A Decade of Action: Setting Priorities for STEM Education in Minnesota

A Presentation for
SciMathMN Policy Makers Briefing

Rodger W. Bybee
Executive Director (Emeritus)
BSCS

St. Paul, Minnesota
13th and 14th February 2008

BSCS
5415 Mark Dabling Blvd.
Colorado Springs, CO 80918
719.531.5550 www.bscs.org

Science Education and the 21st Century Workforce

Introduction

A Look at Education in Minnesota

The Program for International Student Assessment (PISA) 2006

A Decade of Action

Conclusion

Questions and Discussion

National Assessment of Educational Progress - 2005

Minnesota

4th Grade Science

National Average – 156	Minnesota Average – 149
Below Basic	24%
Basic	42%
Proficient	31%
Advanced	3%

Change in Averages Scores

2000 – 157	2005 - 156

National Assessment of Educational Progress - 2005

Minnesota

8th Grade Science

National Average – 147	Minnesota Average – 158
Below Basic	29%
Basic	32%
Proficient	36%
Advanced	4%

Change in Averages Scores

1996 - 159 2000 - 159 2005 - 158

INTERNATIONAL BENCHMARKS FOR MINNESOTA

Statistical Linking of 2005 and 2007 NAER with 2003 TIMSS

In science there are 2 nations achieving significantly higher than Minnesota.

1. **Singapore**
2. **Chinese Taipei**

There are 7 nations which have performance similar to Minnesota.

1. **Republic of Korea**
2. **Hong Kong**
3. **Japan**
4. **Estoria**
5. **England**
6. **Hungary**
7. **Netherlands**

There are 34 nations performing significantly below Minnesota.

Gary Phillips (2007) *Chance Favors The Prepared Mind.* **American Institute For Research**

NEW ECONOMY INDEX 2002

Indicator	Minnesota's Rank Among 50 States
Knowledge & Jobs	9th
Globalization	29th
Economic Dynamism and Competitions	19th
Transformation to a Digital Economy	9th
Technology Innovation Capacity	13th

Progressive Policy Institute (June 2002) *Technology and the New Economy Project*

SUMMARY OF OTHER REVIEWS FOR MINNESOTA

STATE OF STATE SCIENCE STANDARDS Thomas B. Fordham Institute (2005)	B
SMART TESTING, LET'S GET IT RIGHT American Federation of Teachers (AFT) (2007)	Met criteria for alignment at elementary, middle, and high school levels
QUALITY COUNTS (2008)	C
CLOSING THE EXPECTATIONS GAP Achieve, Inc. (2007)	High school graduation requirements align with college and workplace expectations

THE PROGRAM FOR INTERNATIONAL STUDENT ASSESSMENT

PISA 2006

HOW DID U. S. STUDENTS DO ON PISA 2006?

- U. S. was average score – 489
  (OECD average was 500)

- 57 Countries participated in PISA 2006
  (30 OECD countries and 27 non-OECD countries)

- 16 OECD countries were measurably higher than the U.S.

- 20 OECD countries ranked higher than the U.S.

COMBINED SCIENCE SCALE FOR SIX LEVELS OF PROFICIENCY

- **U. S. STUDENTS AT HIGHER LEVELS OF PROFICIENCY**
  - **For levels 5 and 6 U. S. has the same percentage as the OECD - 9.0%**
  - **However, other countries have much higher percentages at levels 5 and 6 – Finland (20.9%), New Zealand (17.6%), Japan (15.1%)**

- **U. S. STUDENTS AT LOWER LEVELS OF PROFICIENCY**
  - **The U. S. had 24.5% of students below the baseline, level 2**
  - **About one quarter of U. S. students do not demonstrate competencies that will allow them to productively engage in science and technology related to life situations.**

OTHER INSIGHTS ABOUT THE U.S.: *HISTORICAL RANKING*

- **The relative standing of the U.S. in PISA-SCIENCE has declined across the three assessments.**

YEAR	RANK
2000	14
2003	19
2006	21

OTHER INSIGHTS ABOUT THE U.S. *GENDER DIFFERENCES*

- **Overall boys did better than girls**
- **Boys did better on:**
    - **Explaining phenomenon scientifically**
    - **Knowledge <u>of</u> science**
- **Girls did better on:**
    - **Identifying scientific issues**
    - **Using scientific evidence**
    - **Knowledge <u>about</u> science**

OTHER INSIGHTS ABOUT THE U.S.: *ATTITUDES*

- **Students generally value science for social purposes.**
- **Students see less value of science when it concerns them.**
- **A minority of students report interest in a scientific career.**

Educational Goals for the 21st Century

- **PREPARING STUDENTS FOR BOTH COLLEGE AND CAREERS** (e.g. what students have to know and be able to do for college and careers are the same)
- **DEVELOPING "HARD" SKILLS** (e.g. problem solving, and the ability to apply science and mathematics in new situations)
- **DEVELOPING "SOFT" SKILLS** (e.g. work with people from other cultures, write and speak well, think in a multidisciplinary way, evaluate information critically, solve problems creatively)

FRAMEWORK FROM A DECADE OF ACTION

contexts

Life and work situations that involve science and technology require individuals to

competencies

- identify scientific and technological issues,
- acquire and use scientific and technical information,
- understand complex systems,
- use a variety of technologies, and
- apply thinking skills.

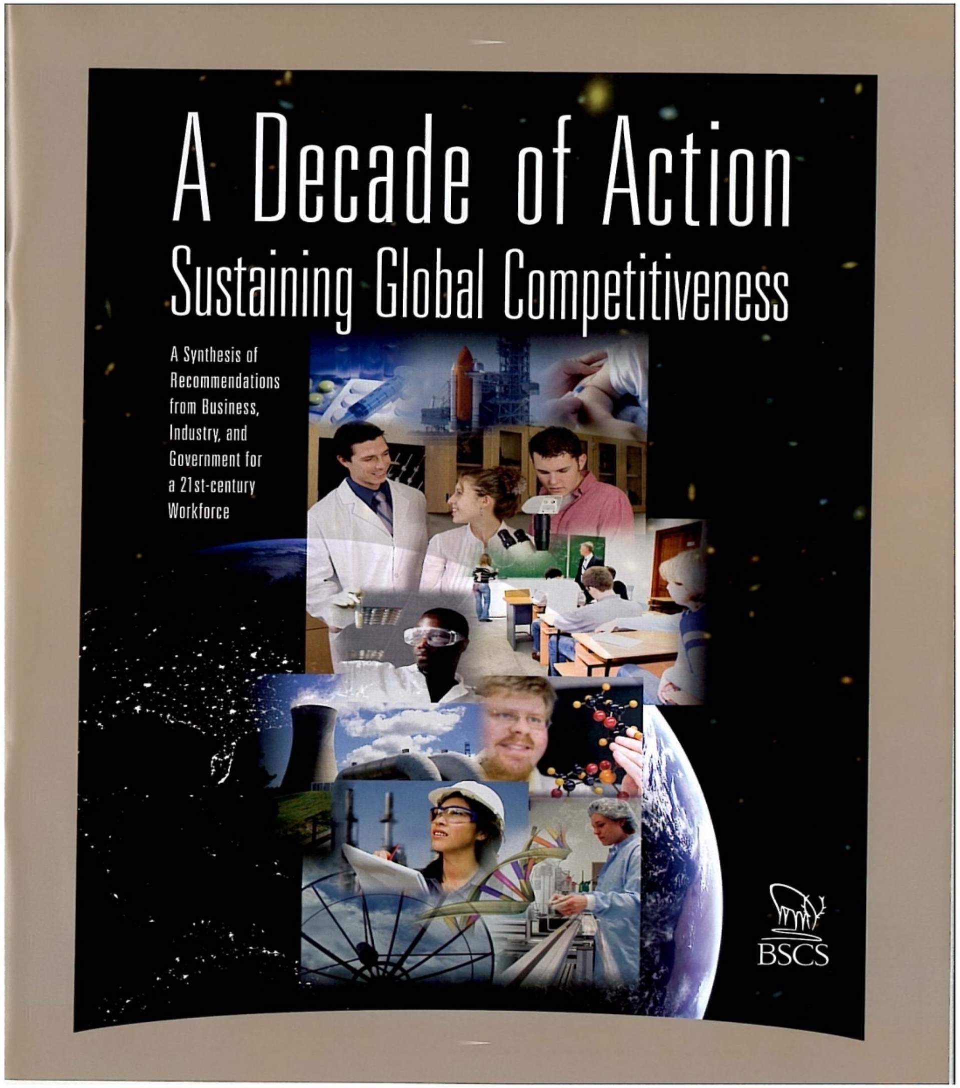
An individual's competence is influenced by content and abilities, skills, and attributes

content

- knowledge about the natural and designed world
- knowledge about science and technology as a domain of human endeavor

abilities, skills, and attributes

- workplace competence
- foundational skills
  - basic skills
  - thinking skills
  - personal qualities


A Decade of Action
Sustaining Global Competitiveness
A Synthesis of Recommendations from Business, Industry, and Government for a 21st-century Workforce
BSCS

FOSTERING SCIENTIFIC LITERACY IN THE UNITED STATES: WHAT DO WE NEED TO DO?

- Emphasize scientific literacy as a major goal of science education.
- Develop a new generation of curriculum materials for scientific literacy.
- Support professional development of science teachers.
- Align certification and accreditation with contemporary priorities of scientific literacy.
- Build district-level capacity for continuous improvement of programs for scientific literacy.
- Explain to the public why an emphasis on scientific literacy will benefit their children and the United States.

FOSTERING SCIENTIFIC LITERACY IN THE UNITED STATES: HOW WE CAN BEGIN

- **Center change on critical leverage points and high yield components of the educational system.**
- **Unit of change – School Districts.**
- **Theory of change – Curriculum reform with complementary professional development and changes in assessment.**
- **Components of change – Educational purposes, policies, programs, and practices.**
- **Essential targets of change – teachers and teaching, content and curricula, assessment and accountability.**

FOSTERING SCIENTIFIC LITERACY IN THE UNITED STATES: A DECADE OF ACTION

Phase	Timeline	Goal
Initiating the reform	Two years	Design, develop, and implement model instructional units
Bringing the reform to scale	Six years	Change policies, programs, and practices at local, state, and national levels
Sustaining the reform	Two years	Build capacity at the local level for continuous improvement of school science and technology programs
Evaluating the reform	Continuous, with a major evaluation in 10 years	Provide formative and summative data on the nature and results of the reform efforts

Types of Reforms in Science Education

Purpose Purpose includes aims, goals, and rationale. Statements of purpose are universal and abstract, and apply to all concerned with reforming science education. Preparing the 21st century workforce is an overreaching educational purpose. Achieving scientific literacy is a purpose statement for science education.
Policies Policies are more specific statements of standards, benchmarks, state frameworks, school syllabi, and curriculum designs based on the stated purpose. Policy statements are concrete translations of the purpose and apply to subsystems such as curricula, instruction, assessment, teacher education, and grade levels within science education. Specification of the knowledge, skills, and attitudes required to improve scientific literacy in all grades is an example of policy.
Programs Programs are the actual materials, textbooks, software, and equipment that are based on policies and developed to achieve the stated purpose. Programs are unique to grade levels, disciplines, and types of science education. Curriculum materials for K-12 scientific literacy and a teacher education program are two examples of programs.
Practices Practices describe the specific actions of the science educators. Practice represents the unique and fundamental dimension, and it is based on educators' understanding of the purpose, objectives, curriculum, school, students, and their strengths as a teacher.

TABLE 1

THE DIMENSIONS OF REFORMING TECHNOLOGY EDUCATION

Educational Perspective	*Time* How long it takes for change	*Scale* Number of individuals involved	*Space* Scope and location of the change activity	*Duration* How long innovation stays once change has occurred	*Materials* Actual products of the activity	*Agreement* Difficulty reaching agreement among participants
Purpose - Reforming goals - Establishing priorities for goals	*1-2 Years* To publish document	*Hundreds* Educators who write about aims and goals of education	*National/Global* Publications and reports are disseminated widely	*Year* New problems, new goals, and priorities proposed	*Articles/Reports* Relatively short publications, reports, and articles	*Easy* Small number of reviewers and referees
Policy - Establishing design criteria for programs - Identifying criteria for instruction	*3-4 Years* To develop frameworks and legislation	*Thousands* Policy analysts, legislators, supervisors, and reviewers	*National/State* Policies focus on specific areas	*Several Years* Once in place, policies not easily changed	*Book/Monograph* Longer statements of rationale, content, and other aspects of reform	*Difficult* Political negotiations, trade-offs, and revisions
Program - Developing materials or adopting a program - Implementing the program	*3-6 Years* To develop a complete educational program	*Tens of Thousands* Developers, teachers, students, publishers, software developers	*Local/School* Adoption committees	*Decades* Programs, once developed or adopted, for extended periods	*Books/Courseware* Usually several books for students and teachers	*Very Difficult* Many factions, barriers, requirements
Practices - Changing teaching strategies - Adapting materials	*7-10 Years* To complete implementation and staff development	*Millions* School personnel, public	*Classrooms* Individual teachers	*Several Decades* Individual practices for a professional lifetime	*Complete System* Books plus materials, equipment, and support	*Extraordinarily Difficult* Unique needs, practices, and beliefs of individuals, schools, and communities

DIFFICULTIES OF REFORMING TECHNOLOGY EDUCATION

Perspectives	*Risk to Individual School Personnel*	*Cost to School in Financial Terms*	*Constraints Against Reform for School*	*Responsibility of School Personnel for Reform*	*Benefits to School Personnel and Students*
Purpose - Reforming Goals - Establishing priorities for goals	Minimal	Minimal	Minimal	Minimal	Minimal
Policy - Establishing design criteria - Identifying criteria for instruction - Developing frame work for curriculum and instruction	Moderate	Moderate	Moderate	Moderate	Moderate
Program - Developing materials or adopting a program - Implementing the program	High	High	High	High	High
Practices - Changing teaching strategies - Adapting materials to unique needs of schools and students	Extremely High	Extremely High	Extremely High	Extremely High	Extremely High

IMPLICATIONS FOR STEM EDUCATION IN MINNESOTA

THANK YOU!

WWW.BSCS.ORG

BSCS

1958–2008

INNOVATION
REFORM
VISION