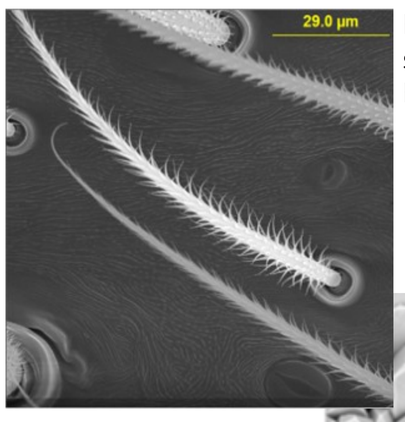
Utilization of Nano-Themed Research to Enhance Undergraduate Research

Jared Ashcroft
Pasadena City College, 1570 E Colorado Blvd, Pasadena, CA91106
jmashcroft@pasadena.edu

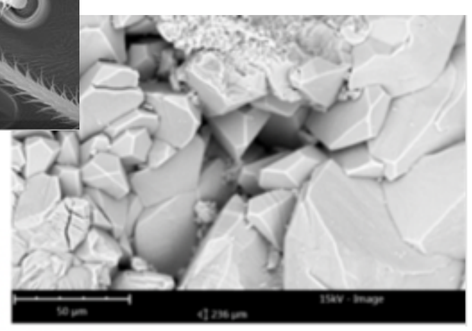
Introduction

Nanotechnology is defined as the study of particles in the 1-100 nm range. Its application in chemistry involves the ability to manipulate and see individual atoms and molecules, although it can be applied to many different disciplines within science, engineering and medicine. At Pasadena City College (PCC) we are approaching nanotechnology through projects based on the ability to characterize and isolate different particle sizes. Instrumental techniques, such as Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM) and qNano particle size analyzer, and research collaborations with four-year universities, such as CSU Northridge and UC Riverside are being used to give students hands on experience in laboratory techniques.

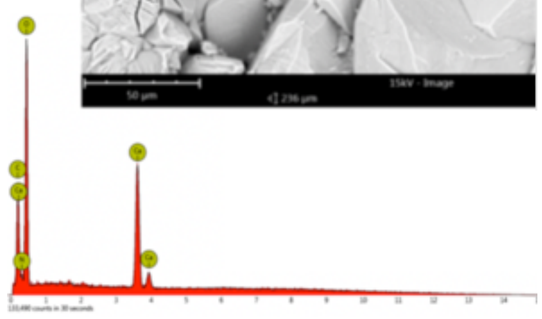
Over the past five years, PCC has designed a robust Earl Career Undergraduate Research Experience (eCURe) which engages students in research projects embedded within undergraduate STEM courses, partners students with mentors and encourages applications to summer URE opportunities. The combination of nanotechnology and undergraduate research has led to over thirty PCC students being accepted into summer URE programs, eight peer reviewed publications and over fifty regional and national conference presentations.



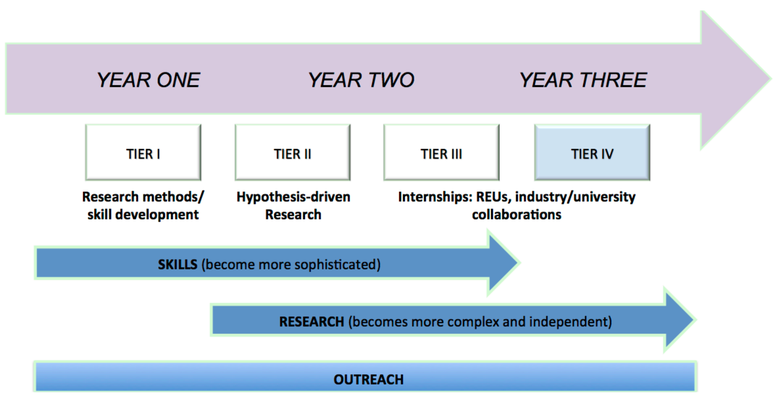
Fine hairs on a spider seen thru a Scanning Electron Microscope.



Scanning Electron Microscope image of limestone with elemental analysis from EDS (Energy Dispersive Spectroscopy).



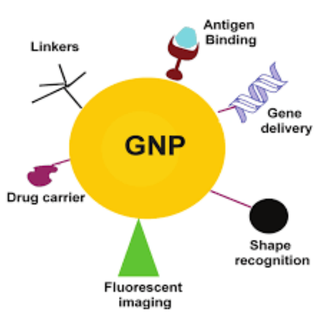
Tiered Approach to Undergraduate Research



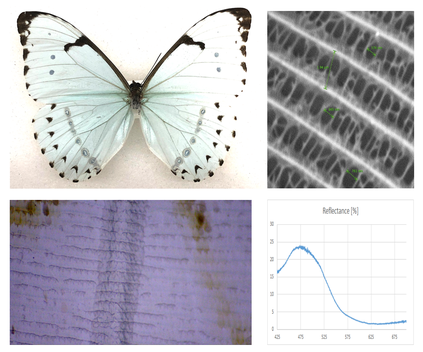
Goals of eCURe at PCC

- ✓ Increase student success and retention in STEM fields through collaborative and interdisciplinary projects in basic science
- ✓ Inspire enthusiasm for scientific research by introducing students to research projects with a broader impact in terms of energy, the environment and emerging scientific technologies
- ✓ Provide students with opportunity to participate in all aspects of a scientific campaign, including research experience (lab work, literature review) and communication of scientific data (oral/poster presentations, writing manuscripts).

Nanotechnology-Based Projects



Nano-bioconjugates



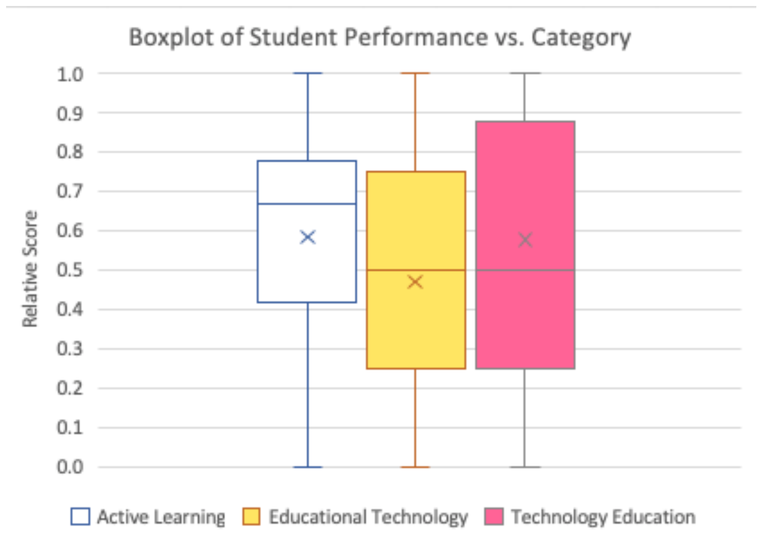
Butterfly Wings – *morpho catenerius*

Conclusions

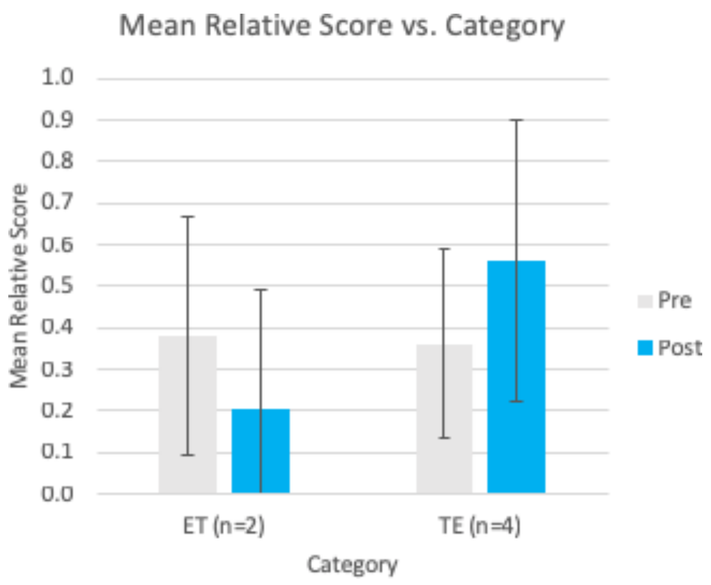
- Incorporating advanced technology into science lessons and research increases students interest and success in STEM.
- Student attitudes toward Scientific Research and understanding increased.
- This redefines the role of undergraduate research in community college STEM Pathways

Remotely-Accessible Instruments in Nanotechnology (RAIN)

Student Learning

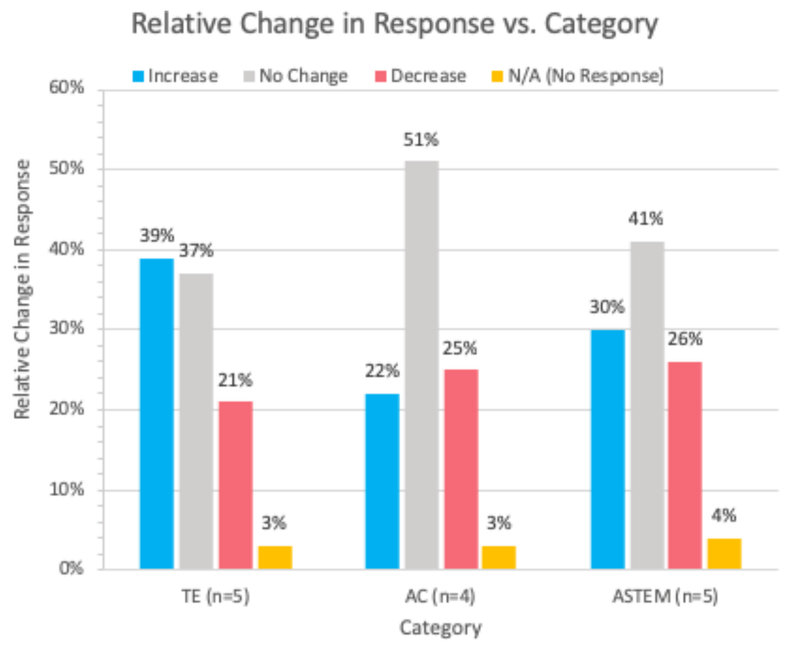


Boxplot of student performance during the lesson sequence. Active Learning (AL), Educational Technolgoy (ET), and Technology Education (TE) were compared. Student learning in AL was used as a baseline due to established research on AL success. Matched-pair t-test confirms that the students did not perform as well in the ET category (in yellow).

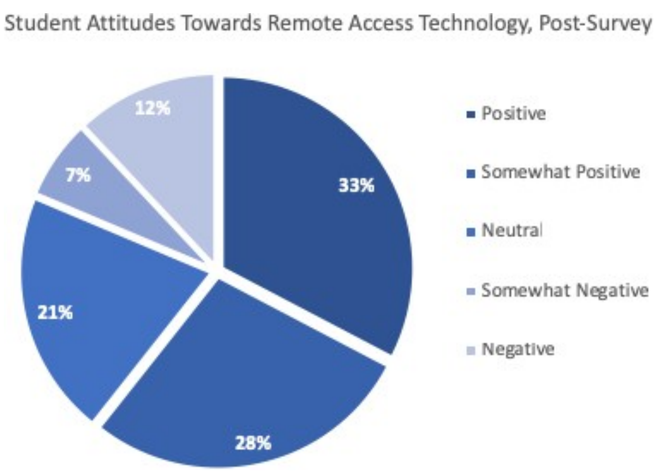


Comparison of students' scores on the pre-survey compared to the post- survey. Multiple choice questions tracked student fact-based learning. Due to different number of questions in each category, the relative mean score was taken. As expected, students showed no difference in their knowledge of ET versus TE at the beginning of the school year. Matched-pair t-test confirms, at the end of the lesson sequence, students clearly had a greater understanding of advanced scientific technologies.

Student Attitudes



Bar chart displays changes in student attitudes on Likert items with a 1-5 scale. Questions were divided into Attitudes toward Technology (TE), College (AC), and science in general (ASTEM). AC and ASTEM showed no significant change. However, TE showed an increase in student interest and positive attitudes towards scientific technologies. Wilcoxon Matched-Pairs Signed Ranks Test confirms.



Student attitudes towards remote access technology at the end of the lesson sequence. Every student completed at least 3 lessons, with majority completing all 5.

References

1. Jared M. Ashcroft, et. al.; "It's RAINing: Remotely Accessible Instruments in Nanotechnology to Promote Student Success." Current Issues in Emerging eLearning, Vol. 4, Issue 1, Article 4, 2018.
2. Brandon Rodriguez, et. al.; "Bridging the Gap Between 'Rocks for Jocks' and the Mars Sample Return Program: Using NASA Resources and Remote Access to Promote Geology." Science Scope, 41, 8, 48-57, 2018 .
3. Brandon Rodriguez, et. al.; "Contextualizing Technology in the Classroom Via Remote Access: Using Space Exploration Themes and Scanning Electron Microscopy as Tools to Promote Engagement in Multidisciplinary Geology/Chemistry Experiments." *Journal of Technology and Science Education.* 8, 1, 86-95, 2018.
4. Jared M. Ashcroft, Ashley Min, Isabel Bojanini, Melanie Hacopian, Kristine Schroeder, Attilla O. Cakmak, Brandon Rodriguez; "Cultivating Mars: A Problem-Based Learning Lab Designing an Oxygen-Rich Environment on the Red Planet." *Journal of Laboratory Chemical Education.* 6, 1, 4-11, 2018 .
5. Jared Ashcroft, Walter Klingerman, Brandon Rodriguez; "Using Remotely Accessible Microscopy in the Elementary Classroom." *Frontiers in Education Technology.* 1, 2, 137-148, 2018.
6. Ashley Min, Jared Ashcroft, Joel Monroy, Vanessa Wolf, Christina Lee, Josée Horton, Robert Ehrmann, Brandon Rodriguez; "Making it RAIN: Using Remotely Accessible Instruments in Nanotechnology to Enhance High School Science Courses." *Frontiers in Education Technology.* 2, 2, 74-87, 2019 .
7. Christina Lee, Nay Chi P. Naing, Daisy Herrera, Gerardo Aguirre, Brandon Rodriguez, Jared Ashcroft; "Light up My Life: An Active Learning Lan to Elucidate Conductive Properties of Electrolytes." *Journal of Laboratory Chemical Education.* 7, 1, 1-7, 2019.

Acknowledgements

Thanks to the students of Aspire Middle School,who participated in the labs and surveys, and Jill Mayorga and Diana Campos at Aspire. Thanks to the RAIN network, including Robert Ehrman and Dr. Osama Awadelkarim at Pennsylvania State University. Support came from BUILD PODER, funded by National Institute of General Medical Sciences of the National Institutes of Health under award number RL5GM118975. eCURE is an undergraduate research program at Pasadena City College funded by National Science Foundation Advanced Technical Education grant award number 1601813. Thanks to Dr. Brandon Rodriguez and NASA Education for supporting the research.