

# Modeling and Secondary School STEM Education

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AND ENGINEERING

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THE CALVIN L. RAMPTON SALT PALACE  
CONVENTION CENTER  
SALT LAKE CITY, UTAH, USA

## National Need: MATH CAN HELP

- Environmental Problems
- Sustainability Issues
- Technology Explosion
- Big Data
- Medicine
- ECONOMY

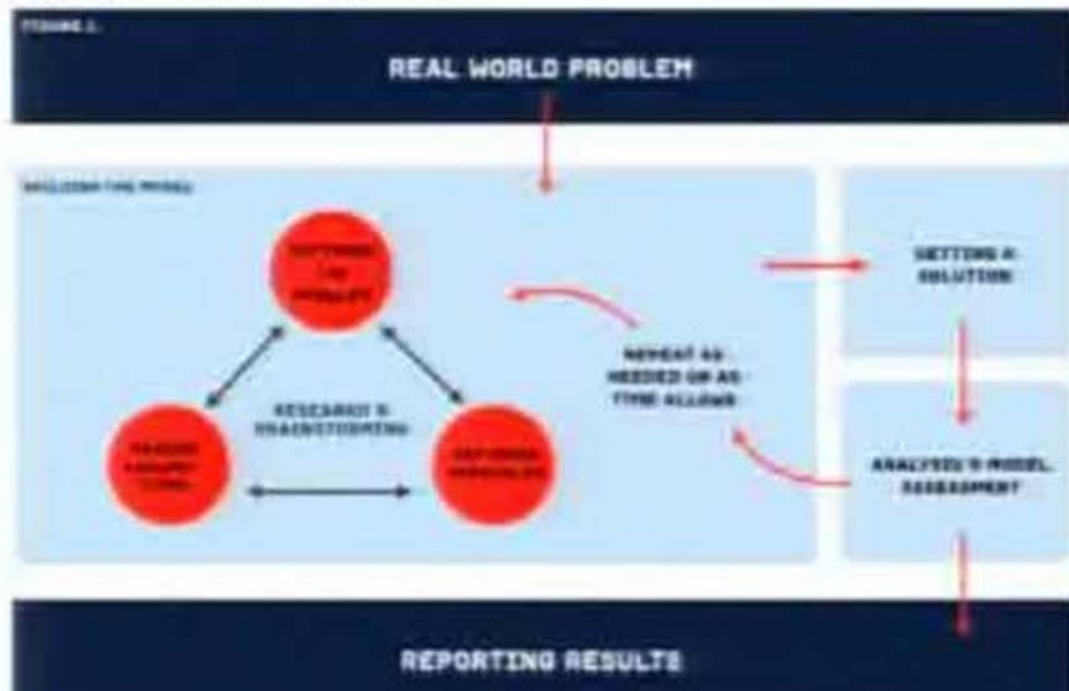


We need an innovative workforce to create solutions to problems which are *today unimaginable*

# Model with Mathematics

- Challenges for teachers and students
  - What is modeling?
    - The use of mathematics and statistics to analyze empirical situations, understand them better, and improve decisions.
    - Choosing and using appropriate mathematics and statistics.

- Experience?
- Open-ended  
can be **scary!**
- Resources?
- Time consuming!
- Assessment?



## Our Charge

- To explore high school **teaching and learning** of modeling and computation, and to make *recommendations* for ways the **mathematical sciences community** can influence content and teaching practice at the *high school level*.

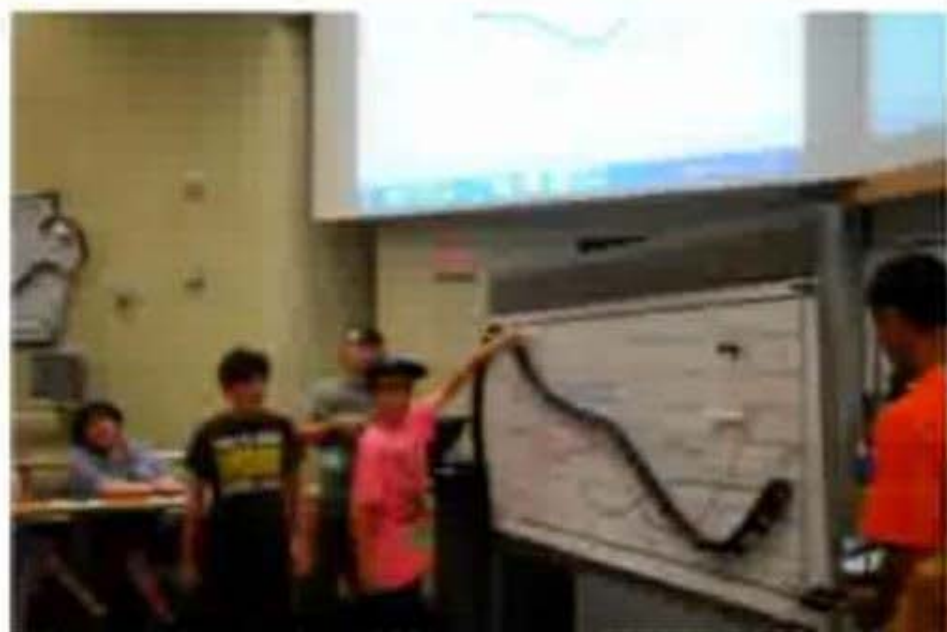
## Our Vision

- Transformational, large-scale effects on pre-college teaching and learning of applied and computational mathematics.
  - I've seen it happen!



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- What would it take to weave modeling into preK-elementary curriculum as integral part of understanding mathematics and experiencing research?
- Modeling  $\neq$  story problems.
  - How to keep modeling from being reduced to test prep or problems solving?
  - Do curriculum developers presume modeling is 'done' in science labs?



## Link to Undergraduate Program

- Fostering connections across early grades, middle and high school grades, and **undergraduate program years is a critical part** of transforming the culture of mathematical sciences in the US formal education environment
- **Preparing students for college expectations**





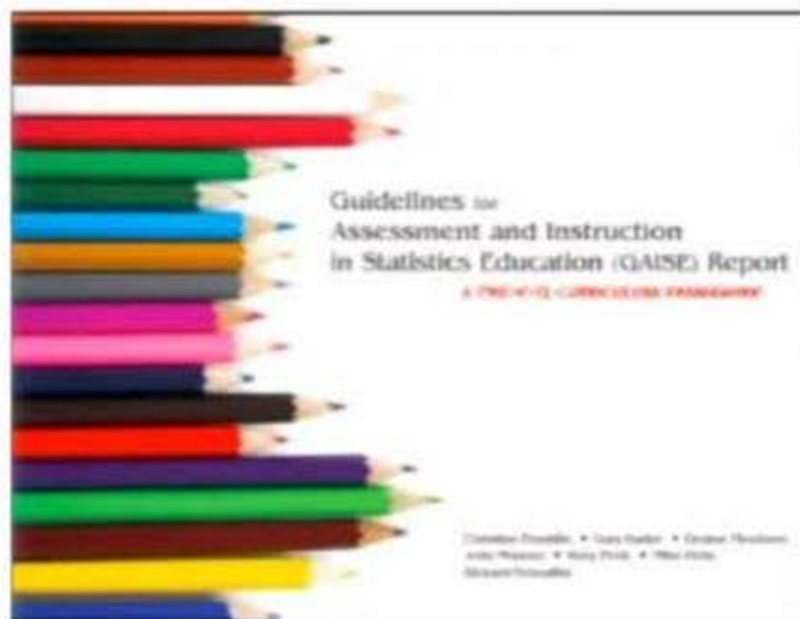
# Recommendations

1. A GAIMME Report
2. AIM-Style Workshop The logo for the American Institute of Mathematics (AIM), consisting of a blue wavy line and the text 'American Institute of Mathematics'.
3. Infusion Working Group
4. Professional Development Working Group
5. Assessment Working Group
6. Repository of Peer-Reviewed Resources
7. Public Awareness



# GAIMME

- Inspired by the ASA's GAISE Report (Guidelines for Assessment and Instruction in Statistics Education), we call for Guidelines for Assessment and Instruction in Mathematical Modeling Education
- Joint effort with SIAM and COMAP
- In progress!





- **communicate** (parents, counselors, teachers, school leaders) what *mathematical modeling* is

## A GAIMME Report Can

- **communicate** (parents, counselors, teachers, school leaders) what *mathematical modeling* is
- **promote** meaningful *mathematical literacy*
- **connect** to real world experiences and careers
- **provide guidance** for communication, collaboration, critical thinking and creativity in mathematical sciences classrooms
- **set the stage** for developing assessment, curriculum, and professional development



- Two goals
  - create a new or refine an existing modeling course appropriate for high schools
  - explore broad issues surrounding the culture change needed to support such a course
- Issues
  - for most high schools, it may be easier to embed modeling into other courses than as a stand-alone
  - such a course could be aspirational in the way that statistics (particularly AP Stats) is for many schools
  - potential new framework via AP Capstone Experience

## Infusion Working Group

- Focus on directly supporting teachers and schools in launching modeling tasks *within their existing curricular frameworks*.
- Important *challenge*: don't overwhelm teachers who are already fully loaded implementing common core and managing an increase in standardized testing
  - Through mathematical modeling, other standards are naturally met

## PD Working Group

- Develop a **range** of professional development programs or *recommendations* for programs that support teachers in transforming their practice (not a one size fits all!)
- What existing programs would welcome partnership?
- Can we develop an intensive summer institute?

## Assessment Working Group

- Two approaches:
  - inspired by GAISE which includes a useful set of examples
  - assemble a library of existing, peer-reviewed assessments that can be “endorsed” in some regular way
- Inspired by the Force Concepts Inventory from physics



## Repository of modeling resources

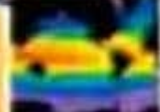
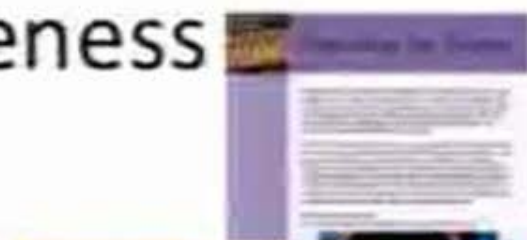
- Centralized
- Regularly updated
- Peer reviewed
- Carefully curated by a librarian or team who would manage the review, inclusion, and updating process

## Repository Project Outcomes

- A summary of *best practices* in modeling education and examples of these
- An overview of and links to existing resources
- Identification of gaps and challenges in accessing existing resources
- Recommendations for collaborators, for an institutional home, and for possible funding sources

## Public Awareness

- Professional societies could (should?) take the lead in declaring a *Year of Mathematical Modeling*, with activities inspired by MPE, Statistics2013.org, and the Math Awareness Month project
- We need a vision statement and pointers to existing resources



## Take-Away Message

- We need to take the very long view, laying the groundwork for infusing modeling throughout the system.
- All K-12 students by graduation should have a **significant modeling experience**, possibly through a well-designed course supported or endorsed by SIAM, MAA, AMATYC, NCTM, ASA, AMS, NCSM, ICM, IEEE, ACM, AMS,...



## Caution and Respect

- This is a new (possibly uncomfortable?) way of thinking about math education for some teachers, students, citizens
- Need to use caution: “Yet another reform?”
- Every step: grounded in serious, reputable research led by teams who have substantial experience in teaching K-12 students