Research Experience for Teachers: Data Analysis & Mining, Visualization, and Image Processing

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SIGCSE 2014, Atlanta Appalachian RET Program– http://www.cs.appstate.edu/ret
The NSF RET in Engineering and Computer Science program supports the active involvement of K-12 STEM teachers and community college faculty in engineering and computer science research in order to bring knowledge of engineering, computer science, and technological innovation into their classrooms.

The goal is to help build long-term collaborative partnerships between K-12 STEM teachers, community college faculty, and the NSF university research community by involving the teachers and community college faculty in engineering and computer science research and helping them translate their research experiences and new knowledge into classroom activities.

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5736

Appalachian RET Program– http://www.cs.appstate.edu/ret
The RET Program at Appalachian State University
Data Analysis & Mining, Visualization, and Image Processing

- The Department of Computer Science at Appalachian State University received funding from the National Science Foundation to establish an RET program site in Data Analysis & Mining, Visualization, and Image Processing.
- The objective is to provide 12 diverse in-service high school teachers and community college faculty an opportunity to work with faculty mentors and their graduate and undergraduate assistants to conduct research in these fields.
- During the six-week summer program, participants will gain skills that they can utilize to assist their students in solving interdisciplinary problems.
- Participants will create course modules that they can use to teach a concept or to solve interdisciplinary problems in their courses.

Appalachian RET Program—http://www.cs.appstate.edu/ret
Appalachian State RET Program Components

- Summer program (Six weeks, June 17, 2013- July 26, 2013)
  - Building a strong community of summer participants
  - Training in software tools and applications
  - Experiencing common learning modules
  - Conducting research
  - Developing new course modules
- Academic year workshops
- Repository of course modules
- Strong community of interested educators

Eleven High School Teachers and one Community College Faculty participated in the program.
Program Training

Week 1 and 2

- Image processing
- NetLogo - Simulation for Data Analysis
- ImageJ - Applying image processing to solve problems
- Audacity – Audio processing
- Visualization basics, Excel
- Programming in Scratch
- Introduction to Octave
- Using Octave for image processing
- Conducting scientific research
- Genetic probability in Excel
- Genomics in Octave
- Writing a scientific report or paper
- Presenting research
Common Learning Modules

Hands-on opportunity for teachers to work with software tools and applications to solve STEM problems.

- Pendulum Motion
- Kinect Skeleton Tracking & Kinect Face Recognition
- Monte Carlo Simulation for Finding Unknown Areas
- Audio Experiment

Appalachian RET Program– http://www.cs.appstate.edu/ret
We had several ongoing research projects with which participants could get involved. However, we allowed participants to come up with a research project of their own as well. Participants worked in teams of two from two different institutions.

- **Plotting 3D Coordinates Using Microsoft Kinect**  
  Rebecca Cooper and Nick Westveer

- **A Statistical Analysis of Basketball Comebacks**  
  Jessica Jenkins and Adam Benoit

- **Historical Height and Weight Analysis of Male Athletes in Professional Sports**  
  Nicholas Inman and L. Wayne Hamlin

- **Identification of Leaves By Interior Shape and Texture**  
  Veronica Dooly and Jennifer LeBlanc

- **Reading a River Through Computer Science**  
  Thomas Brown and Rayvis Key

- **Determining Honey Bee Behaviors using Audio Analysis**  
  Loren Hord and Errol Shook
Goal: Determine Cartesian coordinates of the eight corner points of a rectangular prism using Kinect.

A procedure was developed to collect, analyze and report data for these points.

Volumes were calculated for each rectangular prism and compared to measured volumes to determine accuracy.
A Statistical Analysis of Basketball Comebacks

Greatest comeback: 13 points in 33 seconds.

Developing Course Modules

- Developed course modules in the afternoons
- Teachers designed course modules that they could use in their own courses
- Incorporated computational tools from the training period
- Collaboratively built a common template for all modules

- Modules reviewed and tested by two other teams
- The final revision was done by the program directors.

- The modules are posted in the repository for use.
Research Experience for Teachers Program

Summer Program, June 15 - July 25, 2014, Appalachian State University, CAP Building

The Department of Computer Science at Appalachian State University has received funding from the National Science Foundation to establish a Research Experience for Teachers (RET) Program site in Data Analysis & Mining, Visualization, and Image Processing. The objective is to provide 12 diverse in-service high school teachers and community college faculty an opportunity to work with faculty mentors and their graduate and undergraduate assistants to conduct research in these fields. During this six-week summer program, participants will gain skills that they can utilize to assist their students in solving interdisciplinary problems. In addition, participants will have hands-on experience with sample modules that they can use to teach a concept or solve interdisciplinary problems in their courses.
• 1. Period of the Pendulum Motion and its Dependency on Length, Angle, and Mass
Teacher's Manual, -- Lab Activity and Teacher's One-page Power Point
Subject Area(s): Physics, Physical Science, Mathematics

Computer Science Tools: Image J, Movie Maker, Microsoft Excel (or equivalent spreadsheet software)

Activity Title: “Pendulum Motion”

Grade Level: 11-12

Time Required: 90 minutes

Recommended Group Size: 2 - 3 students

Summary: In this activity, students use Movie Maker and Image J to analyze the motion of a simple pendulum. Students will determine what effect, if any, changing the mass, angle, and length of the pendulum have on the period. Students will have an opportunity to determine the acceleration of gravity (gravitational field on the surface of the earth), from their experimental data.

Computer Science Connection: Students will develop a basic understanding of image processing and data analysis using computer science software.

Keywords: pendulum, period, gravity, oscillation, Image J, spreadsheet

Pre-Requisite Knowledge: Students should have experience working with Image J, Movie Maker, graphing in Excel, and video recording. Students should also be familiar with solving and manipulating algebraic equations.

Learning Objective:

Using video recording and image processing to find the period of the pendulum motion and determining the acceleration due to gravity.
Introduction/Motivation:

Simple pendulum motion dates back to the early 1600’s with its usefulness in timekeeping. Since then, analyzing pendulum motion has been beneficial in understanding the effects of gravity on falling objects, the law of conservation of energy, and simple harmonic motion. Students will be able to investigate, through this hands-on activity, what factors influence the period of a pendulum.

Materials List:

- Digital camcorder / tripod (suggested)
- string (flexible, but not stretchable)
- meter stick, measuring tape, or reference size object (i.e. 3x5 index card)
- lab equipment to make a holder for the pendulum
- several small masses

![Figure 1 – List of Materials and Tools](image-url)
“Pendulum Motion”

Summary: In this activity, students use Movie Maker, ImageJ and MS Excel software to analyze the motion of a simple pendulum. Students will determine what effect, if any, changing the mass, angle, and length of the pendulum have on the period. Students will have an opportunity to determine the acceleration of gravity (gravitational field on the surface of the earth), from their experimental data.

<table>
<thead>
<tr>
<th>Time</th>
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How does the graph look like?
How does changing the mass affect the period?
How does changing the length of the pendulum affect the period?
How does changing the angle of the pendulum affect the period?
Wayne is a physics teacher in Asheville, NC

Rebecca is a science teacher in Wilkesboro, NC

Thomas is a physics teacher in Boone, NC

11/12 summer participants have used a module in their classroom
6 additional teachers have used modules from the program
Course Module Use by Summer or Workshop Participants

Module 1. Period of the Pendulum Motion and its Dependency on Length, Angle, and Mass
Module 25. Introducing Programming with Scratch
Module 31. Projectile Motion in MS Excel
Module 28. Significant Figures in Chemistry and Physics with Scratch and Excel
Module 24. Creating Images using Text Files

23/32 modules have been used in the classroom.
Scratch has been successfully used in several subject areas

Kinect has been used to teach standard deviation and the golden ratio

Octave has been used in math and chemistry to apply matrices to solve problems
The Academic Year Workshop

- Expose additional teachers to course modules
- Hands-on experience
- Expand community
- Summer participants act as mentors
- Recruit for upcoming summer program

- First workshop Nov. 16, 2013
  - 9/12 summer participants assisted with the workshop
  - 13 high schools teachers and one math education major attended
  - All showed interest in participating in the summer program
The Academic Year Workshop

Program Activities
8:30 - Coffee and Bagel
9:00-9:30, Introduction and overview
9:30-11:10, Parallel Modules (Module 3. Kinect Skeleton and Module 1. Pendulum)
11:10-11:20, Break
11:20-12:30, Computer based Module (25. Introducing Programming with Scratch)
12:30-1:15, Working Lunch
1:15-3:00, Parallel Modules
3:00-3:15, Break
3:15-4:30, Developing ideas for new Modules
4:30-5:00, Survey and future plans
Survey for the Summer RET Participants Summer Survey Follow Up

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Outcomes

• The program successfully created a strong learning community where faculty mentors and participants shared their experiences.
• Nine out of 12 summer participants returned to assist with the Fall workshop.
• Participants conducted six research projects, where they applied their experience from the summer program.
• The high number of course modules, 32, indicates strong connection of this program to the classroom.
• The quality of research projects is indicative of the participants’ professional development.
• By accepting participants in pairs from the same school we initiated collaboration that could continue into the school year.
• Participants worked in pairs and rotated during the program to foster stronger community and future collaboration.

The survey conducted by our program evaluator indicates that:
• participants found the program challenging but enjoyable.
• participants reported that their perspective of computer science has widened.
• the program has helped teachers identify students who are well-suited to pursue computer science.
• the program made the connection between computer science and STEM disciplines clear.
• the program introduced teachers to new computer science concepts.

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