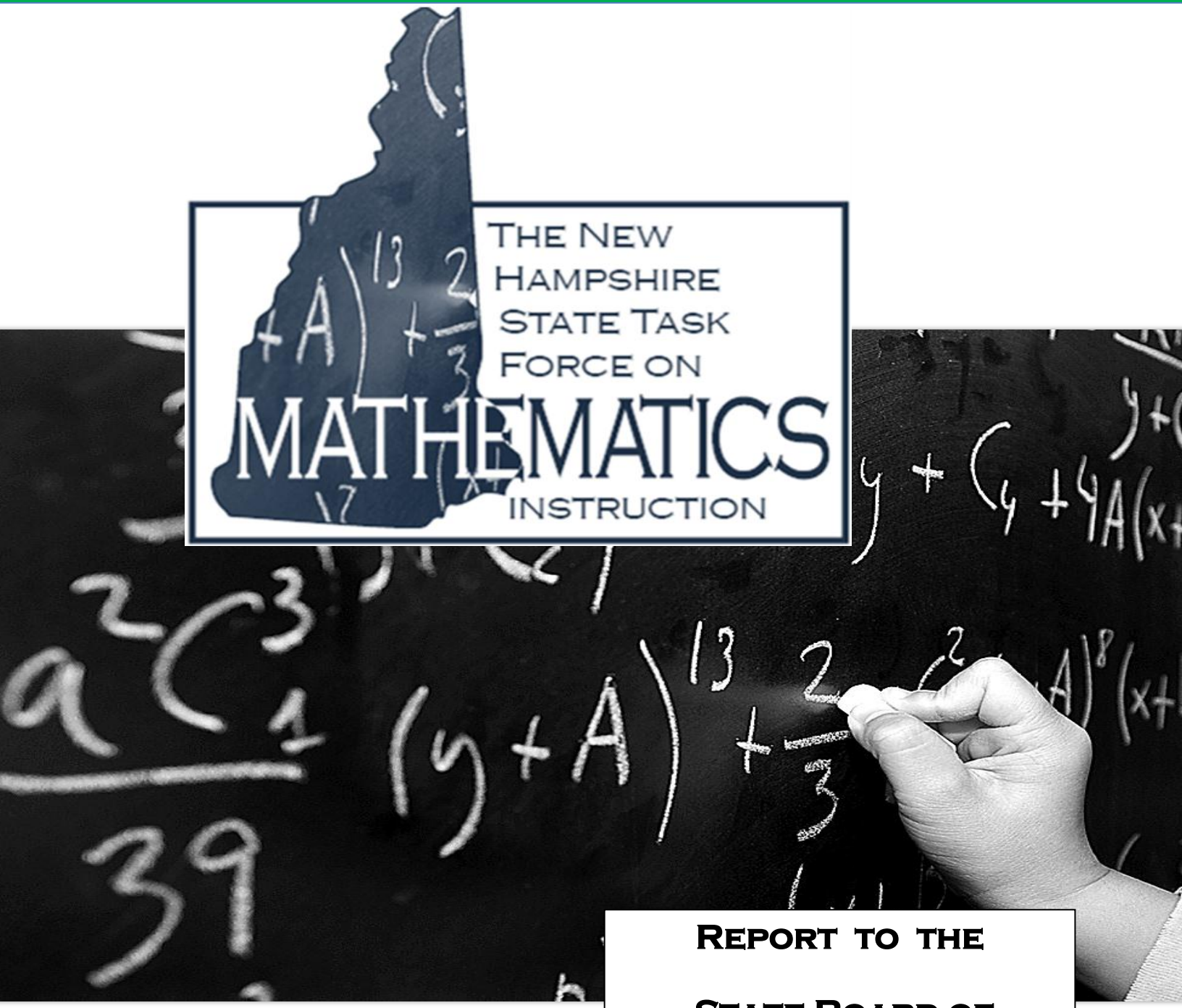

Report to the State Board of Education

March 2012

Rev. 10/17/12

New Hampshire
Department of Education

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March, 2012

Dear Colleague,

The New Hampshire State Task Force on Mathematics Instruction was established jointly by the New Hampshire Department of Education and State Board of Education in response to mathematics performance trends at secondary and post-secondary levels. The task force met monthly from July 2011 through January 2012. It was comprised of leaders and educators representing various stakeholders from New Hampshire schools, institutes of higher education, and state organizations.

The task force committed to articulating recommendations that would accomplish two goals – promote K-12 mathematics curriculum and instruction that eliminates the need for mathematics remediation beyond high school and inspire educators to design and implement authentic mathematical experiences and assessments. The recommendations contained in this report can be used by state, district, and school leaders and stakeholders to frame conversations and improvement efforts relating to K-12 mathematics performance.

Members of the task force are to be congratulated for their focus on the importance of improving mathematics achievement for all New Hampshire students. The discussions held by the Taskforce demonstrated a deep understanding of the challenges ahead for all stakeholders and the importance of linking current research and initiatives with the recommendations.

As Commissioner, I honor the work of the task force as it represents New Hampshire's initial efforts to prepare all students to be career and college ready; and become engaged citizens. Furthermore, it demonstrates the collaborative effort needed across the state to ensure each New Hampshire student is mathematically prepared for any future opportunities. It is my hope this report will become the impetus for state, district, and school improvements in mathematics education.

Sincerely,

Virginia M. Barry

Virginia M. Barry, Ph.D.
Commissioner of Education

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March 8, 2012

Dear Colleague:

In the Fall of 2011, the Chairman of the Community College Board of Trustees, Paul Holloway, and the Chancellor, Richard Gustafson, presented to the State Board of Education on their concerns regarding the high remediation levels of students entering Community Colleges across New Hampshire. They reported that close to two thirds of students required one or more remedial courses prior to entering a degree granting program. In addition, they indicated that the vast majority of the remediation requirements are in Math. At the same meeting, the State Board reviewed the results for NH Math NECAP scores for cohorts that started in third grade to eleventh grade. Although New Hampshire students had relatively high levels of proficiency in the third grade, this dropped off to below 30% by grade 11. As State Board members, our concern for this overall performance could not have been greater. We immediately charged the Commissioner and the Deputy Commissioner of the Department to establish a Taskforce, including educators at all levels, to study the problem and to report back to the Board as soon as possible. The taskforce was subsequently formed and reported back to the State Board at our February, 2012 meeting.

I can think of no more critical issue in education today than our student's proficiency in Math and in English Language Arts. Their future, whether it be in attending college or in future careers, absolutely depends on their mastery of these academic requirements. It is for this reason that as the Chairman of the State Board of Education, I highly endorse the recommendations of this report. Further, I ask that each and every educator in the state read the report and immediately seek to implement the recommendations in relevant curriculum, instruction, and assessment activities as soon as possible. By taking these actions, you will start us on the road to assuring that each New Hampshire student graduates from high school ready for the challenges and rewards of life ahead. Thank you for your service in this crucial matter.

Sincerely,

John E. Lyons, Jr., Chairman
State Board of Education

JEL:PB

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REPORT TO THE STATE BOARD OF EDUCATION

Abstract

The purpose of this report is to disseminate the findings and recommendations of the New Hampshire State Task Force on Mathematics Instruction, which was convened in mid-July 2011 by the Department of Education upon a charge by the State Board of Education. After approximately six months of focused study on the state of mathematics curriculum and instruction in New Hampshire, the task force developed recommendations categorized by three areas. These recommendations promote a K-12 continuum of mathematics curriculum and instruction that eliminates the need for mathematics remediation at post-secondary institutions. An additional goal is to inspire educators in their task to design and implement authentic mathematical experiences and assessments so that students will effectively understand and apply their mathematical knowledge to new situations. The recommendations contained in this report can be used by state, district, and school leaders and stakeholders to frame conversations and improvement efforts relating to K-12 mathematics instruction and achievement.

This report includes four sections and three appendices. The first section is entitled *About the New Hampshire State Task Force on Mathematics Instruction*. The intent of this section is to provide background information relating to the formation of the task force, its purpose, and the process followed to arrive at recommendations to improve mathematics instruction. Appendix A offers a complete listing of task force members and their affiliations at the time of the writing of this report. Section #2 is *Mathematics Achievement of NH Students.* Its purpose is to frame current mathematics performance by New Hampshire students on assessments relating to the New England Common Assessment Program (NECAP) and National Assessment of Educational Progress (NAEP). In addition, it includes data that helped to identify the trend of increased mathematics remediation at post-secondary levels of education. This section provides much of the data that became the impetus for the creation of the task force. The third section called *Vision and Recommendations to Improve Student Achievement in Mathematics* is designed to articulate the shared beliefs of the task force and research relating to the recommendations. Section #4 is titled *Connections to Trends in Mathematics Education.* This section describes how the recommendations articulated by the task force have far-reaching impact and alignment to the Common Core State Standards, competency based assessments in grades 9 through 12, national and state movements toward elementary mathematics specialists, and the recently released *New Hampshire Task Force on Effective Teaching Phase 1 Report* (2011). Section #4 serves as the conclusion to the report and indicates the urgency that is needed to improve the state of mathematics in New Hampshire. Lastly, Appendix B provides an overview of the key points of the report. References are located in Appendix C.

Finally, New Hampshire Department of Education Deputy Commissioner, Paul Leather, would like to thank each member of the task force for their contributions to this report. Without their time and effort this project would not have been possible. Thank you to everyone!

(Photo taken by Deborah de Peyster)

About the New Hampshire State Task Force on Mathematics Instruction

The New Hampshire State Task Force on Mathematics Instruction was formed to investigate the state of secondary mathematics curriculum, instruction, and assessment. Upon request from the State Board of Education, the task force was charged to review existing mathematics curriculum and instruction and provide recommendations on how to improve mathematics instruction throughout New Hampshire. This charge originated from two trends in mathematics education that have emerged over the last few years.

> **Trend #1** Student scores on NECAP (New England Common Assessment Program) assessments in mathematics demonstrated a substantial decline in performance as students moved from elementary through middle school to secondary grades.
> **Trend #2** Mathematics remediation increased at the post-secondary level for both the University System of New Hampshire and the Community College System of New Hampshire.

On July 15, 2011, New Hampshire Deputy Commissioner of Education, Paul Leather, convened the first meeting of the task force. The decision was made to invite various educational stakeholders with multiple perspectives from the field on what was and was not working in terms of mathematics instruction. The task force was comprised of New Hampshire educators representing the following stakeholder groups. (See Appendix A for a complete listing of task force members and affiliations.)

- Practicing Mathematics Teachers
- Principals and School Administrators
- Instructional Coaches
- Superintendents and District Administrators
- Curriculum Specialists and Coordinators
- Faculty and Administrators from the University System of New Hampshire
- Faculty and Administrators from the Community College System of New Hampshire
- NH Department of Education Administrators and Consultants

The task force met monthly from July 2011 through January 2012. Through these meetings the task force reached consensus on the recommendations provided in this report.

The task force established two goals to guide its focus and efforts.

Goal #1 Provide recommendations that promote a K-12 continuum of mathematics curriculum and instruction that eliminates the need for mathematics remediation at post-secondary institutions.

Goal #2 Inspire educators in their task to design and implement authentic mathematical experiences and assessments so that students will effectively understand and apply their knowledge to new situations.

The task force acknowledges the importance of improving mathematics achievement for all New Hampshire students. John Lyons, Chair of the NH State Board of Education, has stated that improving mathematics achievement is as important to New Hampshire students as the drop-out issue. The importance of mathematics education is also evident in the final report from The National Mathematics Advisory Panel (2008). In its *Foundations for Success* (2008), the panel stated, "Sound education in mathematics across the population is a national interest. Success in mathematics education is important for individual citizens, because it gives them college and career options, and it increases prospects for future income. A strong

grounding in high school mathematics through Algebra II or higher correlates powerfully with access to college, graduation from college, and earning in the top quartile of income from employment." (Foundations for Success, 2008, p. xii) Improving mathematics education for every student in New Hampshire must be a systemic effort beginning with the mathematics taught at elementary levels through post-secondary and career opportunities. New Hampshire must reverse the trend of poor mathematics performance in its high schools and minimize the need for remediation at post-secondary institutions. This will develop a future New Hampshire work force that is well prepared for college and career.

Mathematics Achievement of New Hampshire Students

The formation of a state task force to investigate the state of mathematics curriculum and instruction in New Hampshire evolved from two trends relating to student achievement in mathematics at the secondary and post-secondary levels throughout the state.

The first identified trend demonstrated a substantial decline in student achievement on the NECAP assessment for 11th grade. Figure 1 provides the percentages of students performing at each of the four different NECAP achievement levels during Fall 2011. In terms of statewide accountability, achievement levels 3 and 4 represent those students who are designated proficient in mathematics. For grades 3 through 5, the percent of students proficient in mathematics is consistently 76%. However, the data in Figure 1 also suggests a decline in performance that becomes evident during the middle grades (6th through 8th grade). The percent of students proficient in grades 6 through 8 is 72%, 68%, and 68%, respectively. Analyzing student performance across the grades for Fall 2011 NECAP leads to further questions.

- Is this declining trend of mathematical performance from grades 3 through 8 and 11 unique to New Hampshire?
- Do other states demonstrate a decline in performance at the middle grades?
- What is causing the decline in mathematics performance as students enter and exit the middle grades?
- How can the decline from 8th grade mathematical performance to 11th grade results be explained?

Attempts can be made to address some of these questions by looking at results from other NECAP states, such as Vermont and Maine. It should be noted that Maine's participation in NECAP Mathematics began in 2009 for grades 3 through 8 only. Figure 2 demonstrates a comparison of Fall 2010 NECAP mathematics performance in New Hampshire, Vermont, and Maine for grades 3 through 8, and 11. This data supports that New Hampshire's decline in mathematics performance at the middle grades is more evident and noteworthy when compared to other states.

If grade 11 results are removed from the graph to further analyze the performance of grades 3 through 8 only, then New Hampshire should be concerned by its 10% range in performance from grade 3 to 8 with a consistent downward trend from one grade to the next. Contrary, Vermont and Maine exhibit only 6% and 4%, respectively, in their range of students proficient on NECAP Mathematics. In addition, both states show slight increases in grades 4 through 6 and another one at grade 8.

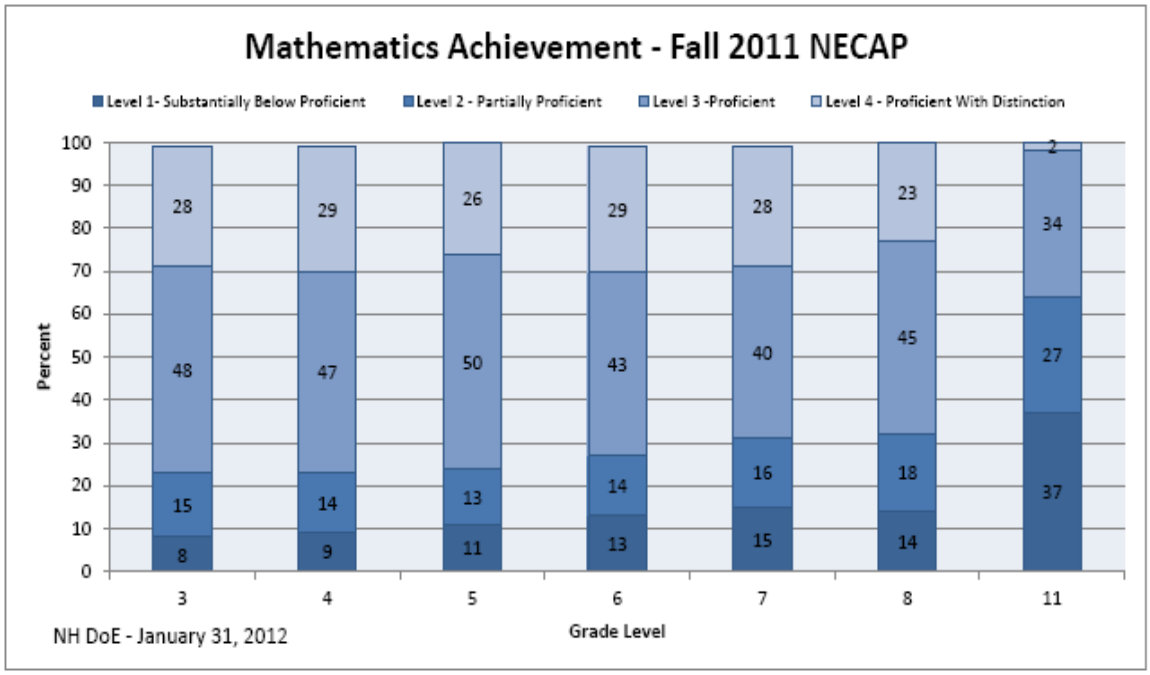

Figure 1: Comparison of NECAP Achievement Levels in Grades 3 through 8 and 11 based on Fall 2011 NECAP Testing

When performance is compared to other content areas, there is further data to suggest that mathematics at the middle and secondary levels should become a priority for New Hampshire. (See Figure 3) For all grades tested by NECAP, mathematics performance is lower when compared to achievement in reading. Figure 3 also demonstrates the trend of declining mathematics achievement in the middle grades. While the percentages of students proficient in reading seem to remain consistent during grades 6 through 8, this is not the case for mathematics. In addition, the gaps between reading and mathematics performances increase during the middle grades. This gap is evident in grade 11 with a 41% difference in proficiency between reading and mathematics. Also, it is worth noting comparisons to writing performance. Writing is tested only at grades 5, 8, and 11 using NECAP. In grade 5, mathematics achievement is higher with a difference of 21%. However, that difference decreases to 7% in grade 8 and eventually the difference reverses in grade 11 where writing performance is greater by 10%.

While these comparisons do not include a discussion about the differences in content knowledge required in learning mathematics versus reading or writing, it is worth mentioning the performance differences among the different content areas. Mathematics curricula and programs require students to apply reading, writing, listening and speaking skills, specifically in demonstrating the "8 Mathematical Practices" articulated in the Common Core State Standards for Mathematics (2010). The standards for Mathematical Practices "rest on important processes and proficiencies with longstanding importance in mathematics education including NCTM process standards of problem-solving, reasoning and proof, communication, representation, and connections." (CCSSM, 2010, p. 6). At the heart of these mathematical practices are students' abilities to communicate (verbally and in written form) using the language and structure of mathematics. "Mathematically proficient students try to communicate precisely to others." (CCSSM, p. 7)

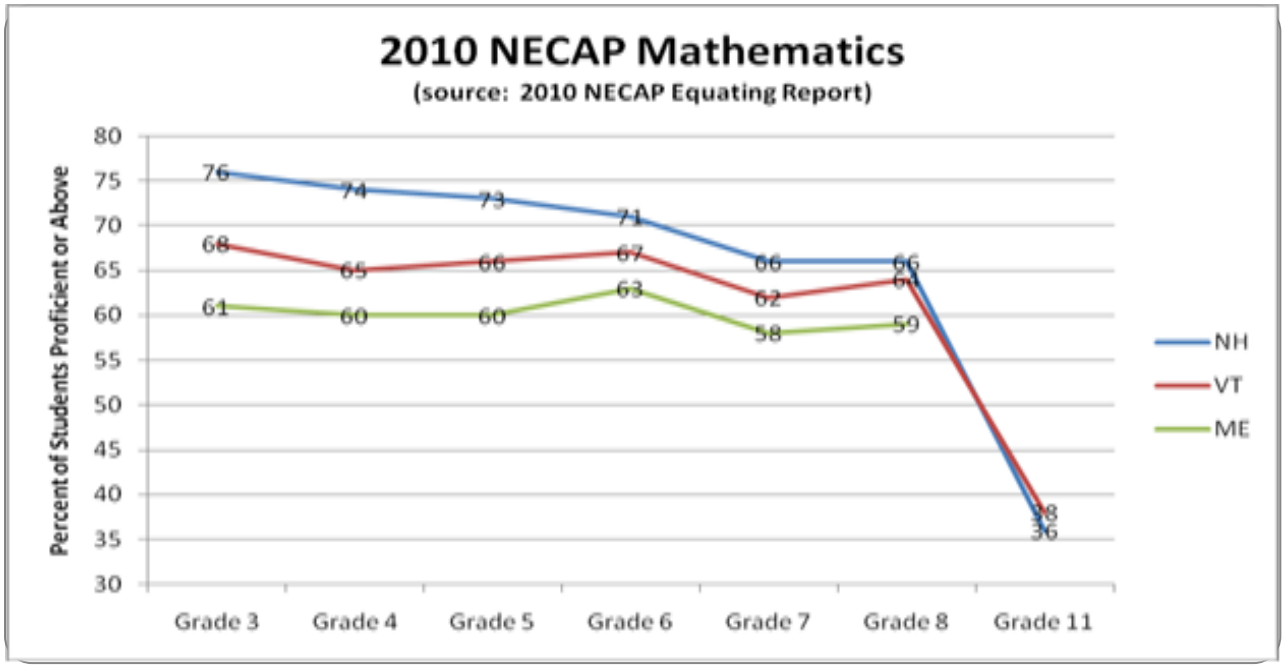

Figure 2: Comparison of Fall 2010 NECAP Mathematics Performance for NH, VT, and ME.

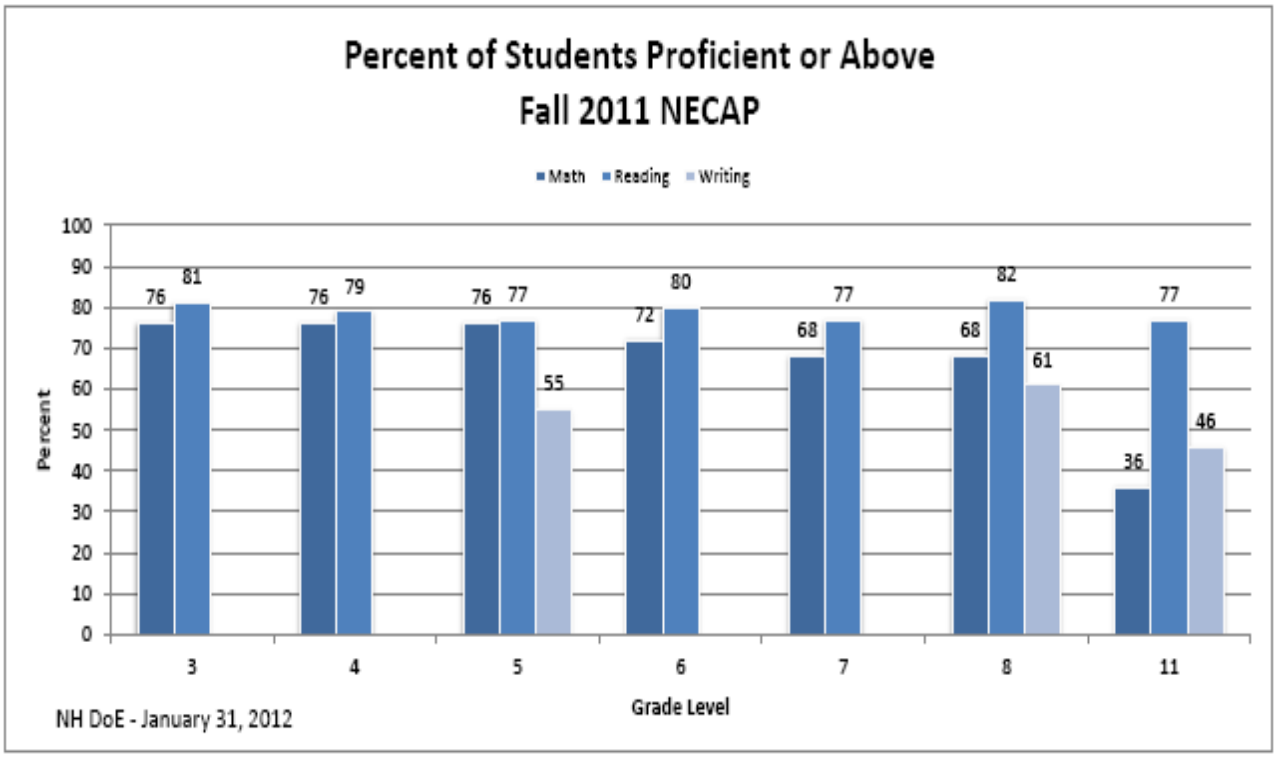

Figure 3: Percent of Students Proficient in Reading, Writing, and Mathematics for Grades 3 through 8 and 11 based on Fall 2011 NECAP Testing

Furthermore, the *New Hampshire PreK-16 Numeracy Action Plan for the 21st Century* (2010) describes quantitative literacy as involving the synthesis of several skills. Specifically noted in this synthesis of skills is the ability to read and understand quantitative representations, and effectively communicate using mathematical structures. Current trends seen in literacy instruction propose all educators, regardless of their specialized discipline, must also be teachers of reading and writing. If this is the case, then analyzing and comparing why mathematics performance is not consistent with reading and writing performance may provide additional pathways for increasing mathematics achievement for those students whose learning styles are more linguistic in nature than quantitative.

In addition to the integration of reading and writing in mathematics curricula, the SMARTER Balanced Assessment Consortium for CCSS is committed to emphasizing the mathematical practices in its development of a summative assessment . Four claims have been articulated

> **Claim #1:** Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.
> **Claim #2:** Students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.
> **Claim #3:** Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.
> **Claim #4**: Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.

"Claims are broad statements of the assessment system's learning outcomes…that will identify the set of knowledge and skills that are important to measure." (Draft 2 Content Specifications SMARTER Balanced Consortium, 2011, p. 16-17) With words such as explain, interpret, construct, and analyze, the application of reading and writing skills is essential for students to adequately demonstrate the mathematical practices and content knowledge that will be required by the SMARTER Balanced summative assessment. As the rigor of content knowledge required by Common Core State Standards and SMARTER Balanced summative assessments increases so will the demand for the integration of reading and writing skills. Thus, a comparison of mathematics and reading/writing performance is justified as a source for articulating a set of recommendations to help improve mathematics instruction in schools throughout New Hampshire.

Finally, Figure 4 tracks student cohort groups from Fall 2005 NECAP testing through Fall 2011. In this chart, the performance of student cohorts from one grade level to the next is displayed by selecting a year (on top) and grade level (to the left). To track the performance of the selected cohort start on the left, reading down and to the right for the next year's percent of students who scored proficient or better in mathematics. For example, 61% of 6th grade in 2005 were proficient or above in mathematics. This cohort of students demonstrated 62% proficient or above in 2006 (Grade 7), 58% in 2007 (Grade 8), and 36% in 2010 (Grade 11). This cohort supports the trend of declining performance in the middle grades. Another example is the grade 3 cohort in 2005, which is also the cohort of students for grade 8 in 2010. This group shows a trend from 3rd through 8th grade of 68%, 66%, 69%, 69%, 66%, and 66%. Based on the proposed transition timeline for NECAP to SMARTER Balanced assessment, this cohort will be the last to take NECAP mathematics in grade 11 during Fall 2013.

The National Assessment on Educational Progress (NAEP) also supports this trend in mathematics achievement in grades 3 through 8, and 11. Often referred to as "the Nation's Report Card," NAEP results confirm the academic achievement of New Hampshire students. "Along with Massachusetts, New Hampshire grade 4 students, on average, continue to have the highest performance compared to grade 4 students in all other state and jurisdictions throughout the nation on the NAEP Mathematics assessment. For grade 8, New Hampshire students were among the top-ten highest performing states in the Nation on both the Mathematics and Reading assessments. Only two states - Massachusetts and Minnesota - had higher achievement that was statistically significant compared to New Hampshire on the grade 8 Mathematics assessment." (www.education.nh.gov) While this news seems to provide a positive outlook for mathematics in grades 4 and 8, it is worth noting that the percentage of students proficient or above in 2011 for grade 4 was 58% and grade 8 was 44%. These percentages are lower than performance on NECAP. Figure 5 presents data from NAEP results in mathematics for grades 4 and 8 from 2003 through 2011. Once again, data supports the trend of declining performance during the middle grades. Figure 5 displays how the performance gap between 4th and 8th grade has grown from 2003 to 2011. While the elementary grades have improved in mathematics, middle grades have not improved at a similar rate to elementary performance.

Mathematics

Percent of students scoring Proficient or better

				Year	Year				(Goal)
Grade	2005	2006	2007	2008	2009	2010	2011	2012	2013
1									
2									
3	68	69	73	72	76	76	76		(100)
4	65	66	68	73	75	74	76		(100)
5	63	67	69	73	75	73	76		(100)
6	61	67	68	69	72	71	72		(100)
7	59	62	63	66	66	66	68		(100)
8	56	57	58	65	66	66	68		(100)
9									
10									
11			28	32	33	36	36		(100)
12									

Figure 4: NECAP Cohort Chart Fall 2005 to Fall 2011 Displays Student Cohorts Progress from One Grade to the Next Grade Per Year

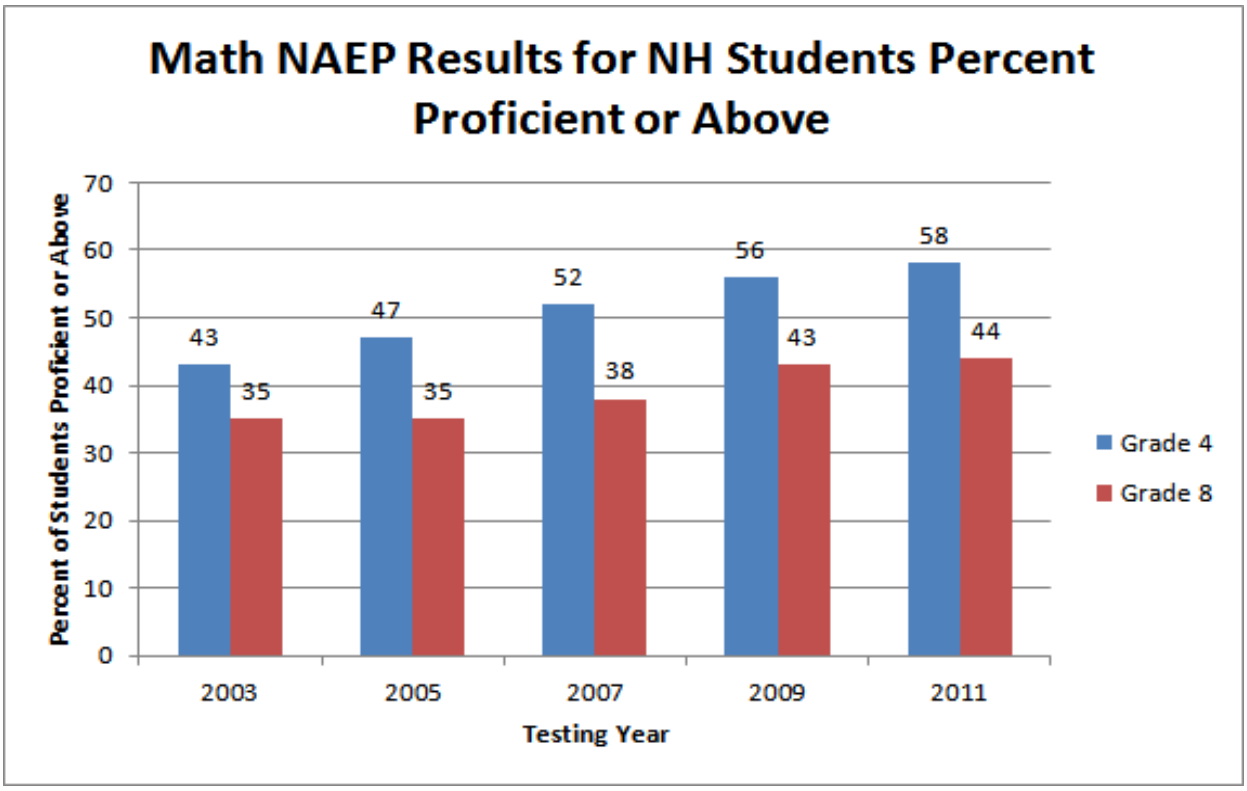

Figure 5: Math NAEP results for NH Students proficient or above in Grades 4 and 8 from 2003 through 2011

NAEP is limited in its data for mathematics achievement at the secondary level. In 2009, for the first time in the history of the NAEP assessment program, state-level data was collected for Grade 12 schools participating in the Grade 12 NAEP Pilot. Eleven states participated in this pilot, including New Hampshire. The other ten states participating included: Arkansas, Connecticut, Florida, Idaho, Illinois, Iowa, Massachusetts, New Jersey, South Dakota, and West Virginia. The State of New Hampshire elected to participate in the NAEP 2009 Grade 12 Reading and Mathematics Pilot to not only complement the existing grades 4 and 8 NAEP participation in Reading and Mathematics, but to also provide comparative assessment measures to its Grade 11 Reading and Mathematics New England Common Assessment Program (NECAP). In 2009, 32% of grade 12 students in New Hampshire performed proficient or advanced on the NAEP assessment in mathematics. The 2009 NECAP mathematics results for grade 11 indicated 33% of students tested were proficient or above. Thus, the 2009 NAEP performance is similar to the results of NECAP and confirms the need to prioritize mathematics achievement at the secondary level in high schools across New Hampshire.

The second trend articulated by the task force was identified through a presentation by the Community College System of New Hampshire (CCSNH) to the State Board of Education indicating the percent of students requiring remediation in mathematics at the post-secondary level. The CCSNH presentation stated that mathematics remediation was a challenge. According to the National Center for Education statistics, nearly two-thirds (63%) of those who require one or two remedial math courses fail to earn degrees. In contrast, nearly two-thirds (65%) of students who do not

require remediation complete associate's or bachelor's degree. The presentation further stated that approximately 65% of students entering New Hampshire's community colleges in the Fall of 2009 tested not ready for their first college-level mathematics course. It seems this data could have been predicted based on the 2009 NECAP and NAEP results which demonstrated that approximately only one-third of grade 11 and 12 students were proficient in mathematics.

In June 2006, a report entitled *Making the Transition from High School to College and the Workforce (MaTHSC)* was released by the New Hampshire Impact Center at Plymouth State University. The report was an outgrowth of a Mathematics and Science Partnership grant (Title IIb) and funded by the New Hampshire Department of Education and the U.S. Department of Education. Like the community college system in New Hampshire, the university system also faces similar challenges with mathematics remediation. In fact the *MaTHSC* report stated:

> "The highest level of mathematics reached in high school continues to be a key marker in pre-collegiate momentum, with the tipping point of momentum toward a bachelor's degree now firmly above Algebra 2." (MaTHSC Report, 2006, p. 1)

The report suggested that students who had completed mathematics in high school beyond the Algebra 2 level would be almost twice as likely to earn a bachelor's degree when compared to those who had not completed beyond Algebra 2. (Adelman, 2006, p. 20) The cost associated with mathematics remediation at the post-secondary level has been estimated into the millions of dollars. New Hampshire cannot afford these educational costs and based on the data presented in these reports, New Hampshire students will not be prepared to compete internationally for 21st century career opportunities.

As a result of the data collected and analyzed, the task force generated a list of essential questions to guide its work in framing a vision and set of recommendations to improve student achievement in mathematics. The list included the following questions.

- What does effective instruction in mathematics look like?
- What does student mastery in mathematics look like?
- What content and pedagogy knowledge is necessary for mathematics teachers to be effective in all grades?
- Where and how does mathematics connect to other content areas, including STEM (Science, Technology, Engineering, and Mathematics) and CTE (Career and Technical Education)?
- What mathematical knowledge and predispositions are colleges expecting?
- How are teacher preparation programs providing relevant training for mathematics in the 21st century?
- What continuum of teaching methods from kindergarten through post-secondary should be recommended?
- What essential support systems need to be in place to promote mathematics learning for all students?
- What is unique about today's learner and how do educators engage today's student?

These questions were the framework for developing the vision and recommendations presented in the next section.

Vision and Recommendations to Improve Student Achievement in Mathematics

In its report, the New Hampshire State Task Force on Effective Teaching (2011) stated, "Effective teachers focus relentlessly on the achievement of their learners. They are also deeply committed to the success of all learners. Research has shown that teacher knowledge and skills in key areas such as the learner and learning, content knowledge, instructional practice, and professional responsibilities contribute, in varying degrees, to student growth and achievement." (Effective Teaching Phase 1 Report, 2011, p. 8) Two out of the four areas of recommendation (referred to as pillars of effective teaching) focused on teacher preparation and professional development. As a result, a natural connection presented itself among the elements of the blueprint for effective teaching and the charge of this task force to develop recommendations for improving mathematics instruction in New Hampshire. The task force engaged in collaborative dialogue and research to articulate recommendations in three areas:

- *Impact on Teacher Preparation and Professional Learning,*
- *Implications for Elementary and Middle School Mathematics Instruction, and*
- *Curriculum and Instruction for High School and Beyond.*

Prior to identifying recommendations, the task force articulated five statements that reflect the vision or critical beliefs and values needed to improve instruction and ultimately change the course of mathematics performance for every New Hampshire Student. This vision included:

- System of professional learning and teacher preparation that reinforces the implementation of best practices in mathematics instruction,
- Smooth transitions in robust learning and assessment defined in a continuum from elementary to middle school to secondary,
- Quality learning experiences for students which integrate STEM, CTE, and other relevant real-world applications to deepen understanding of mathematics,
- Clear guidance for curriculum and competencies from kindergarten through post-secondary,
- Assurance that all NH students are well prepared for college and career after high school,

The task force also stipulated measures of success that could be used to gauge progress toward the vision. These measures of success included:

- Sufficient number of adequately prepared mathematics educators available for kindergarten through grade 12 positions in schools throughout New Hampshire.
- Increased number of NH schools with elementary mathematics specialists.
- Fewer students enrolled in remedial classes at all educational levels.
- Consistent mathematical proficiency percentages grade to grade to indicate stable performance from one grade level to the next.
- Greater number of students enrolled in more challenging STEM courses.
- Students applying mathematical knowledge, practices, and dispositions on a consistent basis, as measured by summative assessments based on Common Core State Standards, in order to demonstrate mathematical literacy needed for the 21st century.

Although the list of recommendations included in this report are organized by three different areas, all of the recommendations are connected and work in conjunction with one another to improve mathematics instruction and achievement for all New Hampshire students Therefore, leaders and educators across all grade levels are strongly encouraged to read the recommendations contained in each of the three areas and not only those listed for their specific situation.

Impact on Teacher Preparation and Professional Learning

Instructional change is a priority for the Mathematics Task Force. Researching and implementing effective instructional practices is key to improving mathematics achievement across all grades in New Hampshire, including post-secondary. Based on a variety of research, effective instruction in mathematics includes components ranging from an emphasis on mathematical practices, such as those found in the CCSS, to teacher content and pedagogical knowledge. As New Hampshire schools focus on instructional change in teaching mathematics these questions should be considered.

1. How can mathematical reasoning and problem solving become a consistent focus as students learn mathematics?
2. How do teachers and students address mathematical thinking in the classroom?
3. How does teacher questioning affect the learning of mathematics?
4. How can teachers motivate students to enjoy and want to learn mathematics?
5. How can mathematics become more challenging and interesting to students, even for those who struggle?
6. What impact does teacher content and pedagogical knowledge have on student learning of mathematics?
7. What role does teacher attitude about mathematics play in improving student achievement in mathematics?

The National Council of Teachers of Mathematics (2009) released a series of publications called *Focus in High School Mathematics: Reasoning and Sense Making.* The intent of this research is to provide instructional models that emphasize reasoning, problem solving, and mathematical thinking in classrooms. Additionally, this coincides with the 8 Mathematical Practices in CCSS. "High school mathematics prepares students for possible postsecondary work and study in three broad areas:

1. Mathematics for life
2. Mathematics for the workplace
3. Mathematics for the scientific and technical community.

As the demands for mathematical literacy increase, students face challenges in all three areas. First, the report of the Programme for International Student Assessment (2007) suggests that students in the United States are lagging in mathematical literacy, which that report defines as the ability to apply mathematics to analyze, reason and communicate effectively as they pose, solve and interpret mathematical problems in a variety of situations. Second, globalization and the rise of technology are presenting new economic and workforce challenges and the traditional mathematics curriculum is insufficient for students entering many fields. Finally, the U.S. is in danger of losing its leadership position in science, technology, engineering, and mathematics." (Focus in High School Mathematics, 2009, p. 3) An emphasis on mathematical practices and processes will help students to apply mathematical procedures, understand why those procedures work, and how they might use them to interpret results. Ultimately, this will. produce

quantitatively literate citizens who will make informed decisions

A classroom environment with a focus on mathematical practices and processes is also directly connected to the use of quality questioning to promote mathematical discourse on a consistent basis. "Teachers maximize learning when they encourage questions, expect students to elaborate on and explain their answers, and provide frequent feedback. In classrooms where there is effective instruction, both large and small group discussions between the teacher and students and among students commonly occur." (McREL, 2008, p.16) Asking questions allows the teacher to gauge student understanding, misunderstandings, and diagnose misconceptions. It requires skill and planning. Some strategies to improve questioning techniques in the mathematics classroom include:

- Asking questions of all types and varying degrees of depth of knowledge. Studies of questioning techniques in the typical mathematics classroom confirm that most questions asked have only minimal demands on student thinking and that low-level questions do not give a good picture of a student's grasp of mathematical concepts.
- Planning questions while preparing lessons. Questions should uncover student understandings, misunderstandings, and misconceptions. Questions should focus student thinking on processes rather than right or wrong answers.
- Providing multiple opportunities for discussion and social interactions around mathematical ideas so an environment conducive to high-quality mathematical discourse is created routinely for students.
- Modeling self-questioning techniques for students through the use of "Think Alouds." Teachers should act out their own thinking when approaching problems, such as "I wonder what I should do next. Maybe I should try…" (adapted from McREL, 2008, p. 16-17)

These are some approaches to promoting discourse in the mathematics classroom. Additional questioning strategies and techniques can be found in related research and resources.

In 2008, the *National Mathematics Advisory Panel Final Report: Foundations for Success* included recommendations relating to the social, motivational, and affective influences on mathematics achievement. Specifically, "children who seek to master an academic topic are said to have mastery-oriented goals. These children show better long-term academic development in mathematics than do their peers whose main goals are to get good grades or outperform others. Students who believe learning mathematics is strongly related to innate ability show less persistence on complex tasks than peers who believe that effort is more important." (National Math Panel Report, 2008, p. 31) Furthermore, there is a general perception that success in mathematics is largely a matter of inherent talent. This needs to be changed.

Research studies have shown that increased emphasis on the importance of effort in learning mathematics is related to greater engagement during learning and ultimately improved mathematics achievement. Dweck (2002) conducted research on the different theories that students have on intelligence. She described two theories known as fixed intelligence and malleable intelligence. If students believe that intelligence is fixed and unchangeable, then they also believe that failure in learning something, as well as the need to expend effort to learn something, indicates low intelligence. When students who believe in this type of intelligence encounter concepts they do not understand immediately, without effort, they believe that they are

incapable of understanding, and react by putting forth even less effort. In contrast, students who believe that intelligence is malleable are not as threatened by failure and willing to apply effort to learn new concepts. These students believe that the effort applied during learning is worthwhile because it will lead to greater understanding. Dweck also proposes that students' beliefs on intelligence can be changed and there are ways in which teachers can help students to start thinking of intelligence as malleable. A few of these strategies include the use of praise with students and empowering students with understanding the role they play in their own learning. As a result of this research, the National Mathematics Panel Report (2008) recommended "that teachers and other educational learners use research-based interventions to help students and parents understand the vital importance of effort in learning mathematics." (National Math Panel Final Report, 2008, p. 31) By understanding and implementing strategies related to the theories of intelligence students can develop self-efficacy, persistence, motivation, and self-regulation, which are critical components of success in learning mathematics.

A final component of instructional change is the impact teacher content and pedagogical knowledge, and attitudes about mathematics have on student learning and achievement. "Teachers need a deep understanding of the mathematics they teach including concepts, practices, principles, representations, and applications, to support effective instruction." (McREL, 2008, p. 24) A teacher's conceptual understanding of mathematics influences the decisions teachers make about classroom instruction. However, strong content knowledge is not enough. "Effective mathematics teachers employ a large repertoire of instructional methods, strategies, and models to produce more successful learners. Different instructional methods accomplish different learning goals for different students." (McREL, 2008, p. 27)

In general, teachers with deep mathematical content and pedagogical knowledge are able to:

- Present topics in the context in which they occur in daily life.
- Model content in a word problem format so students will become accustomed to the way mathematics is commonly encountered in the real world.
- Link mathematics to other content areas.
- Relate learning mathematics to understanding of technology, personal and social perspectives, historical issues, and cultural values.
- Encourage all students to learn for understanding.
- Foster healthy skepticism.
- Allow for, recognize, and build on differences in learning styles, multiple intelligences, and abilities.
- Carefully align curriculum, assessment, and high standards.
- Conduct formative/interim assessments of students' progress and use the results to improve instruction.
- Measure instructional effectiveness through student performance and achievement.
- Use a problem-solving approach.
- Hold high expectations for all students.

(adapted from McREL, 2008)

Another piece of this puzzle is teacher attitudes and beliefs about mathematics learning. According to a 2008 study by the National Mathematics Advisory Panel, 62% of Algebra I teachers reported that the "single most challenging aspect" of their jobs is "working with unmotivated students." The report indicated that often teachers have low expectations of students and this is demonstrated through classroom activities and lessons that do not engage or challenge students. "Educational change depends on

what teachers do and think, as does the success or failure of the educational process. Teachers mediate between the learner and the subject to be learned; consequently teachers' beliefs, attitudes, and expectations have a major impact on student achievement." (McREL, 2008, p. 28)

In conclusion, implementing effective, research-based instructional strategies in mathematics, in essence creating educational change, requires:

- Integration of mathematical reasoning and thinking along with problem solving in the mathematics classroom on a consistent basis.
- Effective use of quality questioning techniques to increase the depth of student mathematical understanding.
- Strategies to motivate students to enjoy and want to learn mathematics so the content can become more challenging and interesting.
- Improvements in teacher content and pedagogical knowledge and an understanding of the role teacher beliefs and attitudes have on student achievement in mathematics.

The bridge that links implementation of effective instructional strategies with improved student achievement in mathematics is teacher preparation programs and professional learning for practicing mathematics educators.

The task force recommends teacher preparation programs and professional learning for practicing mathematics educators:

Recommendation #1
Create new models of teacher internships and learning that shift from current practices of independent teaching to mentoring, co-teaching, coaching, and full collaboration and engagement with lead teachers using effective, research based instructional models (i.e. Japanese Lesson Study, Instructional Coaching, etc.).

Recommendation #2
Establish professional learning that utilizes the NH Department of Education's *Numeracy Action Plan for the 21st Century and Common Core State Standards - 8 Mathematical Practices* with both pre-service and practicing mathematics educators. Provide educators with researched based learning structures (i.e. professional learning communities, book study, etc.) so mathematical literacy and processes can be applied and incorporated into daily practice.

Recommendation #3
Encourage dedicated and job-embedded professional learning weekly for mathematics educators at the school level to collaborate and grow professionally as cohesive groups. This shared professional time could include action research, collaborative lesson planning, peer-to-peer feedback models, and data discussions. All with a purpose to engage mathematics educators in reflective practice and authentic learning with peers.

Recommendation #4
Promote teacher content and pedagogical knowledge along with attitudes and beliefs that will positively affect students' learning and achievement. This includes creating a sense of excitement and motivation relating to the study of mathematics with students and honoring teachers who exhibit innovation, dedication, and commitment to the teaching of mathematics. Strategies should embed the research on theories of intelligence promoting the notion that student effort plays an important role in mathematics achievement.

Recommendation #5
Include training on how to effectively utilize and incorporate 21st Century Skills, such as STEM and CTE outcomes, in mathematics instruction and provide students with opportunities to apply mathematical understanding in authentic contexts with real world applications.

Recommendation #6
Utilize effective data analysis models and protocols to review formative and summative student achievement data to inform instruction, diagnose student needs, and improve student outcomes.

Recommendation #7
Provide research and training in the use of extended learning opportunities (ELOs) for students to demonstrate proficiency with mathematical competencies in order to be prepared for experiences beyond high school. ELOs should challenge and engage students as they learn mathematics through practical applications.

Recommendation #8
Include the implementation of quality questioning techniques to create productive mathematical discourse in mathematics classrooms. An emphasis on quality questioning should provide pathways for students to communicate mathematical understandings, misunderstandings, preconceptions, and misconceptions. This strategy should serve mathematics educators in diagnosing student learning needs.

Implications for Elementary and Middle School Mathematics Instruction

While the impetus for this report was the declining mathematics performance of students at the secondary and post-secondary levels, the task force acknowledges that the recommendations in this report should include implications for the teaching of mathematics in elementary and middle schools throughout New Hampshire. While data presented previously in this report demonstrates acceptable levels of performance in some elementary grades, the fact remains the decline in mathematics achievement is noticeable beginning in middle school. As a result, too many students are entering high school and institutions of higher education with significant gaps in mathematical understanding. Four general components of elementary and middle school mathematics instruction are emphasized through the set of recommendations provided in this section. Curriculum articulation is the first component followed by the selection, implementation and sustainability of curriculum resources and materials. Connected to these first two components is the need to increase mathematical content and pedagogical knowledge for elementary and middle school educators. The final component is the relationship that should be established between school and communities to support the development of mathematical practices and habits of mind.

The National Mathematics Panel Report (2008) emphasized the urgency and need for a focused and coherent mathematics curriculum in elementary and middle schools across the United States. They further defined the terms *focused* and *coherent* by the following definitions:

"By the term *focused*, the Panel means that curriculum must include (and engage with adequate depth) the most important topics underlying success in school algebra. By the term *coherent*, the Panel means that the curriculum is marked by effective, logical progressions from earlier, less sophisticated topics into later, more sophisticated ones." (Foundations for Success, 2008, p. xvii)

This national emphasis has become the set of student learning expectations known as the Common Core State Standards in Mathematics (CCSS). This set of articulated learning progressions for mathematics from kindergarten through the completion of high school provides the focus and coherence of rigorous content knowledge and mathematical practices to ensure all students are career and college ready.

In order to promote mathematical literacy with all New Hampshire students, mathematical content knowledge and processes need to be emphasized at the elementary and middle grades through articulated curriculum standards that utilize the work of CCSS. In addition, the four assessment claims proposed by the SMARTER Balanced Assessment Consortium need to be emphasized in curriculum development from kindergarten through 8th grade.

> **Claim #1** Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.
> **Claim #2** Students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.
> **Claim #3** Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.
> **Claim #4** Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.

While development of mathematics curriculum in terms of content knowledge and mathematical practices is important in grades K through 8, the selection, implementation, and sustainability of mathematical programs used at elementary and middle grades is also critical to improving student achievement. Implementation and sustainability of commercially produced mathematics programs, especially at the elementary level, typically include discussions linked to fidelity and consistent use of program materials from one teacher to the next. The decision to purchase any type of program is especially significant to schools and districts in New Hampshire given current economic factors affecting educational budgets.

The focus of the National Council of Teachers of Mathematics (NCTM) 72nd yearbook was *Mathematics Curriculum Issues, Trends, and Future Directions* (2010). This resource provides guidance for the selection, implementation, and sustainability of mathematical programs and materials. In addition, the National Council of Supervisors of Mathematics released *Common Core State Standards (CCSS) Mathematics Curriculum Materials Analysis Project* (2011) to assist schools and districts with selection of mathematics materials. When designing the selection process for adoption of mathematics materials and programs, three goals are often considered.

1. Determine which materials are the best fit for an articulated mathematics curriculum.
2. Build teachers' commitment to using the new program.
3. Ensure that the selection process is fair and transparent.

In addition, curriculum leaders use the following questions to review program materials under consideration for adoption in a school or district.

- How do these materials align with national and state standards and assessments?
- Do these materials support good mathematics teaching and learning?
- What materials are similar districts using and how are their students performing?
- Are these materials a good fit for students and teachers in the district?
- What support will these materials need in order to be implemented and sustained well in the district?
- Can these materials be used as a lever for change?

(adapted from Mathematics Curriculum Issues, 2010, p. 208-209)

Finally, factors that are considered important when reviewing and adopting new materials are:

- Instructional Design
- Content Emphasis
- Support for Student Learning
- Support for Teacher Learning
- School and District Considerations
- Research on the Curricular Outcomes and Effectiveness

While the above all contribute to the selection of materials, implementation and sustainability are just as important. Research has been conducted in these areas relating to:

- Myths about Curriculum Implementation,
- The Importance of Technology Integration,
- Understanding Teachers' Strategies for Supplementing Materials,
- Teachers' Perspectives on Fidelity of Implementation to Materials, and
- Impact of Curriculum Materials on Learning for Students and Teachers.

Effective implementation and sustainability of materials will include significant professional development opportunities for practicing and new educators to understand a district's choice of mathematical materials and expectations. The choice to adopt a mathematical program needs to be strategically designed based on research and articulated with a vision that supports sustainability among all teachers and students long after the first few years of implementation. With such a plan, well -chosen materials can support student achievement in mathematics.

Once curriculum has been articulated and a mathematics program has been selected to develop and support curriculum standards, it is now in the hands of the elementary and middle school educators to bridge what students need to know with what they are able to demonstrate in terms of mathematical understanding. For this reason, increasing the content and pedagogical knowledge of elementary and middle school educators is the third component of the recommendations presented in this section. The 2008 National Math Panel Final Report recommended the use of elementary mathematics specialists as a practical alternative to increasing the content knowledge of all elementary teachers. Elementary Mathematics Specialists are teachers, teacher leaders, or coaches who are responsible for supporting effective mathematics instruction and student learning in the classroom, school, district, or state levels. (AMTE, 2010). Currently, New Hampshire has a state committee formed that has utilized research relating to elementary mathematics specialists to create professional development opportunities linked to Intel Math through Mathematics Science Partnership (Title IIb) funding and to establish standards for an elementary mathematics specialist credential. The goal to increase content and pedagogical knowledge in mathematics for elementary and middle school educators is already underway in New Hampshire.

The final component of elementary and middle school recommendations connects schools to families and communities in New Hampshire. Messages relating to implementation of the Common Core State Standards; importance of developing mathematical practices such as communication, reasoning, and problem solving; along with research indicating the importance of effort, and not innate ability, to improve mathematical achievement need to be consistently delivered across New Hampshire by state and local public officials and educators. Mathematical literacy is about quantitative situations which present themselves through everyday situations. It should not be acceptable to use the excuse, "I am just not good in math or I could never do math so it is okay for my student not to be good in math either." It is not acceptable to be illiterate in today's society, why then should it be acceptable to be quantitatively illiterate?

Mathematical habits of mind such as perseverance, risk-taking, curiosity, and self-confidence need to be developed at home, in communities, as well as in schools. "Acquisition of these habits of mind supersedes mastery of any content knowledge. Their achievement is necessary because it is not enough to know something; the learner must possess the ability to do something with that knowledge, whether it is to solve a problem, reach a conclusion or present a point of view." (Kansky, 2006)

The task force recommends elementary and middle school mathematics instruction:

Recommendation #1
Reflect a vertically aligned curriculum emphasizing the learning progressions articulated in the Common Core State Standards (CCSS) for Mathematics. Instruction should promote an increased depth of knowledge relating to critical concepts and skills needed for advanced mathematical ideas. In addition to content knowledge, mathematical practices and effective habits of mind should be developed and emphasized in grades K through 8.

Recommendation #2
Include differentiated instruction that embeds

- ongoing formative, interim, and diagnostic assessments,
- principles of Response to Intervention (RtI),
- integration of mathematical concepts and skills,
- use of multiple modalities, and
- authentic applications of mathematical concepts.

Recommendation #3
Support mathematical fluency with a goal that all students will be fluent with basic mathematical facts and operations. In addition, instruction should balance conceptual and procedural understanding, promote mental mathematics, reasonableness of solutions, problem solving, and grade level expectations as outlined in the CCSS domains and mathematical practices for each grade level.

Recommendation #4
Reflect the need for elementary and middle school educators to have sufficient mathematical content and pedagogical knowledge to make instructional decisions relating to the use of program resources. A balance between fidelity to a mathematical program and educator understanding of grade level expectations and standards is critical.

Recommendation #5
Support the selection, implementation, and sustainability of mathematical programs, resources, and materials. Research based systems that promote implementation and sustainability should be used once the selection of materials is completed to provide consistency of use and articulation of common expectations.

Recommendation #6
Implement, utilize, and sustain resources such as mathematics instructional coaches and elementary mathematics specialists (EMS) to develop effective instructional practices . EMS professionals can provide the content and pedagogical knowledge and peer leadership to support the focus, coherence, and precision that is needed in elementary and middle school mathematics.

Recommendation #7
Extend beyond the walls of the classroom to include collaboration with families and communities in the development of mathematical practices and habits of mind. A common goal for K-12 mathematics education and New Hampshire communities should be the increase of quantitatively literate citizens.

Curriculum and Instruction for High School and Beyond

In February 2010, the New Hampshire Department of Education released the *New Hampshire PreK-16 Numeracy Action Plan for the 21st Century.* This action plan is "to be used by school administrators to lead district efforts to adapt and strengthen their quantitative literacy programs to best meet the challenges of 21st century schooling. It is also hoped that teachers of mathematics and teachers of all disciplines will see this document as a resource to guide them as they work to ensure their students have the skills required to be quantitatively literate." (NH Numeracy Action Plan, 2010, p. 3). The State Numeracy Plan in conjunction with the *Making the Transition from High School to College and the Work Force (MaTHSC)* report (2006) and the 2010 Common Core State Standards (CCSS) provide the guidance needed to improve student mathematics achievement at the secondary level and prepare students for college and career.

Three themes encompassing the recommendations to improve mathematics instruction at the high school level were developed by the task force. The first theme highlights the need to transform instructional practices at the high school level from routine teaching methods in which information is disseminated to an instructional environment that promotes reasoning and sense making. Also, connected to the transformation of instructional practices is the theme of mathematical applications in real-world contexts. The final theme for the high school recommendations focuses on creating student support systems to diagnose student needs, close gaps in mathematical understanding, and decrease the need for remediation at the post-secondary level.

"Reasoning and sense making should occur in every high school mathematics classroom every day. An emphasis on students' reasoning and sense making can help students organize their knowledge in ways that enhance the development of number sense, algebraic fluency, functional relationships, geometric reasoning, and statistical thinking. When students connect new learning with their existing knowledge, they are more likely to understand and retain the new information than when it is simply presented as a list of isolated procedures." (NCTM Focus in High School Mathematics Reasoning and Sense Making, 2009, p. 5). Teachers can develop mathematical reasoning habits by implementing some of these suggestions.

- Provide tasks that require students to figure things out for themselves.
- Ask students to restate the problem in their own words, including any assumptions they have made.
- Give students time to analyze a problem intuitively, explore the problem further by using models, and then proceed to a more formal approach.
- Resist the urge to tell students how to solve a problem when they become frustrated.
- Ask students a variety of questions that will prompt their thinking.
- Provide adequate wait time after a question for students to formulate their own reasoning.
- Encourage students to ask probing questions of themselves and one another.
- Expect students to communicate their reasoning to classmates and the teacher, orally and in writing while using proper mathematical notations and vocabulary.

- Highlight exemplary explanations and have students reflect on what makes them effective.
- Establish a classroom climate in which students feel comfortable sharing their mathematical arguments and critiquing the arguments of others in a productive manner.

(adapted from Focus in High School Mathematics, 2009, p. 11)

Implementing instructional practices grounded in a focus on reasoning and sense making will provide students with engaging mathematical discourse and tasks that both interest and challenge students to further their mathematical knowledge.

Criticisms of mathematics curriculum at the high school level in the United States have included a lag in promoting mathematical or quantitative literacy among its students. While there is no one acceptable standard definition of quantitative literacy, there are a few common components that help define what is meant by it. Quantitative literacy involves:

- real-life situations,
- problem solving,
- synthesis of several skills, and
- responsible citizenship.

(adapted from NH Numeracy Action Plan, 2010)

In addition, high school mathematics curriculum and instruction often focus on the mastery of conceptual and procedural knowledge rather than on the application of concepts and procedures linked to real-world contexts. When comparing lessons from Japan and the United States, Stigler and Hiebert (1999) noted content is not absent from U.S. lessons, but the level is less advanced and requires much less mathematical reasoning than in other countries. In many studies that analyze lessons presented to students, U.S. teachers provided definitions of terms and demonstrated procedures for solving specific problems. Students were asked to memorize the definitions and practice procedures. Stigler and Hiebert coined this style of lesson delivery as "learning terms and practicing procedures." In order to provide students with mathematical applications, educators need to access resources from the National Council of Teachers of Mathematics and Common Core State Standards to integrate regular use of technology and mathematical modeling in high school mathematics classrooms.

Additionally, STEM (Science, Technology, Engineering, and Mathematics) outcomes, CTE (Career Technical Education) competencies, GAISE (Guidelines for Assessment and Instruction in Statistical Education) recommendations, and Common Core State Standards are demanding the focus on mathematical applications to relevant real-world contexts. In its May 2011 Policy Brief, the Alliance for Excellent Education called for *A Time of Deeper Learning: Preparing Students for a Changing World.* "Our increasingly complex world demands much of its students. In almost every aspect of their lives, young people are being asked to learn more, process more, and produce more. These increasing demands mirror the world around them. Now more than ever, the nation's education system is being challenged by a technology-driven global economy that requires a skilled and deeply literate workforce. Deeper learning is simply what highly effective educators have always provided: the delivery of rich core content to students in innovative ways that allow them to learn and then apply what they have learned. Rigorous core content is the heart of the learning process; true deeper learning is developing competencies that enable graduating high school students to be college and career ready and then make maximum use of their knowledge in life and work." (Alliance for Excellent Education, 2011, p. 1)

Student supports need to be developed that accomplish three tasks.

1. Systems of support, based on Response to Intervention (RtI) principles, should be developed to close the gaps for struggling mathematics students.

2. Students should be provided with remedial opportunities, prior to graduating from high school, to equip them with mathematical literacy that will be needed to be college and career ready.

3. Opportunities should be provided to students that allow dual enrollments in advanced mathematics at post-secondary institutions while still attending high school to ensure increased likelihood of achieving post-secondary degrees.

The data indicates too many students are entering high school with significant mathematical gaps. A systematic approach to closing those gaps is required if mathematical achievement is going to improve at the secondary level across New Hampshire.

Appendix A of the Common Core State Standards (2010) offers some strategies, consistent with Response to Intervention practices, which may be helpful in supporting students so they want to learn mathematics.

• Creating a school-wide community of support for students
• Providing students a "math support" class during the school day
• After-school tutoring
• Extended class time (or blocking of classes) in mathematics
• Additional instruction during the summer

"Watered-down courses which leave students uninspired to learn, unable to catch up to their peers and unready for success in postsecondary courses or for entry into many skilled professions upon graduation from high school are neither necessary nor desirable. Furthermore, research shows that allowing low-achieving students to take low-level courses is not a recipe for academic success (Kifer, 1993). The goal should be to provide support so that all students can reach the college and career ready line by the end of the eleventh grade, ending their high school career with one of several high-quality mathematical courses that allows students the opportunity to deepen their understanding of the college-and career-ready standards." (CCSS Mathematics Appendix A, 2010, p. 5)

The task force recommends high school curriculum and instruction:

Recommendation #1
Include teaching strategies that promote reasoning and sense making. Research based, effective instructional practices should be the focus of professional learning opportunities and teacher preparation programs.

Recommendation #2
(Rev. by State Board of Education, 10/17/12)
Encourage all students to complete mathematics each of their four years in high school demonstrating proficiency and substantial depth of understanding that is directly aligned to any of the four model course pathways articulated in *Common Core State Standards for Mathematics Appendix A : Designing High School Mathematics Courses Based on the Common Core State Standards*. In addition, ensure that the high school mathematics curriculum focuses on mathematical practices, quantitative literacy, and statistical reasoning so all students meet rigorous competencies in these areas that are aligned to Common Core State Standards. Develop flexible paths that allow students to meet these standards through a focus on communication, reasoning and sense making, and mathematical modeling.

Recommendation #3
Promote varied opportunities for students to remediate mathematical gaps prior to exiting high school, dual enroll in mathematics courses at post-secondary institutions, and participate in a high school course emphasizing quantitative literacy. This should include collaborations among high schools and community colleges or universities in New Hampshire (i.e. CCSNH Mathematics Learning Communities).

Recommendation #4
Provide increased opportunities for deeper learning including applications of mathematics in real world contexts. Connections should be made to extended learning opportunities utilizing science, technology, engineering, career technical education, and other relevant applications.

Recommendation #5
Include competencies aligned to the Common Core State Standards and Numeracy Action Plan. Consistent rubrics and performance indicators should be developed and implemented in NH High Schools that measure proficiency of mathematical competencies.

Recommendation #6
Provide student support services (such as Response to Intervention) to address individual learner needs, especially struggling mathematics students.

Recommendation #7
Promote student ownership of performance on statewide accountability measures such as NECAP and SMARTER Balanced Assessments relating to Common Core State Standards.

Conclusion - Connections to Trends in Mathematics Education

The final two recommendations of the task force provide guidance for the future direction of mathematics education in New Hampshire. They reach across all three areas used to categorize prior recommendations.

Recommendation:
The statewide system of accountability should measure student growth over time. To improve mathematics achievement of students, a measure is needed to determine the effects of closing mathematical gaps for approximately 2/3 of high school students who currently require remediation at the post-secondary level. Gaps in student understanding of mathematics grow over time; thus, student progress should also be measured similarly with a system that rewards significant gains in student mathematical growth.

Recommendation:
The State of New Hampshire should develop resources for schools and districts to support the recommendations connected to teacher preparation programs, professional learning for practicing teachers, and curriculum and instruction changes at elementary, middle and high schools. The task force recommends prioritizing resources to ensure consistent implementation of these recommendations throughout New Hampshire.

For at least the past five years and since the first grade 11 pilot test for NECAP, there has been an ongoing call from educators in schools across New Hampshire to develop a systemic approach to improving mathematics achievement for students at the secondary and post-secondary levels. The data presented in this report justifies this call for help.

Throughout this report, connections have been made to the following trends in mathematics education both in the state of New Hampshire and across the United States.

1. Implementation of the Common Core State Standards in Mathematics and development of the SMARTER Balanced Assessment
2. Emphasis on increasing K-8 teacher content knowledge in mathematics
3. Utilization of Elementary Mathematics Specialists and Mathematics Coaches to support effective instruction kindergarten through grade 12
4. Implementation of recommendations from the NH Task Force on Effective Teaching Phase 1 Report
5. Statewide support for consistency relating to competency based assessment and extended learning opportunities
6. Collaboration between secondary and post-secondary institutions to provide students with a smooth transition from high school to college or the work force
7. Implementation of programs that promote quantitative literacy
8. Professional development that blends the content and pedagogy knowledge needed for effective instruction with the power of data to drive decision making

As demonstrated by this list, the resources exist on which to build the future path to increase student achievement in mathematics across all grade levels. Whether the recommendations presented in this report reach sustainability and redirect the course of mathematics learning for students in New Hampshire is based on the decisions that are made now in terms of prioritizing funding, resources, and focus. This report articulates recommendations that encompass existing resources and can serve in guiding New Hampshire and its schools in developing action plans to meet the mathematical needs of the 21st century. The task force hopes this report will become the impetus for state, district, and school improvements in mathematics education.

APPENDIX A List and Affiliations of Task Force Members

Name	Position and Affiliation
Paul Leather	Deputy Commissioner, NH Dept. of Education
Joseph Miller	Director, Division of Instruction, NH Dept. of Education
Tim Kurtz	Administrator, Curriculum and Assessment, NH Dept. of Education
Tim Eccleston	NAEP Program Specialist, NH Dept. of Education
Chuck Annal	Vice Chancellor, CCSNH
Cecile Carlton	Retired Math Supervisor, Nashua School District & Consultant
Dean Cascadden	Superintendent, Bow School District
Michael Chandler	Professor, University of New Hampshire-Manchester
Brian Cochrane	Assistant Superintendent, Nashua School District
Rose Colby	Educational Consultant, Competency-based Learning
Beth Doiron	Community College System of New Hampshire
Christine Downing, Lead Writer	Mathematics Coach and Consultant, Newport School District
Kristen Gallo	Principal, Mast Way School, Oyster River
Karen Graham	Director, Leitzel Center and Professor, UNH-Durham
Chris Harper	Dean of Academic Affairs, Pinkerton Academy
Tamara Hatcher	Mathematics Coordinator, Concord High School
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Mike Jette	Principal, Merrimack Valley High School
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Jeanine King	Mathematics Coordinator, Hanover High School
Lucie Kinney	Mathematics Teacher, Berlin High School
Frank McBride	Principal, Goffstown High School
Gary McCue	Mathematics Teacher, Nute High School
Chip McGee	Assistant Superintendent, Bedford School District
Nick Miranda	Mathematics Dept. Chair, Berlin High School
Mary Moriarity	Assistant Superintendent, Rochester School District
Susan Randall	Dropout Prevention, NH Dept. of Education
Greg Superchi	Math Teacher, Lisbon High School & President Elect, NHTM
Michael Tursi	Assistant Superintendent, Manchester School District
Natalya Vinogradova	Professor and Director of Impact Center, Plymouth State Univ.

APPENDIX B OVERVIEW

REPORT TO THE STATE BOARD OF EDUCATION

Identified Trends in Mathematics Achievement

Trend #1 Student scores on NECAP (New England Common Assessment Program) assessments in mathematics demonstrated a substantial decline in performance as students move from elementary through middle school to secondary grades.

Trend #2 Mathematics remediation increased at the post-secondary level for both the University System of New Hampshire and the Community College System of New Hampshire.

Goals of the Task Force

Goal #1 Provide recommendations that promote a K-12 continuum of mathematics curriculum and instruction that eliminates the need for mathematics remediation at post-secondary institutions.

Goal #2 To inspire educators in their task to design and implement authentic mathematical experiences and assessments so that students will effectively understand and apply their knowledge to new situations.

Essential Questions

- What does effective instruction in mathematics look like?
- What does student mastery in mathematics look like?
- What content and pedagogy knowledge is necessary for mathematics teachers to be effective in all grades?
- Where and how does mathematics connect to other content areas, including STEM (Science, Technology, Engineering, and Mathematics) and CTE (Career and Technical Education)?
- What mathematical knowledge and predispositions are colleges expecting?
- How are teacher preparation programs providing relevant training for mathematics in the 21st century?
- What continuum of teaching methods from kindergarten through post-secondary should be recommended?
- What essential support systems need to be in place to promote mathematics learning for all students?
- What is unique about today's learner and how do educators engage today's student?

APPENDIX B OVERVIEW continued

Vision

1. System of professional development and teacher preparation that reinforces the implementation of best practices in mathematics instruction
2. Smooth transition in robust learning and assessment defined in a continuum from elementary to middle school to secondary
3. Quality experiences for students that integrate STEM, CTE, and other relevant real-world applications to deepen the understanding of mathematics
4. Clear guidance for curriculum and competencies from kindergarten through post-secondary
5. Assurance that all NH students are well prepared for college and career after high school

Measures of Success

1. Sufficient number of adequately prepared mathematics educators available for kindergarten through grade 12 positions in schools throughout New Hampshire
2. Increased number of NH schools with elementary mathematics specialists
3. Fewer students enrolled in remedial classes at all educational levels
4. Consistent mathematical proficiency percentages grade to grade to indicate stable performance from one grade level to the next
5. Greater number of students enrolled in more challenging STEM courses
6. Students applying mathematical knowledge, practices, and dispositions on a consistent basis, as measured by summative assessments based on the Common Core State Standards, in order to demonstrate mathematical literacy needed for the 21st century

APPENDIX B OVERVIEW continued

Areas of Focus and Recommendations

Statewide system of accountability needs to measure student growth over time.		
State of New Hampshire needs to develop resources for schools and districts to support recommendations.		
Impact on Teacher Preparation Programs & Professional Learning	**Implications for Elementary and Middle School Mathematics Instruction**	**Curriculum and Instruction for High School and Beyond**
1. New models of teacher internships	1. Curriculum alignment to CCSS	1. Include teaching strategies that promote reasoning and sense making
2. Professional learning linked to quantitative literacy and mathematical practices	2. Use of Differentiated Instruction	2. Encourage all students to complete mathematics each of their four years of high school.
3. Job-embedded professional learning to build collaboration	3. Support mathematical fluency	3. Promote varied opportunities for students to remediate gaps prior to leaving high school and dual enrollment in secondary and post-secondary mathematics opportunities
4. Promote teacher attitudes and beliefs, as well as content and pedagogical knowledge	4. Balance fidelity to programs and instructional decision making based on increased content and pedagogical knowledge	4. Increase opportunities for learning to include practical, real-world applications of mathematics
5. Incorporate 21st Century Skills including STEM & CTE outcomes to provide applications of mathematics	5. Support selection, implementation, and sustainability of mathematical programs/materials with research	5. Competencies and performance indicators aligned to CCSS and Numeracy Action Plan
6. Utilize effective data analysis models to inform instruction	6. Utilize mathematics coaches and elementary mathematics specialists	6. Increase student support services (RtI)
7. Research and training on Extended Learning Opportunities	7. Collaborate with family and community to develop and promote mathematical practices and habits of mind	7. Student ownership of assessment performance
8. Implement research on quality questioning and promoting discourse in the classroom		

APPENDIX C REFERENCES

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NOTES

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