



# FINDING THE

*A Call For Collaboration*

# SOLUTION

Bringing Mathematics and Science  
Education in Ohio Into the 21st Century



Ohio Mathematics & Science Coalition





“The need for a  
*cooperative  
venture in  
education* –  
from teachers  
to administrators  
to the state – is  
*paramount.*”

*An Ohio Teacher  
OMSC Teacher Colloquium  
2000*

The Ohio Mathematics and Science Coalition (OMSC) is an independent advocacy group comprised of representatives from the education, business and public sectors working to improve and revitalize Pre K-16 mathematics and science education in Ohio. The OMSC's mission is to lead and assist collaborative efforts statewide to achieve continuous, systemic and sustainable improvements in the mathematics and science education system serving all of Ohio's approximately 1.83 million students.

In 2000, the OMSC engaged various organizations and individuals to provide data, facts and recommendations from referenced studies and sources for this document. These sources are acknowledged at the end of this document.

This document presents an approach to improving mathematics and science education in Ohio that is coherent, research-based and designed to result in systemic and sustainable improvement. It begins with a short statement of "Ohio's Shared Vision" and is followed by a summary of the current state of mathematics and science education in Ohio and the challenges presented by this current state. Five priorities for change, each discussed in a separate section, form the basis for Ohio's Vision. The document concludes with recommendations that will turn this vision into a reality. OMSC acknowledges the important role of technology in the teaching and learning of mathematics and science, but does not attempt to address the state of, or the needs of, technology education in this document.

This document is written for all Ohioans. Outstanding and successful efforts for improving mathematics and science are underway by organizations, institutions and individuals across the state. However, the excellent work of professional and trade organizations, government agencies, businesses, other institutions and individuals is not enough if each entity works in isolation.

**The key to Ohio's mathematics and science education is the collective wisdom of all. This document is a "call for collaboration" across sectors. The time to work together to maximize the success of our students is now.**

# Ohio's Shared Vision for Mathematics and Science Education



The State of Ohio will have a system of mathematics and science education that enables and motivates **all** students to learn and apply mathematics and science at school, at home and in the community. This system will

- **Implement learning standards** that are research-based and professionally recommended;
- **Implement research-based curricula and assessments;**
- **Empower qualified teachers** who are provided in adequate numbers and supported by the necessary resources;
- **Commit to shared accountability and responsibility** by all stakeholders; and
- **Align the system** of standards, curricula, instruction, assessments and accountability measures.



## The Current State of

# Mathematics and

“As computers and advanced technology become commonplace features across American workplaces — on factory floors, in small grocery stores, and in client-service operations — the basic and technical skill requirements of traditional jobs are changing. And, as American companies embed more knowledge in their product offerings and explore new, more team-oriented working models, the average worker will need greater skills.”

U.S. Department of Commerce  
1999



The knowledge and skills acquired through mathematics and science education are the new currency for success in today's technology-driven, information-fueled economy. An effective mathematics and science education, along with language skills, personal skills and an understanding of technology, is an essential resource for literate, thoughtful and well-informed citizens who are the foundation of a well-functioning democracy.

Student achievement in mathematics and science is improving in Ohio. For example, in *The Nation's Report Card: Mathematics 2000*, the National Assessment of Educational Progress reported that Ohio's fourth-grade and eighth-grade scores increased 12 points and 15 points, respectively, since 1992. These improvements are one important indicator of progress. OMSC applauds the many successes of Ohio's current systemic reform efforts, while suggesting that further improvements can be achieved through collaborative efforts to provide

- greater access for students to curricula based upon the knowledge and skills needed in the new century,
- more opportunities for teachers to acquire and apply the best research-based practices in their classrooms,
- increased expectations for learning and for closing the achievement gap for all students, and
- policy and resource allocations aligned with identified needs.

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*“Improved mathematics and science education is essential to giving students who graduate from Ohio's schools a competitive edge in the global economy. As we marshal our energy and resources to address this critical need, let's also continue our efforts to assure that all children are reading at or above grade level by the fourth-grade. Fundamental proficiency in reading is the gateway for student success, whether young people aspire to become aerospace engineers or physicians. But, make no mistake, OMSC is right on target with its advocacy for ratcheting up mathematics and science education in Ohio.”*

Richard A. Stoff  
President, Ohio Business Roundtable

# Science Education in Ohio

## WHAT'S AT STAKE?

**The 21st century society demands a significantly higher number of mathematically and scientifically literate people than has been the case in the past.**

The primary message of the 2000 Glenn Commission report *Before It's Too Late* held that "America's students must improve their performance in mathematics and science if they are to succeed in today's world and if the United States is to stay competitive in the integrated global economy."

Given significant technological advances over the last 20 years, the products and technical capabilities we once considered state-of-the-art are now commonplace. As technology comprises a larger role in our lives, it also commands a larger role in the workplace. And as our world becomes more technological, mathematics and science knowledge and skills become indispensable keys to opportunity, success and prosperity.

For most of the 20th century, the majority of students left school and entered the manufacturing sector for its abundance of unskilled jobs and received on-the-job training that gave them the requisite skills. Today, the depth of science and mathematics literacy required, even for entry-level positions, is rapidly increasing.

These new workplace opportunities and challenges require better-educated workers who are adept at reasoning and problem solving. In the age of the computer and the Internet, obtaining information is not the problem — analyzing, making sense of, and effectively using it is. Understanding is key. Employers increasingly reward workers who

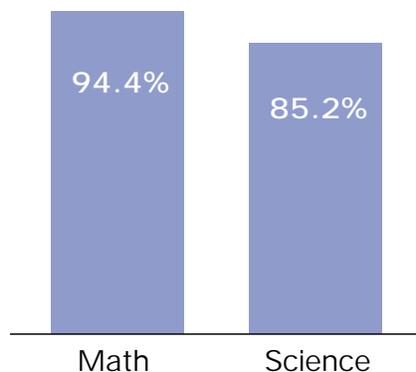
can develop solutions to an ever-changing set of problems and who become lifelong learners capable of independently acquiring new knowledge, skills and reasoning.

In everyday life, it is vital to have a mathematically and scientifically literate society. The environment, energy, health care, nutrition, construction, manufacturing, agriculture, bio-technology and personal finance are all areas where understanding is key to making sense of the complex issues that influence how we govern ourselves and how we conduct our individual lives.

The ability to approach problems logically, to apply reasoning to decision making, and to understand how things work are exactly the kinds of skills that are developed through meaningful mathematics and science education.

Crucial to Ohio's ability to retain and attract new business investments is the need for rigorous mathematics and science education driven by caring and qualified teachers. This will equip all students with the core knowledge and skills to learn for a lifetime.

Percentage of Ohioans who agree or strongly agree that improvements in mathematics and science education will improve children's job opportunities



Source: University of Cincinnati Survey, 2001

## WHAT'S THE PROBLEM?

**Ohio's mathematics and science education system is not providing all students with the mathematics and science knowledge and skills they need to be successful in today's technology-driven, knowledge-based society.**

While models of success exist, the education system that is expected to provide mathematics and science “life skills” is not meeting society's expectations. Consider some of the more compelling evidence:

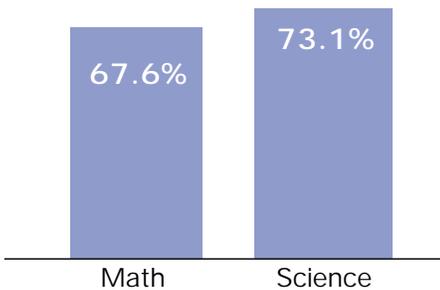
- Overall mathematics and science performance of students in the United States lags behind that of students in most other industrialized nations.
- In 1995, results of the Third International Mathematics and Science Study (TIMSS) of 41 industrialized nations showed that while U.S. students were above the international average at the fourth grade, by the eighth grade they were at best average, and by the twelfth grade they were near the bottom, comparable to third-world countries. In 1999, seventeen of 30 SMART (Science and Mathematics Achievement Required for Tomorrow) Consortium member districts participated in a replication of the TIMSS Study at the eighth grade (also known as the TIMSS 1999). The data show that the relative position of U.S. eighth-graders was below the international average in 1999 just as it was in 1995. Performance of Ohio students, like that of U.S. students, was consistently weak in the areas of geometry and measurement.
- Too many job candidates in Ohio are unable to apply fundamental mathematical and scientific principles to work-related problems. A 1997 study of more than 14,000 students in Ohio high schools showed that Ohio has a significant skill gap — that only one in every 14 Ohio twelfth-graders (or about 7 percent) meets workplace standards as defined by WorkKeys assessments in applied mathematics, reading for information, applied technology and locating information. (Ohio Business Roundtable, Ohio Department of Education and ACT, Inc., *Knowledge & Know-How: Meeting Ohio's Skill Gap Challenge*, 1998)
- Ohio earned only a C+ for how much mathematics and science training students get before college and how well they score on advanced placement and college entrance exams. (National Center for Public Policy in Higher Education, *Measuring Up*, 2000)
- Many of Ohio's metropolitan areas are rated low in workforce education levels, far behind regions with better-educated technical workers such as Austin, Texas; North Carolina's Research Triangle; and Boston. (Case Western Reserve University's Center for Regional Economic Issues, 1999)
- In 2003, the average Ohioan will earn \$2,720 less per year than the average U.S. citizen, resulting in a staggering \$30.7 billion loss in aggregate income to Ohioans. Much of this shortfall can be traced directly to inadequate science and mathematics training for our future citizens. As a result of the “learning gaps” in mathematics and science, many employers are forced to assume the huge cost of remediating and training their employees — a cost expected to reach \$78 billion nationwide by 2005. (Ohio Board of Regents Chancellor R. G. W. Chu, testimony to the Ohio House Finance and Appropriations Committee; A. P. Carnevale, *Education and Training for America's Future*, 1998)

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*“Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed.”*

NCTM Principles and Standards for School Mathematics, 2000

Percentage of Ohioans who believe essential mathematics and science skills have changed over the last 30 years



Source: University of Cincinnati Survey, 2001

One additional shortcoming of our current mathematics and science education system is that while the system serves some students extraordinarily well, in reality it does not effectively serve the majority.

One can imagine a future society stratified by those with knowledge and skills in mathematics and science and those without such skills and knowledge. Individuals who lack adequate understanding and cannot sufficiently apply mathematics and science knowledge and skills will have less access to opportunities for career advancement and economic prosperity than those who possess such understanding, knowledge and skills.

Failure to address these shortcomings in Ohio will take a heavy toll on our students as they move into their adult lives. Further, these shortcomings threaten the economic viability of our state in a competitive global environment, undermine Ohio's ability to retain and attract new business investments and inhibit the preparation of our students to be informed decision makers.

"So rampant is mathematics and science illiteracy in the United States that there is little stigma attached to it. Many adults readily confess 'I was never good at mathematics,' as if displaying a badge of courage for enduring what was for them a painful and useless experience. In contrast, no one freely admits they can't read."

Dr. Michael T. Battista  
Professor of Mathematics  
Education  
Kent State University  
2001





## WHAT'S THE CHALLENGE?

**Ohio must transform the state's mathematics and science education system.**

Our challenge now is to transform our current mathematics and science education system to a **world-class** system — from the classroom and school district level to the state level of education administration and policy making. The system must ensure that **all** students in Ohio — not just an elite few — are prepared to succeed and prosper. Then, Ohio business and industry will have access to the highly skilled workforce they need to remain competitive in global markets, and Ohio will be positioned for growth and prosperity in the 21st century.

Additionally, a priority must be placed on the system to create the quality and numbers of graduates with requisite skills to meet Ohio's needs.

Standards need to come to the forefront of our discussions; that is, we must carefully develop and align standards for learning, teaching, curricula, assessment, teacher preparation, professional development and school organization.

Building on the strengths of the current system, we must do nothing less than **change** the way we teach mathematics and science to our students, **change** the way we educate our mathematics and science teachers, and **change** the way we assess performance and measure mathematics and science knowledge and skills.



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*"Today . . . the most urgent social issue affecting poor people and people of color is economic access. In today's world, economic access and full citizenship depend crucially on math and science literacy."*

Robert P. Moses,  
Radical Equations: Math Literacy and Civil Rights, 2001

## WHAT'S THE SOLUTION?

**Ohio's strategy for creating a world-class mathematics and science education system in Ohio is a vision that reflects five priorities for change:**

1. Implement learning standards;
2. Implement research-based curricula and assessments;
3. Empower qualified teachers;
4. Commit to shared accountability and responsibility; and
5. Align the system.

The state-wide and system-wide implementation of the five priorities for change will dramatically and positively affect student learning in mathematics and science.

A more detailed discussion of each of the five priorities for change follows on the succeeding pages.

"Why is science literacy important? First, an understanding of science offers personal fulfillment and excitement — benefits that should be shared by everyone. Second, Americans are confronted increasingly with questions in their lives that require scientific information and scientific ways of thinking for informed decision making."

*NRC National Science Education Standards, 1996*



# IMPLEMENT LEARNING STANDARDS

# 1

There can be no “substitute for publicly enunciated academic standards that are clear, specific, and measurable; are widely publicized and are available to every teacher and parent; and are used to guide the design and development of curriculum, teacher preparation and professional development programs and state assessments.”

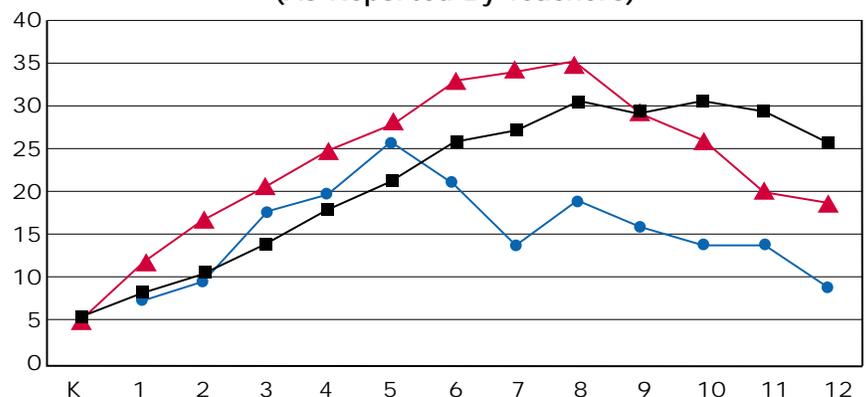
Achieve, Inc., 1999

**All Ohio schools need to implement mathematics and science learning standards that clearly define what students need to know and be able to do.**

## Where Ohio Stands Today

- The Ohio Department of Education and the Ohio Board of Regents initiated efforts in 1999 to create standards for mathematics and science education.
- Amended Substitute Senate Bill 1, which was signed into law in June 2001, mandated the development and communication of content standards and aligned assessments. The legislation substantially reflects the final report of the Governor’s Commission for Student Success, which was issued in December 2000.
- Some teachers and schools teach curricula that are “a mile wide and an inch deep” because (a) the traditional curricula keep teaching the same topics over and over, even when new topics are added; and (b) the traditional approaches to teaching do not always emphasize understanding.
- Many schools implement *de facto* standards through their selection of and reliance on textbooks to supply the content and organization of mathematics and science lessons.
- Communities are slow to embrace new curricula, teaching strategies and/or technology that are different from previous generations’ experiences.

**Mathematics Topics Taught By Grade**  
(As Reported By Teachers)



Source: A.J. van der Ploeg, *K-12 Mathematics in Ohio*, 2001

## Ohio's Vision for the Future

**Mathematics and science education in Ohio will be centered on a uniform set of research-based, professionally recommended standards that clearly guide curricula, instruction and assessment.**

- Ohio's academic content standards (currently proposed and future versions) will be implemented in all classrooms, schools and districts across the state.
- This set of standards will function as a statewide guideline defining what students need to know (facts, concepts, understandings and principles) and be able to do (procedures, ways of reasoning, types of problems to solve) to ensure success in higher education, the workforce and modern life. These standards will guide the development of local and statewide assessments.
- Ohio's mathematics and science standards will mirror the best thinking about what is central to the two disciplines, what is relevant to life and work in today's world, and what is interesting and accessible to all students. Academic content standards will be supported by detailed models of curricula materials and instructional approaches that embody the standards.

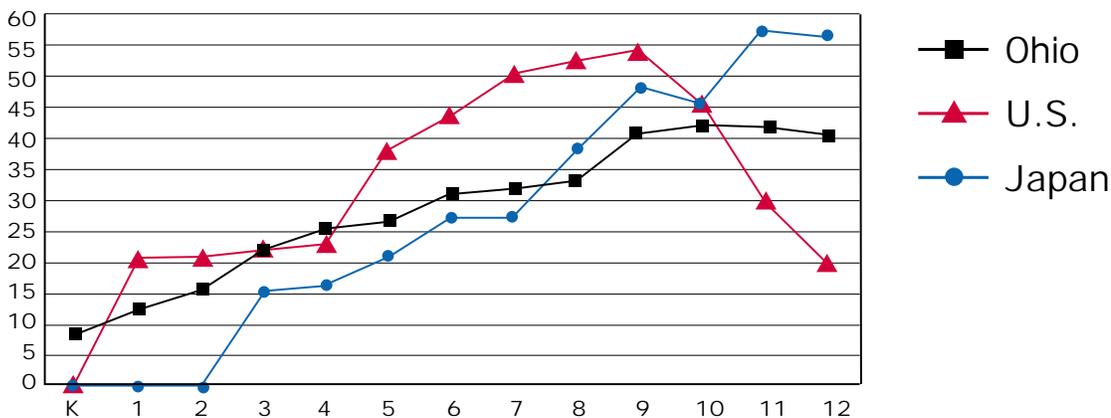
- It is essential that Ohio's content standards be firmly grounded in current research on students' learning of mathematics and science.
- It is important that standards be established with input from all major education stakeholders.
- Finally, learning standards for mathematics and science education will apply to **all** students – a system that helps each student reach his or her potential.

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*More than 90 percent of Ohioans support standards for teaching and learning in mathematics and science.*

University of Cincinnati Survey, 2001

**Science Topics Taught By Grade**  
(As Reported By Teachers)



Source: A.J. van der Ploeg, *K-12 Science in Ohio*, 2001

# IMPLEMENT RESEARCH-BASED

## 2

“Today many students are not learning the mathematics they need. In some instances, students do not have the opportunity to learn significant mathematics. In others, students lack commitment or are not engaged by existing curricula.”

*NCTM Principles and Standards for School Mathematics: An Overview, 2000*

**Ohio needs mathematics and science curricula, instruction and assessments that are grounded in the latest research.**

### Where Ohio Stands Today

- There are a number of exemplary programs with highly effective educators engaged in student learning and teacher preparation. The dilemma is that these educators are too few and unevenly distributed in terms of equal access.
- In too many mathematics and science classrooms, curricula and instruction are limited to basic skills and outdated bodies of knowledge. Understanding is often compromised by efforts to cover the textbook or content from previous grades.
- Teaching in today’s mathematics and science classrooms is often prescriptive and teacher-centered. Learning consists of memorizing information and imitating procedures presented by teachers and textbooks. Curricula are a “rhetoric of conclusions,” and learning is often reduced to “mindless mimicry.”
- In many instances, mathematics and science instruction fails to take into account different learning styles.
- Tradition-based instruction typically is not grounded in current research on how students learn. The consequence is that most students are unable to make genuine sense of mathematical and scientific ideas, and thus resort to rote memorization.
- Time spent practicing repetitively for standardized tests and memorizing lower-level specific content is less effective than engaging in meaningful learning experiences and in building understanding of overarching principles or underlying concepts.

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*“Participants believe . . . that learning and memorizing specific formulas and definitions is far less important than understanding math as a way of thought or a tool for further learning. . . . For K-12 science education, participants emphasize the need for students to attain an understanding of science by doing science.”*

OMSC Teacher Colloquium, 2000

# CURRICULA AND ASSESSMENTS

## Ohio's Vision for the Future

**Practices and policies will reflect the most recent, widely accepted research about how students most effectively learn mathematics and science.**

- Curricula, instruction and assessment will emphasize understanding of concepts rather than rote memorization. Mathematics will be viewed as reasoning rather than just rule following. Science will be viewed both as inquiry and as a complex body of knowledge.
- Curricula materials, instructional methods and assessments will feature genuine problem solving rather than mindless repetition and imitation. The focus must be on fewer core topics with greater depth. Students will be engaged in learning experiences that will be more interesting and relevant to students — not just by using real-world applications, but also by focusing on “sense making” and understanding.
- Teachers will think systematically and reflectively about their practice, using classroom experience and knowledge gleaned from education, training and professional interactions to recognize appropriate instructional approaches to fit each individual student's specific learning needs.
- Curricula, instruction and assessment will be aligned with each other and with Ohio's academic content standards for mathematics and science.
- Improvements in high-stakes assessments will be valid, research-based measures of mathematics and science learning.

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*“If the core of mathematics and science is about inquiry, then too many of today's mathematics and science classrooms come up short. Students are crippled by content limited to ‘What?’ They get only a little bit about the ‘How?’ (or ‘How else?’) and not nearly enough about the ‘Why?’ Missing almost entirely is ‘Why should I care?’ It is hard to imagine that students in these classes are gaining the conceptual and problem-solving skills they need to function effectively as workers and citizens in today's world.”*

Glenn Commission, 2000



# EMPOWER QUALIFIED TEACHERS

## 3

"The United States is one of the few countries in the world that continues to pretend — despite substantial evidence to the contrary — that elementary teachers are able to teach all subjects equally well. It is time that we identify a cadre of teachers with special interests in mathematics and science who would be well prepared to teach young children both mathematics and science in an integrated, discovery-based environment."

*National Research Council,  
1989*

**Ohio needs teachers empowered with the confidence, knowledge and skills to be effective teachers of mathematics and science for all students.**

### Where Ohio Stands Today

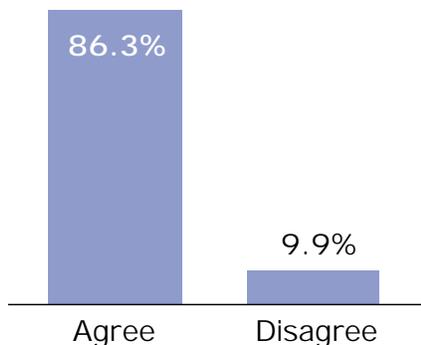
- Ohio does not have enough qualified mathematics and science teachers. Some districts have had to hire mathematics and science teachers under the provisions of alternative and/or temporary certification. Lack of specific content knowledge diminishes teachers' effectiveness and confidence.
- In some Ohio communities, there are outstanding instances of excellent teachers and programs in mathematics and science. Unfortunately, these instances are too few and too widespread.
- Many teachers lack background and understanding about how students learn mathematics and science. They seldom use the most appropriate instructional methods for optimizing student learning of specific mathematics and science concepts, content and skills.
- Some teacher preparation programs have been redesigned to reflect research-based practices. However, a lack of cohesiveness within teacher preparation programs and between courses and instructional methods in Colleges of Education and Arts and Science still exists in many institutions.
- The shortage of qualified teachers influences the experiences of student teachers. Too often a pre-service teacher is placed with a teacher modeling traditional, rather than research-based, teaching methods. When that happens, the student teaching experience does not provide an opportunity to observe and practice professionally recommended instructional methods.
- Historically, education programs are among the least expensive programs offered by state universities. As a result, state subsidies for education enrollments are relatively low. Each university has the option to reallocate funding, but generally Colleges of Education are not given priority.

## Ohio's Vision for the Future

**A teacher's lifelong learning system will begin with and continue to build on solid content knowledge and effective, research-based teaching methods.**

- Aspiring teachers will acquire a rich, deeper understanding of content knowledge than most currently possess, as well as a firm understanding of how students learn mathematics and science and appropriate instructional methods to employ in specific learning situations.
- Throughout every teacher's career, the system will also provide continuous opportunities to build and update content knowledge and knowledge of how students learn and to enhance and refine classroom skills through a wide range of collaborative professional development experiences. Programs will reflect ongoing research in how students learn, as well as the teaching of mathematics and science, and will be available during the school day as well as after hours and during school vacations. The system also will support teachers' professional growth by setting aside significant work time for such learning.

Percentage of Ohioans who believe teachers need specialized training to teach mathematics and science



Source: University of Cincinnati Survey, 2001

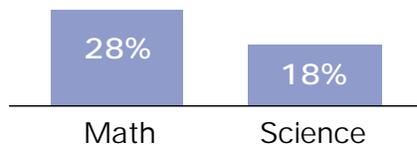
- Colleges and universities will take the lead in making changes in the way mathematics and science are taught in Ohio's schools. In content and education courses, students will be exposed to inquiry-based methods so that aspiring teachers experience as students the same kind of high-quality mathematics and science teaching we expect them to deliver to their students.
- Arts, sciences, business, and engineering faculty will work closely with schools of education to assure proper preparation of our future mathematics and science teachers.
- Teachers will receive adequate support to continue their professional development training. They will be compensated at a level that attracts them to and retains them in the profession.

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*"A 2000 OSI-Discovery survey reported that Ohio's state-supported universities graduate approximately 200 secondary mathematics and 240 secondary science teachers per year. This number is too meager to supply Ohio's approximately 1,500 middle and secondary schools that face growing retirements of veteran teachers and an attrition rate of nearly 20 percent of beginning teachers after three years."*

Jonathan Tafel  
Vice Chancellor  
Ohio Board of Regents

Percentage of U.S. teachers who are teaching without a major or minor in their field



Source: Richard Ingersoll, *American Education Researcher*, March 1999

# COMMIT TO SHARED ACCOUNTABILITY AND

## 4

**All of Ohio's education stakeholders – students, parents, teachers, school administrators, businesses, government, colleges and universities, the public – need to accept their role for improving the mathematics and science education system.**

### Where Ohio Stands Today

- Ohio's stakeholders are often unaware of efforts undertaken by other stakeholders. Lack of information impedes the functioning of the mathematics and science education system.
- Many of Ohio's students do not have a nurturing adult outside of the school environment.
- Far too many parents and other adults fail to recognize how negative attitudes about mathematics and science adversely influence a child's chances for success.
- Faculty members outside of the colleges of education rarely see themselves as educators of teachers.

### Ohio's Vision for the Future

**Everyone has a stake in the success or failure of Ohio's mathematics and science education system and will be accountable and responsible for improving student learning in mathematics and science.**

- All stakeholders will provide input to support the continuous improvement of accountability measures that are fair and aligned with the curricula.
- All stakeholders in the system will recognize and embrace their role in improving student learning. They will fulfill their roles with a personal commitment that extends beyond mere job descriptions and occupational responsibilities. They will accept shared ownership of the results the system is producing — what it is achieving, or failing to achieve.
- A strong “systems” approach will go hand-in-hand with an emphasis on shared accountability and responsibility for results. Ohio's education system will operate as a coherent whole; its many people, structures and processes, and all of their interactions, will be coordinated and support one another. All efforts will be coordinated, including a statewide communication plan.
- Students will link acquisition of mathematics and science skills with success in the workplace.

“The active involvement of parents is absolutely critical to a child's success in school. Because teachers cannot do it alone, preschool programs' capacity to offer parent training and information should be expanded.”

Governor's Commission for Student Success, 2000

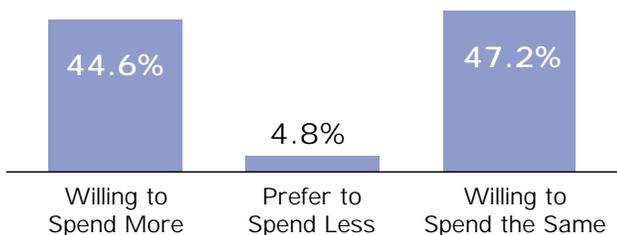
# RESPONSIBILITY

- Students will demand more of themselves and the education system.
- Increased parental expectations and involvement will both foster and support mathematics and science education improvements and encourage students to work hard and explore, understand and apply mathematics and science.
- Continued investments by businesses and the community at large will provide the resources and technical expertise needed to drive improvements in mathematics and science education. Further, businesses and the community at large will help students see direct links between the mathematics and science skills needed for life and work in the 21st century.
- College and university faculty in all disciplines will view themselves as educators of teachers. All classes will exhibit model instruction for any student in any class who may be a prospective teacher.
- Enlightened state leaders will assure that financial resources are in place to accomplish agreed upon goals.

“Over 50 percent of students say they could bring home grades of C or worse without their parents getting upset. Twenty-five percent say they could bring home grades of D or worse without upsetting parents.”

*North Central Regional Educational Laboratory (NCREL), 2001*

Willingness of Ohioans to spend tax monies to support improvements in mathematics and science education



Source: University of Cincinnati Survey, 2001



# ALIGN THE SYSTEM

## 5

**The components of Ohio's mathematics and science education system need to be aligned and work effectively with one another.**

### Where Ohio Stands Today

- Successful models for improving students' performance in mathematics and science have not been widely replicated. There is limited consensus on future directions, particularly at the school and community levels. The lack of alignment between state and local improvement efforts is part of the problem.
- Significant efforts are underway to develop mathematics and science standards and new assessments. However, present curricula, instruction and assessments in some districts do not reflect state standards.
- There is little agreement among all stakeholders as to what students need to know and do, as well as what teachers need to know and do.
- All too often, stakeholders do not make decisions about mathematics and science education based on the same vision — nor are the improvements systemic or long-term.

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*"Bringing a system together such that what makes sense for the participants is coherent with what makes sense for the system does not happen of its own accord. There need to be strategies in place that allow reconciliation of these different perspectives to occur as a normal part of the functioning of the system, whether it be a classroom, a school district, or teacher professional development."*

Dr. Peter W. Hewson  
Professor of Curriculum and Instruction  
University of Wisconsin-Madison  
2001

"... the prevailing attitude among teachers is that change has little support from administration decision makers."

*OMSC Teacher Colloquium, 2000*

## Ohio's Vision for the Future

### **Creating a world-class mathematics and science education system for Ohio requires a unified vision of what the system will be and how it will work.**

- Standards, curricula, instruction, assessment and accountability will be aligned to form a coherent system.
- Parents, students, educators, business and industry, policy makers and community leaders will work together to align the system and support its realization. They will work to achieve common goals, and they will identify and eliminate situations where they are working at cross-purposes to each other.
- To achieve alignment in mathematics and science education, two fundamental principles about curricula and instruction will be accepted:  
(1) a focus on depth of understanding of concepts and their applications will be established, and  
(2) research about how students learn will be used to guide these decisions.
- A process will be developed to measure the success of the agreed upon vision and to determine how the system and its components will be held to the vision.
- The shared vision will be communicated to all stakeholders in the system. Everyone will monitor his or her efforts to be sure they are consistent with the vision and contributing to progress toward turning the vision into reality.
- Adequate resources at state and local levels will be allocated to support a vision for the future and to make it a reality for all students.

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*“We are recommending clear standards of what should be taught and learned. We are recommending assessments designed to measure progress and provide helpful diagnostic information. We are recommending rewards and sanctions that will hold everyone – students and adults – accountable for results. Importantly, these elements come together as a system aligned around the standards and what it takes to help students to succeed.”*

Governor's Commission for Student Success,  
2000



# RECOMMENDATIONS for Ohio's Mathematics

As advocates for quality mathematics and science education, OMSC and its member affiliates support actions that will provide meaningful and rigorous experiences for Ohio students. Collaboration between and among all stakeholders will result in the quality educational system that all students deserve. Critical to the success of this process and the effective implementation of the recommendations below is the implementation of the new academic content standards and other related efforts involving all stakeholders.

## 1. Implement Learning Standards

- Continue to develop a uniform, statewide set of age-appropriate, research-based and professionally recommended learning standards that have been benchmarked against national and international standards.
- Continue to educate stakeholders about the new standards and how they apply to each component of the mathematics and science education system.
- Monitor how the standards are being applied to ensure they are reflected in curricula, instruction and assessment.

## 2. Implement Research-based Curricula and Assessments

- Use curricula, instructional methods and assessment tools that reflect current scientific research in mathematics and science learning and that have been developed and tested by recognized experts.
- Ensure that mathematics and science curricula and instruction are carefully aligned with standards and assessments.
- Ensure that curricula and instruction reflect mathematics and science as inquiry-based disciplines; focus in greater depth on fewer core topics; are supported with appropriate resources; and are fair, genuine and useful to all students.
- Use research-based, professionally recommended assessments that specify, measure and report whether students meet specific content learning standards.
- Provide timely feedback from assessments so that schools and teachers can use the information to improve student learning in mathematics and science.
- Participate regularly (as a state) in national and international assessments to learn how Ohio's students are doing in comparison to students in other states and nations.

## 3. Empower Qualified Teachers

- Require school districts to use qualified mathematics and science teachers for all mathematics and science instruction.
- Develop a teacher licensure and training system that ensures all teachers who teach mathematics and science have adequate knowledge of (a) mathematics and science content; (b) scientific research on how students learn mathematics and science; and (c) instructional methods and appropriate, meaningful and effective materials for teaching the subjects at all grades specified on their license.
- Ensure that mathematics and science content and methods courses in colleges and universities are consistent with, and model, research-based content and instruction.
- Provide professional development learning opportunities in different forms, such as courses, coaching, mentoring, peer support groups and attendance at professional conferences.
- Set aside significant daily work time for teachers to devote to professional development activities (time away from regular teaching duties).

# and Science Education System

- Support development of school cultures that support professional collaboration among teachers, administrators and professional mathematicians and scientists, and that overcome professional isolation.
- Require school and district administrators to play an active role in collaboration with teachers and in designing and implementing in-service opportunities based on sound scientific practice for professional development.
- Provide resources to support long-term, sustained professional development.
- Offer statewide leadership, support, and requirements to help school districts implement continuous professional development programs at all grade levels.
- Provide compensation to mathematics and science teachers at a level that encourages them to remain in the classroom.

## 4. Commit to Shared Accountability and Responsibility

- Implement a comprehensive, coordinated statewide mathematics and science education system that guides and connects the following components: learning standards, curricula and instruction, assessment, teacher licensure, university programs for teacher education, teacher professional development and education funding.
- Implement a mechanism for regularly monitoring and analyzing the functioning of mathematics and science education goals, including their implementation and results at the state, district, school and classroom levels.
- Conduct a public review of all components of the statewide mathematics and science education systems by experts every five years.
- Encourage all stakeholders to commit to the shared vision for mathematics and science education in Ohio.
- Educate all stakeholders about the benefits of implementing scientifically sound, professionally recommended practices in mathematics and science education.
- Put aside differences based on specific stakeholder interests to work together to promote improved teaching and learning in mathematics and science.
- Encourage all high school students to take mathematics and science courses beyond state minimums.

## 5. Align the System

- Develop a unified, coherent vision that guides all aspects of mathematics and science education in Ohio.
- Support cooperating mechanisms at the state level to assure that mathematics and science programs and policies are research-based and led by experts in mathematics and science education, and that standards, curricula, instructional strategies and assessments are aligned.
- Secure a commitment from all stakeholders to design, implement, support and share responsibility for an accountability system for mathematics and science education that
  - Provides supportive learning environments in which **all** students learn challenging, applicable, and suitable mathematics and science material;
  - Makes mathematics and science more interesting and relevant to **all** students by providing real-world applications and exploring how mathematics and science can help them make sense of their world;
  - Develops in **all** students a deep and genuine understanding of mathematics and science concepts, emphasizing depth and application of understanding rather than breadth of coverage; and
  - Provides **all** students with learning experiences that allow them to express their own ideas, compare them with other ideas, make reasoned choices between them, and exercise personal judgment.
- Formulate and implement a multi-year, integrated improvement plan that addresses all elements of Ohio's Pre-K-16 mathematics and science education system.

# CONCLUSION

Ohio's mathematics and science education system needs improvement. The consequences of not supporting a unified vision could be severe for Ohio students who would have limited employment choices and reduced opportunities for success in the world. Without an adequately skilled workforce, Ohio business and industry will find their competitiveness in the global economy weakened. Ohio's ability to retain and attract new business investments will be undermined. Our economic prosperity and overall quality of life will be at risk.

All Ohioans must share responsibility to

- help all students learn mathematics and science with understanding and purpose;
- help all mathematics and science teachers teach with enthusiasm and competence through research-based professional practices;
- provide adequate resources for all schools and school districts;
- support students and teachers in their ongoing learning through appropriate and aligned resources and policies; and
- align the system to achieve the vision.

**The key to Ohio's mathematics and science education is the collective wisdom of all. This document is a "call for collaboration" across sectors. The time to work together to maximize the success of our students is NOW.**

# COMMISSIONED DOCUMENTS

The following documents were commissioned by the Ohio Mathematics and Science Coalition and were used extensively in the preparation of this document. They are available on the OMSC website at [www.oai.org/OMSC](http://www.oai.org/OMSC).

“A New Vision for Mathematics Education in Ohio,” M.T. Battista, Kent State University, September 2001.

“Ohio’s Vision for Science Education in the Twenty-first Century,” P.W. Hewson, University of Wisconsin-Madison, September 2001.

“Addressing Public Opinion and Awareness of Ohio’s Education System in Mathematics and Science – Final Report,” University of Cincinnati College of Education and Evaluation Services Center, March 2001.

“How We Learn, How We Teach: Synthesis of the Research,” C. Otto and A.J. van der Ploeg, Ohio Mathematics and Science Coalition, Cleveland, OH, 2000.

“Common Problems, Common Goals: The OMSC Teacher Colloquium, An Interpretive Synthesis,” C. Otto, A.J. van der Ploeg, and T. Blakeslee, Ohio Mathematics and Science Coalition, Cleveland, OH, 2000.

“K-12 Mathematics in Ohio: What Districts Intend to Teach, What Teachers Teach,” A.J. van der Ploeg, Ohio Mathematics and Science Coalition, Cleveland, OH, September 2001.

“K-12 Science in Ohio: What Districts Intend to Teach, What Teachers Teach,” A.J. van der Ploeg, Ohio Mathematics and Science Coalition, Cleveland, OH, September 2001.

Complete citations for all other references used in this document can also be found on the OMSC website at [www.oai.org/OMSC](http://www.oai.org/OMSC).

# GLOSSARY: A COMMON LANGUAGE

**Academic content standards for mathematics and science** are the specifications of knowledge, understanding and application of concepts that students are expected to achieve during their formal education.

**Accountability** is being responsible and answerable for students achieving academic standards.

**Assessment** is the process of measuring the progress of students toward achieving academic standards.

**Curriculum** specifies what should be taught and when so students may achieve the academic standards.

**The educational system** is the complex group comprised of legislative and administrative entities, educational professionals and support staff, students, parents, and other community entities whose purpose is the education of students. The System uses aligned academic standards, curriculum, instruction, technology, assessment and accountability to accomplish its purpose.

**Instruction** is a deliberate arrangement of learning opportunities designed to carry out the curriculum.

**Pre K-16 education** is the continuum of formal learning experiences of students from before kindergarten through four years of college, normally culminating in a certificate such as a high school diploma, an Associate Degree or a Baccalaureate Degree.

**Mathematics** is the study of number, form, arrangement and associated relationships using rigorously defined literal, numerical and operational symbols.

**Science** is the observation, identification, description, experimental investigation and theoretical explanation of natural phenomena.

**Stakeholders** are those persons, organizations, institutions, businesses and governmental entities affected by, involved in or in any way related to improving mathematics and science education in Ohio.

*Note: The definitions on this page were developed and approved by OMSC membership in May 2001. Definitions for **mathematics** and **science** are from The American Heritage Dictionary and adopted by OMSC.*



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