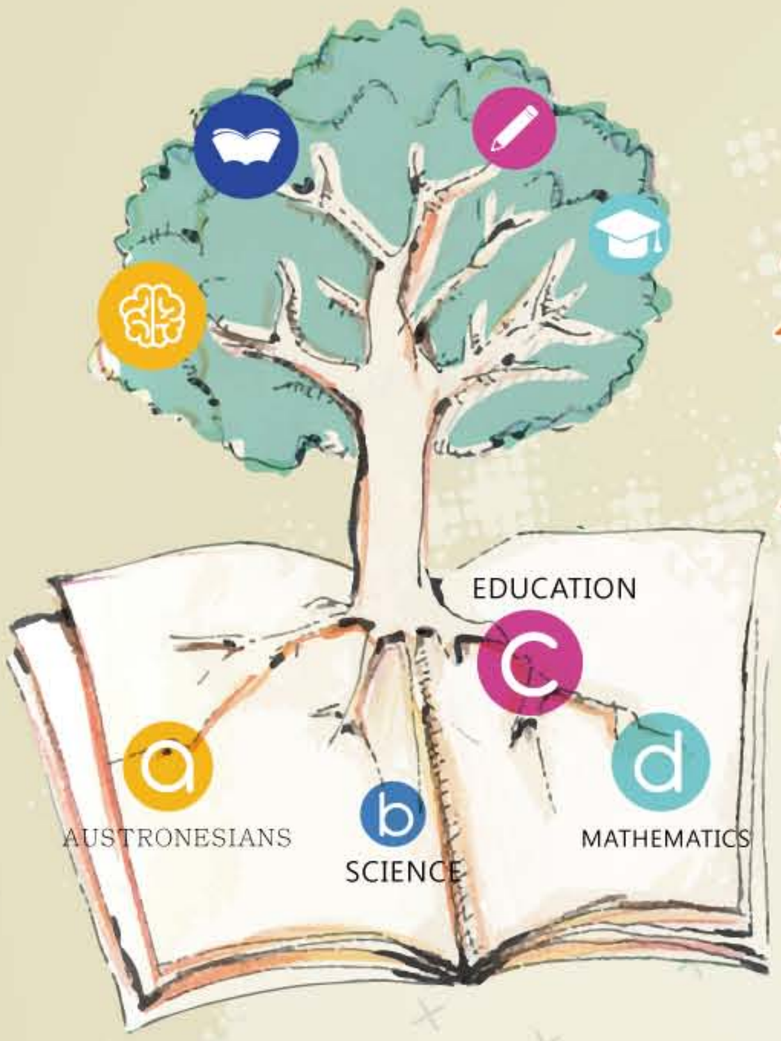

2016年南島民族科學與數學教育學術研討會

The 2016 Austronesians Conference on Science and Mathematics Education

KEYNOTE SPEECH I

Keynote Speaker:

Professor Karen C. Liu

Department of Teaching and Learning, Bayh College of Education, Indiana State University, U.S.A.

Topic:

Planning the Seeds for STEM Learning: Start with Young Children

Handout 演講資料

Sponsor:
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Planning the Seeds for STEM Learning: Start with Young Children

Planning the Seeds for STEM Learning: Start with Young Children

Dr. Karen Liu
Professor
Bayh College of Education
Indiana State University

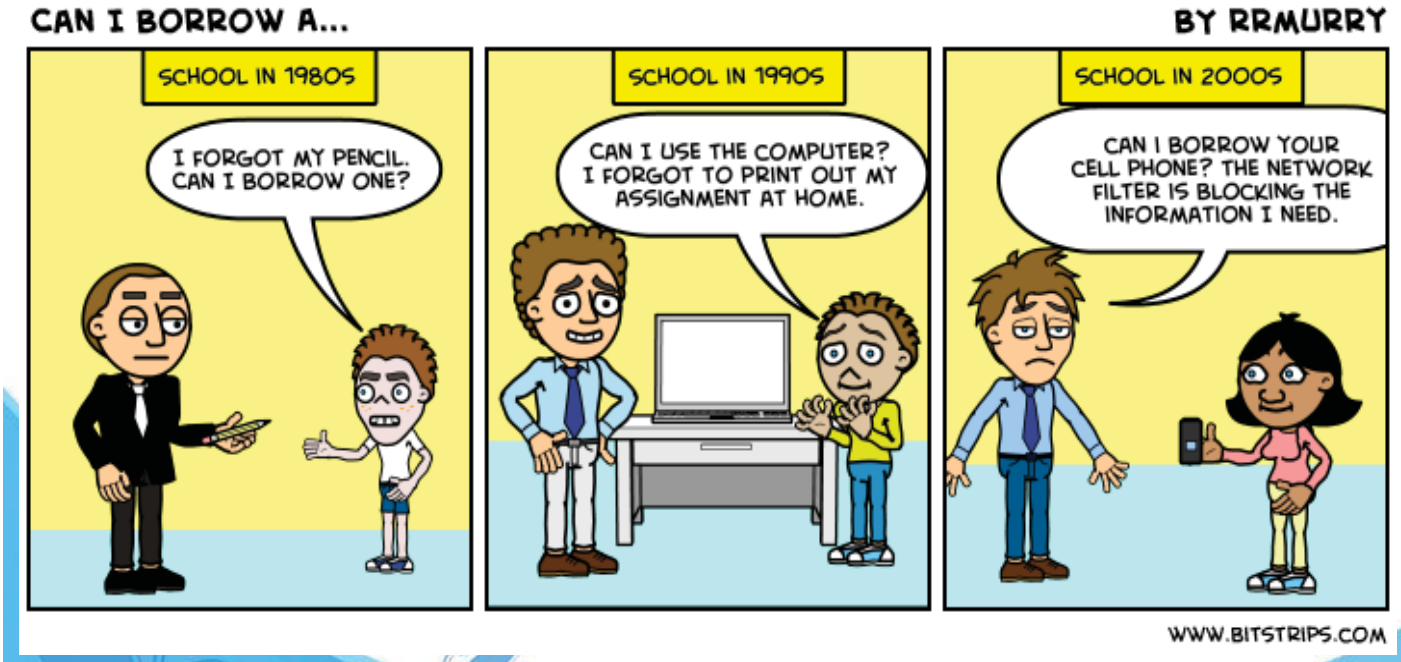
Indiana State University

The 2016 Austronesians Conference on Science and Mathematics Education

Agenda

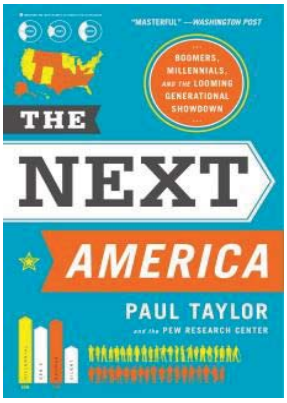
- An Introduction
- The Current US Students' Academic Performance
- US Educational reform and Standards Movement
- The Math and Sciences Standards in the State of Indiana
- The Next Generation of Learners & The 21st-Century Skills
- The National and State STEM Initiatives
- Nurturing STEM Skills in Young Learners
- Early STEM Learning through the Arts
- Resources

New Generation of Students



The Next America

- *The Next America* by Paul Taylor, Executive Vice President of the Pew Research Center
- In his book…."Today's Millennials who are well-educated, tech savvy, and underemployed , are at risk of becoming the first generation in American history to have a lower standard of living than their parents. "



Source: http://www.pewresearch.org/the-next-america-book/

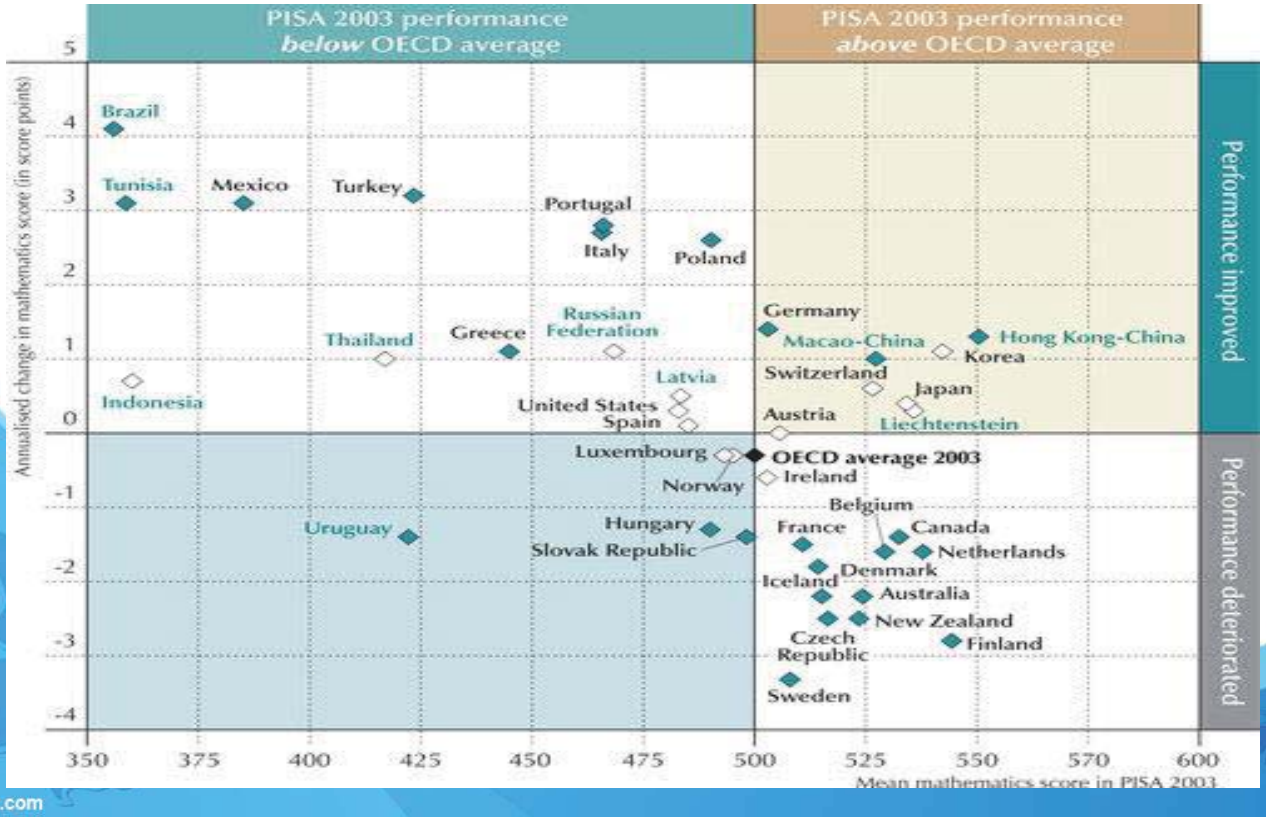
Sputnik Changed the World

- The Soviet Union successfully launched Sputnik I. to space on October 4, 1957; it marked the start of the space age (Moskowitz, 2012).
- The Sputnik launch drew Americans' attention to science research and the creation of National Aeronautics and Space Administration (Garber, S. (2007).
- In July 1958, Congress passed the National Aeronautics and Space Act (commonly called the "Space Act"), which created NASA as of October 1, 1958 (Pearlman, 2011).
- NASA's space shuttle program officially ended on August 31, 2011 (Pearlman, 2011).

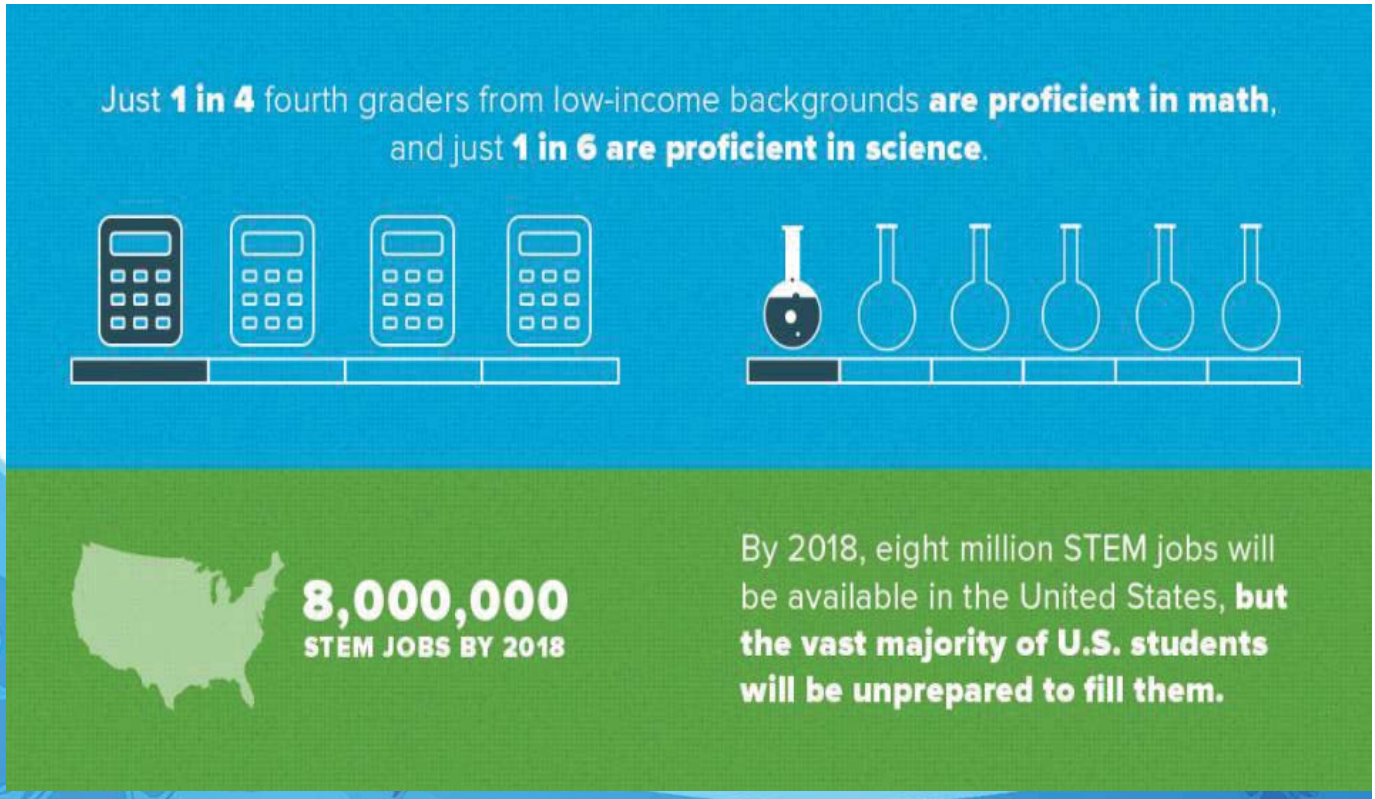
PISA Global Competition

- PISA stands for Programs for International Student Assessment (PISA).
- PISA is an international assessment that measures 15-year-old students' reading, mathematics, and science literacy every three years.
- PISA was first conducted in 2000. Data collection for the most recent assessment was completed in Fall 2015 (National Center for Educational Statistics).
- The latest results, from 2012, show that U.S. students ranked below average in math (ranked 29) and in science (ranked 23) among the world's most-developed countries. US students were close to average in science and reading (Chappell, 2013).

A graphic released with the 2012 PISA results shows the annualized change in performance in average math scores between 2003 and 2012. The chart includes only nations that have comparable data from both 2003 and 2012 (Chappell, 2013)

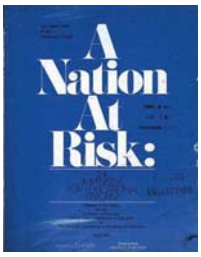


The Need for STEM Training



Source: https://www.teachforamerica.org/about-us/our-initiatives/stem-initiative

Educational Reform



- In 1983, President Reagan's National Commission on Excellence in Education published a report on *A Nation at Risk: The Imperative for Educational Reform.*
- The report provided 38 recommendations in 5 areas:
  - Content
  - Standards and Expectations
  - Time (7-hour school day & 200-220 day/school year)
  - Teaching
  - Leadership and Fiscal Support

Source: A Nation at Risk (1983) archived Information. Recommendations.

Standards-Based Educational Reform

- Standards-based educational reform started in the middle of 1980s which was largely driven by the setting of performance or academic standards for what people should know and be able to do.
- A standards-based system measures each person against the concrete standard.
- NBPTS and INTASC standards were published in 1989.
- The *National Council of Teachers of Mathematics* published the *Curriculum and Evaluation Standards for School Mathematics* which was the first math standards (cepionline.org).

Global Standards Movement

- Global Educational Reform Movement is here!
- Establish Global standards for education and training in a field.
- National Standards & State Standards in content areas (Common Core Standards)

The State of Indiana

- **Indiana is located in the mid-western and Great Lakes regions .**

The State of Indiana vs. Taiwan

- **Indiana has a total land area of 36,418 square miles which makes it ranks as the 38th largest state (National Atlas of the United States, 2016)**
- **Taiwan has a total land area of 13,974 sq. mi which is around 1/3 in size of Indiana.**
- **Based on the *U.S. Census Bureau's* estimation, the population of Indiana was 6,619,680 (6.6 millions) on July 1, 2015 which makes it as the 16th largest state by population among the 50 States (The United States Census Bureau, 2016)**
- **Based on the *National Statistics,* Republic of China (Taiwan)'s estimation in July 2016, the population of Taiwan was 23,508,362 (23.5 Millions). It is near 4 times of the population in Indiana.**

Indiana Academic (Content) Standards

- The Indiana State Board of Education approved the adoption of new standards on April of 2014 for English/Language Arts and Mathematics.
- These new standards are designed to identify, evaluate, synthesize, and create high-quality, rigorous standards for Hoosier students (IDOE, 2016).

IMAGINING the possibilities. MAKING THEM HAPPEN.

Indiana Department of Education
Glenda Ritz, NBCT
Indiana Superintendent of Public Instruction

Source: http://www.doe.in.gov/standards

What are Academic Standards?

- Academic standards are benchmark measures and define **what students should know and be able to do at specified grade levels.**
- The academic standards are NOT a curriculum which identifies the sequence of instruction in each grade (what will be taught and how long.
- Academic standards focus on what students will need to learn in order to be college and career ready and to be competitive in the job market.

Source: http://www.doe.in.gov/standards

IMAGINING the possibilities. MAKING THEM HAPPEN.

Indiana Department of Education
Glenda Ritz, NBCT
Indiana Superintendent of Public Instruction

Indiana Kindergarten Math Standards

Indiana:

Skills available for Indiana kindergarten math standards

- **Math Process Standards (SEPS) (8 process standards)**
- **K.NS Number Sense (11 sub-standards)**
- **K.CA Computation and Algebraic Thinking (5 sub-standards)**
- **K.G Geometry(4 sub-standards)**
- **K.M Measurement (2 sub-standards)**
- **K.DA Data Analysis (1 sub-standard)**

http://www.doe.in.gov/sites/default/files/standards/mathematics/2014-07-21-math-gk-architecturewith-front-matter_br.pdf (May 1, 2014)

Indiana Academic Science Standards

- **The revised (2016) Indiana's Academic Science Standards reflects current scientific content and the core principles that science education should be an inquiry-based, hands-on experience.**
- **The revised science standards implement during the 2016-17 school year.**
- **The science standards focus on the following topics; physical science; earth and space science; life science; and literacy. For K-8, there are computer science and engineering standards (IDOE-b, 2016).**

Indiana Kindergarten Science Standards

Indiana:

Skills available for Indiana kindergarten science standards

- **Science and Engineering Process Standards (SEPS) (8 process standards)**
- **IN. K.PS. Physical Science (4 sub-standards)**
- **IN.K. ESS. Earth and Space Science (4 sub-standards)**
- **IN.K. LS. Life Science (3 sub-standards)**
- **IN.K-2nd.E. Engineering (3 sub-standards)**

Source: http://www.doe.in.gov/sites/default/files/standards/indiana-kindergarten-standards-2016-41116.pdf

Indiana Kindergarten-2nd Computer Science Standards

Indiana:

Skills available for Indiana kindergarten – 2nd grade Computer Science Standards

- **IN.K-2nd. DI. Data and Information (3 sub-standards)**
- **IN.K-2nd. CD. Computing Devices and Systems (1 sub-standard)**
- **IN.K-2nd. PA. Programs and Algorithms (3 sub-standards)**
- **IN.K-2nd. NC. Networking and Communication (2 sub-standards)**
- **IN.K-2nd. IC. Impact and Culture (2 sub-standards)**

Source: http://www.doe.in.gov/sites/default/files/standards/indiana-k-2-computer-science-standards-2016-0519.pdf

Indiana Early Learning Foundations

- **Indiana's Early Learning Development Framework: The Foundations (2015) provides core elements that children should achieve from birth to age five in order to be ready for future success.**
- **Indiana's Early Learning Foundations development framework aligned to the 2014 Indiana Academic Standard.**
- **The 2015 revision was based on research, feedback from practitioners, and work from professionals with expertise in each specialized area.**

Source: http://www.doe.in.gov/earlylearning

Indiana Early Learning Math Foundations

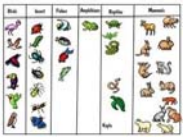
Indiana:

Skills available for Indiana Early Learning Math Foundations (page 12 to page 18)

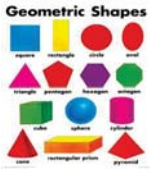
- **Math Foundation 1: Numeracy**
  - **M 1.1: Demonstrate strong sense of counting**
  - **M 1.2 Demonstrate understanding of written numerals**
  - **M 1.3: Recognition of number relations**

- **Math Foundation 2: Computation and Algebraic Thinking**
  - **M 2.1: Exhibit understanding of mathematic structure**
  - **M 2.2: Demonstrate awareness of patterning**

In EL Math Foundations



- **Math Foundation 3: Data Analysis**
  - M 3.1: Demonstrate understanding of classifying
- **Math Foundation 4: Geometry**
  - M 4.1: Understanding of spatial relationships
  - M 4.2: Exhibit ability to identify, describe, analyze, compare, and create shapes



- **Math Foundation 5: Measurement**
  - M 5.1: Understand concept of time
  - M 5.2: Understand measurement through description and comparison

Indiana Early Learning Science Foundations

Indiana:

Skills available for Indiana Early Learning Science Foundations (page 29 to page 34)

- **Science Foundation 1: Physical Science**
  - SC 1.1: Demonstrate ability to explore objects in the physical world
  - SC 1.2: Demonstrate awareness of the physical properties of objects

- **Science Foundation 2: Earth and Space Science**
  - SC 2.1: Recognize the characteristics of earth and sky
  - SC 2.2: Recognize seasonal and weather elated changes

In EL Science Foundations

- **Science Foundation 3: Life Science**
  - ❑ **SC 3.1: Demonstrate awareness of life**
- **Science Foundation 4: Engineering**
  - ❑ **SC 4.1: Demonstrate engineering design skills**
- **Science Foundation 5: Scientific Inquiry and Methods**
  - ❑ **SC 5.1: Demonstrate scientific curiosity**

The Next Generation of Learners

news.yale.edu

Did You Know?

- Did You Know 2016? (6:56)
- 教育的未來 (Did you know?) (6:18)
  2007/4/3/ by luciferpr

fastcompany.com

What are the 21st-century skills kids need for life beyond the classroom, and why they are important?

21st Century Skills

Learning Skills	Literacy Skills	Life Skills
Critical Thinking	Information Literacy	Flexibility
Creative Thinking	Media Literacy	Initiative
Collaborating	Technology Literacy	Social Skills
Communicating		Productivity
		Leadership

Source: https://k12.thoughtfullearning.com/FAQ/what-are-21st-century-skills

National and State Initiatives to Promote STEM Learning

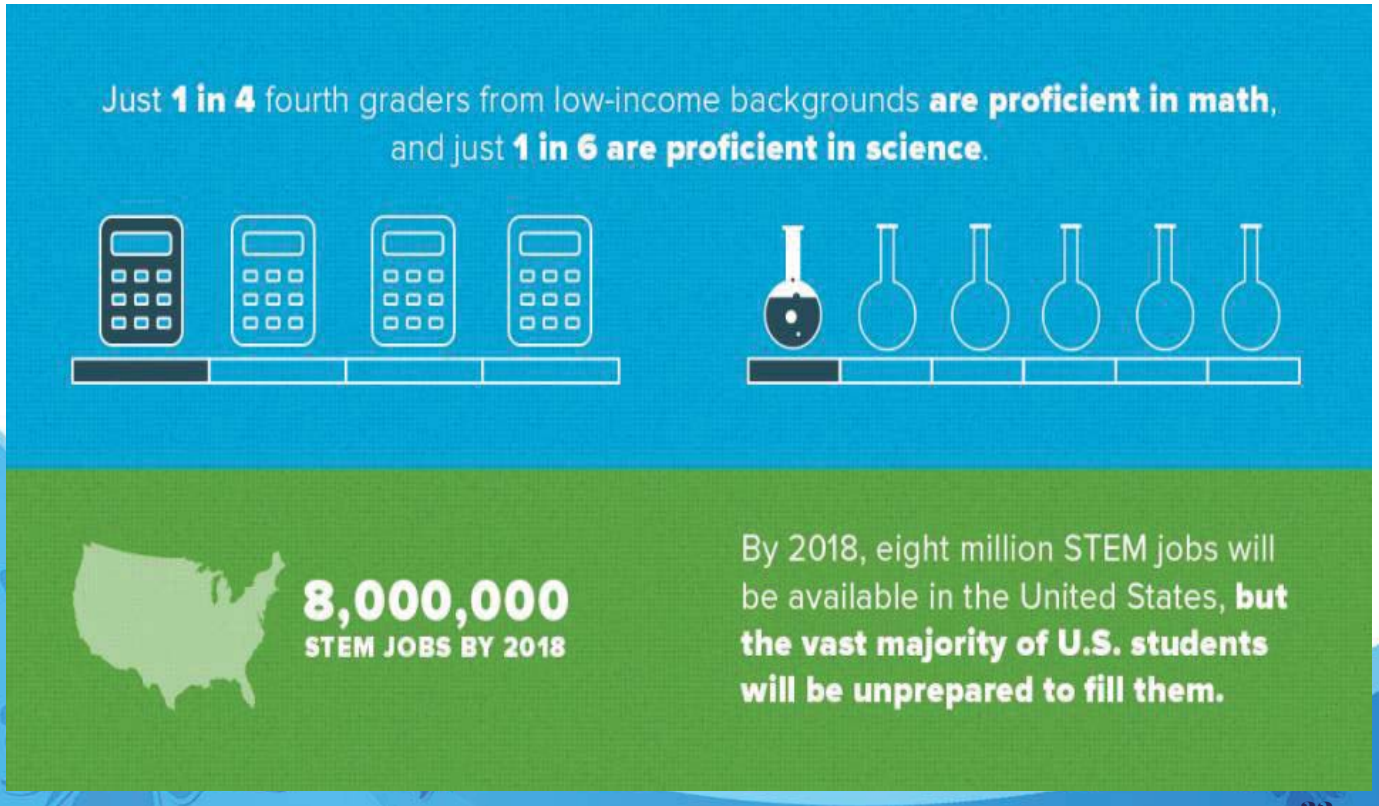
STEM Science, Technology, Engineering, Mathematics

Obama's "Educate to Innovate" Campaign

- **President Obama on November 23, 2009 launched the "*Educate to Innovate*" campaign, which included over $260 million in public-private investments to help reach its goal of moving American students from the middle to the top of the rank in science and math achievement over the next decade (The White House, 2009).**

- **The "*Educate to Innovate*" initiative involves building partnerships with leading companies, foundations, non-profits, and science and engineering societies to motivating and inspiring young people across America to excel in science and math (The White House, 2009).**

STEM Matters



Source: https://www.teachforamerica.org/about-us/our-initiatives/stem-initiative

US India Tribal Communities STEM Initiatives

- **The United States has 566 federally recognized Tribal communities. These tribal communities were confirmed by the Constitution of the United States, treaties, statutes, executive orders and judicial decisions (US Department of Energy, Office of Economic Impact and Diversity, ND).**
- **US DOE launched the American Indian Research and Education Initiative (AIREI) in 2011.**
  - **This initiative encourages partnerships and brings STEM research and education funding to American Indian students at the Tribal Colleagues and other universities.**

Source: http://energy.gov/diversity/american-indian-research-and-education-initiative-airei

The SUN Project

- **The SUN Project was launched in 2013 as a collaboration between US DOE (Energy Department) and the American Indian Science and Engineering Society to engage urban Native American youth in STEM fields.**
- **The project provided resources and support to urban Native American youth and encouraged them to participate Energy Department sponsored National Science Bowl competitions (DOE, 2013).**
- **The Sun Project offered *Power Up Workshops* on Energy literacy and scientific method to Native American youth at two middle and two high schools per pilot city. These training provided team members an opportunity to compete at the National Science Bowl competition in the spring of 201.4 (DOE, 2013)**

TeachForAmerica Initiative

- Teach For America and the Amgen Foundation launched the STEM Initiative in 2006, announcing our commitment to empowering all students with a great STEM education. Today, Teach For America is one of the largest—and most diverse—providers of STEM teachers in the country. Approximately 3,500 of our corps members teach an elementary or secondary STEM subject in schools (TeachForAmerica, 2016).

STEM AmeriCorps

- In 2007, the Carnegie Foundation commissioned a group of distinguished researchers and experts and concluded there is a national imperative to educate the new generation with a thorough understanding of science, technology, engineering, and mathematics (STEM.)
- In April, 2013, President Obama at the White House Science Fair announced the STEM AmeriCorps program. This new initiative connects AmeriCorps members with scientists and engineers in nonprofit organizations across the county. This program is intended to inspire young people to excel in STEM field(Corporation for National & Community Service., 2013).

Source: Sneideman , 2015

Indiana STEM Education Initiative

- Recognized the need to prepare Hoosier students for success in the 21st century, and to establish more rigorous and engaging STEM education, in 2012 the statewide STEM Education Plan was initiated.
- The initiative to become an Indiana DOE certified STEM school, "Becoming a STEM School," was piloted in 2014-2015 academic year.
- Indiana STEM Education has Made it Happen
  http://www.doe.in.gov/sites/default/files/ccr/mih-stem.pdf

Indiana's STEM Implementation Matrix

Full STEM Implementation

Whole school or district STEM initiatives. This is a non-traditional model of education in which the classroom resembles a work environment and students contribute to solving problems in the community. STEM careers, experiences, and skills drive the curriculum. Curriculum is integrated in authentic problem-based learning that is STEM career oriented and cross disciplinary. Students collaborate in teams to solve problems. Teachers facilitate teams of students towards solving problems and developing work force skills, commonly the skills required by STEM businesses in that area or region. Frequently, schools have partnerships with businesses to provide materials, resources, and capital.

Approaching STEM Implementation

This is a non-traditional school experience. STEM experiences and related skills are integrated into the curriculum. The STEM program may be school wide, with teachers collaborating across disciplines for long term projects. These projects may be in addition to the normal curriculum or used to enhance the educational process. This may also include a school in which only a portion of the student body participates in these long term projects, interdisciplinary learning, or STEM career-based courses in CTE. Frequently the schools maintain business partnerships for materials, resources, and capital.

Indiana's STEM Implementation Matrix

Developing STEM Implementation

This is a traditional school setting. STEM-related problem-based learning is supplemental to the adopted curriculum. This could include separate STEM units, often done at the end of a unit or school year. It could also include short units offered by industry or non-profits such as Project Learning Tree or National Energy Foundation. These units serve to briefly provide STEM experiences to students and develop skills required in the workforce.

Initial STEM Implementation

Schools may offer STEM experiences that are not a part of the regular school day. This may include but is not limited to afterschool programs, summer programs, school clubs, and academic competitions and fairs.

Modified from the STEM Immersion Matrix for Schools and Districts © 2012, The Immersion Guide © 2013, created by and work product of The Arizona STEM Network, led by Science Foundation of Arizona in collaboration with Maricopa County Education Service Agency.

Becoming Indiana STEM School : 4 Immersion Levels

- Initial STEM Implementation
  - Schools may offer STEM experiences that are not a part of the regular school day. This may include but is not limited afterschool programs, summer programs, school club, and academic competitions and fairs.
- Developing STEM Implementation
- Approaching STEM Implementation
- Full STEM Implementation

IMAGINING the possibilities. MAKING THEM HAPPEN.

Indiana Department of Education
Glenda Ritz, NBCT
Indiana Superintendent of Public Instruction

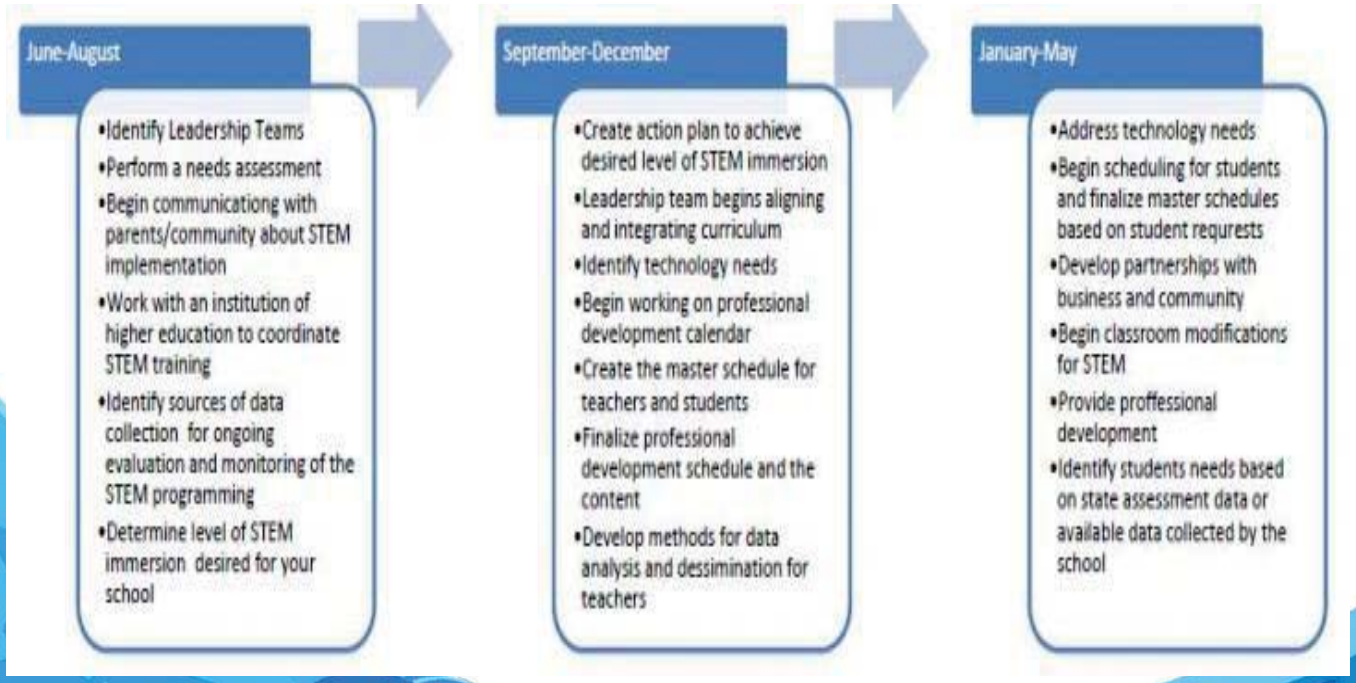
Indiana's Full STEM Implementation

STEM

"Whole school or district STEM initiatives. This is a non-traditional model of education in which the classroom resembles a work environment and students contribute to solving problems in the community. STEM careers, experiences, and skills drive the curriculum. Curriculum is integrated in authentic problem-based learning that is STEM career oriented and cross disciplinary. Students collaborate in teams to solve problems. Teachers facilitate teams of students towards solving problems and developing work force skills, commonly the skills required by STEM businesses in that area or region. Frequently, schools have partnership with businesses to provide materials, resources and capital."

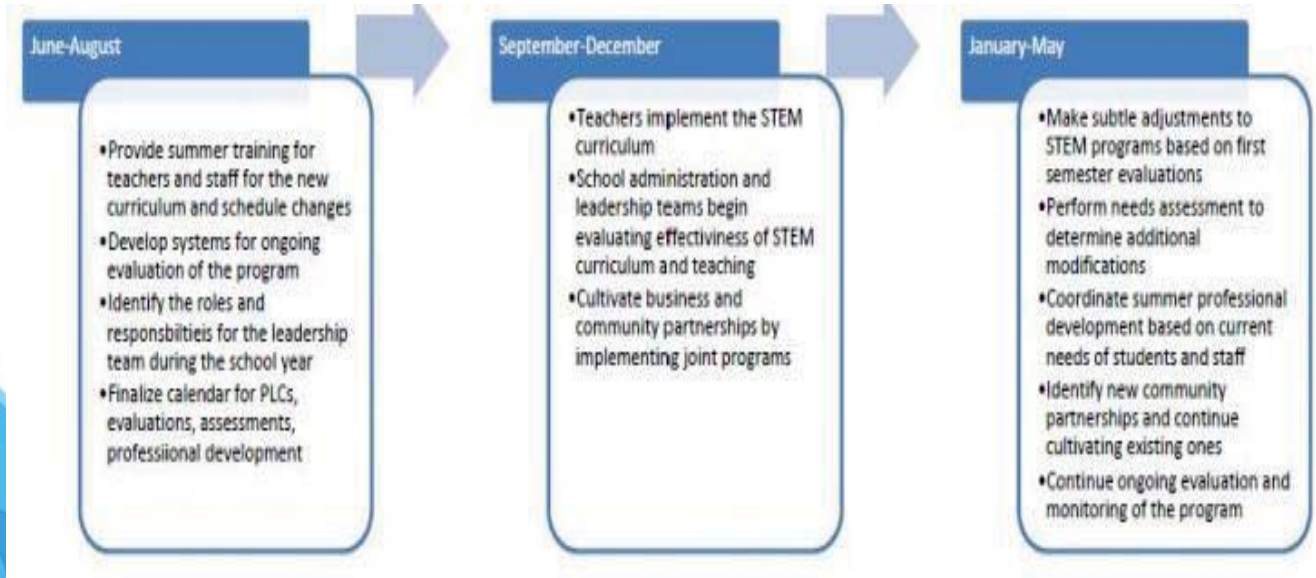
Quote from "Indiana's STEM Implementation Matrix"

Timeline: School Year Prior to STEM Implementation



Source: http://www.doe.in.gov/ccr/indiana-stem-education-science-technology-engineering-and-mathematics

Timeline: Year 1 of Implementation



Source: http://www.doe.in.gov/ccr/indiana-stem-education-science-technology-engineering-and-mathematics

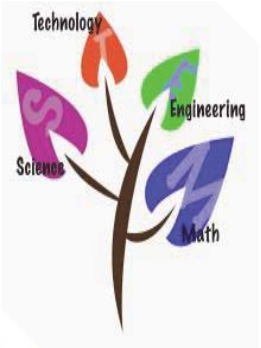
Becoming a STEM School

- Send out the kick off memo from IDOC to all superintendents and principals.
- Review Indiana's Framework for STEM Education plan document
- Select STEM implementation level (initial, developing, approaching, full implementation)
- Assess the Elementary and Middle School STEM Implementation document or the High School STEM implementation document
- Examine STEM implementation rubric
- Develop self-evaluation
- Attend "Becoming a STEM School" Overview Webinar (http://www.doe.in.gov/sites/default/files/ccr/thinking-about-stem-school-certification.pdf)
- Complete the application

STEM
Science • Technology • Engineering • Math

➢ *There were 6 schools becoming STEM schools at the first round, and 9 schools received STEM certificates at the 2nd round.*

Nurturing STEM Skills in Young Learners



GREAT Minds in STEM

Children are Natural Explores

Young Children and STEM Learning

Are Young Children Ready for STEM Learning? Why and why not?

1. Write down your opinion on the post card.
2. Give an example on your reason(s).
3. Share your response with 2-3 participants.
4. Compare your responses.
5. Report back to the large group.

Children are ready for STEM learning

Young children are:

- ❑ **Natural STEM investigators**
- ❑ **Eager to explore and invent**
- ❑ **Love hands on activities**
- ❑ **With enormous creative ideas**
- ❑ **Curious and anxious to find answers**

❖ **Brain Research: Early years are learning years!**

Teaching STEM to Early Learners

Joshua M. Sneideman in his article, *Engaging Children in STEM Education Early* said: "The most important thing to remember about teaching STEM to early learners is that they are perfectly adapted to learn STEM concepts, and it is not difficult to teach STEM to young children. The secret is to tap into their natural and innate curiosity about the living world. By simply allowing them to investigate, by encouraging them to ask questions about the real world, you are engaging children in STEM."

STEM Learning Challenges

What are the challenges in STEM learning?

Challenges in 3 areas in the early learning landscape may prohibit to produce successful STEM learning:

1. **Standards**
2. **Professional Development**
3. **Curriculum and Instruction**

(Successful STEM Education, 2013)

Fimy-pictures.picphotos.net

Challenge I: Standards

- **Standards are the benchmarks to guide what children need to know and be able to do. Standards are NOT the curricula.**
- **Many standard-based assessments are using one size fits all approach without considering learning difference in each individual child. (Successful STEM Education, 2013)**

EARLY LEARNING INDIANA

EARLY LEARNING INDIANA

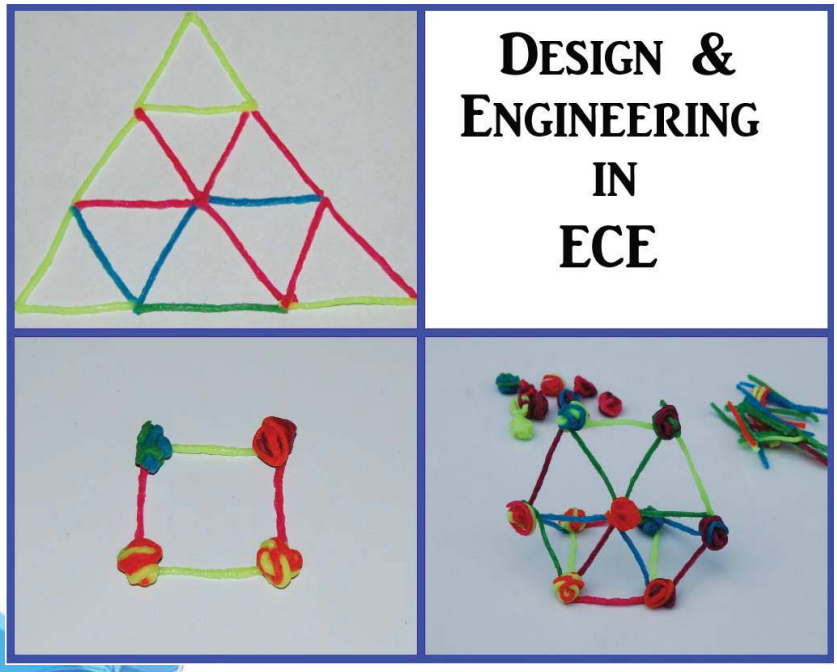
Challenge2: Professional Development

- Some teachers (PreK-3) are not adequately trained to effectively nurture, plan and scaffold children's STEM (math and science) learning.
- Some programs (PreK-3) are not sufficiently support teachers' professional development by providing adequate time and resources to allow teachers to grow and improve.
- States need to offer teachers credit-bearing STEM courses to improve and enhance teachers' ability to implement inquiry-based & child-initiated instruction and to foster children's math and science concept development and understanding. (Successful STEM Education, 2013)

Challenge3: Curriculum and Instruction

- Many preK-3 programs place an emphasize on children's language and literacy development, but put limited time on math and science learning.
- Early childhood educators need to examine the distinctions between *academic* and *intellectual* goals and activities rather than to insist on a dichotomy of either formal instruction or play (Katz, 2010).
- STEM curriculum, that is, a plan for learning, cannot be delivered; it must be provided to young children (Katz, 2010).

Early STEM Learning through the Arts



Early STEM/Arts

- In 2013, President Obama gave his State the Union address, outlined two key educational fronts: 1) high quality preschool for all 4-years olds, and 2) preparing a news generation of Americans in STEM learning.
- With the support from the US DOE, the Wolf Trap Institute for Early Learning Through the Arts initiated it learning STEM through the arts program in Fairfax County (Virginia) Public Schools (USDOE, 2013)

WOLF TRAP
Early Childhood
STEM Learning
Through the Arts

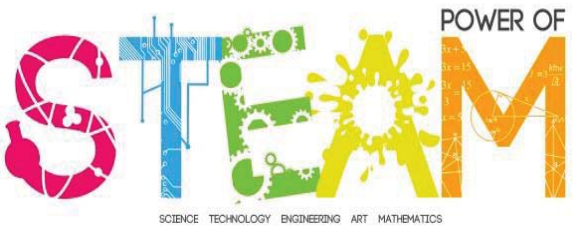
- **STEM/Arts program developed skillsets to engage students in performing arts learning experiences (music, dance, drama) that develop early childhood mathematics learning skills in number and number sense, measurement, geometry, algebra, data analysis, statistics, and probability.**

- **STEM Learning Through the Arts: An Effective Teaching Strategy (Video, 4:19)**

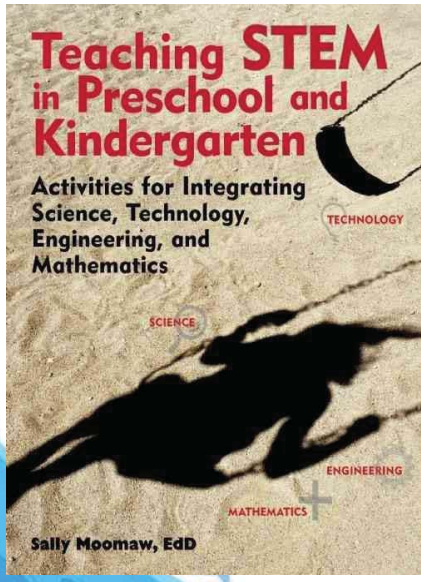
Source: Wolf Trap, http://www.wolftrap.org/education/institute-for-early-learning-through-the-arts/impact.aspx

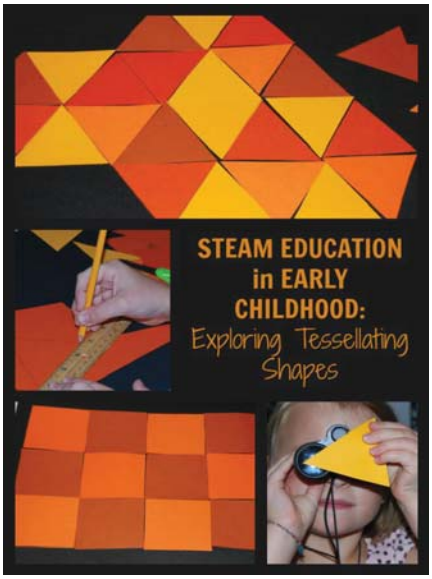
Idea Sharing

Identify 3 ideas that foster young children's STEM learning through creative arts (such as music, dance, and drama) .



STEM Resources





Q & A

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謝謝!

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