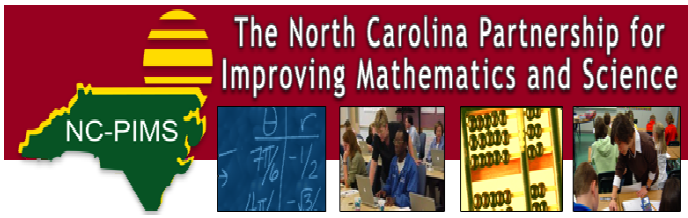

Equity for All Students of Mathematics: Aligning Beliefs and Practices

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Abstract

A major issue for mathematics educators is helping students with disabilities; minorities, females, and low socioeconomic groups become proficient mathematicians. Although teachers voice a belief that all children can learn mathematics, their practices are not consistent with that belief. In order to achieve equity, it is essential that teachers carefully examine this "disconnect" and align beliefs and practices. The many gaps in achievement can only close by narrowing the teaching gap and by using instructional strategies that accommodate the needs of each student of mathematics and provide equitable access, opportunity, high expectations, appropriate support, and challenge for ALL students (Principles and Standards for School Mathematics [PSSM], 2000). There must be school-based and system-wide support that bridges beliefs and practices with expenditures of time and money, structures of operation, and deep understanding of and commitment to change if each student is to receive equitable treatment and opportunity to learn mathematics.

The vision of the National Science Foundation Mathematics and Science Partnership Grant: North Carolina Partnership for Improving Mathematics and Science (NC-PIMS), is to improve the mathematics and science learning of all students, while simultaneously closing the achievement gaps between racial and ethnic groups. The goals are to: develop leadership and policies to support instruction in science and mathematics, create and deliver high-quality professional development to teachers and design and implement activities which encourage students to remain engaged in science and mathematics learning. We strongly believe that ALL students can learn mathematics and we tirelessly support teachers to make quality mathematics learning available to ALL students.

Teachers express firm commitment to the National Council of Teachers of Mathematics (NCTM) position that ALL children can learn mathematics. However, many of their instructional

and assessment practices do not address the learning needs or styles of every student in their class. They set different expectations for individuals and groups of students. Assignments are reduced for some, so every student is taught the same lesson at the same time. Lack of home support and previous poor classroom instruction are blamed for limited mathematical knowledge and skills. Although students enter school with deficits in mathematical understanding, teachers and schools must accept students as they are and maintain expectations and provide support that ensure these prior gaps are closed. Teachers can no longer depend upon social promotions to mask achievement discrepancies. They cannot ignore students whose learning needs do not fit the norm. Teachers need to assess students' levels of understanding of fundamental concepts before moving to the next topic. Remediation lessons must address identified gaps in mathematical understanding. These conditions must exist if ALL students have equitable opportunity to learn.

In NC-PIMS schools, mission statements are prominently and proudly displayed in central offices and local school buildings. They commit to helping ALL students achieve their optimum potential. Schools and system administrations verbalize support of improved content knowledge and changed practices, but demonstrate a disconnect, similar to that of their teachers, among espoused beliefs, decisions, and daily practices. Professional development is seldom based on identified needs of teachers or designed to improve teaching and learning. Structures do not support change initiatives. Time and monies are rarely directed toward supporting and sustaining proposed changes. The question is how to help teachers, school administrators, and system leaders understand the misalignment between their beliefs and practices, and how to change the teaching and assessment of mathematics to provide equitable practices for ALL students.

Throughout the past four years, NC-PIMS Lead Teachers have participated in professional development to learn mathematics, content pedagogy, and support their leadership responsibilities. They know and use the NCTM Principles and Standards for School Mathematics, learn the characteristics of significant mathematical tasks, know the change literature (Fullan & Hargraves, 1991) and change process as presented in the Concerns Based Adoption Model, CBAM. They complete graduate courses to increase their mathematical content knowledge. They participate in and present workshops especially designed to align content knowledge and content pedagogy. They serve as mathematics leaders in their school and system.

Changes are beginning to occur in teaching practice and administrative instructional leadership. Teachers' content knowledge is growing and many are aware of what mathematics they do not know and need to learn. Lead Teachers report changes among their colleagues in how they think about mathematics teaching and learning. For example, Jason, an elementary Lead Teacher, reported that professional validation results from observing other teachers use strategies and lessons presented in NC-PIMS workshops. He and other Lead Teachers delight in having colleagues consult them as "the math expert" in the school. This contact affirms time spent on NC-PIMS activities and challenges them to become more knowledgeable and prepared for the next questions. Jason also reports that teachers discuss changes in students' commitment to and talk about mathematics. Students are disposed to learning mathematics that is useful and engaging. This is evidenced by one fifth grader's comment that his lesson on measuring the variables of wind speed helped him understand "how his father used mathematics in choosing best days for crop dusting."

School systems are recognizing the need for ongoing, coherent, content-specific professional development to support teachers' continued growth and help principals to

understand what learning "looks like" in the mathematics classroom. One Central Office Curriculum Support Specialist reported a plan for restructuring supervisory support at the system level for each grade band, PreK-5, 6-8, and 9-12 and in each of the core content areas. The central office administration admits that one person cannot support all core curricula, K-12, for the 765 teachers and 11,000 students. This results from the recognition that mathematical content knowledge is lacking among elementary teachers due to the limited pre-service requirements and poor preparation in their earlier school experiences. The administrative leadership knows the teachers must have the content knowledge before they can teach it to their students.

As a result of the *Lenses on Learning* professional development, principals and central office staff recognize the need for teachers' leadership. It is essential for teacher leaders to contribute to, and facilitate changes in, mathematics from "within their community of peers," rather than imposing these initiatives from "above." For example, principals speak of observations incorporated in *the Lenses on Learning* training as a bridge connecting instructional leadership with routine classroom visits. "Our focus changes from looking merely at teacher behaviors as a measure of effectiveness and evaluation to observing for student learning." These observations provide a context for talking about student learning as the purpose of teaching and observing. To quote one principal, "Asking the question, 'what did you learn from your students today?' initiates conversation about the correlations between teaching and learning for ALL. The manner in which a teacher responds permits me to know what he/she attends to during teaching. It also helps me understand his/her use of assessment as a tool of instruction. It focuses discussion on the relationship between teacher actions and student learning."

Teachers demonstrate genuine care for their students and are committed to their learning. However, in some classrooms, teaching practices reflect a belief that mathematics "genes" are

inherited, that there are those students who want to learn, and that some just don't care about learning mathematics. These underlying, traditional, and popular beliefs cause teachers to intuitively set unequal expectations for individuals and groups of students. Teachers do not use a variety of instructional presentations strategies or teach an assortment of procedures that make mathematics accessible, meaningful, and useful to all students. They blame students' mathematics low achievement on low expectations and limited experiences with mathematics at home. Thus, they allow excuses to circumvent teaching ALL students to make sense of mathematics.

The accountability practices of teachers in grades K-12 are inconsistent and seldom based upon the research that establishes the power of formative assessment in instructional decision-making. Accountability in classrooms, grades 3-12, generally consists of pencil-and-paper tests. These inform students of what they miss rather than helping them identify what they need to know. Sometimes teachers use the End-of-Grade or End-of-Course test results to determine deficient areas although these are not criterion-reference measures. Some Lead Teachers engage students in using rubrics to assume responsibility for their own learning and to ascertain what they know and need to learn. There is uneven implementation of the North Carolina K-2 Mathematics Assessment tools and processes mandated by General Statute. Many teachers who complete the K-2 Assessment requirements do not use the results to determine next instructional steps. There is a "disconnect" between the NCTM assessment principles and teacher practices. This lack of coherence among assessment principles and practices adds another disconnect to the "formula" for mathematical success of ALL students.

School systems' and local schools' mission statements commit to providing every student a high-quality education including mathematics. However, administrators do not structure

schedules, allocate funds, or provide professional development that supports teachers increasing their mathematical content knowledge or learning new strategies for teaching mathematics. School systems rarely conduct needs assessments to determine the content and pedagogy deficits of teachers and to define professional growth needs. Professional development is planned by administrators and focused on school or system initiatives. The design of workshops is "one shot," "one-size-fits-all," in which teachers "sit and get" information. There is limited, if any, follow up to the workshop that permits teachers to engage in professional dialogue or receive feedback on implemented changes. There is no opportunity to discuss the impact of new teaching strategies on student learning, or inquiry to gain and test new ideas. This contradicts the NC-PIMS professional development and delivery model, as well as standards established by the National Staff Development Council (Revised, 2001) which explicitly describe the Context (learning communities, leadership and resources), Content (data-driven, evaluation, research-based, design, learning and collaboration) and Process Standards (equity, quality teaching and family involvement) that improve learning for all students.

Often times, the administrative support required to implement equitable practices are not available to those teachers whose beliefs and practices are parallel. There is limited understanding and commitment from administrators for additional time, appropriate tools, alternative assessments, individual professional growth opportunities, and standards-based mathematics texts. Staff meeting agendas, allotments of planning time, and school-based professional development are imposed upon teachers. These are often based upon goals set by persons not working in classrooms and demonstrate limited understanding of the change process or systemic conditions that facilitate lasting modifications in theory and practice.

Frequently, the most highly qualified teachers are assigned to the highest achieving students. “No matter which measure of teacher qualifications you use, poor and minority children end up with less qualified teachers” (The Renaissance Group, 2004, p. 4). However, we know that if a student has an ineffective teacher for five consecutive years, the learning gaps will not be closed (Lee Stiff, NCTM 2006 Conference). As early as 1996, The National Commission on Teaching and America’s Future defined the kind of teacher, learning environment, instructional planning, and engagement that provide optimum learning for ALL students (for all content areas). This study reiterates that the teacher’s knowledge has the greatest impact on what students learn. In fact, “teacher effectiveness is not just the most important factor in student achievement; it is *the* factor that can overcome most other impediments to learning” (Linda Starr, 2002).

The report, *What Matters Most: Teaching for America’s Future* states:

> What teachers know and do is the most important influence on what students learn. Competent and caring teaching should be a student right. The climate in which students learn is exemplified when new ideas are connected to what they already know and have experienced; when they are actively engaged in applying and testing their knowledge using real-world problems; when their learning is organized around clear, high goals with lots of practice in reaching them; and when they can use their own interests and strengths as springboards for learning. When teachers can work together to build a coherent learning experience for students throughout the grades and within and across subject areas—one that is guided by common curriculum goals and expectations—they are able to engender greater student achievement (p. 6).

We know from multiple sources that current mathematics education is not producing highly qualified teachers or students. From the 2003 Third International Mathematics and Science Study (now known as the Trends in International Mathematics and Science Study, http://nces.ed.gov/timss/), we learned that of the 24 countries participating, U.S. fourth graders outperformed their peers in 6 countries but were outperformed by 11 countries.

Countries in which 4th grade students outperformed U.S. 4th graders

Country	Score
Singapore	594
Hong Kong	575
Japan	565
Chinese Taipei	564
Belgium-Flemish	551
Netherlands	540
Latvia	536
Lithuania	534
Russian Federation	532
England	531
Hungary	529

Countries in which 4th grade students scored below U.S. 4th graders

Country	Score
Cyprus	510
Moldova, Republic of	504
Italy	503
Australia	499
New Zealand	493
Scotland	490

Countries in which 8th grade students outperformed U.S. 8th graders

Country	Score
Singapore	605
Korea, Republic of	589

Hong Kong SAR	586
Chinese Taipei	585
Japan	570
Belgium-Flemish	537
Netherlands	536
Estonia	531
Hungary	529
Malaysia	506
Latvia	508
Russian Federation	508
Slovak Republic	508
Australia	505

Countries in which 8th grade students scored below U.S. 8th graders

Country	**Score**
Lithuania	502
Sweden	499
Scotland	498
Israel	496
New Zealand	494

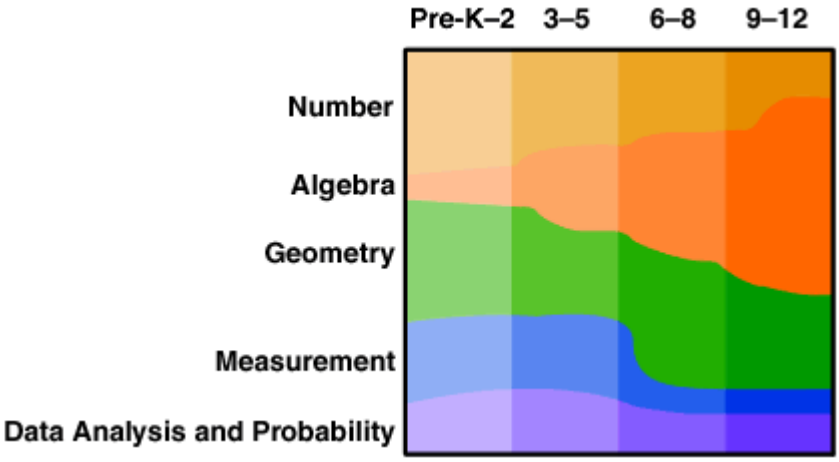
In the National Research Council of the National Academy's report, *Adding It Up: Helping Children Learn Mathematics* (NRC, 2001) Jeremy Kilpatrick, committee chair, describes the condition of mathematics teaching and learning in the United States and the requirements for improving them:

> "Too few students leave elementary or middle school with adequate mathematical knowledge, skill, and confidence for the nation to be satisfied with the condition of school mathematics. Simply developing speed in pencil-and-paper arithmetic may have been sufficient when their parents and grandparents were in school, but today's students need a deeper understanding of mathematics to thrive in an increasingly technical economy. Improvement requires a comprehensive and sustained effort among policy-makers, administrators, teachers, university faculty, parents, and others to enhance both instruction and achievement."

As stated in the North Central Regional Education Laboratory paper, *Critical Issue: Ensuring Equity and Excellence in Mathematics*, "Some people believe that inherent differences in ability among males and females, racial and socioeconomic groups, and individual students make high expectations for all students unrealistic and ill-conceived" (Herrnstein & Murray, 1994). This prevailing attitude and current accountability practices oppose the opportunity for equitable support and challenge for the neediest students.

Much knowledge from research and many new tools are available to support teachers' and school systems in helping ALL students become mathematically proficient. Principles and Standards for School Mathematics (NCTM, 2000) provide us a vision for mathematics teaching and learning and a set of foundational principles for high-quality mathematics programs. These begin with the Equity Principle which names "high expectations and strong support for all students" as essential for learning mathematics (PSSM, 2000, p. 11). The curriculum principle describes curriculum as "more than a collection of activities: it must be coherent, focused on important mathematics and well articulated across the grades" (PSSM, p. 11). Teaching requires "understanding what students know and need to learn and then challenging and supporting them to learn it well" (PSSM, p. 11). If students exemplify the Learning Principle they are actively engaged in "building new knowledge from experience and prior knowledge" (PSSM, p. 11). Assessment must support the learning of important mathematics and provide useful information for students and teachers that are used for planning instruction. The Technology Principle clearly asserts that many and varied technological tools are appropriate and necessary for enhancing the teaching and learning of mathematics. These are consistent with the current research on how children learn and what educators need to do to support their learning.

A clear, coherent set of mathematical content and process standards are accessible in the Principles and Standards for Mathematics (NCTM, 2000). They define key ideas ALL students need to know and procedures for teaching, learning, and applying those ideas, PreK-12. The standards (content and process) are consistent across the grades with different, developing expectations at each grade band, PreK-2, 3-5, 6-8, and 9-12. Specific examples from real classrooms illuminate the concepts and present pictures of their implementation. The table on page 30 of Principles and Standards for Schools Mathematics (NCTM, 2000) shows the distribution of each content strand across the grades. Each mathematical strand, Number and Operations, Algebra, Geometry, Measurement and Data Analysis, and Probability, appears at each grade, PreK-12. The North Carolina Standard Course of Study builds upon and incorporates these content standards.



Distribution of Content Strands PreK-12 (PSSM, 2000)

The process standards support the necessity for PreK-12 students to experience and apply each of them. For example, it is equally important for Pre-K students as it is for 12th graders to reason and prove by answering "why" questions and providing supporting rationale for their propositions. This reflective engagement causes students, of all ages, to formulate and consider

the validity and/or fallacy of their notions and to support them with evidence. When students communicate their knowledge of concepts, they make their thinking public. By so doing, they are able to examine their thoughts and make adjustments, clarifications, and enhancements exposed in the discourse.

The Representation Standard explains the need for a range of ways to present mathematical information providing access to ALL students. Representations must be used to "model and interpret physical, social and mathematical phenomena" (PSSM, 2000, p. 70). Teachers note the number of visual learners in class yet often limit "visual representations" to symbols rather than pictures, diagrams, and words, both static and dynamic. Teachers must create and use representations to organize, record, and communicate mathematical ideas to students (PSSM, 2000, p. 67). They must "select, apply, and translate among mathematical representations to solve problems (PSSM, 2000, p. 69).

The Connection Standard reemphasizes the necessity for considering new knowledge in light of prior learning to connect ideas and make sense of how they "fit" with one another. Making these connections enables students to make sense of mathematical ideas for practical applications. Problem solving is the essence of all mathematical activity. When students are challenged to resolve situations, they construct new math knowledge through problem solving activities. They identify their own strengths and expose weaknesses. In finding multiple solutions, they apply and adapt knowledge and recognize limits in their understanding.

The Principles and Standards writing team developed dynamic models (E-Examples http://illuminations.nctm.org/Standards.aspx) of mathematical ideas to help teachers "see" how to represent them in new, different, and powerful ways. These allow teachers to "see" ideas in a forceful way helping them visualize abstract thinking. The NCTM Illuminations website

presents dynamic representations and adds new technology tools to facilitate the visualization of ideas. There are tools to aid the organization and analysis of data, and computational fluency, flexibility, and accuracy. The lessons and applets provide interactive tools that model mathematical concepts, stimulate student sharing of ideas, solution strategies, and hypotheses. These dynamic representations of mathematical ideas provide access to many learners who are often challenged when abstracting ideas from static representations. Research reports the value of "visualization tools" to present conceptual relationships with graphic components (Searching on the right side of the brain, Sherman, 2001. *http://www.searchtools.com/info/visualization.html*). Research by an author of this paper, found that students performing at level 2 on state tests repeatedly saw and could explain fractional and proportional relationships more readily when using an interactive applet than with manipulatives or pictures. Geometer's Sketchpad is one visualization tool that enables students to construct and manipulate ideas in a dynamic environment, observing relationships not possible to represent with pencil and paper. There is a developing collection of data software that allow mathematicians to organize, present, and analyze data, to collect research, explore other's observations, and make queries. These have major potential for making mathematics accessible to all students by illustrating abstract ideas.

In addition to descriptors of content and processes that students should know and be able to use, a signature of the standards movement is the description of quality teachers and teaching. In 1991, the National Council of Teachers of Mathematics published the Professional Standards for Teaching Mathematics. It is a set of standards that define the teachers' role in selecting worthwhile tasks, structuring classroom discourse, creating the learning environment, and selecting tools to enhance teaching and learning of mathematics. It also describes the evaluation

cycle as a means of collecting, analyzing, and using data to plan instruction and professional development. It defines teachers' knowledge of content and how to teach it as critical to effective learning. The Professional Standards describe the kind of professional development that supports and improves mathematics teachers and teaching. They address the groups responsible for sustaining high-quality mathematics teachers and learning: policymakers in government, business and industry, schools, colleges and universities, and professional organizations.

Standards-based curricula include textbooks that provide rich tasks founded on important mathematics. The National Science Foundation funded several initiatives to develop curricula to support mathematics reform. Among these instructional texts are Investigations, Math Trailblazers, Connected Math, and Everyday Mathematics. The mathematical tasks they include use situations that occur in daily life. They engage students in investigating a range of related ideas and connect them as they solve problems. This focus on problem-based learning requires students to consider the dimensions of the task, apply solution strategies they know, and identify what they need to know to reach a conclusion. These types of tasks enforce the idea that there are multiple solution paths that yield the "correct" answer. Thus, they reduce the demand for "one right answer" and emphasize problem-solving as the foundation of mathematical activity. Students use invented algorithms helping them develop competence and confidence with "real" mathematics. When students make their understandings public by sharing them orally or in writing, these intuitive understandings give teachers access to what students know, what is confusing and what they need to learn. When teachers match the student's learning needs with instructional tasks and strategies, this leads to a deepening of student content knowledge.

The NCTM Curriculum Focal Points (NCTM, 2006) further narrow the curriculum focus for each grade level to achieve a coherent understanding of mathematical development, PreK-8.

The focal points cover the most important mathematical ideas at each specific grade level with related skills and content that give students a deeper understanding and long term continuous learning. The set of curriculum focal points allows teachers the opportunity to develop and use lessons with related topics that help students reinforce their mathematical knowledge and make important connections. The curriculum focal points support the concept of a high-quality mathematics education for ALL students.

High-stakes accountability presents major challenges to helping ALL students achieve because each student must reach the same level of achievement at the same time. This defies the research that describes standardized testing as a tool for identifying students who perform at different points on the Bell Curve (Herrnstein & Murray, 1994). The consequences of standardized accountability measures cause teachers to practice for the test rather than teach for the test. This one-size-fits-all accountability contradicts the nature, role, value, and requirement of formative assessment for informed instructional decision-making. Research informs us that more significant learning occurs when teachers begin teaching by assessing what students know and using those data to construct plans and instruction. However, many teachers continue to depend upon high-stakes testing as the sole measure of students' achievement (Popham, 2005). It is the fear of punishment and public ridicule that drives teachers to depend upon "end-of-year," kick you in the seat of the pants high-stakes tests. This is a political and administrative disconnect that must be addressed for teachers to have the confidence to use proven-practice and meet standards of accountability.

In North Carolina, there are opportunities to reward teachers who critically examine their beliefs, their practice and the congruence between the two. This is possible through National Board Certification. The National Board for Professional Teaching Standards defines what

accomplished teachers should know and be able to do for twenty-four different certificate areas. The certification process allows teachers three years to submit evidence of their accomplished practice and become a National Board Certified Teacher (NBCT). The state of North Carolina rewards teachers who secure certification with a 12% salary increase for the ten-year life of the certificate. Research demonstrates that more than 75 % of 150 NBPTS research studies found NBCTs make a significantly measurable impact on teacher performance and student learning, engagement and achievement (http://www.nbpts.org/resources/research). Students of NBCTs score 7 to 15 percentage points higher on year-end tests than students of non-NBCTs. In 1992, Hanushek found that "students with a very highly qualified teacher will achieve a learning gain of 1.5 grade level equivalents, while a student without a highly qualified teacher will achieve a gain of only 0.5 grade level equivalents. Thus, the quality of a teacher can make the difference of a full year's learning growth." In 2003,Goldhaber completed a study of the impact of National Board Certification on student performance. He found the greatest gains in student achievement in mathematics. There is roughly 14 percent of a standard deviation in the growth in mathematic scores for students in grades 3-5 between NBCTs and non-National Board Certified Teachers. The study also found that NBCTs are particularly effective with minority students (p. 5).

New research-based tools for administrative leadership, such as *Lenses on Learning*, present structures, tools, and practices that facilitate principals' professional growth and instructional leadership. These teach principals how to look for mathematics-specific learning. They engage the teachers in using data collected from classroom observations as content for professional inquiry into the teaching-learning process. They focus observation on professional dialogue about the relationship between teaching and learning rather than merely judging discrete teacher and student behaviors. *Lenses on Learning* is based upon generative learning,

which provides a framework to help teachers construct new knowledge by thinking about their own thinking and related practice. This dialogue provides reciprocal, generative learning for all who participate. This powerful professional growth moves teachers to new ways of seeing and doing things. These changes occur because teacher recognize the need for change and have a forum for collecting and testing new innovations and strategies to do things differently.

Equity means to totally support and challenge ALL students to learn mathematics. This does not mean, "One size fits all." It requires that teachers have a clear understanding of the unique needs of each child and ways to meet those needs. ALL students must have access to a competent, caring teacher who has a deep understanding of important mathematics and skill in communicating that knowledge to students they teach (Lee Stiff, PP). They need to have daily experiences with rich mathematical tasks and in solving problems in a variety of ways including intuitive and conventional strategies. They need to think and reason mathematically and engage in rich mathematical inquiry with each other and their teacher. ALL students need an environment that encourages and supports testing mathematical hypothesis. They need to experience and create a range of models to represent mathematical ideas. They need assessment practices that support and enhance, rather than punish, learning. Students must believe they are mathematicians and behave accordingly.

The descriptions of quality content, pedagogy, and teaching from research are the foundational principles of NC-PIMS professional development design and activity. Based on this premises, our focus is and has been to improve the impact of teacher knowledge and a teacher's actions and decisions about student learning. Our professional development helps teachers and students connect "new knowledge" with "old" to assimilate new ideas and make sense of how they relate. Students (teachers and children) engage in considering problems, making conjectures

and testing them in situations that are of interest and pertinence to their personal situations. Important mathematics is presented with problem-based tasks in which students use what they know (strengths) as a beginning solution strategy. They identify what they need to know, link prior knowledge and experience with new, and extend their understanding. This coherence is supported within a single grade with activities for teachers at that grade, and across all grades, with projects and activities requiring dialogue, collaboration, and activity among different grades. Connecting concepts and activities is designed to eliminate the need for duplication of topics and to support continuous learning.

A Horizon Research study, funded by the National Science Foundation (NSF), found that high-quality instruction in schools is observed in less than 20% of school districts throughout the country. Fifty-nine percent of 300 mathematics and science classroom sessions observed in 31 school districts were rated low in quality of instruction. Twenty-seven percent were of medium quality and 15% of high quality. In addition the study reports that 80% of teachers across the country report they are ill-prepared to teach diverse populations (Hambrick, p.12). To address quality teaching, NC-PIMS Lead Teachers are supported by Facilitators who coach and mentor them during and following professional development sessions: graduate courses, leadership development, and content professional development that they teach to colleagues. These Facilitators work with approximately 30 Lead Teachers, limiting the amount of time available to each Lead Teacher. These relationships permit some professional dialogues about mathematics teaching and learning. Facilitators are a resource for additional information, clarification, and feedback for classroom teaching, school leadership, and presentation of professional development. The benefits of this model would grow exponentially with a lower ratio between

Facilitators and teachers, giving opportunity to increase frequency of coaching and focus more intensively on the specific needs of fewer teachers.

Through their mission statements, NC-PIMS schools and school systems acknowledge that ALL students must learn mathematics to guarantee our country's ability to compete in the global market. The evolving brain research on cognition gives us greater knowledge of how children learn and how to facilitate that learning (Kilpatrick, et al, 2001). These findings teach us how to address the traditionally held beliefs that mathematics "genes" are inherited, that there are those students who want to learn, and that some students just don't care about learning mathematics, and give us tools for changing these beliefs and practices. They define the necessity for multiple representations, a range of tools, and diverse teaching strategies to help ALL students make sense of mathematical concepts.

Seventy principals and central office administrators are completing or have completed, forty hours of the *Lenses on Learning* professional development course. This research-based program, generated by the Education Development Center, exposes participants to mathematics, allowing them to experience the thoughts and feelings students' have as they work on tasks. They observe videotaped mathematics lessons as they occur in classrooms. When principals observe in their schools, they document evidence of content knowledge, pedagogy, learning, and the intellectual environment, and discuss how this evidence provides meaningful discussion about learning. At the close of each of the 10 three-hour sessions, participants complete a "bridging to practice" exercise that serves as plan for action. This professional experience for principals helps support the tenets of the Extend study by having them assess the use of available teacher resources to support students. It gives them information about the best-prepared teachers so they know whom to assign to the neediest students. This process empowers teachers

committed to teaching under-represented individuals and groups. Through observations and dialogue with teachers, principals can identify content and pedagogy deficits and match professional development with these needs.

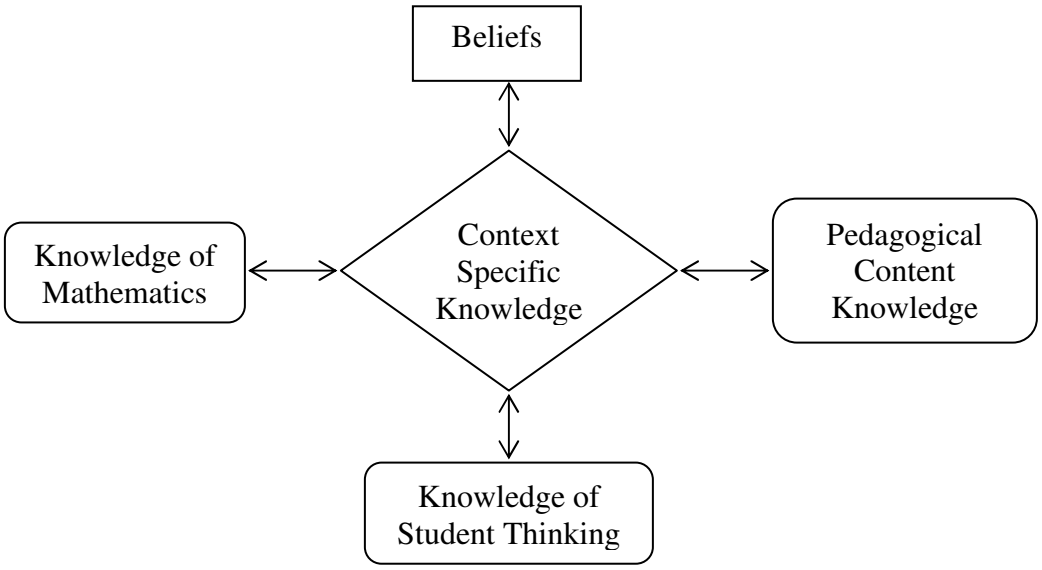
The goal of equitable learning is for each student to become mathematically proficient from the beginning of his/her school career. This means that no students are placed in the forgotten corner of schoolrooms. We need to help teachers and schools understand the lack of congruence between having students "achieve to the best of their ability" and having all students ready for the 21st century as described in the North Carolina State Board of Education "Future-Ready Students for the 21st Century (See Appendix A)."

The NC-PIMS professional development model creates more equitable opportunities for more students. One Lead Teacher comments that he is pleased to see the teachers in his school using the lessons with their students that he and his Co-Lead Teacher taught in the NC-PIMS professional development. The NC-PIMS Cascade Model of professional development strengthens the mathematical content and pedagogical knowledge of Lead Teachers, builds their leadership skill and resources, and prepares and trains them to facilitate the development of their colleagues. This site-based focus on mathematical leadership creates competent, informed teachers, affords access to resources and standards-based teaching tools and high-quality professional development. All teachers report a new or renewed awareness of the value of discourse as a tool for understanding what students know and need to know. Teachers also intentionally plan lessons that use discourse as a generative learning strategy. They describe changes in task selection, addition of multiple and different strategies, and listening to students to assess knowledge and learning needs. They share adjustments made to the learning environment including the acceptance of errors as opportunities for learning. Because tasks connect with real

contexts from their daily experiences, students recognize the usefulness of mathematics. Students have more competent, caring teachers. They engage in problem solving tasks that cause them to ask mathematical questions requiring thinking and reasoning. Students use mathematics to solve daily problems that are of interest and import to them.

"Research confirms that a teacher's education and experience account for more differences in student achievement than any other factor. Teachers' knowledge of subject matter and teaching methods is a key factor in student achievement" (Renaissance Group, p. 7). "Leaving no teacher behind is a theme that all education schools must embrace as they confront the challenges of NCLB" (Renaissance Group, p. 5).

A model for changing teacher beliefs was presented in 1992 by Fennema and Franke when they described the components and relationships among beliefs, context specific knowledge, pedagogical content knowledge, knowledge of student thinking, and knowledge of mathematics. As shown below, the conceptual model makes it clear that beliefs impact all that the teacher knows and does in his or her specific context.



Model of Teacher Knowledge
(Fennema & Franke, 1992)

If we are to establish congruence among beliefs and practices, teachers' belief systems must be changed through professional development. These experiences must include instruction and discussion about the correspondence among systems of belief, content knowledge, understanding of student thinking, context of the school and students and instructional practices employed in the classroom. Teachers must understand their "Hidden Curriculum," dimensions of diversity, strategies for teaching students with diverse needs, as well as assessment tools and practices that provide useful information for designing and monitoring learning experiences. Teachers need awareness of unintentional behaviors and their impact on teaching and student learning. They also need strategies for identifying and remediating these unintentional behaviors that inhibit student learning. Teachers must understand the need to know a student's prior knowledge and experience and use that information for planning mathematics lessons. They must use the instructional strategies that benefit ALL students. Teachers are obliged to use discourse in creating communities of mathematical inquiry allowing students to learn from each other. The NC-PIMS Cascade Model of Professional Development must continue and be extended to educate teachers about mathematical content, equity, and equitable practice. Teachers need professional opportunities that teach ways of supporting and challenging ALL students. Teachers need ongoing support that facilitates their growth and helps them align beliefs and instructional practices.

Local school administrators and central office personnel must align espoused beliefs, decisions, and daily practices. Professional development must be based on identified needs of teachers and designed to improve teaching and learning. Structures must support and sustain change initiatives. Time and monies must be directed toward making long-term differences.

Principals need to understand what teaching and learning "looks like" in effective mathematics classrooms. They must learn to observe for quality teaching and learning, document evidences of both, and engage in dialogue with teachers that promote professional growth. They must understand the relationship between the teaching and learning process rather than attend to discrete behaviors of teachers and students. Incorporating and expanding the professional opportunities for schools administrators that are part of NC-PIMS means employing research-based practices that nurture reform in mathematics and provides a systemic approach to change.

School administrators and system leaders must thoughtfully orchestrate a coherent and comprehensive plan to change the teaching and assessment of mathematics to provide equitable practices for ALL students. There must be an "intentional" desire, an organized plan and reflective review for helping students with disabilities; minorities, females, and low socioeconomic groups become proficient mathematicians.

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