Preparing Future STEM Educators

Women in STEM Roadshow
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February 5, 2018 through February 24, 2018

Overview

- What is STEM?
- What is science education?
- STEM professional supply and demand
- STEM learning challenges
- International study
- Inquiry – science process skills

What is STEM?

Science
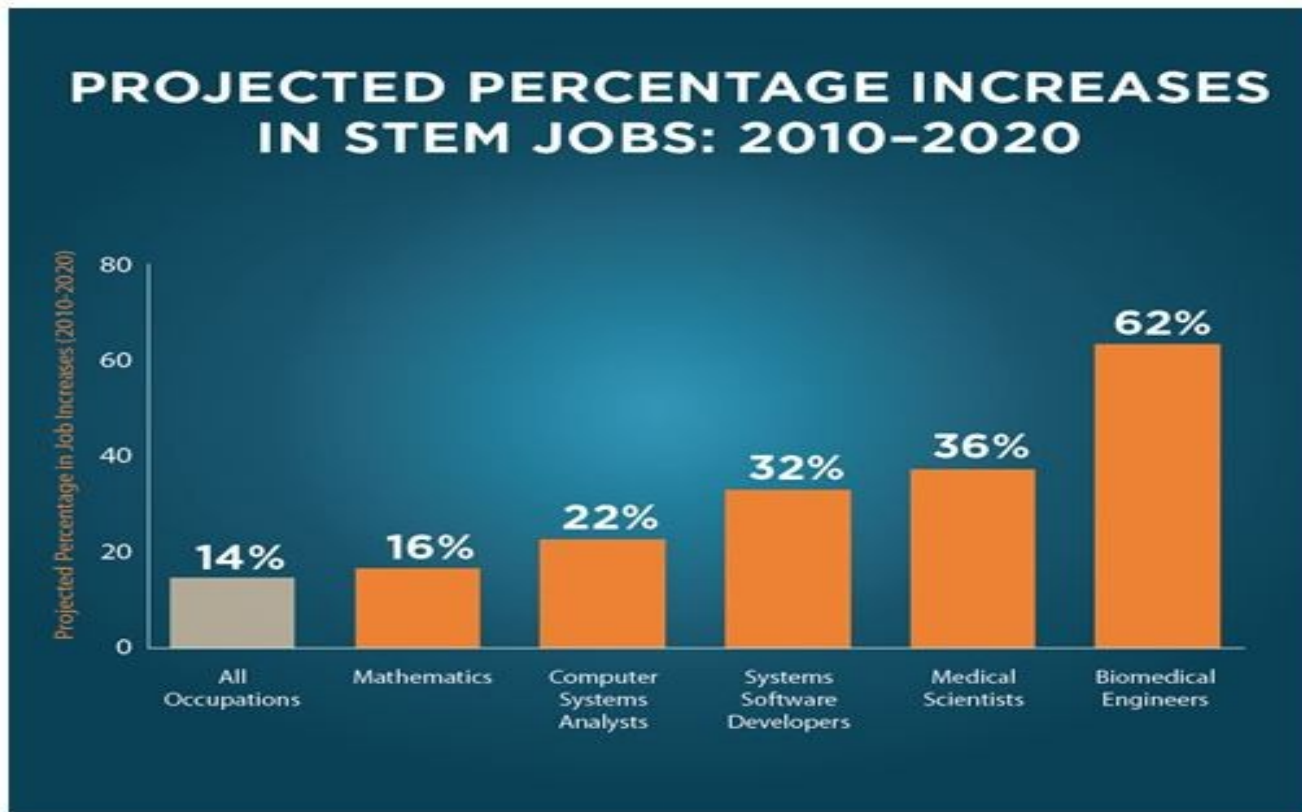
Technology

Engineering

Mathematics

What is Science Education?

- Sharing of science content and processes

- Learners may be children, college students, or adults

- Includes scientific methodologies, social sciences, and science of learning & teaching

- Includes many different science disciplines

Supply & Demand

PROJECTED PERCENTAGE INCREASES IN STEM JOBS: 2010–2020

- All Occupations: 14%
- Mathematics: 16%
- Computer Systems Analysts: 22%
- Systems Software Developers: 32%
- Medical Scientists: 36%
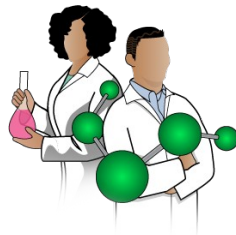- Biomedical Engineers: 62%

The Learning Challenge

- Only ~**16%** of US high school seniors are proficient in math and science
- ~**40%** of U.S. students who enter college with declared STEM majors, switch majors.
- If Pre-Med students are counted, ~**60%** leave STEM fields

Drew, 2011
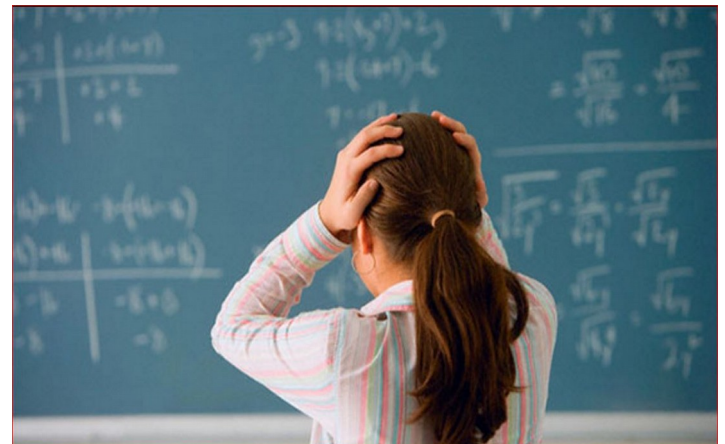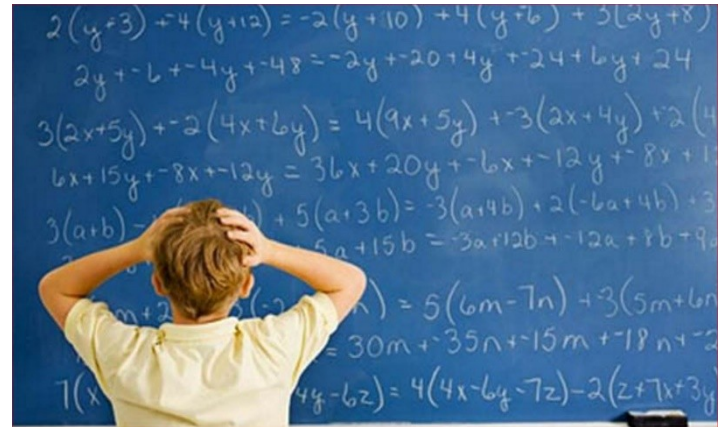
The Learning Challenge

- Students have choices about what to study.

Aaron Wolf

Drew, 2011

The Problem

- Increase the supply of talented STEM professionals
- Teaching and learning STEM is difficult
- High quality graduates are needed
- How can you broaden access to STEM education in India?

Preparing to Teach

- Effective teaching is challenging
- STEM teacher candidates must understand their STEM content as well as how to teach that STEM content to others.

Good Teaching Matters

- Systematic, planned, implemented and evaluated educational programs work better
- Realistic and measurable outcomes are needed
- Talented teachers help produce talented scientists, engineers, and mathematicians

Science of Teaching & Learning

- If you want to know how to help people learn, you should know something about how learning works.

- If you want to be an effective teacher, you should know what works in the classroom.

Meyer, 2011, p vii

PSYCHOLOGY

Study of mental processes responsible for cognition & behavior

PEDAGOGY & ANDRAGOGY

Study of the science of teaching

NEUROSCIENCE

Study of the brain's development, structure and function

PSYCHOLOGY
Study of mental processes responsible for cognition & behavior

PEDAGOGY & ANDRAGOGY
Study of the science of teaching

EDUCATIONAL NEUROSCIENCE

NEUROSCIENCE
Study of the brain's development, structure and function

Educational Neuroscience

- Emerging scientific field
- Explores the interactions between biological processes and education
  - Cognitive neuroscience
  - Educational psychology
  - Educational technology
  - Educational theory

Meyer, 2011, p 2

Preparing STEM Educators

- STEM content knowledge
- STEM research experience
- Science of learning (instruction & assessment)
- Teaching practice & mentoring

Teaching & Learning

Instruction → Learning → Assessment

Meyer, 2011, p 2
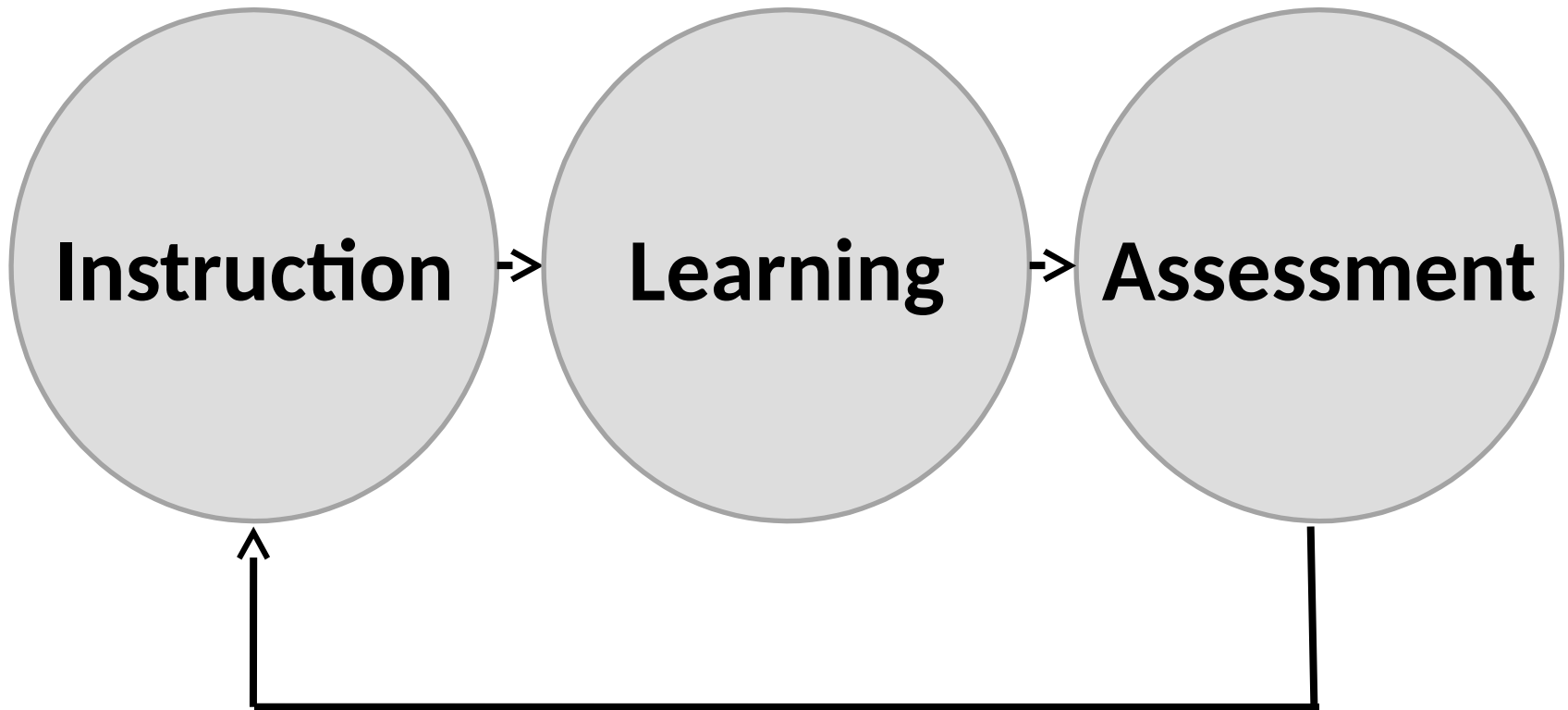
Teaching and Learning in the 21st century

- Post-millennial technologies have changed the nature of pedagogy & andragogy
- Opportunities for students to engage with content have changed

Teaching and Learning in the 21ˢᵗ century

- Huge volumes of information instantly available
- Time and distance barriers different
- Networking opportunities vastly increased
- OERs and GNUs reduce financial burden

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OER
OPEN EDUCATIONAL RESOURCES

X — FOCUS ON SCALABILITY

C — FOCUS ON COMMUNITY AND CONNECTIONS

MOOC
MASSIVE — OPEN — ONLINE — COURSE

What is massive?
- 100?
- 1,000?
- 10,000?
- 100,000?

Open registration?

Open content?

Free of charge?

Affordable?

Local cohorts?

Real-time interaction?

Self-paced?

Start/end dates?

College credits?

Badges?

Role of the instructor?

Learning community?

Scripted assessments and feedback?

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# **MOOCs at Ohio State University (OSU)**

- Provide for the common good
- Platform to experiment with different teaching methods
- Collect data about technology-empowered learning experiences
- Reach a global audience
- Promote awareness about the university
- Boost enrollment

MOOCs at OSU

- 2012 partnership with Coursera to offer MOOCs
- By 2013, >101,000 students from 150+ countries enrolled
- Expanding the global impact of the university while helping to inform the way we teach on campus.

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Ohio State MOOC Catalog

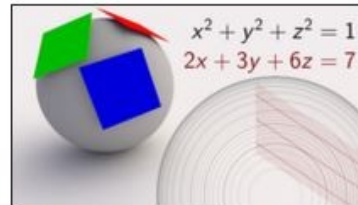## COLLEGE OF ARTS AND SCIENCES
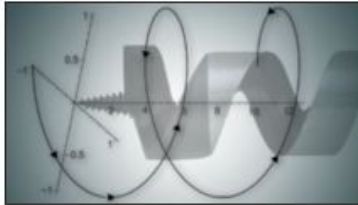
Calculus One

Calculus Two: Sequences and Series

Latin American Migration

Latino Pop Culture for the Clueless

Massively Multivariable Open Online Calculus

Writing II: Rhetorical Composing

COLLEGE OF ENGINEERING

TechniCity

Technology and Ethics

COLLEGE OF PHARMACY

Generation Rx: The Science Behind Prescription Drug Abuse
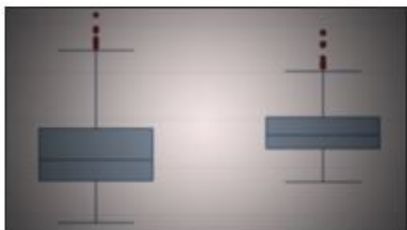

Introduction to Pharmacy

COLLEGE OF SOCIAL WORK

Human Trafficking

COLLEGE OF PUBLIC HEALTH

Applied Logistic Regression
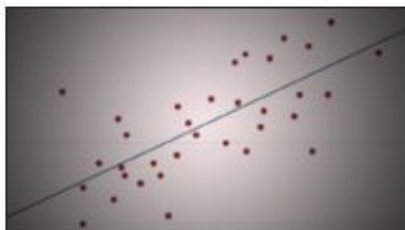
Applied Regression Analysis

Teaching and Learning in the 21ˢᵗ century

- Established practices are challenged by modern technologies
  - Lecture halls
  - Rigid timelines
  - Schedules
  - Controlled access to learning resources
  - Traditional practice

Teaching and Learning in the 21st century

- Student choice in learning pathways
- Changing relationships between students and universities
- Administrator choice of 'free' resources like TED talks, MOOCs, OERs
- Student expectations for digital and social media

Teaching and Learning in the 21st century

- Must be relevant & competitive
- Provides knowledge and skills on the cutting edge
- Students must **know how** and **know what**
- Collaborative teamwork skills important
- Making informed choices with incomplete information

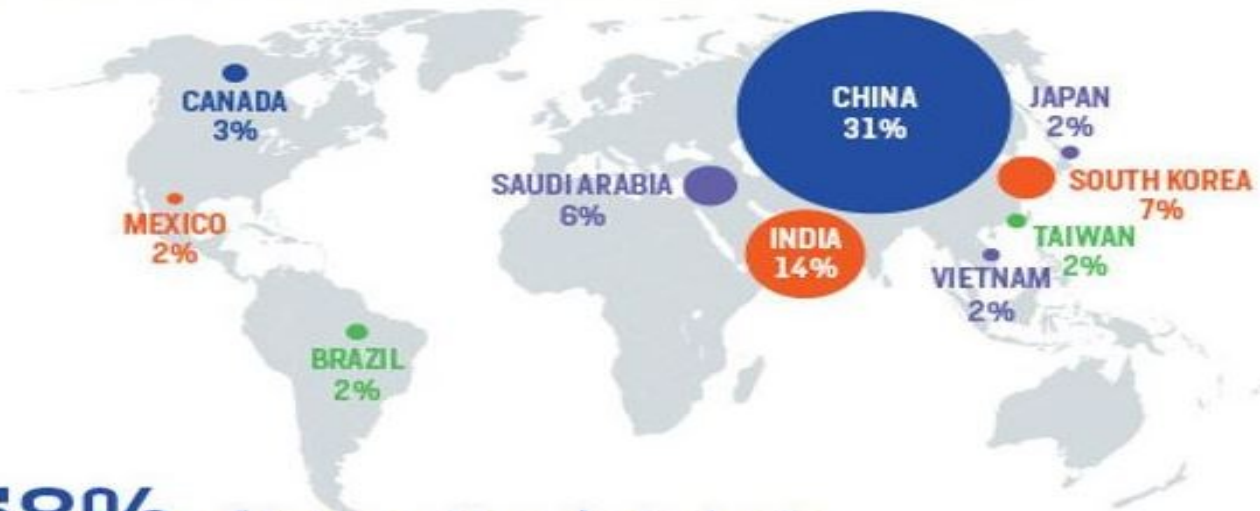# International Students in the USA

974,926 international students studied at U.S. colleges and universities in 2014/15.

Open Doors is conducted by the Institute of International Education with the support of the Bureau of Educational and Cultural Affairs of the U.S. Department of State. Online at: www.iie.org/opendoors

opendoors®

Global Community

TOP TEN PLACES OF ORIGIN OF INTERNATIONAL STUDENTS

CANADA
3%

MEXICO
2%

SAUDI ARABIA
6%

CHINA
31%

INDIA
14%

JAPAN
2%

SOUTH KOREA
7%

TAIWAN 2%

VIETNAM
2%

BRAZIL
2%

58% of international students
come from China, India, South Korea, and Saudi Arabia.

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opendoors®

Distribution in the US

U.S. DESTINATIONS OF INTERNATIONAL STUDENTS

> 60,000
30,001–60,000
10,001–30,000
< 10,000

1 out of **3** international students
studies in California, New York, or Texas.

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India's Challenge

- Competitive higher education environment
- Global economy
- 21st century communications opening new educational opportunities
- Improved pre college educational opportunities
- Enormous human capital potential

Science Inquiry

- What kinds of questions can science answer?
- How do scientists design and conduct science investigations?
- What kinds of tools and techniques do they use?

Science Inquiry

- How do they recognize alternative theories?
- How do they communicate problems & explanations?

Let's try a small Science Inquiry

- What do you observe?
- What can you infer?
- What is the difference between an observation and an inference?

Let's try a small Science Inquiry

- If we look at the 6th side of the cube, what will we see?
- With your group – come to a decision.
- Provide evidence to support your decision.

Let's try a more difficult Science Inquiry

- Each group has one cube. **Do not touch the cube with your hands**. You may use the small wooden spoon to touch it.
- Do not turn it over.
- Collect evidence about the cube.

Let's try a more difficult Science Inquiry

- What do you observe?
- What can you infer?
- What do you think you will find on the hidden side?
- Make an argument supported with evidence for your ideas.

Let's try a more difficult Science Inquiry

- How confident are you in your argument?
- Could you be wrong?
- Is there more than one possible choice?

Let's try a more difficult Science Inquiry

- What information might help you decide between the alternatives?
- A new technology has been invented that could help you gather more information….

Let's try a more difficult Science Inquiry

- Use your new technology to check one number on the corner of the hidden side.
- What number do you find?
- Does this information help you decide among different alternatives?

Lesson Design – 5E

- Engage
- Explore
- Explain
- Elaborate
- Evaluate

What does this lesson teach?

- Scientific explanations are
    - Based on empirical data
    - Made in the public space
    - Tentative
    - Historical (based on previous info)
    - Probabilistic (statistically based)
    - Assume cause-effect
    - Limited

How to find the lesson

National Academy of Science (NAS)
Teaching about Evolution and the Nature of Science

http://www.nap.edu/catalog/5787.html

Take Home Thoughts

- India needs talented STEM professionals
- Excellent teachers are needed to produce STEM professionals
- Teaching is based on science
- **You can be a STEM teacher** and contribute to the future of India

Thank You

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