The Ohio Framework for World-Class Science and Mathematics Education

April 1995

Introduction

The Ohio Framework for World-Class Science and Mathematics Education provides a structure to guide continuous improvement of science and mathematics education at the local, regional, and state levels.

Each individual and every organization in Ohio must take an active role in improving science and mathematics education. Using this Framework, individuals and organizations should develop plans of action that will contribute to the coordinated improvement of science and mathematics education locally and for the state.

The benefits of using this State Framework will include:

- promotion of a common vision for Ohio science and mathematics education
- improved student performance;
- greater educational access to science and mathematics literacy;
- increased support, including funding and other resources;
- establishment and strengthening of linkages among stakeholders;
- better connections between school, work and life;
- increased quality and quantity of research and information and their effective dissemination and use.

The imperative for improvement of mathematics and science education comes from many sources. Most recently, the National Education Goals recognize the significance of science and mathematics education to our society. Goal 5[1] specifically addresses the importance of world-class scientific and mathematical literacy for every individual. This framework for systemic improvement is a mechanism to guide the efforts of Ohioans as we work together to strengthen science and mathematics education.

As a framework, this document can fulfill many roles: (1) it is a broad game plan to which professional organizations, state agencies, and stakeholder groups should be expected to commit; (2) it can be a political action tool for communicating needs and raising necessary resources; (3) it is a long-range plan to which action takers might refer in outlining their own efforts; (4) it is a vehicle for focusing needed attention and for sustaining long-term action; and (5) it provides the criteria against which to measure progress toward improving the system at large.

The Importance of a Systemic Approach

Ohio's educational system is complex. It is composed of students, parents, teachers, administrators, schools, districts, boards of education, county offices of education, higher education, and more. Ohio is rich in educational resources – human, institutional, public and private – but

[1]The national goal pertaining to science and mathematics was National Goal 4 on the original list of six national goals but is now number five on the expanded list of goals identified by the *GOALS 2000: Educate America Act*.

poor in systemic tools to accomplish change. Such a complicated and interrelated system cannot be changed piecemeal. A systemic approach is required. This State Framework is a tool for *systemic change.*

Sidebar definition:
By the term **systemic change,** we mean change encompassing every aspect of educational improvement impacting science and mathematics achievement, such as assessment, curriculum, instruction, policy, professional development, finances, and resources.

Striving toward a goal of the scope of world-class education calls for a commonly shared sense of purpose. One function of this framework is to provide a **structure for subsequent plans of action** to be devised and coordinated at many different levels of the system. The Framework identifies seven broad areas of activity that are in need of large-scale and long-term improvement if the total system of science and mathematics education is to achieve world-class standards. Within each activity area are specific goals that will contribute toward that improvement area. The seven broad areas of target activity are:

Promote a Common Vision
Improve Performance
Expand Access
Build Linkages
Strengthen Research, Development and Information Dissemination
Provide Systemic Support for Change
Ensure School-to-Work-to-Life Transitions

Rational for these Target Areas

These target areas for focused improvement have been identified by collaborative input and consensus-building as critical needs in improving Ohio's system locally and as a whole. These areas are consistent with national and state standards efforts, and they support the systemic improvement of the general education system. The importance of each area of activity is described briefly as follows.

Promote a Common Vision.

National standards[2] outline significant new visions for K-12 science and mathematics programs that can guide world-class instruction and prepare students for the 21st century. Those standards will not be achieved until all stakeholder groups and individuals **locally commit to the vision behind those standards** and come to agreement as to what local programs should be. Old visions and beliefs – informed by attitudes, values, history, personal experience, and economics – must be revised to enable necessary changes.

Sidebar: "[A common] vision of change must be powerful enough to focus the public and all levels of the governance system on common challenging purposes and to sustain that focus over an extended period of time." (O'Day and Smith in Furman, in press, p. 267)

Improve Performance.

To build toward a world-class science and mathematics education, we must be able to document our progress with actual performances – student learning, instructional effectiveness, teacher preparation, student preparation for work, etc. **Ohio must become a national leader in**

[2] The National Council of Teachers of Mathematics has published *Curriculum and Evaluation Standards for School Mathematics* © 1989 and the National Research Council has a draft *National Science Education Standards* © 1994 which constitute national standards for K-12 mathematics and science.

various measures of performance. We must state what we wish to attain, measure our progress, and be guided by our results in advancing toward our goals.

Expand Access.

The fundamental belief that ***every child*** **can learn challenging content** and that all children should be expected to learn such content to high standards of performance is basic to reform of science and mathematics education. Historically, many within our culture have been ill-served by the traditional system in aspiring to this goal – women, minorities, and economically disadvantaged. The field of opportunity must be leveled by providing the *necessary support* to assure that such learning can occur.

Strengthen Research, Development, & Information Dissemination.

Ohio's educational system **must invest in capacity-building** – of the system and for the individuals within that system. We cannot expect to accomplish major change without providing the tools and information necessary to support that change. Improving science and mathematics education requires decision-making to impact current practice. To enable the best decisions, individuals must have access to: (1) accurate and comprehensive information; (2) research tools and findings; and (3) means to link with others.

Build Linkages.

Science and mathematics **cannot be learned effectively without the support and involvement** of numerous entities – families; communities; administrators; teachers; colleges and universities; and policymakers in government, business and industry. Linkages must be developed and maintained among these various stakeholders to assure appropriate participation and leadership to support a world-class science and mathematics education system.

Provide Systemic Support for Change.

System change requires system approaches. System support must address **breadth of change** – assessment, instruction, policy, finances, resources, professional development. Support must consider the performance of **each part of the system,** how each is dependent upon and linked to what has come before and what is to follow. Support must be **coordinated** across many activity fronts, monitored, directed, and in consideration of long-range needs. Support must aim for **fundamental change**, not likely to occur within the limitations of the existing system.

Ensure School-to-Work-to-Life Transitions.

A world-class education in science and mathematics is one means to equip Ohioans for **employability, competent citizenship, and personal growth.** Everyone benefits by having each individual well-prepared for these adult functions. We must be concerned with transitions that students make in life-long learning, with students' capacities for using scientific and mathematical thinking in a high-tech world, and with the development of the technical knowhow and preparation of our workforce.

Using this Framework

Improving science and mathematics education across Ohio is the collective responsibility of many agencies, organizations, and individuals of the state. Improvement efforts must engage multiple levels of activity – state, regional, and most particularly local. Efforts should involve schools, colleges and universities, communities, families, government, professional organizations, business and industry, and others. All have a stake in improved science and mathematics education. All have a role to play.

Many specific action plans need to be mapped out by the appropriate entities working toward improvement within their particular areas of responsibility and action. Ideally, these

specific plans of action will contribute toward improvement of the system as a whole by addressing many of the critical areas of need identified by this framework umbrella. The framework conveys a broad sense of what needs to be done, but it is not so specific in its statement of goals that those goals become exclusionary of good activities that might not be anticipated.

By virtue of specific circumstances and personal experiences, different readers of this framework may read the framework goals differently. For that reason, the paragraphs which accompany the goal statements and the *Interesting Fact* boxes play important roles. They help to expand individual readers' understanding of just how broad a particular area of focused activity might be when considering the range of stakeholder groups who can contribute to improvement. Ohio's system of science and mathematics education is massive and diverse; all who contribute toward that system should find a role in how they can contribute to its improvement.

Promote a Common Vision

A common vision involves agreement to develop and reach ultimate goals. Vision takes on clarity and grows through reflection, discussion, and negotiation over time. Individuals representing personal, community, regional, state, and national perspectives must come to a broadly accepted common vision in order for systemic change to take place.

Goals for Promoting a Common Vision

- **Communicate broadly the importance and needs of science and mathematics education.**
- **Provide the momentum and the mechanism to establish and maintain a common vision.**
- **Expand advisory and leadership support to bring common visions to reality.**
- **Develop consensus long-range strategic planning for science and mathematics education, translating plans into recommendations and policies.**
- **Target existing resources and leverage new funding for identified short- and intermediate-range goals.**

A common vision enables a strategy for realignment of policies, for redirection of resources, and for planning significant activities, events, and mechanisms to reshape the existing system along the lines of the intended change. A common vision cannot be impressed on individuals from above. It will be effective only when shared by the community through involvement at all levels. A common vision provides the feeling of destination. It imparts to all participants a sense of common mission.

Interesting Ohio Facts

- The majority of Americans believe that the quality of science and mathematics education in the U.S. is currently inadequate.
- The National Education Goals Panel revealed that at the pace our educational system is changing today [1993], we will not come close to achieving (Goal 5).
- Over three-quarters of the U.S. believes that science (73%) and mathematics (87%) courses should be required of all students every year.

The Public Understanding of Science and Technology in the U.S., 1990

- Forty-two states require more units of science for high school graduation than Ohio (1 unirt).
- Four of the largest 100 cities in the U.S. are in Ohio.
- Nearly 27% of Ohio schools are rural, serving 380,000 students. Sixty percent of these schools enroll less than 400 students.
- Eight percent of the population of Ohio are children 0-17 who live in poverty.

The Condition of Rural Schools 1994

- Total enrollment in higher education in Ohio (1991): 569,326
  - percent minority: 11.6%
  - up 9.8% since 1987
  - full-time freshmen: 74,756 *correct data and get more data*

Sidebar:

State Requirements for High School Graduation

Mathematics

Ohio - 2 units

Other States - 13 require 2.5 - 3 units
30 require 2 units

Science

Ohio - 1 unit

Other States - 6 require 2.5 - 3 units
36 require 2 units
1 requires 1 unit

Source: Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1993, p. 72

Improve Performance

Continuous growth in mathematics and science is demanded by our society. Improved performance by individuals can be measured by the increased ability to apply knowledge and demonstrate understanding. A major challenge to measuring improved performance is to avoid narrowly defined targets and indicators of progress.

Goals for Improving Performance

- **Assist schools to become units of change for implementing improvements in performance.**
- **Apply validated approaches to remedy specific concerns in student achievement.**
- **Promote understanding of world-class education, methods of teaching, expectations, learning, achievement, and assessment.**
- **Implement national standards and model curricula; and develop methods of measuring their impact on improved performance.**
- **Provide sustained professional development for all preservice and inservice educators for continuous improvement.**
- **Identify performance goals and report progress toward these goals to all appropriate constituencies (e.g., families, communities, educators, government, business).**
- **Provide incentives (i.e., recognition, rewards) to promote achievement in mathematics and science.**

A beginning list of reasonable indicators of improved performance will include improved academic performance; increased enrollments in college-preparatory courses and Tech Prep programs; higher scores on national and international assessments; improved basic, academic, functional, and job literacy; and narrowing of achievement gaps across populations. Fundamental educational reform includes making changes in curriculum and instruction, in how institutions are organized and administered, by providing a supportive work environment for educators, by building partnerships and networks, and by increasing the participation of parents and the community.

Society is the ultimate benefactor of improved performance. Students will be better prepared to go on to higher education and/or go into the work force. Their attitudes about mathematics and science will improve along with their self- esteem. When students are performing successfully, less time will be spent reteaching. Teachers can provide more creative and dynamic environments for science and mathematics learning. Parents' attitudes about science and mathe-matics will improve as their expectations for their children are met. Business and industry will have more knowledgeable employees as these students join the work force.

Sidebar:

- A survey of Ohioans supports increasing the high school graduation requirements in mathematics from 2 to 3.5 years and in science from 1 to 3 years.

Interesting Facts

- Students in Ohio spend less time per week on science in grades 1-6 than the national average.

- Among reasons seniors list nationally for not taking mathematics or science in their senior year are:

	Mathematics		**Science**	
	Male	Female	Male	Female
will not need	31%	25%	42%	38%
advised not to	26%	34%	26%	32%

- Nearly 24% of all newly-graduated high school students entering Ohio's state-assisted colleges and universities during 1992-93 required remedial coursework in mathematics.

- 98% of the Class of 1994 had passed the 9th grade proficiency test in mathematics by graduation.

- 68% of the Class of 1994 demonstrated a twelfth-grade level of literacy and basic competency in mathematics and 20% an honors level of performance on the Ohio Twelfth-Grade Proficiency Test.

Expand Access

World-class education means every child must have the opportunity to learn challenging content and will be expected to learn this content to a high standard of performance. Trends indicate that pop¨lations which have been traditionally underrepresented in science and mathematics study will increase in the future. Therefore, an important aspect of systemic reform is expanding access to science and mathematics education.

Goals for Expanding Access

- **Broaden awareness of the learning needs of all individuals, especially underrepresented groups and educationally disadvantaged populations.**
- **Expand the opportunities and access for all individuals, especially underrepresented groups and educationally disadvantaged populations.**
- **Provide the necessary support to decrease disparities in group achievement.**
- **Expand participation in projects which promote access; and actively pursue and obtain targeted funds for this purpose.**
- **Provide for systemic professional development programs, support programs, and resources for innovative or validated approaches that promote access.**

The underrepresentation of minorities, women and the handicapped in scientific careers is well known. Disparities by gender and ethnicity in mathematics and science performance on large-scale assessments are well documented. Studies have shown that differences in the complexity and challenges of curricula – highly correlated with students' economic class – have resulted in differing levels of opportunity to learn. Less widely known is the general underrepresentation of Americans in mathematics- and science-intensive graduate studies in American institutions. These disparities are deeply rooted in our culture, traditions, and social conditions.

Expanding access to overcome these fundamental inequities requires equity of opportunity and proactive support. Equity of opportunity will include challenging curricula, appropriate instructional materials, relevant learning experiences, and teachers with the expertise to effectively engage all minds – independent of where a student resides and receives an education. Proactive support will level the field of opportunity by providing the extra support, dollar resources, and programs to provide more help to those students who need it most.

Sidebar Material:

Expanding access will not mean that all children will receive exactly the same curriculum nor that all children will achieve to the same degree. Specific curricula and instructional experiences will vary with the interests, backgrounds and cultures of the students, but must be targeted toward a common core of learning necessary for responsible citizenship and economic opportunity. Differences in outcomes will continue to occur, but will be equitably distributed, and not the result of such criteria as race, class, gender, handicaps, language, geography, or nationality.

Interesting Facts

- White males, 47% of current workforce, will account for just over 15% of new workers in the next decade; 85% of the new workers will be women, minorities, and immigrants.

Workforce 2000: Work and Workers for the 21st Century, June 1987

- The average salary for teachers in rural areas in 10% lower than teachers in nonrural areas. Rural teachers teach more preparations with fewer students than nonrural teachers.

- Aspirations are commonly lower but student achievement is commonly as good or better than in nonrural areas.

- Minority youth in Ohio have relatively fewer role models for teachers in mathematics and science than similar youth nationally.

- The need to demystify and to demasculinize mathematics and science and to break down gender and racial stereotypes about mathematics and science are cited as key equity issues in an Ohio study.

- NonAsian minority students initially perform significantly less well on the mathematics component of the Ohio Ninth Grade Proficiency Tests than other students.

- Though gains have been made in many technology-dependent professions, women are still very underrepresented in engineering as an intended career compared to men (2% vs 15%).

Percent Passing 9th Grade Math Proficiency	**Class of 94** (9 attempts)	**Class of 97** (2 attempts)
Male	98+	69
Female	97	61
African American	91	31
American Indian	98	52
Asian	99	79
Hispanic	96	42
White	98	70
TOTAL	98	65

Sidebar Graph:

Degrees Awarded in Math and Science in 1992-93

Bachelor's degrees	
percent minorities receiving above	9.5
percent women receiving above	45.5

Source: Goal 5 Report, p. 45

Served and Unserved Gifted Children Chart - State Board Report

- Gender differences with regard to course enrollment in many advanced science and mathematics courses are minimal, although female students are somewhat less likely to take courses such as calculus and physics than are male students.

Strengthen Research, Development & Information Dissemination

World-class science and mathematics education for Ohio will require drawing upon the best information and applied research to achieve that goal. Transforming the existing system to such standards will not be easy because a single template for change will not suffice. Ohio's diversity of resources and local needs will require many approaches and many solutions. It is critical therefore that local decision-makers have access to communication networks and resources relevant to their specific needs.

Goals for Strengthening Research, Development, & Information Dissemination

- **Promote classroom-based research as a vital tool for instructional decision-making.**
- **Secure capital for staff development, research and development projects at all levels.**
- **Promote professional development to facilitate active use of communication networks and information bases (e.g., ERIC, Internet, OHnet) by each institution, especially by teachers and students.**
- **Develop readily accessible data bases for science and mathematics programs (e.g., resources, information, achievement, programmatic and demographic information).**
- **Strengthen the dissemination and application of research findings appropriate to a given situation or population.**

Improvement efforts locally and statewide must be guided by information-based and research-grounded decisions. For that to occur, we must first include researchers and practitioners as partners in classroom-based research. We must also improve the accessibility and use of information and research to individuals who are at the level of making and implementing decisions – particularly at the instructional level. We must increase the willingness of decision-makers to utilize research and development findings; we must improve the expertise of individuals to use the technology of electronic networks and systems; and we must provide the means for individuals to link together and benefit by each others' knowledge and practice in achieving results.

Interesting Facts

- Columbus, Ohio is the home of three national centers
  - ERIC Clearinghouse for Science, Mathematics, and Environmental Education (614-292-6717)
  - Eisenhower National Clearinghouse
  - National Center for Science Teaching and Learning (614-292-3339)
- In 1950, Ohio was substantially above the national average in adults having some college education. In 1980, Ohio was substantially below the national average.

- Schools in the U.S. spent $2.1 billion on education technology in 1992-93, an increase of 20%.

- In 1993, 4.4 million personal computers were installed and about 112,000 CD-ROM drives.

- Workers using computers (1989) 36.0%
  Students using computers at school 27.3%
  Students using computers at home 11.5%
  students using computers at home for schoolwork 4.6%

Sidebar Quote: "If we want to achieve high standards in any subject, we need to recognize the pivotal role that computers and other technology can play."
David Thornburg, "An Active Engagement", Electronic Learning, October 1994, vol. 14, no. 2, p. 22

Build Linkages

Science and mathematics education are too important to be left solely to educators. Learning is influenced and shaped by many sources. For learning to be valued and effective, those who contribute to it must be in agreement as to its importance, utility, and delivery. Improvement efforts must link those stakeholders who influence learning (e.g., families, communities, educators, government and business) to ensure their leadership, involvement, support, and shared vision in accomplishing world-class science and mathematics education.

Goals for Building Linkages

- **Establish communication links in order to bring coordination and coherence to the system of science and mathematics education both vertically (pre-school to doctoral level) and horizontally among all concerned constituencies (e.g., families, communities, educators, government and business).**
- **Establish mechanisms to elicit input from and involvement of all concerned constituencies.**
- **Nurture the involvement and support of family structures for learning and achievement.**
- **Build working relationships with political leaders, business and industry leaders, and various interest groups to translate goals into programs.**
- **Communicate the value to society of improving science and mathematics achievement .**

Sidebar:

"Although teachers are central to reform, they cannot be held solely responsible for achieving it. They need allies ... administrators and education policymakers ... the help and support of community leaders, business and labor leaders, and parents for in the final analysis, education reform is a shared responsibility."

Science for All Americans

Interesting Facts

- In 1992, corporations contributed $2.4 billion to U.S. education, 70% going to higher education.
- Lack of financial support is the public's biggest concern regarding schools, replacing drugs as the 1992 priority.
- (*Insert data from the SCANS Rpt. , The national Business Roundtable Rpt.,etc. that illustrate various conceptions of key educational issues)*

Graph of Parent Level of Homework Assistance - p. 220

We all have a stake in the improvement of Ohio's system of mathematics and science education. The need for a scientifically and mathematically literate workforce and electorate is important to each of us. No single entity or constituency has the resources and reach to improve the system alone. Only by working together can we reap the benefits of collaboration, of sharing limited resources, and of synergies which can bring improvement to the system. To do so we must build and maintain linkages between all concerned constituencies. These linkages are essential to allow true collaborative relationships to grow and flourish. This in turn can bring coherence of policy and practice to a system too often fragmented and uncoordinated.

Provide Systemic Support For Change

For change to succeed, it must be supported where it ultimately occurs, at the individual level – individual people, programs, institutions, and local systems. For change to contribute toward *systemic* improvement, it needs to be focused toward specific improvement goals that will impact the overall system. For change to be effective, support for the change must draw upon validated and system-intensive professional development that can reshape the delivery of instruction.

Goals for Providing Systemic Support for Change

- **Foster support for and coordination among initiatives, programs, and structures that target improved performance and systemic change.**
- **Develop methods for monitoring systemic improvements that result from change efforts.**
- **Develop and enhance community and political support for systemic change.**
- **Expand the means for identifying local and regional needs and translating these needs into actions.**
- **Promote sustained and validated professional development activities as effective systemic change measures.**

Ohio must invest in upgrading signficantly the capacity of the total system to support system-level change. Traditional support approaches have been fragmented, have been instituted on a program-by-program basis, have been the lowest budget priority, and have lacked the depth and scope to result in large-scale and lasting change. The result has been an uneven landscape of individual effort and accomplishment, frustration over unrealistic expectations, and questioning of the change vision. Sustained and effective support for change is THE only way for vision to become a reality.

System-level change must assume a higher priority and commitment. It must be built upon a broader base of participation and support. It must include a different way of thinking about how to execute and carry through change: progress goals translated into timelines; new resources secured and existing resources realigned; new mechanisms created to address emerging needs; research performed to provide data-supported answers; and validated programs to change attitudes, values, and improve performance.

Interesting Facts

Ohio currently has the following independent programs focused on state-wide systemic change in science and mathematics at various levels-

- **Project Discovery**
- **Urban Systemic Initiatives (existing and pending)**
- **Rural Systemic Initiatives (pending)**
- **State Coalition For Science and Mathematics**
- **Tech Prep**
- **Others…**
- **NCREL Ohio Group**

• **Regional Professional Development Centers**

Ohio Teachers (1990-1991)

By Highest Degree		**By Years Experience**	
BS/BA	54.5%	<3	7%
MA	41.3%	3-9	23.4%
EdD	2.4%	10-20	40.5%
PhD	0.6%	>20	29.2%

Recommendations from the Report of the National Education Commission on Time and Learning

Prisioners of Time, April 1994

- that state and local boards work with schools to redesign education so that time becomes a factor supporting learning, not a boundary marking its limits.
- that schools provide additional academic time by reclaiming the school day for academic instruction.
- that teachers be provided with the professional time and opportunities they need to do their jobs.
- that schools seize on the promise of new technologies to increase productivity, enhance student achievement, and expand learning time.

Ensure School-to-Work-to-Life Transitions

Preparing for life-long employability, competent citizenship, and personal growth, demand concern about teaching science and mathematics in ways that reflect their real world uses. Students must learn how to apply their knowledge beyond the classroom. The curriculum and learning experiences within science and mathematics must be designed to equip each student with solid and appropriate backgrounds for meeting their post school needs. Beyond entry level considerations (for work or continuing education) students must acquire a capacity for learning to use mathematical and scientific thinking in a constantly changing world.

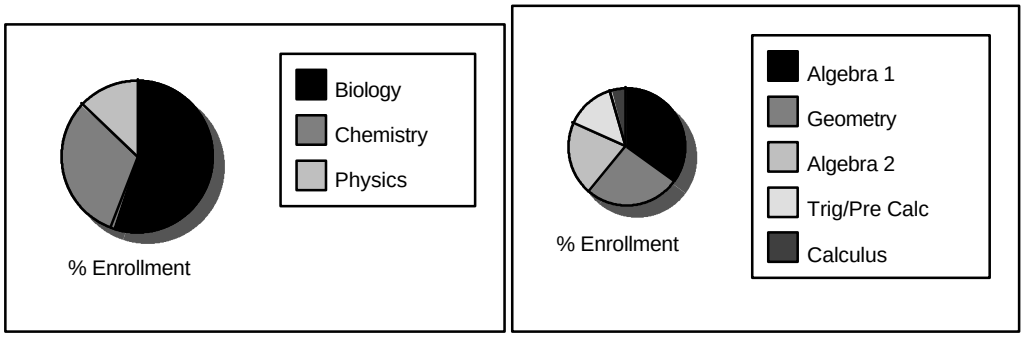
Goals for Ensuring School-to-Work-to-Life Transitions

- **Assure that students have an appropriate background in science and mathematics to meet the demands of their post school needs (e.g., high school to work, technical school to work, high school to college, work to work).**
- **Encourage learning opportunities that reflect the ways that science and mathematics are applied in real world situations (e.g., in the work place, market place, the ballot box).**
- **Promote relationships among businesses, industries, government, and schools that enable students and teachers to experience the application of science and mathematics.**
- **Provide professional development for pre-service and in-service teachers to help them teach how mathematics and science are applied in real world situations.**
- **Support the use of state-of-the-art technolgies (e.g., instruments, procedures) in the learning and assessment of science and mathematics knowledge and applications.**

Ohio's success within the global economy depends upon the mathematical and scientific knowledge of the state's workforce. Employability requires increasing science and mathematics skills and the capacity for life-long learning as technology advances. Good citizenship into the next century will rely upon the individual's ability to make informed decisions about complex technological issues. Schools and teachers need a great deal of assistance to present appropriate learning experiences that connect mathematics and science applications in the real world. This help must come from business, industry, government, the community, and higher education.

Interesting Facts

- *From the SCANS Report----- (Sample "know-how" items...Technology, Thinking Skills..*
- *Students in Ohio are not enrolling in the technical level science and mathematics cources that are available (State Indicators of Science and Mathematics Education 1993.)*



Sidebar:

Graph of "What Happens to Job Applicants Who Are Deficient in Basic Skills?"

- Studies show that up to 14% of all on-the-job delays can be attributed to employees with poor basic skills. It is estimated that the total cost of a poor hiring decision alone for an entry-level position approaches $12,000.

Workkeys USA

Sidebar:

Graph of "The U.S. is not producing enough workers with the job skills employers require."

- Twelve percent of students fail to graduate and are destined to earn less than half the amount of a 1973 dropout.

"School Goals Out of Reach by 2000", USA Today, October 1, 1993

Sidebar: "We are living in an age that is based on the understanding of the principles of science. It is most important that our students acquire the skills to deal with their environment. Comprehensive science education will provide th student with the skills to evaluate concepts and make wise, informed decisions. A science education will provide for career planning in a society that is based on the principles of science. Thje science program must help the student to not only understand the principles of science, but also to appreciate and enjoy these principles and concepts."

Wickliffe Science Department Report, 1994

Conclusion

The preceding framework for systemic improvement is a means to guide the efforts of Ohioans to contribute to National Goal 5 and to become a national leader in science and mathematics education. Care has been taken to recognize a high degree of local responsibility and control, necessary to accommodate local challenges and needs while preserving our rich heritage of local traditions. Key to achieving this level of change is a mechanism for rallying the efforts of Ohioans to a broad, consensus agenda within which change can be nurtured and guided at many levels across the system. That is the purpose of this framework and the collaborative process by which it has been developed.

The ideas and structure of the framework represented herein are the culmination of many prior rich activities and efforts toward statewide improvement of science and mathematics education. The work, insights, and discoveries of numerous individuals and professional organizations have been instrumental in shaping the present document.

What Can I Do?

We all have an interest in seeing that Ohio achieves world-class standards in science and mathematics education. Each of us has a role that we can play in helping toward that goal. Following are some suggestions of ways to assist the aims and purpose of this Framework.

- **Individuals**

  - Keep informed on the importance to society of world-class science and mathematics education – what this means in terms of what is taught, how it is taught, and how it is learned.

  - Be a positive influence to learners in the expectations, values, attitudes, and support you reflect regarding science and mathematics.

  - Consider how you can join your efforts with others to contribute toward National Goal 5.

- **Families**

  - Set high expectations for your children for learning science and mathematics.

  - Visit your child's science and mathematics classrooms; talk to teachers about changes occurring in these subjects; learn how you can participate in your child's learning.

  - Demand rigorous curricula in your local schools; find out what your district is doing to address the critical focus areas of this Framework.

  - Learn how the school district supports the involvement and achievement of underrepresented groups in science and mathematics.

- **Communities**

  - Assure that community expectations, attitudes, and beliefs are consistent with the broad philosophy and aims of National Goal 5 and the Ohio Framework.

- Ensure the availability of resources necessary for the attainment of quality science and mathematics learning (e.g., time, incentives, materials, qualities).

- Develop networks of community leaders and representatives to support increased science and mathematics achievement for all students. Explore the need for programs for disadvantaged students to learn science and mathematics more effectively.

• Schools

- Involve all stakeholder groups in setting community expectations in science and mathematics; inform parents and the public about how well students are meeting these expectations.

- Assure that curricula, instructional materials, and assessments reflect world-class expectations.

- Devise a community action plan for systemic improvement of science and mathematics education; use the Framework as a guide to focus district improvement efforts.

- Promote excellence in teaching; recruit qualified teachers of science and mathematics, with appropriate teaching models for encouraging underrepresented groups.

• Higher Education

- Coordinate higher education reform efforts with those occurring in PreK-12 education.

- Direct educational research efforts, professional development projects, outreach programs, and teacher education toward the focused target areas of the Framework.

- Commit institutional resources and faculty to assisting school districts and teachers with the support to accomplish world-class science and mathematics education standards.

• Professional Groups

- Support the Framework goals; determine implications on policies of the organization.

- Keep your membership informed about the need for systemic improvement of science and mathematics education.

- Lend your organizational support by formally endorsing the Framework and making copies available to your members.

• Business and Industry

- Examine local curricula and graduates' skills against current and future demands of the job market and your business' employment needs.

- Work with schools to use the credibility of the private sector to reinforce National Goal 5 efforts and for rallying community support for this goal.

- Learn how business and industry can become active partners in systemic improvement plans. Focus your support for improvement at the regional and state levels, as well as locally.

- Consider ways in which your resources – fiscal, leadership, and personnel – can enhance local schools' science and mathematics missions (e.g., partnerships, student-faculty internships).

• Political Leaders

- Recognize that world-class science and mathematics education is an investment in Ohio's future. Direct the necessary resources to support this vision.
- Resist pressures for simplistic cures; support long-term systemic approaches to increasing the capacity of the education system to function more effectively.
- Expect high standards of performance and regular measures of progress toward goals.

• State Agencies

- Sustain a strong advocacy for attaining world-class education performance. Aggres-sively seek the necessary support to assist schools and higher education toward this aim.
- Provide the leadership and coordination to direct systemic efforts toward the targeted goals of the framework. Improve information and communication to keep efforts focused.
- Oversee the establishment of performance targets, assess school and higher education progress toward goals, and regularly report progress toward goals.

The Ohio Framework for World-Class Science and Mathematics Education

Promote a Common Vision

- Communicate broadly the importance and needs of science and mathematics education.
- Provide the momentum and the mechanism to establish and maintain a common vision.
- Expand advisory and leadership support to bring common visions to reality.
- Develop consensus long-range strategic planning for science and mathematics education, translating plans into recommendations and policies.
- Target existing resources and leverage new funding for identified short- and intermediate-range goals.

Improve Performance

- Assist schools to become units of change for implementing improvements in performance.
- Apply validated approaches to remedy specific concerns in student achievement.
- Promote understanding of world-class education, methods of teaching, expectations, learning, achievement, and assessment.
- Implement national standards and model curricula; and develop methods of measuring their impact on improved performance.
- Provide sustained professional development for all preservice and inservice educators for continuous improvement.
- Identify performance goals and report progress toward these goals to all appropriate constituencies.
- Provide incentives to promote achievement in mathematics and science.

Expand Access

- Broaden awareness of the learning needs of all individuals, especially underrepresented groups and educationally disadvantaged populations.
- Expand the opportunities and access for all individuals, especially underrepresented groups and educationally disadvantaged populations.
- Provide the necessary support to decrease disparities in group achievement.
- Expand participation in projects which promote access; and actively pursue and obtain targeted funds for this purpose.
- Provide for systemic professional development programs, support programs, and resources for innovative or validated approaches that promote access.

Strengthen Research, Development, & Information Dissemination

- Promote classroom-based research as a vital tool for instructional decision-making.
- Secure capital for staff development, research and development projects at all levels.
- Promote professional development to facilitate active use of communication networks and information bases by each institution, especially by teachers and students.
- Develop readily accessible data bases for science and mathematics programs.
- Strengthen the dissemination and application of research findings appropriate to a given situation or population.

Build Linkages

- Establish communication links in order to bring coordination and coherence to the system of science and mathematics education among all concerned constitutencies.
- Establish mechanisms to elicit input from and involvement of all concerned constituencies.
- Nurture the involvement and support of family structures for learning and achievement.
- Build working relationships with political leaders, business and industry leaders, and various interest groups to translate goals into programs.
- Communicate the value to society of improving science and mathematics achievement.

Provide Systemic Support for Change

- Foster support for and coordination among initiatives, programs, and structures that target improved performance and systemic change.
- Develop methods for monitoring systemic improvements that result from change efforts.
- Develop and enhance community and political support for systemic change.
- Expand the means for identifying local and regional needs and translating these needs into actions.
- Promote sustained and validated professional development activities as effective systemic change measures.

Ensure School-to-Work-to-Life Transitions

- Assure that students have an appropriate background in science and mathematics to meet the demands of their post school needs.
- Encourage learning opportunities that reflect the ways that science and mathematics are applied in real world situations.
- Promote relationships among businesses, industries, government, and schools that enable students and teachers to experience the application of science and mathematics.
- Provide professional development for pre-service and in-service teachers to help them teach how mathematics and science are applied in real world situations.
- Support the use of state-of-the-art technolgies in the learning and assessment of science and mathematics knowledge and applications.

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Framework Endorsements

Ohio Mathematics Education Leadership Council

Miscellaneous

Class Time on Core Subjects (1990-91)

	English	Mathematics	Science	Social Studies
Grades 1-3				
Nation	10.8	4.9	2.6	2.8
Ohio	11.8	4.8	2.1	2.6
Grades 4-6				
Nation	8.7	4.8	3.1	3.5
Ohio	9.9	5.2	3.0	3.8

Source: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1990-91 (P¨blic School Teacher Questionnaire)

Bar Graphs on H.S. Seniors Reasons for Not Enrolling in Science and Mathematics Courses
p 160

Source: National Science Foundation, "Indicators of Science and Mathematics Education, 1992"

Minority Teachrs vs Student Ethnicity - p. 44 , CCSSO

Minority Teachers in Mathematics and Science by Minority Students

	% Minority Students (K-12)	% Minority Teachers (9-12)				
		Math	Biology	Chemistry	Physics	All High School
Ohio	16	3	5	2	1	6
Nation*	31	11	10	7	4	11

(*represents sum of 33 states reporting)

Source: CCSSO, State Indicators of Science and Mathematics Education, 1993

	Ohio	Nation
Grade 8 Math Achievement (1992 NAEP)		
Percent at or above basic level	64	63
Percent at or above proficient level	22	25
Percent at or above advanced level	3	4
Students Taking Advanced Placement Exams		
Calculus (percent of grade 12)	3	4
Biology	1	2
Percent Taking H.S. Courses by Graduation (91-92)		
Algebra/ Integrated Math 1	86	91
Geometry/ Integrated Math 2	62	61
Algebra 2/ Integrated Math 3	50	55
Trigonometry/ Precalculus	35	29
Calculus	10	11
Biology, 1st year	93	95
Chemistry, 1st year	53	49
Physics, 1st year	22	21

Newly Graduated Ohio College Freshman Students Enrolled in Mathematics And English Remediation Courses

	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Math	22.7%	22.3%	17.8%	19.7%	20.2%	22.5%	23.0%	23.8%
English	19.5%	18.1%	16.7%	17.0%	18.8%	19.5%	21.4%	21.4%

College and University Remedial Course Enrollments in Mathematics and English
June, 1994. Ohio Board of Regents

	Ohio	Nation
New Minority and Female Teachers in 1991		
Number of new 1st year mathematics	125	4,229
percent minority of new math	2	14
percent female of new math	60	55
Number of new 1st year science	82	2,519
percent minority of new science	0	12
percent female of new science	50	52

Selected Majors and Career Plans of College Freshmen (nation)

	Intended Major										Intended Career					
	Biolgical Sciences		Engineering		Math/ Statistics		Physical Sciences		Other Technical		Doctor		Engineer		Research Scientist	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1990	4	4	18	3	1	1	3	1	8	4	5	4	15	2	2	1
1988	4	4	19	3	1	1	2	1	6	4	5	4	16	3	2	1
1986	4	4	20	3	1	1	2	1	9	5	5	4	17	3	2	1
1984	4	4	20	3	1	1	3	1	12	7	5	4	19	3	2	1
1982	4	4	22	4	1	1	3	1	15	11	5	4	21	4	2	1
1980	4	4	21	3	1	1	3	1	11	9	5	4	19	3	2	1
1978	5	4	19	2	1	1	4	1	8	7	6	3	17	2	2	1
1976	7	6	15	2	1	1	4	1	9	7	6	3	14	2	3	2
1974	8	6	12	1	2	1	4	1	9	7	7	4	9	1	3	1
1972	5	3	13	0	2	2	3	1	8	3	8	3	10	0	3	2
1970	4	3	16	0	3	4	3	1	5	2	6	2	13	0	4	2
1968	4	3	17	0	4	4	4	1	4	1	6	1	15	0	4	2
1966	4	3	18	0	5	5	5	13	1	7	2	16	0	5	2	