GK-12 Building Bridges: Integrating Math, Science and Engineering on the South Plains

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Book of abstracts

Table of contents

Flipping the Classroom in the STEM Disciplines / 18

Introduction to Flipping

A basic introduction to classroom flipping from flipped classroom pioneer Jon Bergmann.

Flipping the Classroom in the STEM Disciplines / 5

The Effectiveness of Time-Shifting ("Flipping") in the Moderate-Sized General Chemistry Classroom

Dr. CASADONTE, Dominick [1]; GARDNER, Rachel [1]; HART, Robin [1]

[1] *Texas Tech University*

Corresponding Author: dominick.casadonte@ttu.edu

We have time-shifted" or "flipped" the Honors General Chemistry course sequence at Texas Tech University during the 2011-12 and 2012-2013 academic years. All of the lectures were pre-recorded using the Mediasite platform and placed on Blackboard for students to watch in advance of class time. Online web learning homework assignments were used to determine if students had watched the lecture. Class time was used to summarize lectures, clear up muddy conceptual points, and work advanced problems, using a variety of modalities. The efficacy of the method was determined by giving exams that had been given to other honors classes (> 5 years previously) and comparing exam results, as well as through standardized content exams. A 40-question Leikert assessment and a 40-question free-response assessment were also given to the students in a pre-post format. Results of the various assessments, as well as the effectiveness of the method for different student cohorts will be discussed.

Flipping the Classroom in the STEM Disciplines / 8

Creating, Developing, and Enhancing the Flipped Classroom in General Chemistry

Dr. STOLTZFUS, Matthew [1]

[1] *The Ohio State University*

Corresponding Author: stoltzfus.5@osu.edu

The widespread coverage of MOOC's, Sal Khan, peer instruction, flipped classrooms, and the role of technology plays in education in both The Chronicle of Higher Education and Inside Higher Ed is at an all-time high and there are no signs of these topics will be disappearing from the pages of these publications anytime soon. This talk focuses on the motivation for instructors to use technology in their classroom, with a particular emphasis placed on the concept of flipping the classroom.

By recording traditional lecture content and placing it on-line for students to view before class, the classroom space can be transformed into an environment to facilitate problem solving and critical thinking skills, but is it most effective for student learning to simply record traditional lectures and post them on-line? What is the most appropriate use of instructional technology in the flipped classroom?

Best-practices, pitfalls, student comments, assessment data, and other helpful tidbits on my two year journey of flipping a large-scale general chemistry lecture class (N > 300) at The Ohio State University will be shared. A comparison of Tuning Technologies clickers, the polleverywhere response system, and the Learning Catalytics will be discussed as well as the role Ohio State's Digital First Initiative has played in marketing this work on ESPN, NPR, and in an Apple press release.

Flipping the Classroom in the STEM Disciplines / 3

Flipping for Mastery

Mr. LUKER, Chris [1]

[1] *Highland Local Schools*

Corresponding Author: cluker@highlandschools.org

The flipped classroom has received much attention recently among educators as an innovative method to improve instruction in order to make the classroom more student-centered. The flipped class is an approach to teaching that uses technology to provide direct instruction to the student away from the traditional class time. Flipped learning has facilitated a mastery-based approach to teaching that is employed in my classroom. As a result, the purpose of this presentation is to share the "good and bad" of my transformation to a flipped-mastery based chemistry classroom.

Flipping the Classroom in the STEM Disciplines / 2

Flip Your Class! Strategies and Student Reactions to a Flipped Classroom

Prof. BUTZLER, Kelly [1]

[1] *Pennsylvania College of Technology*

Corresponding Author: kbutzler@pct.edu

The flipped classroom is a revised pedagogical approach to classroom instruction that utilizes lecture-capture technologies to allow for increased quality face-to-face time. The flipped classroom eliminates the one-way learning process of the instructor reciting information to the student. The knowledge and comprehension of material is learned by the student outside of class which allows the application, analysis, synthesis, and evaluation of concepts the focus in a face-to-face classroom. The presenter will describe how classroom capture technology is utilized in an organic chemistry class to facilitate low-level learning outside of class. As a result, higher level problem-solving skills are addressed in the classroom in a collaborative and interactive atmosphere. Assessment strategies for information gained outside of class as well as student reactions to these strategies and the flipped classroom will be addressed.

Flipping the Classroom in the STEM Disciplines / 24

PANEL DISCUSSION: The Flipped Classroom: What's Next?

BERGMANN, Jonathan [1]; Dr. STOLTZFUS, Matthew [2]; Mr. LUKER, Chris [3]; Prof. BUTZLER, Kelly [4]; Dr. CASADONTE, Dominick [5]

[1] *Flipped Class*

[2] *The Ohio State University*

[3] *Highland Local Schools*

[4] *Pennsylvania College of Technology*

[5] *Texas Tech University*

Corresponding Author: dominick.casadonte@ttu.edu

You already know about the flipped classroom; you may very well be implementing it in your school or district. But why are you doing it? What are you learning and where do you want to take flipping in the future? Join Jon Bergmann and a few invited panelists for a lively discussion about best practices and the underlying reasons why the flipped classroom is transforming teaching and learning across the globe. This interactive session will feature a "panel" discussion in which audience members are key contributors, participating verbally and via their devices.

WORKSHOP 1: Robotics as a Way of Integrating Math and Engineering / 25

WORKSHOP 1: Robotics as a Way of Integrating Math and Engineering

Dr. GALE, Richard [1]

[1] *Texas Tech University*

Corresponding Author: dominick.casadonte@ttu.edu

Lego NXT robotics give students the tools to investigate "real world" applications of science and mathematics which they might not otherwise encounter in a K12 setting. One project could easily span content from computer science, physics, biology, and mathematics (just imagine trying to design a working C-3PO out of legos!) Our workshop will provide a cursory introduction to the Lego NXT robotics kits, guide participants through a number of sample classroom activities, and discuss the pedagogical strengths and weaknesses to incorporating robotics into your mathematics or science classroom. A number of "student experts" will be on-hand to answer practical questions and assist with the hands-on activities.

Integrated Math/Science/Engineering in Undergraduate Research / 9

Developing Science and Math Integrated Activities for Middle School Students

Dr. SHERROD, Sonya [1]; Dr. DWYER, Jerry [1]; Dr. NARAYAN, Ratna [2]

[1] *Texas Tech University*

[2] *University of North Texas*

Corresponding Author: sonya.e.sherrod@ttu.edu

This paper reports the development and refinement of science and mathematics integrated activities for middle school students. The expectations of the NCTM that students develop an understanding of mathematics and an ability to apply it gave birth to these activities. The expectations of the NSES that students engage in inquiry and discussion, as well as assessments that encourage them to analyze their findings and organize their conclusions, also framed these activities. Three middle school science teachers, who were less than confident in their mathematical abilities, piloted three of the 24 activities. Classroom discourse and teacher feedback were used to refine them. Diverse attitudes regarding the usefulness of mathematics and the comprehensive benefits of integrating mathematics into science activities are reported. Key components of the activities include detailed instructions, resources and references, discussion questions and assessment suggestions. Cooperative learning is highlighted as instrumental in the comprehension of both mathematics and science.

Integrated Math/Science/Engineering in Undergraduate Research / 11

Directing Undergraduate Research Programs

Dr. WILLIAMS, Brock [1]

[1] *Texas Tech University*

Corresponding Author: brock.williams@ttu.edu

We will discuss our experiences organizing programs for undergraduate research. In particular, we will describe our PRISM program, supported by a $1.5 million NSF grant and providing research experiences for freshmen and sophomore math and biology majors. We will provide the "how to" details of our program including mentee training and summer camps.

We will also describe extensions of our work to include research opportunities for teachers in our K-12 multidisciplinary masters programs.

Integrated Math/Science/Engineering in Undergraduate Research / 10

Integrating Cosmology, Evolutionary Biology, Mathematics, and Physics: The Fine-Tuning of Cosmological Parameters for Origin of Life Events

Mr. WILLMS, Joshua [1]; Dr. GREEN, Micah [1]

[1] *Texas Tech University*

Corresponding Author: j.willms@ttu.edu

Understanding and interpreting cosmological information often requires the inclusion of multiple fields of study. Over the past hundred years, physicists and cosmologists have begun to notice that if certain fundamental characteristics of our universe had been anything other than what they are, the evolution of life in our universe would have been impossible. Examples of these characteristics, called "parameters", include the gravitational constant, the cosmological constant, Planck's constant, and the speed of light. The general consensus of the scientific community currently is that these parameters are finely tuned for life, meaning that miniscule variations in the parameters would have rendered the universe unable to support the evolution of any kind of life. In order to formulate valid arguments with regards to fine tuning, scientists must utilize and integrate information from cosmology, evolutionary biology, mathematics, statistics, and physics.

Integrated Math/Science/Engineering in Undergraduate Research / 40

Zombie Outbreak: Math Meets Medicine

Mr. CALHOUN, John [1]

[1] *Texas Tech University*

Corresponding Author: whitney.green@ttu.edu

We will discuss our experiences both doing undergraduate research and mentoring students in funded projects which integrate math and science. For example, will describe research using mathematical disease models to simulate a zombie outbreak.

Integrated Math/Science/Engineering in Undergraduate Research / 12

Panel Discussion with Undergraduate Researchers

Dr. WILLIAMS, Brock [1]

[1] *Texas Tech University*

Corresponding Author: brock.williams@ttu.edu

Several TTU undergraduates will share their experiences conducting undergraduate research in math/science/engineering. Significant time will be reserved for questions and discussions with the audience.

BANQUET AND PLENARY SESSION / 32

KEYNOTE ADDRESS : Reach Every Student in Every Class Every Day

BERGMANN, Jonathan [1]

[1] *Lake Forest*

Corresponding Author: dominick.casadonte@ttu.edu

Learn from Flipped Classroom Pioneer Jon Bergmann as he walks through his transformation from a twenty year lecturer to a flipped class pioneer. He will take you on his journey and show how the flipped class can transform today's educational climate. The Flipped Class allows teachers to have more face-to-face time with students, allows for real differentiation, causes student to take responsibility for their learning, and allows students to master material.

Technology, Education, and the Integrated Classroom / 7

Your Inspired Classroom: myDAQifying STEM Lessons

EDELMON, Gretchen [1]

[1] *National Instruments*

Corresponding Author: gretchen.edelmon@ni.com

National Instruments has equipped engineers and scientists with tools that accelerate productivity, innovation, and discovery since 1976. NI and its curriculum partners develop educational products based on these industry standard tools that allow students to experience the same industry standard tools, but on a student friendly level. This session will describe and demonstrate several examples of how NI tools enable STEM teachers and their students to truly experience STEM topics and immediately see the real world relevance.

Technology, Education, and the Integrated Classroom / 16

Distance Learning Technology and Integration in the Classroom

BROUGH, Justin [1]

[1] *Texas Tech University*

Corresponding Author: justin.g.brough@gmail.com

One of the goals of the GK-12 program at Texas Tech University is to establish distance-learning environments that allow access to remote rural schools. By placing graduate students in the classroom, virtually, through online streaming video, K-12 students are given the opportunity to interact with individuals from STEM related fields. This presentation discusses the technology, both hardware and software, that was used in this arrangement, as well as the experiences and challenges associated with implementing the technology in the schools. A small panel of graduate students and K-12 teachers will be present to answer questions about their experiences with the system.

Technology, Education, and the Integrated Classroom / 27

PANEL DISCUSSION

Corresponding Author: justin.g.brough@gmail.com

Come join us for a panel discussion concerning the use of technology in the classroom.

WORKSHOP 2: Parabolas from Euclid to Dish Network

Dr. KOEPP, Warren [1]

[1] *University of Texas of the Permian Basin*

Corresponding Author: koepp_w@utpb.edu

For most students (and many high school teachers!) a parabola is the graph of a quadratic polynomial, a representation that obscures many of its most interesting properties. By introducing and exploring parabolas the way they were known for the two millenia preceding DesCartes, we come to understand their most interesting physical properties and applications more deeply, and obtain fresh insights into their algebraic representations. String, meter sticks, mirrors, lasers, and a little brainpower will be our tools, with projectiles if time permits!

WORKSHOP 3: Juice Cars: Math Goes Green

HAMES, Elizabeth [1]

[1] *Texas Tech University*

Corresponding Author: teamhames724@gmail.com

The juice car module integrates chemistry, math, and physics. The goal is for students to use all three topics that they have learned throughout the year to build a juice powered race car. The students can improve their cars in several ways using any of the three topics. This demonstration will allow participants to build their own juice powered cars and observe the connections between chemistry, math, and physics.

WORKSHOP 4: Non-Newtonian Fluids: Math and Chemistry Meet

Ms. SINGER, Laci [1]; Ms. OLIVER, Erin [1]

[1] *Graduate Student, Texas Tech University*

Corresponding Author: erin.oliver@ttu.edu

The workshop will be modeled after an in-class project prepared by NSF GK-12 Fellows working at Coronado High School in 2012. The topic of Non-Newtonian Fluids will be discussed, and short lessons on water tension, shearing, and polymers will be shared. The calculations and equations used to make the project a success will also be demonstrated. Additionally, there will be an opportunity to experience the effects of “oobleck” first-hand. This project has been effective in chemistry and mathematics classrooms, and it has clearly shown that building bridges between these two courses can be fun and informative.

The Impact of the GK-12 Program on STEM Education / 6

The Impact of the NSF GK-12 "Building Bridges" Program at Texas Tech University

Dr. CASADONTE, Dominick [1]; Dr. DWYER, Jerry [1]; Dr. BAKER, Mary [1]; Dr. WILLIAMS, Brock [1]; Dr. LAMP, David [1]; Dr. BEVSEK, Holly [2]; GREEN, Whitney [1]

[1] *Texas Tech University*

[2] *The Citadel*

Corresponding Author: dominick.casadonte@ttu.edu

In the NSF GK-12 "Building Bridges: Integrating Mathematics, Science, and Engineering on the South Plains" program, a scientist (engineer) Graduate Fellow and high school science Teacher Fellow pairs with a math Graduate Fellow and a corresponding math Teacher Fellow at the same school to develop learning/teaching cohorts. The program at Texas Tech University is unique within the National Science Foundation's GK-12 program due to its interdisciplinary nature. Besides integrating math and science/engineering, a secondary goal at Texas Tech is to prepare graduate-level STEM researchers and in-service secondary mathematics and science teachers to thrive in an interdisciplinary environment.

The organization of the program at TTU is designed to:

1) Facilitate the research activities of the GK-12 Graduate Fellows.

2) Develop professional experiences for both Graduate and Teacher Fellows, while creating a sense of community among STEM participants.

3) Encourage collaborative design and implementation of an integrated curriculum.

4) Create cyber-capable dissemination platforms for nationwide outreach through a distance-learning classroom environment.

This talk will discuss the successes, challenges, and opportunities of the Texas Tech GK-12 program over the course of its five-years of operation.

The Impact of the GK-12 Program on STEM Education / 4

Moving Forward: Impacts of "Building Bridges" Participation on a Young Faculty Career

Dr. CRAWFORD, Jennifer [1]

[1] *Bethel University*

Corresponding Author: crawfordje@bethelu.edu

Participation in the "Building Bridges" program at Texas Tech University, first as a graduate fellow and later as a post-doctoral research associate, has had many positive impacts on my career following graduate school. These impacts include providing additional experience that helped me to "stand out" during my search for a college level teaching position; giving me insight into the high school math and science curriculum; and providing valuable training in community outreach that I have used in my current faculty position. Examples of these impacts will be given, along with discussion of additional aspects of the program that are of value to me as I progress in my chosen career.

The Impact of the GK-12 Program on STEM Education / 30

The Impact of the GK-12 Program: Faculty and Funding

This presentation will focus on my work after the GK-12 program as a faculty member and Director of the Mesalands Community College's Dinosaur Museum in Tucumcari, NM. I will discuss how my time in the GK-12 program prepared me for the writing and receipt of a $3.7M grant from the National Science Foundation for our STEM work at MCC.

The Impact of the GK-12 Program on STEM Education / 46

Know What You Don't Know

Dr. LOPEZ, Jerry [1]

[1] *University of Washington*

Corresponding Author: dominick.casadonte@ttu.edu

Teaching new concept to students is one of the most challenging tasks a professor or teacher encounters. Primarily because educational "holes" are left during the presentation of these new concepts. When in college, classes are short and concise thus making it difficult to completely explain all the details of a topic. Thus, college student are left to fetch for themselves and fill in the blanks. It is at this point that education begins to show its flaws and students hit a wall that cannot be overcome as they were never educated to "know what you don't know". In this talk, I would like to introduce a self-started program called GUD (Genious Under Development) that aims to teach high school students to truly understand concepts, giving them a clear view of what they truly like and what they don't like; thus, allowing them to set realistic goals and increase their success rate while in college.

WORKSHOP 5: The Geometer Sketch Pad: Mathematics & Applications to Science (Computer/Tablet Required) / 45

WORKSHOP 5: The Geometer Sketch Pad: Mathematics & Applications to Science

Mr. ANDERSON, Ronald [1]

[1] *Texas Tech University*

Corresponding Author: dominick.casadonte@ttu.edu

The Geometer’s Sketchpad provides an interactive, visual way for students and educators to explore mathematical concepts in the sciences and engineering. This workshop will introduce attendees to creating and deploying Sketchpad demonstrations in the K-12 classroom. Some of the topics covered will include a parabolic mirror model, properties of the sine wave, sketch web deployment, and a step-by-step interactive session where attendees can get hands-on experience with the Sketchpad software. NOTE: A laptop computer (Mac or Windows) is required to take part in this workshop.