TIP: Piloting a Physics Partnership

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ABSTRACT

Our HBCU-UP Targeted Infusion Project (TIP) has brought together the faculty and administrators of a four-year HBCU and a nearby two-year, Predominately Black Institution (PBI) to "… form a successful physics partnership between South Carolina State University (SCSU) and Orangeburg-Calhoun Technical College (OCtech) that will strengthen both programs and serve as a model of best practices for developing a STEM collaboration." We report on our successes and challenges after more than two years of a three year project funded by the National Science Foundation.

OCtech has modified its physics instruction using a new textbook and online homework to enhance the problem-solving skills of their students. The TIP project is funding a math instructor at OCtech who is engaged in physics coursework at another university to prepare him for certification to teach physics at OCtech. Faculty members from both OCtech and SCSU are team-teaching the physics lecture and lab courses for the first time in the history of the two schools. OCtech has provided training for SCSU faculty in the use of LabVIEW software, project-based instruction and alternative energy activities.

SCSU has tested and incorporated Invention Instruction activities in the introductory physics lecture and lab courses. Additionally we have developed over 150 videos of short length on select math and physics topics that are viewed by the students prior to class as part of the "flipped" or "scrambled" method of instruction. A member of the SCSU education faculty is serving as the evaluator for the project and has three semesters of results measuring the effectiveness of the new methods of teaching. He has conducted an assessment of our flipped instruction using a variety of techniques including pre- and post-testing, focus groups and individual student interviews. We discuss the evaluation results to date.

Funding for this project has been provided by the National Science Foundation through award HRD-1332449 as well as resources provided by OCtech and SCSU.

Statement of the Problem

The growing need for STEM graduates in the United States is well documented [1,2] as is the underrepresentation of minorities in these fields. For example, in 2006 55% of all scientists and engineers with occupations in science and engineering were white males and 18% were white females while only 2% were black males and 1% black females. [3].

Of particular concern is the relatively small field of physics. Over 400,000 B.S. degrees are annually awarded in the STEM fields [4]. Recent statics from the American Institute of Physics (AIP) show that more than 6,700 B.S. physics degrees are awarded annually and, only about 160 of those degrees in physics are earned by African-Americans.

Mission and Goals

We will strengthen the physics programs at a four-year, Historically Black College/University (HBCU) and a nearby two-year, Predominately Black Institution (PBI) by forging a strong partnership using shared resources.

Goal 1: Develop a collaboration that will share resources and serve as a model for future partnerships in other STEM fields between SCSU and OCtech; and, for future SCSU STEM partnerships with other 2-year institutions.

Goal 2: Strengthen the physics-related programs and courses at OCtech.

Goal 3: Strengthen the physics program at SCSU.

Successes

- ❑ *OCtech is funding additional graduate coursework for math faculty member T. Colter to become certified to teach physics*
- ❑ *OCtech's J. Payne implemented 20 new physics labs*
- ❑ *OCtech's R. Murphy oversaw LabVIEW training & completion of Mock Radiation Lab for safety training*

- ❑ Both schools adopted free-online text in College Physics by OpenStax to ease financial burden on students
- ❑ Both schools adopted online homework by Sapling to improve student problem-solving skills and faculty efficiency

- ❑ *SCSU's J. Cash developed ~150 pre-lecture videos and implemented so called "flipped" or "scrambled" instruction*
- ❑ *SCSU 's D. Smith developed Invention Instruction activities & improved conceptual understanding of physics problems*
- ❑ *SCSU's R. Williams designed & implemented the evaluation plan*

Challenges

- ➢ Departure from OCtech of physics instructor who was Co-PI
- ➢ Professional retirement of 2 SCSU Co-PIs
- ➢ SCSU campus-wide evaluation of Gen Ed requirements is delaying physics curriculum development
- ➢ Time commitments to implement project greater than expected
- ➢ Some technical issues with full implementation of videos
- ➢ Getting students in the habit of doing pre-lecture work

Invention Instruction

Distributed Mass

A sliced loaf of bread is pictured below. How can the mass of the entire loaf be found without putting all of the slices on a scale?

- Prior to lecture, students "invent" a measurement outside of the subject area where the measurement is needed so that transfer to the desired subject is more easily achieved.
- Students are given a easy task that requires their own invention of the concept
- Topics range from vectors, to mass, to electric current, 2-D motion and more.

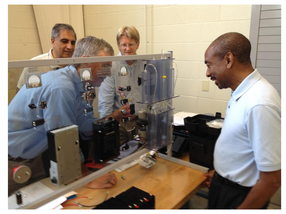
Current and Voltage

Water flows through the pipes in the picture to the left.

What is the effect of the height of the hill on the number of gallons per second flowing?

Shared Resources & Experiences

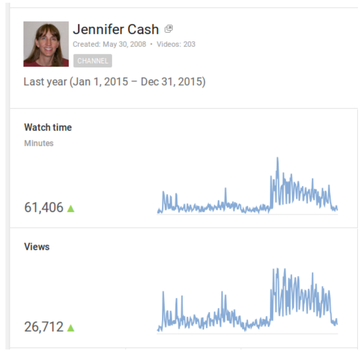
- ➢ OCtech trained SCSU faculty in LabView
- ➢ OCtech Alternative Energy Workshop included SCSU
- ➢ OCtech Project Based Learning Workshop included SCSU
- ➢ SCSU Faculty member teaching physics at OCtech
- ➢ SCSU & OCtech team-teaching physics lab at OCtech
- ➢ SCSU physics videos used at OCtech and SCSU



J. Payne (left) demos alternative energy

Physics class at OCtech

Flipped or Scrambled Instruction



- ❑ Created ~ 150 physics/math videos
- ❑ Each 2-5 minutes long
- ❑ Specific topics (e.g. vectors)
- ❑ SCORM Compliant
- ❑ Students view prior to class
- ❑ Less lecture, more hands on

26, 712 Youtube views in 2015
40,00 projected for 2016

https://www.youtube.com/user/drjenncash

Evaluation Plan

- Used pre and post diagnostic test
- Used online student attitude survey
- Used focus groups of 3-5 students
- Used individual student interviews

- Preliminary analysis from 2014-15
  1. Pre + Post Test show improvement in understanding of physics concepts
  2. Improved attitude about physics
  3. Increased desire to work with other students
  4. Many still wanted traditional worksheets, testing and traditional (hardcopy) textbook

Which of the following would you feel comfortable getting through distance learning	Very Comfortable	Comfortable	Uncomfortable	Very Uncomfortable
my course textbooks	3 (13%)	15 (65%)	6 (26%)	0
classroom experiments/lab work	4 (9%)	9 (39%)	11 (49%)	1 (4%)
homework that are worksheets	0	17 (74%)	6 (26%)	2 (9%)
guest speaker presentations.	1 (4%)	20 (87%)	4 (17%)	0
homework that requires research	1 (4%)	17 (74%)	6 (26%)	1 (4%)
tests	3 (13%)	15 (66%)	6 (26%)	4 (17%)

References

[1] Members of the 2005 "Rising Above the Gathering Storm Committee" (2010). NAS Report. *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5.*

[2] Members of the Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline (2011). NAS Report. *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads..*

[3] National Science Foundation, Division of Science Resources Statistics, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2011*, NSF 11-309,

[4] Hodapp, T. 2011 *The Economics of Education: Closing Undergraduate Physics* Programs, American Physical Society, APS News, Volume 20, Number 11

Acknowledgements

Funding for this project has been provided by the National Science Foundation through award HRD-1332449. Additional resources have been provided by OCtech and SCSU.

More Information

http://physics.scsu.edu