What Everyone Should Know About the Successful K-12 STEM Education Report

Successful K–12 STEM Education

Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Jerry D. Valadez, Ed.D., Member

Committee on Highly Successful Schools or Programs for K-12 STEM Education

Board on Science Education and Board on Testing and Assessment

Division of Behavioral and Social Sciences and Education

BACKGROUND TO THE REPORT

Over last 13 years several key reports and research have informed STEM education, including:

Project 2061; Science For All – 1989; Investigating the Influence of Standards: Framework For Research In STEM – 2001; America's Lab Report: Investigations in high school science – 2005; Rising Above The Gathering Storm – 2005 & 2010; How Students Learn Science – 2005; NSB Commission On 21st Century Education In STEM – 2006; Taking Science To School – 2006; Ready, Set, Science – 2007; Report To the President On STEM; Help Wanted: Projections Of Jobs and Education Requirements Through 2018; Surrounded by Science – 2010; Successful K-12 STEM Education – 2011; Blueprint To Transform Career Technical Education – 2012; The Nations Report Card – 2011.

Links to STEM reports can be found on:
http://cvscienceproject.ning.com

BACKGROUND TO THE REPORT

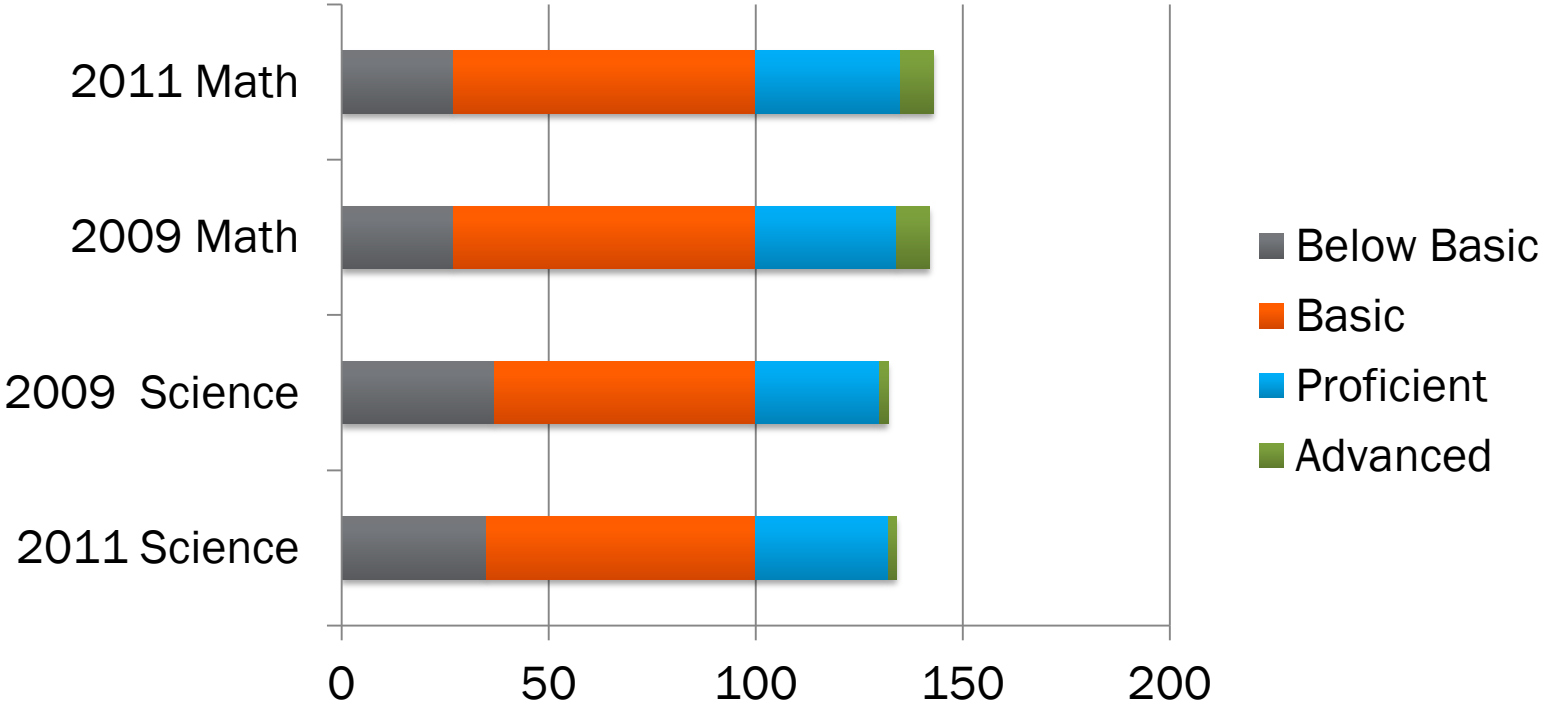
- **Request from Rep. Frank Wolf (R-Va.) for the National Science Foundation -- to identify highly successful K-12 schools and programs in STEM fields.**
- **The quality of K-12 STEM Education is of great national interest and continues to be a national security issue.**
- **Successful K-12 STEM Education is essential for scientific discovery and economic growth.**
- **All students should become scientifically literate.**

THE NEED TO IMPROVE K-12 STEM LEARNING PERSISTS

Too many students leave school unprepared

- 75% of 8th graders are not proficient in mathematics
- 10% of 8th graders meet international benchmarks in science
- Gaps among students from underrepresented groups and socio-economic backgrounds are wide

2011 NAEP – 8TH GRADE SCIENCE AND MATHEMATICS – ALL STUDENTS



New framework beginning in 2009

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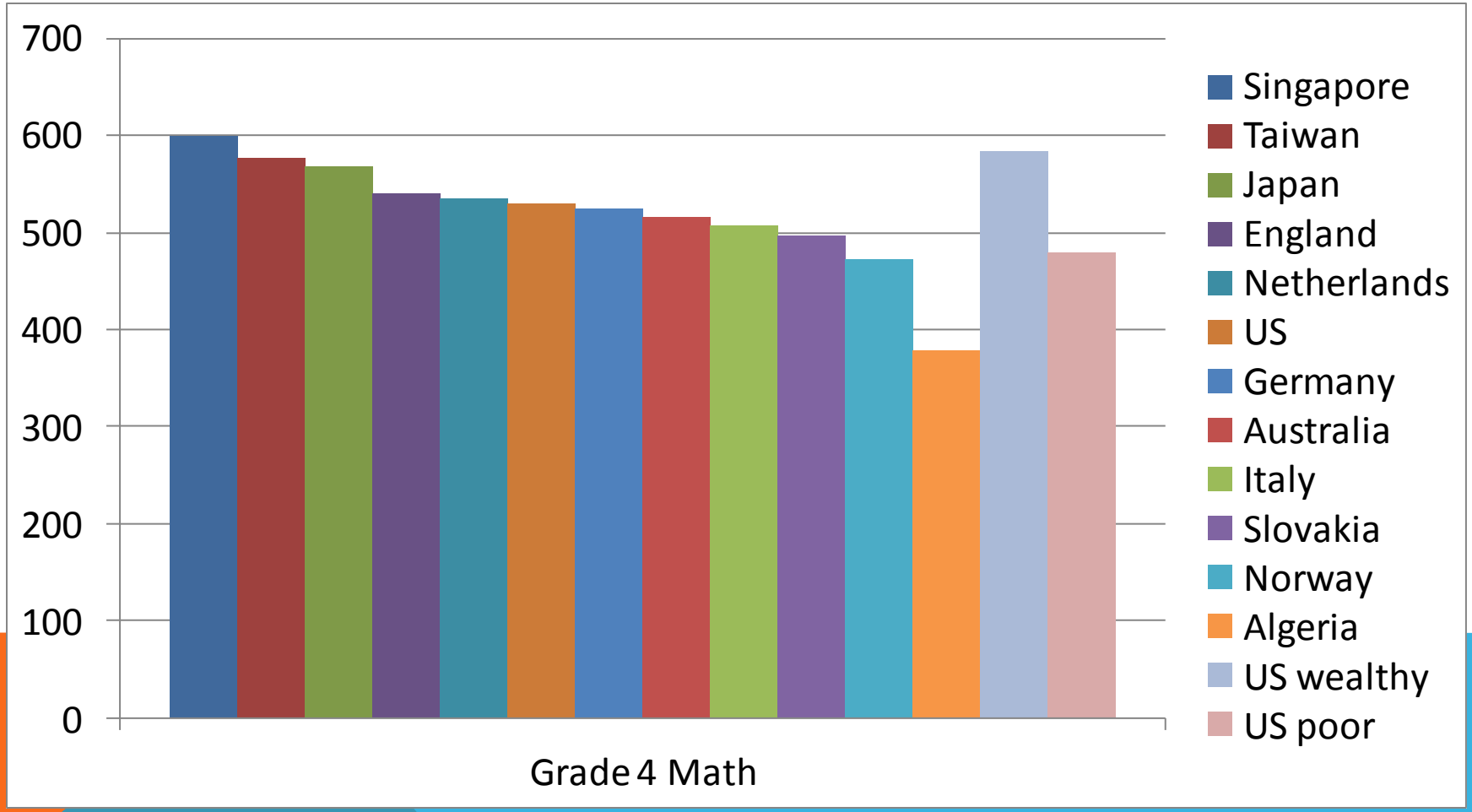
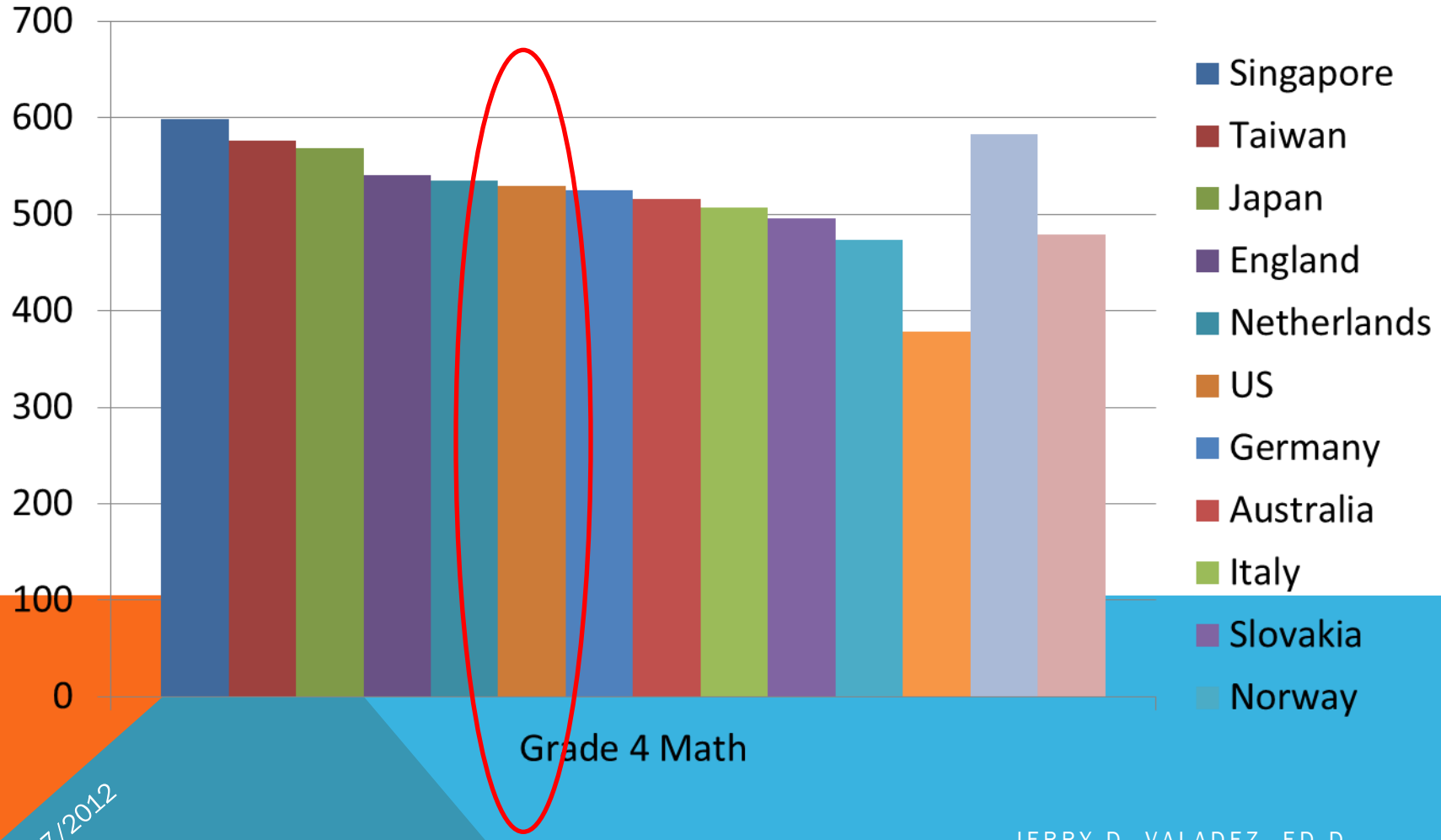
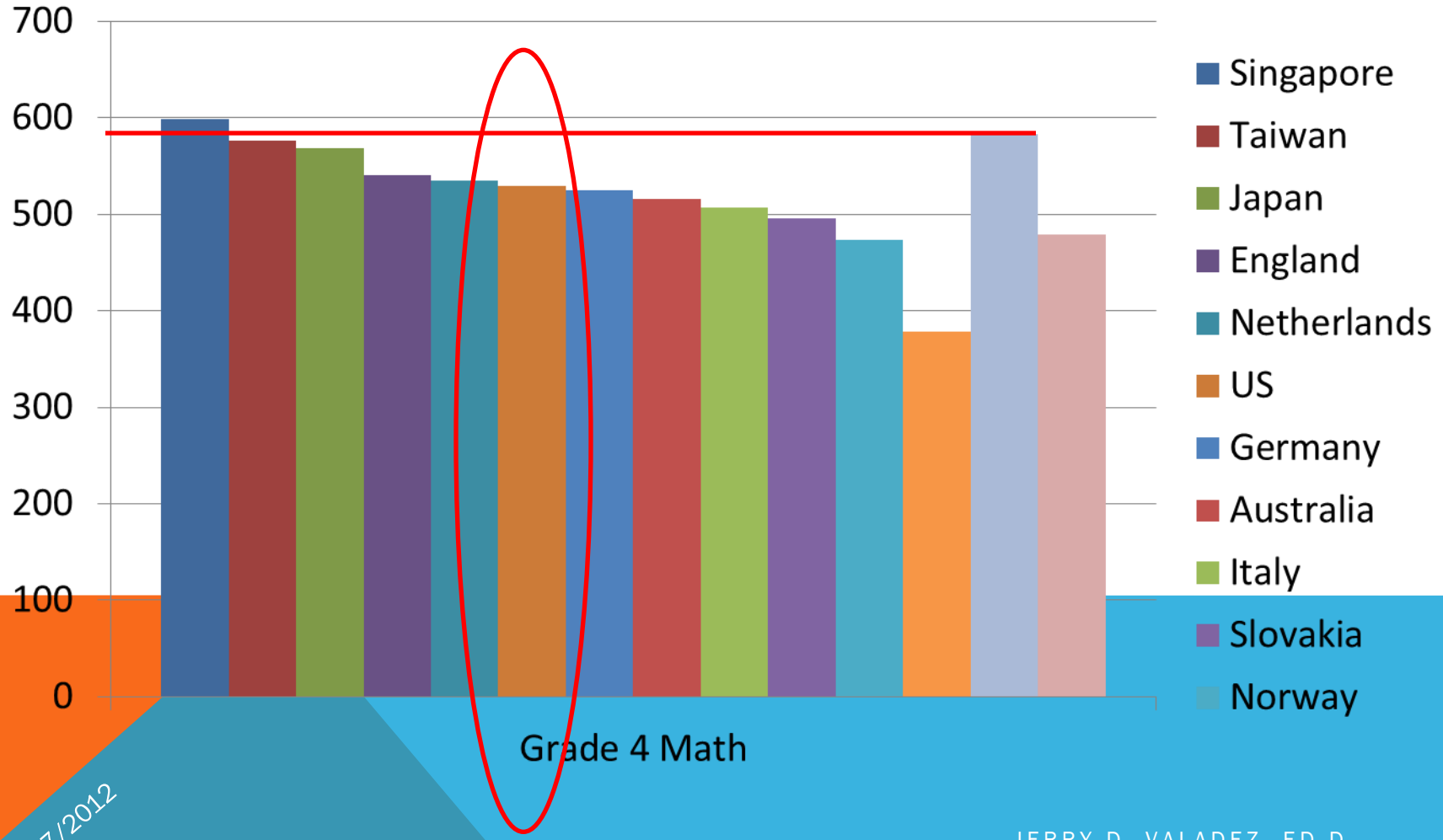
Average 2007 TIMSS Scores, Grade 4 Math



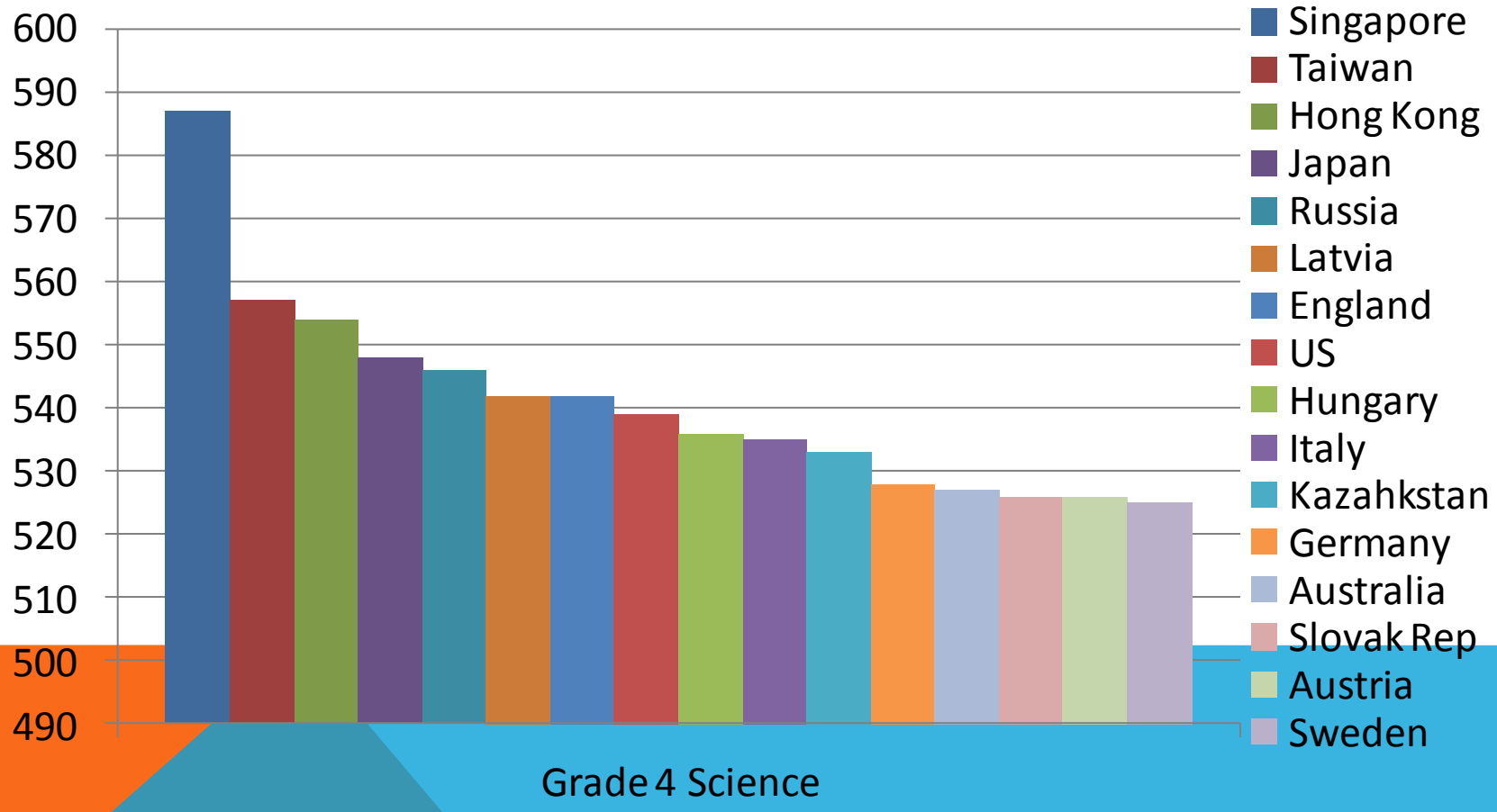
Average 2007 TIMSS Scores, Grade 4 Math



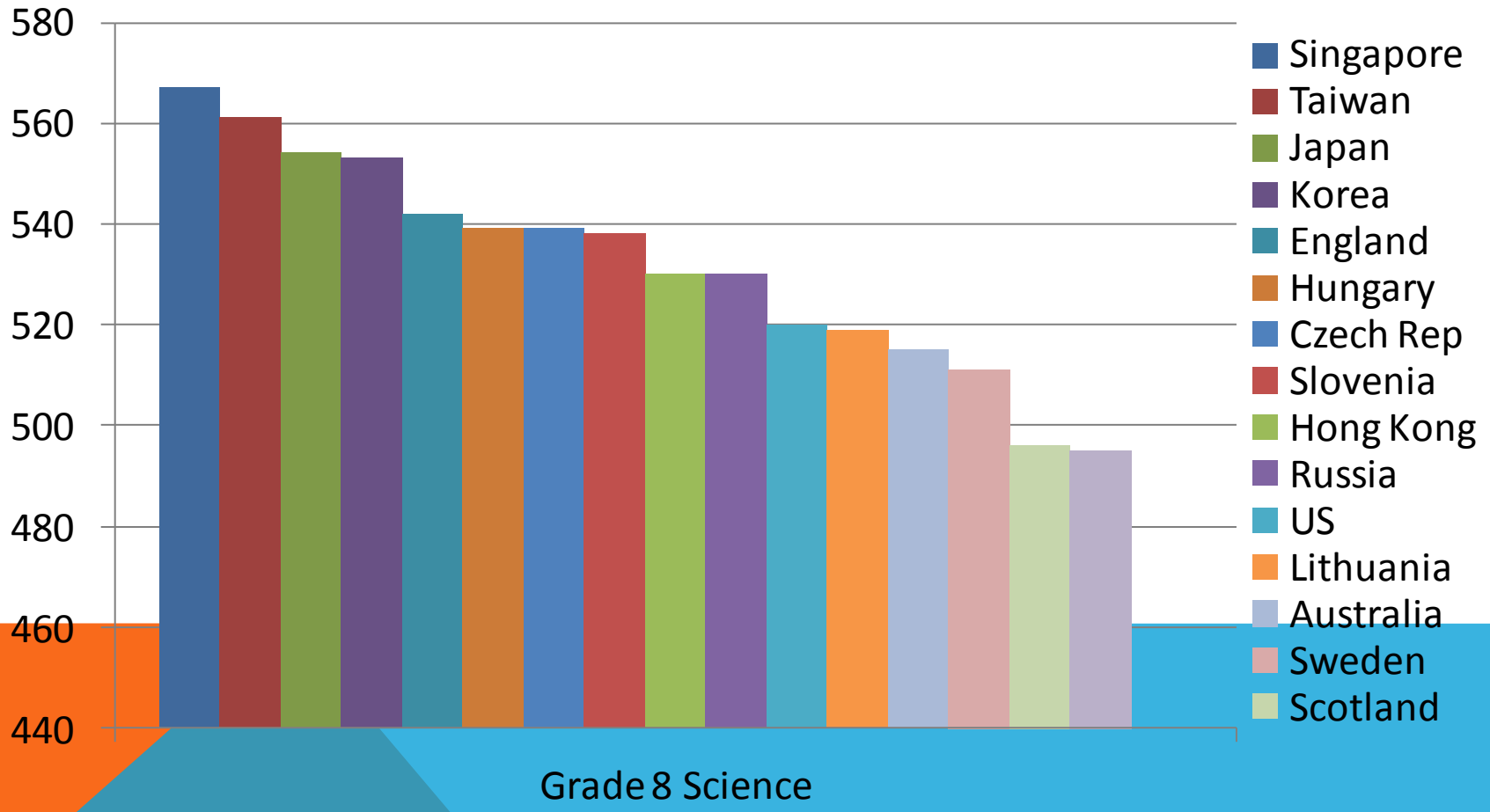
Average 2007 TIMSS Scores, Grade 4 Math



Average 2007 TIMSS Scores, Grade 4 Science



Average 2007 TIMSS Scores, Grade 8 Science



SUCCESSFUL K-12 STEM COMMITTEE

Adam Gamoran, Sociology, U of Wisconsin (Chair)

Julian Betts, Economics, UC-San Diego

Jerry P. Gollub, Biology/Physics, Haverford

Max McGee, Illinois Academy of Mathematics and Science

Milbrey W. McLaughlin, Education, Stanford

Barbara M. Means, Ctr for Technology in Learning, SRI

Steven A. Schneider, STEM Program, WestEd

Jerry D. Valadez, California Science Project, Fresno State

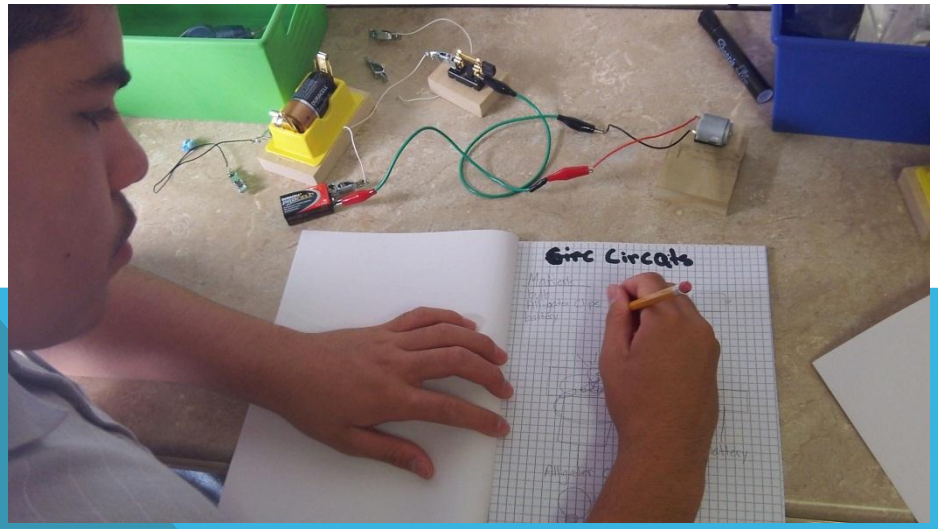
http://books.nap.edu/catalog.php?record_id=13158

CHALLENGES FACED BY THE COMMITTEE

1. **Knowledge about K-12 STEM education unevenly distributed across STEM domains.**
2. **Dearth of research on STEM focused schools and programs. Assess the evidence:**
   - Suggestive evidence: Conditions associated with success.
   - Evidence of success: Disentangle effects from selection.
3. **Before answering questions of criteria for success in K-12 STEM education, must identify the goals from which success would be measured.**

GOALS FOR U.S. STEM EDUCATION

1. **Expand the number of students who pursue STEM careers, and increase women and minority participation.**
2. **Expand the STEM-capable workforce and increase women and minority participation.**
3. **Increase STEM literacy for all students.**



EXAMINED SUCCESS IN THREE AREAS

1. Student outcomes

2. STEM-focused schools

3. Effective STEM instruction and school conditions

STUDENT OUTCOMES AS CRITERIA FOR SUCCESS

- **Achievement tests.**
- **Are test scores the outcome by which success is measured?**
  - Example: Thomas Jefferson High School of Science & Technology – school mission includes:
    - To inspire joy of learning through STEM.
    - Foster innovation in the context of STEM.
    - Promoting ethical behavior and contributing to good of mankind.
    - Ability to use STEM knowledge outside of school and beyond.

STEM-FOCUSED SCHOOLS

- **Three types of specialized schools**
  1. **Selective STEM schools**
     - Mainly high schools that enroll small numbers of highly talented and motivated students
  2. **Inclusive STEM schools**
     - Organized around STEM disciplines but without selective admissions criteria
  3. **STEM-focused CTE schools**
     - Mainly high schools, aim to foster engagement and to prepare students for STEM-related careers

STEM-FOCUSED SCHOOLS

- **Limited research base to compare effectiveness**
- **Potentially promising findings for each type of school**
  - Success in selective schools occurs through student research experiences.
  - Inclusive schools promote engagement and modestly lift test scores.
  - Mathematics instruction and occupational education can be successfully integrated in CTE schools
- **Specialized programs in regular schools such as AP and IB may also promote advanced study and career preparation**

EFFECTIVE STEM INSTRUCTION

- **Research base on effective practices is much stronger.**
- **Effective instruction capitalizes on students' early interest, builds on what they know, provides experiences to engage in the practice of science:**
  - Vision consistent with the *Conceptual Framework for Next Generation Science Standards (NGSS)*
  - Evidence presented at workshop and drawn from past NRC reports.
- **Effective instruction can occur in all school types. Key elements include:**

KEY ELEMENTS OF EFFECTIVE INSTRUCTION

1. A coherent set of standards and curriculum.
2. Teachers with high capacity to teach in their disciplines.
3. A supportive system of assessment and accountability.
4. Adequate instructional time.
5. Equal access to high-quality learning opportunities.

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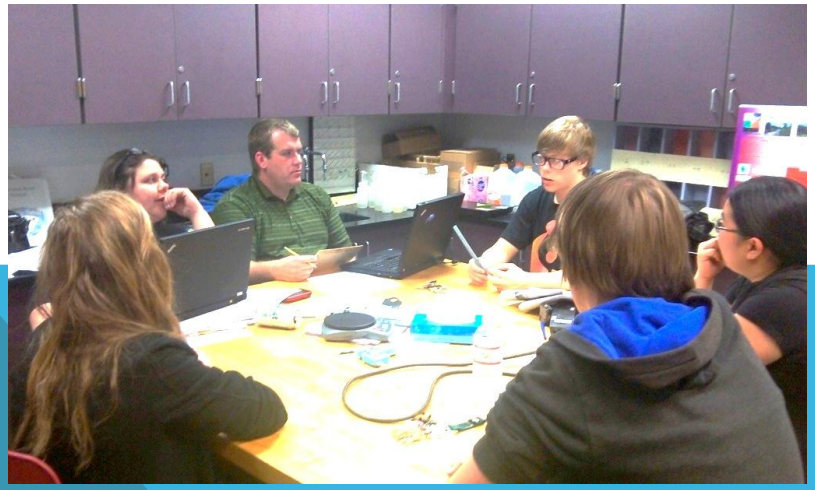
SCHOOL CONDITIONS THAT SUPPORT LEARNING

1. School leadership as the driver for change.
2. Professional capacity of faculty and staff.
3. Parent-community ties.
4. Student-centered learning climate.
5. Instructional guidance for teachers.



RECOMMENDATIONS FOR DISTRICTS

- ✓ **Consider all models of STEM-focused and comprehensive schools.**
- ✓ **Devote adequate instructional time and resources to K-5 science.**
- ✓ **Ensure that STEM curricula are focused on core topics, are rigorous, and articulated as a sequence.**
- ✓ **Enhance K-12 teacher capacity.**
- ✓ **Provide instructional leaders with professional development to create supportive conditions.**

RECOMMENDATIONS FOR POLICY MAKERS

- ✓ **Elevate science to the same level of importance as reading and mathematics.**
- ✓ **Develop science assessments aligned with standards and emphasize science practices.**
- ✓ **Invest in a coherent, focused, and sustained set of supports for STEM teachers.**
- ✓ **Support research that addresses key gaps in current knowledge.**

KEY AREAS FOR FUTURE RESEARCH

- **Research that links organizational and instructional practices to longitudinal data on student outcomes.**
- **Research on student outcomes other than achievement.**
- **Research on STEM schools and programs that:**
  - Disentangles school effects from characteristics of students.
  - Identifies distinctive aspects of educational practices.
  - Measures long-term effectiveness relative to goals.
- **Research on effects of STEM teacher professional development and school culture on student achievement.**

COMMISSIONED PAPERS

- ***STEM Reform: Which Way to Go*** **– James Schmidt – Michigan State University**
- ***Effective STEM Teacher Preparation, Induction, and Professional Development*** **– Suzanne Wilson – Michigan State University**
- ***Delivering STEM Through Career and Technical Education Schools and Programs*** **– James Stone – University of Louisville**
- ***Effective STEM Education Strategies For Diverse and Underserved Learners*** **– Okhee Lee – University of Miami, FL**
- ***Study of the Impact of Specialized Science High Schools*** **– Rena Subtonik, Robert Tai.**
- ***Inclusive STEM Schools: Early Promise In Texas and Unanswered Questions*** **– Viki Young – SRI International.**
- ***Engineering For Effectiveness In Mathematics Education: Intervention at the Instructional Core In an Era of Common Core Standards*** **– Jere Confrey, Alan Maloney – NC State University.**
- ***Building On Learner Thinking: A Framework For Improving Learning and Assessment*** **– Jim Minstrell, Ruth Anderson – FACETS; Min Li – University of Washington.**
- ***Mathematics Learning and Diverse Students*** **- Na'ilah Suad Nasir, et al – UC Berkeley**

Commissioned papers link:

http://www7.nationalacademies.org/bose/STEM_Schools_Workshop_Papers.html

THANK YOU

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