching all students. Each institute meets for 30 contact hours, often over 5 days. A teacher participating in an institute can elect 2 hours of graduate credit by paying a reduced tuition fee. One set of institutes focuses on the mathematics strands in the Michigan Grade Level Content Expectations. A second set of institutes focuses on the pedagogical moves teachers make that hinder or support student understanding. In these institutes teachers are given a grade-appropriate task that requires some creative thinking and that leads to various solution paths. Teachers gain insight into diverse ways students might think about the problem and encourages them to support students thinking in these same ways. These institutes often use case studies of a teacher's work with his or her students in working on a task. The institute design is built on the belief that effective teacher professional development must be long-term, sustained, collaborative, school-based, linked to curricula, and focused on student learning (Hiebert, Gallimore and Stigler 2002).

“Lenses on Learning” is a program to help administrators learn about mathematics and mathematics teaching. Through this K-12 program, administrators learn about the nature of mathematics, mathematical understanding and how this develops in children, discourse-based instruction, and different approaches to professional development that support a standards-based classroom. The program takes place in three modules: Instructional Leadership in Mathematics, Teacher Learning for Mathematics Instruction, and Observing Today’s Mathematics Classroom. Participants work through problems to experience for themselves how mathematics is handled in a standards-based course. They then examine videos of teachers working with students on the problem and use this as a basis of discussion on issues of teaching and learning.

Appendix B: Literature Reviewed

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Steen, Lynn Arthur (2007). Every Teacher is a Teacher of Mathematics. *Principal Leadership, January 2007*. pp 16-20.

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Corbett, Dick, Wilson, Bruce, and Williams, Belinda (2005). No Choice But Success. In: *Educational Leadership: Learning from Urban Schools, 62 (6).* pp 8-12. Association for Supervision and Curriculum

Mewborn, Denise S. and Cross, Dionne I. (2007). Chapter 15: Mathematics Teachers' Beliefs about Mathematics and Links to Students' Learning. In: *The Learning of Mathematics: The 69th NCTM Yearbook.* pp 259-269. Reston, VA: National Council of Teachers of Mathematics

Middleton, James A (1999). Curricular influences on the motivational beliefs and practice of two middle school mathematics teachers: A follow-up study. *Journal for Research in Mathematics Education, 30 (3).* Washington

Teacher Content Knowledge

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Koency, Gina & Swanson, Judy (2000). *The Special Case of Mathematics: Insufficient Content Knowledge a Major Obstacle to Reform.* Prepared for American Educational Research Association.

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Appendix C: Mathematics Steering Committee Members

Name	Position	District/Agency
Debi Arington	Teacher	Lincoln
Wendy Arntson	Teacher	Manchester
Amanda Badge	Teacher	Fowlerville
Hyman Bass	Professor of Mathematics	U of M
Ann Beyer	Teacher	Ann Arbor
Joanne Caniglia	Professor of Mathematics	EMU
Brooke Collins	Teacher	Whitmore Lake
Kate Curtin	Principal	Lincoln
LeeAnn Dickinson-Kelley	Director, Elementary Education	Ann Arbor
Bonnie Dornbos	Teacher	Willow Run
James Fielder	Teacher	Manchester
Nicole Garcia	Mathematics Coordinator	WISD/LESA
Kate Gregory	Teacher	Hartland
Jenny Guziel	Teacher	Lincoln
Delena Harrison	Graduate Research Assistant, SoE	U of M
Jenny Heath	Teacher	Milan
Jean Hoeft	Teacher	Whitmore Lake
Jenny Jandron	Teacher	Fowlerville
Lisa Kaniewski	Teacher	Pinckney
Clint Kraft	Teacher	Milan
Karen Kurcz	Teacher	Chelsea
Linda Kuzon	Instructional Consultant	Dexter
Sheila Larson	Curriculum Director	Fowlerville
Peter Loveland	Teacher	Saline
Shelly Lyon	Teacher	Whitmore Lake
Michele Madden	Instructional Support	Ann Arbor
Lisa Malboeuf	Teacher	Lincoln
Mary Marshall	Principal	Dexter
Kevin Mowrer	Principal, H.S.	Manchester
Naomi Norman	Director of Instruction	WISD
John Porter	Teacher	Lincoln
Molly Porter	Teacher	Ypsilanti
Jim Reese	Director, General Education	LESA
Deborah Regal Coller	Teacher	Pinckney
Laura Roop	Outreach Director	U of M, School of Education
Rick Schaffner	Curriculum Director	Lincoln
Sarena Shivers	ECA Project Coordinator	WISD
Amber Siebert	Teacher	Whitmore Lake
Paula Sizemore	Math Specialist	Ypsilanti
Dan Stearn	Teacher	Lincoln
Lana Tatom	Director, Academic Service	Willow Run
Loren Thorburn	Teacher	Chelsea

Larissa Tindall	Teacher	Manchester
Natalie Turner	Teacher	Willow Run
Roger Verhey	Professor of Mathematics	U of M Dearborn
Richard Weigel	Curriculum Director	Ypsilanti
Virginia Weingate	Teacher	Brighton
Regina Williams	Curriculum Facilitator	Willow Run
Tammy Wroblewski	Teacher	Willow Run
Tim Jackson	Director, CTE	LESA

Appendix D: Process Used to Prepare the Implementation Plan

The Math Steering Committee of the Effective Practices/Assessment Work Group has met over the past two years. Membership has been varied over this time, with some people maintaining continuity while others helped to broaden the base of knowledge. The purpose of the first year was to provide a broad range of the learning opportunities available for math professional development. During this year, the Steering Committee recognized that members of the mathematical community in Washtenaw County were involved in innovative, research-based professional development that improved instruction and student achievement. In light of this finding, presentations were organized to expose teachers, administrators, and other leaders of mathematics instruction to the methods and outcomes of these practices. Response to the presentations was overwhelmingly positive. This encouraged the committee to use the great resources that exist in Washtenaw County as part of the professional development plan by providing open lines of communication, training in instructional practices and content matter, consistent feedback to practitioners, and instructional/ administrative support.

2006-2007 Steering Committee Recommendations

In May of 2007, the Math Steering Committee offered the following recommendations which were then accepted by the superintendents of Washtenaw County:

1) adopt a multi-phase approach to the development and implementation of a mathematics professional development plan
2) provide professional development opportunities during 2007-08 focusing on math institutes for elementary, middle and high school math concepts, lesson study, administrator awareness and understanding of essential mathematics instructional practices and countywide opportunities to see innovative mathematics instructional activities in action.
3) extend the work of the steering committee for another year to fully develop Phase 2 of the implementation plan.

In the second year, the group refined work from the first year to develop a plan that would have the greatest impact on the greatest number of people and get at the heart of math literacy. What follows is a synopsis of the meetings during the past year.

November 5, 2007

Outcomes:

- To review student data and previous work
- To define the purpose and parameters of committee work
- To identify goals and challenges to meeting these goals

Key Processes and Ideas:

- Introduced Michigan School Improvement Framework Strands I Teaching for Learning and III Personnel and Professional Learning.
- Introduced Professional Learning Community
- Reviewed 2006-2007 work of committee
- Set Goals:
    1. Engage in research that crosses all spheres influencing student learning in mathematics.
    2. Develop and implement a plan to inform administrators and policy makers about the need for quality professional development in mathematics.
    3. Identify and implement a needs analysis of/for staff and student learning in mathematics.
- Reviewed MEAP Data from 2005-2006:
    1. Clear gap in ethnicity with African-American and Hispanic groups scoring significantly lower than Asian and Caucasian students.
    2. All ethnicities continuing a downhill slide in mathematics from grade 3 to 7.
    3. Economic gap also evident

December 11, 2007

Outcomes:

- To understand the Michigan Professional Development Standards as written in the Framework
- To explore literature for best instructional practice and supporting professional development
- To identify common needs of all math teachers
- To create a communication/dissemination of information plan to better inform administrators and colleagues

Key Processes and Ideas:

- Need for embedded PD and strong infrastructure to support it
- Need for strong communication
- Need for measurable goals in plan
- Need for strategies for all learners
- Use of higher-level thinking skills in math investigations

- Need for teacher to work with students as learners; use and show metacognitive strategies
- Need for teacher connection/rapport with students

February 5, 2008

Outcomes:

- To determine math professional development for 2008-2009 and the infrastructure needs necessary to support it
- To begin to develop our plan
- To determine what information still needs to be collected to clarify and implement our math theory of change
- To develop a plan for sharing information with our administrators.

Key Processes and Ideas to Incorporate in the Plan to Increase Math Literacy:

- Inquiry-based learning
- Differentiated instruction, specifically for "At Risk" learners, for active engagement
- On-site
- Collaborative
- Importance of networking
- Use of math coaches, trained through WISD
- Individual and small-group support
- Infrastructure changes in each district
- Use of technology
- Importance of student/teacher relationship

March 6, 2008

Outcomes:

- To understand the types of evaluation options and determine which would be most appropriate for the Math PD Plan
- Review and give feedback on the preliminary plan
- Discuss parameters for gaining interest and commitment to the PD plan
- Continue to work on our group dissemination plan

Key Process and Ideas:

- Identification of dimensions of learning
- Class observation as a learning process
- Evaluation as a learning process and an indication of growth