

STEM inSight: Developing a Research Skills Course for First- and Second- Year Students

Dr. Dirk Colbry and Dr. Katy Luchini-Colbry

Institute for Cyber Enabled Research

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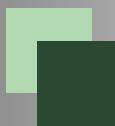


Agenda

- Class description and design
- Project vs. Workflow
- What didn't work
- What worked
- Future Plans

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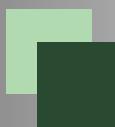




UGS 200H: Class Structure

- First and Second Year Honors students
- 3 Credit hour class
- Two semesters (Fall and Spring)
- 60-90 minutes per week
- Goal: give first and second year students an experience in research with a focus on engineering

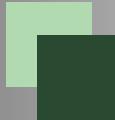




Class Overview

- First semester - Background
 - Brainstorming sessions
 - Research skills
 - Hands on experience
 - Project selection
- Second Semester – Research Projects
 - Individual research projects
 - Presentation skills
 - Campus wide poster presentation



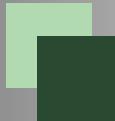
Research Focus

<p>Project Based</p> <ul style="list-style-type: none"> • Everyone works on the same overall research area • Students' individual projects explore ways to solve the overall problem in different ways 	<p>Workflow Based</p> <ul style="list-style-type: none"> • Everyone uses the same methodology and tools to solve problems • Students' individual projects are in different research areas across the campus
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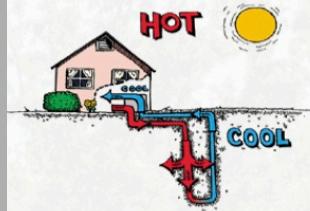


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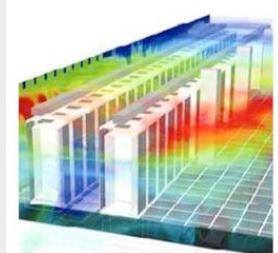


Project Based Class

- Sustainability in Super Computing (CyberGreen)
 - Research ways to make the High Performance Computing Center more energy efficient



Model of Geothermal Cooling System



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Project Based Research

- Alternative Energy Sources – Hydropower
- Geothermal Energy – Red Cedar Cooling
- Environmental Influences – Invite the Burglars
- Alternative Heat Conduction – Deep Fried Server
- Thermo-Electric Power – Thermal Recycling
- CPU Supply Chain Management





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Workflow Based Class

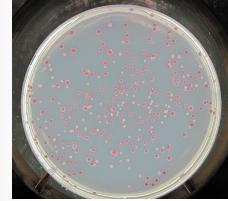
- Study of Scientific Measurement using Digital Images and Video
 - Research ways to optimize researchers time analyzing images for research





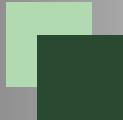








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Workflow Based Research



- Correlating size of the brain with age in MRI scans
- Streamlining Biology image analysis software
- Comparison of MRI brain scans relating to human desire for salty/sweet snacks
- Background subtraction in scientific imaging
- Face expression analysis based on face based points
- Tracking of chameleon eye movements in video
- Measuring the quality of chestnuts in CT scans
- The timing of image analysis in horse gait measurements

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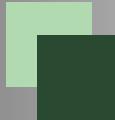



Studying the Biomechanics of Equine Circular Locomotion





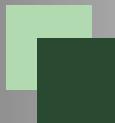

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Classroom Work

Project Based	Workflow Based
<ul style="list-style-type: none"> Introduction to Computational Fluid Dynamics Scientific Estimation Measurement and accuracy 	<ul style="list-style-type: none"> How computers store digital images Standard image analysis tools (ffmpeg, imagej, gimp, etc.) Evaluation of research workflows

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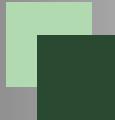



Disadvantages

Project Based	Workflow Based
<ul style="list-style-type: none"> CFD group project was over some students' heads Limited number of interesting projects Difficult to find external research mentors 	<ul style="list-style-type: none"> Broad focus made for less enthusiastic students Novice students often lack the technical and/or programming skills for engaging projects in their field of interest

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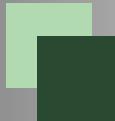




Advantages

Project Based	Workflow Based
<ul style="list-style-type: none"> • Exciting project, potential to “change the world” • Common theme for research projects • Easy for students to share ideas and offer helpful insights 	<ul style="list-style-type: none"> • Easier to find external faculty mentors willing to help supervise students’ individual projects • Easier to match research projects and faculty mentors to students’ individual / disciplinary interests • Many different types of projects can be found

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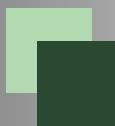



Closing Thoughts

- First and second year students can complete interesting research projects in STEM fields
- Lack of technical skills
- Three stage projects
 - Trivial Task (1-2 hours – 1 week)
 - Toy problem (2 weeks)
 - Full Research Problem

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