MSU Stem Alliance Meeting Agenda
Friday December 13, 2013
11:30 a.m. - 2:00 p.m., BPS 1425

1. Introductions/Updates (30 min; 11:30 a.m. – 12:15 p.m.)
   Chivukula (intro), Geier (website), Cooper (AAU)

2. Breakout groups (45 minutes; 12:15 – 1:00 p.m.)
   a. Organizers will assign a strict timekeeper and a group secretary to collect information. The group can choose a reporter to speak in the “large group report out” session.
   b. Lightening talks
      i. 1 page handout; also posted on the website.
      ii. Within breakout groups, each person speaks for 2 minutes about their 1 page handout and then answers questions.
      iii. Different people in one project can talk about different aspects of the project.
   c. General Discussion. Some questions to consider:
      i. What issues/projects are group members interested in?
      ii. Is there significant overlap? Are there significant differences?
      iii. How might group members work together?
      iv. How might the STEM Alliance provide support?
   d. Prepare a 5 minute report out:
      i. Summarize the issues/projects that group members are interested in.
      ii. Describe significant overlap and plans for working together.
      iii. Identify support that the STEM Alliance might provide to move your work forward.
      iv. What are your next steps?

[15 minute break]

3. Large group report out and summary of upcoming grant opportunities (30 min; 1:15 – 1:45 p.m.)
   (Handout out summary of grant opportunities)

4. Next Steps (15 min; 1:45 – 2:00 p.m.)
   a. Which individual(s) will organize activities?
   b. When should we meet next?
Breakout Groups/Lightning Talks

**Breakout A - Sekhar Chivukula (Coordinator) - BPS 1425**

Jim Smith, *Integrative Case Approach to Evolution Education*
Tammy M. Long, *Conceptual modeling: a tool for practicing and assessing students’ thinking about biological systems*
Claudia Vergara, *Summary of EEES (NSF STEP) and CPACE (NSF CISE/CPATH)*
Melanie Cooper, *beSocratic*
Stephen Thomas, *Development of a Rubric for Generating Visuals in Science*

**Breakout B - Renee Bayer (Coordinator) - BPS 1400**

Rob Pennock, *Learning Evolution and the Nature of Science using Digital Organisms*
Douglas B. Luckie, *Impact of curricular interventions in introductory biology (e.g. inquiry labs, oral exams) on student content knowledge and longitudinal performance*
Raven McCrory, *Improving outcomes for students in remedial mathematics*
Tom Deits, *Innovation5*
Mark Urban-Lurain, *Automated Analysis of Constructed Response (AACR) research group*
Wolfgang Bauer/Mark Urban-Lurain, *First Year Engineering Integration*

**Breakout C - Elizabeth Simmons (coordinator) - BPS 1300**

Diane Ebert-May, *Faculty, postdoc, and graduate student professional development in biology education*
Sarah Jardeleza/Mark Voit, *Overview of the Biology Initiative*
Gerald Urquhart, *Underprepared Students in Lyman Briggs College*
Danny Caballero, *Research on student practice in physics*
Aklilu Zeleke, *Teaching Intro Stat through real data generated by students in the classroom*
Julie Libarkin, *Factor Analysis: Greenhouse Effect Models*
Breakout Session A
BPS 1425
Integrative Case Approach to Evolution Education
Jim Smith, Merle Heidemann, and Peter White

“The most productive team I’ve ever had the pleasure to be a part of.”

Published Works, Workshops and Presentations (2013)
- Smith JJ. “An Integrative Approach to Teaching Evolution”, invited talk at Univ. Ill. PEEC, Sept. 18, 2013.

Future Activities and Directions
- Peter White will be joining the Lyman Briggs faculty (tenure-stream) in 2014.
- Case 5 involves Lenski Lab work on Citrate Utilization Evolution in E. coli, Case 6 involves Lactose Tolerance in Humans.
- We need to figure out a good exit strategy and plan for sustaining the Evo-ED Web Site.
- Second Case Study (Mendel’s Peas) to be submitted to Buffalo.
- Manuscript for “2x2 Study” in progress.
- Doug Luckie to use Cases in LB144/LB145 in F14/S15.

Students appear to learn more evolution concepts in courses where the cases are used.
Thomas and Libarkin (2013)

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(Thomas, 2013)
Breakout Session B
BPS 1400
Research Program 1: Cystic Fibrosis Research Laboratory
Investigators: Luckie, Tai (& Hootman) + 1 grad & 6 undergrads

Research Program 2: Science (STEM) Learning Laboratory
Investigators: Luckie, Sweeder (& Ebert-May) + 6 undergrads

- Current CF Research [funded by CFF, PACFI & industry]
  1. pHo: The effect of CFTR malfunction on extracellular pH
     [assay, screening, mechanism via HCO3-]
  2. Pathogens: Innate defenses of airway cells versus pseudomonas & burkholderia et al.

- Current STEM Research [funded 2000-2016 by NSF]
  BRAID, C-TOOLS, Teams+Streams, Verbal Finals projects
  Each project studies the effect of acute instructional interventions
  (e.g. visual modeling, inquiry, oral exams) on longterm student performance: in course, in later science courses, on MCAT, on expert interviews, etc.

Figure 1.
The event of the NF gives the student one on the three with the professor. They both follow a structured experiment called the scientist. The results are recorded in the form of a visual display, and every student understands. The chart on the right shows the variation of the results. The chart on the left shows the variation of the results. The chart on the right shows the variation of the results. The chart on the left shows the variation of the results. The chart on the right shows the variation of the results. The chart on the left shows the variation of the results. Each chart is divided into several segments, each with a different color, and the numbers under each segment provide a detailed explanation. The visual display is designed to help the student understand the concept and make comparisons. The questions in the chart are written in the language of the course, and the answers are clearly explained. The chart is very helpful in understanding the concept and making comparisons.

Figure 2.
The event of the NF gives the student one on the three with the professor. They both follow a structured experiment called the scientist. The results are recorded in the form of a visual display, and every student understands. The chart on the right shows the variation of the results. The chart on the left shows the variation of the results. The chart on the right shows the variation of the results. The chart on the left shows the variation of the results. The chart on the right shows the variation of the results. The chart on the left shows the variation of the results. Each chart is divided into several segments, each with a different color, and the numbers under each segment provide a detailed explanation. The visual display is designed to help the student understand the concept and make comparisons. The questions in the chart are written in the language of the course, and the answers are clearly explained. The chart is very helpful in understanding the concept and making comparisons.

Figure 3.
Students who passed the Vf scored higher on the MAT exam than peers who did not. Normalized MAT performance distribution (scores in percentage vs. frequency in percentage) is shown comparing cohort of students who passed the Vf (n = 168) with students who did not pass (n = 265). No students scored below a 20%, while one student scored at 80%. Students who passed the Vf are represented in blue. Students who did not pass the Vf are represented in red. *p < 0.001 / trend compared pooled data of two cohorts.

Figure 4.
Participation occurs from a broad range of students with a variety of academic and cultural backgrounds. Yes, the ACT also used to estimate the student population of each semester into academic performance-based academic standing quantiles. All students who passed the Vf were counted for each cohort (n = 168), a subset of students who did not pass the Vf (n = 265). Pairs scale data for quartile 1 and 2 are equivalent; quantiles 3 and 4 are equivalent. Distribution of students who participated but did not pass is also represented. Both, the self-reported ethnicity and gender of students who passed the Vf was also examined. Total number of students in study each group is represented in percentage of students who passed the Vf is reported (four students do not report ethnicity).
Automated Analysis of Constructed Response (AACR) Research Group
www.msu.edu/~aacr

- PI: Mark Urban-Lurain (urban@msu.edu), Center for Engineering Education Research
- PI: John Merrill (merrill3@msu.edu), Director of the Biological Sciences Program
- Co-PI: Melanie Cooper (mmc@chemistry.msu.edu), Lappan Phillips Professor, Chemistry
- Co-PI: Carl Lira (lira@egr.msu.edu), Chemical Engineering

Constructed response questions – in which students must explain phenomena in their own words – create more meaningful opportunities for instructors to identify their students’ learning obstacles than multiple choice questions. Answering constructed response questions is also a different cognitive task than selecting an answer in a multiple choice format, regardless of the Bloom’s level of the multiple choice items and is a more authentic scientific practice. However, the realities of typical large-enrollment undergraduate classes restrict the options faculty have for analyzing student writing.

In the Automated Analysis of Constructed Responses (AACR, pronounced "acer") Research Group, we are exploring the use of computerized lexical analysis of students’ writing in large enrollment undergraduate biology and chemistry courses. We have created analytic models that categorize student responses with > 90% accuracy. These categories can be used to predict expert ratings of student responses with accuracy approaching inter-rater reliability among expert raters. These techniques also provide insight into students’ use of analogical thinking, a fundamental part of scientific modeling. These techniques have potential for improving assessment practices across STEM disciplines.

The AACR Research Group consists of researchers from seven universities with backgrounds in various STEM disciplines (biology, chemistry, engineering, and statistics), linguistics and educational research. We hope this research can help us gain greater insight into student thinking about “big ideas”, such as evolution, energy, and genetics. We are looking to expand the scope of this work and seeking interested collaborators across STEM disciplines.

The AACR research group has recently received two National Science Foundation grants totaling $5.7 million, funds that will utilize computer software to analyze student writing in science and engineering classes. The goal is to help retain more students who are enrolled in the so-called STEM disciplines – science, technology, engineering and mathematics. The two grants include $5 million for five years to develop a website where student exam answers can be analyzed; and an additional three-year, $718,000 grant to develop faculty learning communities to support faculty in the use of AACR items as part of reformed teaching in undergraduate courses across these institutions.
First-Year Integrated Engineering (FYIE)

**Thumbnail Description**

**Current CoE first year**
- “Huge” improvement dating from 2008
- Courses in EGR: EGR 100/egr design (2 hr), EGR 102/computing tools & PS (2 hr)
- Courses in sci / mth: MTH 132 (3 hrs), PHY 183 (4 hrs), CEM 141 (4 hrs)
- Course in writing (4 hrs)
- Residential (for most) setting

**Key issues to strengthen**
- Identification with EGR and with CoE
- Problem solving competencies
- Computing principles & competencies
- Development of “communities of practice”
- An holistic sense of engineering coursework
- Ability to apply principles of professional ethics
- Communication and group work
- Increased retention

**Vision**
- An immersive, intensive one semester, first year course integrating: engineering problem solving, calculus 1 (3 hrs), physics 1 (4 hrs), computing competencies (3 hrs), and engineering writing (4 hrs)
- An holistic treatment of engineering and its supporting disciplines
- The course will be engineering problem oriented and use problem-based learning as the driving pedagogy to engage students, including under-served populations
- The course learning space will be a “REAL-like” environment suitable for team work and team interaction, content delivery will followed a “flipped classroom” model
- The course will engage stakeholder groups from the outset: students, faculty, administrators, industry, accreditation agency (ABET)

**Background**
- NSF supported development of integrated first year engineering curricula in the 1990’s
- Most were “loosely coupled” program - interlocking at the syllabus level. Courses would be taught in their “standard departments”.
- Some were “tightly coupled” programs where teaching of multiple subject areas was undertaken in one physical classroom, but with instructors from the subject area interacting in the one classroom with students.
- Student outcome results were very positive; e.g. 20% increase in retention
- None of the integrated curricula persist currently with the exception of U Mass Dartmouth

**What went wrong?**
- Continuing faculty loading too high
- Originators of the effort went on to other activities
- Institutional (departmental) priorities shifted after NSF funding expired
- Fundamentally, design for sustainability of such programs was not understood well

**What is different now?**
- Design for sustainability will be in the initial “blue print” for FYIE
- Advisory input from each engineering major will be gathered yearly
- Advisory input from other constituencies will be gathered bi-annually
- FYIE will be institutionalized as part of the engineering first year as part of the CoRe program, and hence be part of an existing structure within the College of Engineering

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1 This varies across majors and individuals. The courses listed are a norm of what students take in the first year of engineering. One exception is PHY 183, which is typically taken in the third semester. Students who arrive “calc ready” will typically take MTH 133 as well in the first year. The listing includes writing because written communication skills are important for engineering. Students will likely take other humanities courses in the first year.

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- Mark Urban-Lurain (urban@msu.edu)
- Claudia Vergara (vergara@msu.edu)

**Wednesday, December 11, 2013**

Center for Engineering Education Research @MSU
Breakout Session C
BPS 1300
Transforming experiences for science and engineering students: Integrating scientific practices into introductory calculus-based mechanics

Project Leaders:
Danny Caballero (Department of Physics and Astronomy)
David Stroupe (Department of Teacher Education)

Developing students’ skills with scientific practices is key for preparing science and engineering professionals, science educators, and, more broadly, critical consumers of scientific information. And yet, most undergraduate instruction in science, technology, engineering, and mathematics (STEM) severely lacks authentic scientific practice (e.g., developing and using models, designing experiments, using computational modeling). Courses that leverage scientific practices engage students in creative and inspiring ways that are simply not possible in traditional lecture environments.

We propose a project in physics education research (PER) that investigates how students learn scientific practices. The setting for this research will be a new course in introductory mechanics. Through the study of complex problems and the use of multi-day projects, students will learn core physics content while engaging in the practices of doing science. Our project will begin to answer four fundamental questions in PER:

1. How do students blend conceptual knowledge, mathematical tools, and computational algorithms when engaging in different scientific practices?
2. What challenges do students face when they are engaged in different scientific practices?
3. How does engaging students in scientific practice shape their views of science and engineering?
4. What roles do different social interactions play in how students develop their proficiency with scientific practice?

In addition to starting a project at the forefront of PER, this work will facilitate the development of evidence-based teaching materials for an introductory mechanics course that leverages active and social learning and employs modern tools such as video analysis and computational modeling. Through this work, we aim to impact the culture of the department by fundamentally transforming the instructional model for our introductory courses and growing our transformation to include at least five faculty prepared to teach the transformed course.

With this work, we will be able to collect preliminary evidence that will be used to seek external funding to grow and to sustain our research and transformation efforts.

This work has been funded by an LFP-CMP2 Innovation grant.
Factor Analysis: Greenhouse Effect Models

Bouncing Model

Greenhouse Model

Ozone Hole Model

Pollution, etc. Model

Scientific Model

Libarkin, Thomas, Ording, 2013
Libarkin, Thomas, Miller, Spadafore, 2013