Enhancing Bioengineering Undergraduate Students' Learning and Research Experiences through Hands on Experiments on Bio-Nanoengineering

Narayan Bhattarai
Department of Chemical, Biological, and Bioengineering
North Carolina A & T State University, Greensboro, NC

National Science Foundation Engineering Education and Centers-Nanotechnology Undergraduate Education (NUE): Enhancing Undergraduate Students' Learning and Research Experiences through Hands on Experiments on Bio-nanoengineering. This project takes into account the need for a better marriage between theory, experiment and applications. Several hands-on exposures are being provided to students in the areas of bionanotechnology and, characterization and measurement of nanostructured systems and devices. Four objectives of this project; (i) developed and implemented biomedical nanotechnology modules in existing bioengineering courses i.e. Introduction to Biomedical Engineering (BMEN 220) and Biomaterials (BMEN 310) (ii) developed a team-based biomedical nanotechnology course, (iii) developed a semester long research experience course related to biomedical nanotechnology, and (iv) developing an Interdisciplinary Bio-Nano Engineering Certificate Program(BECP) at NCA&T. Content assessment and student satisfaction were measured through the use of pre and post-test satisfaction surveys in developed courses. Students were asked Likert scale questions and open-ended questions related to their experience with the course and the learning module. Student satisfaction was measured through the use of focus groups conducted by the Educational Assessment and Administrative Coordinator for Engineering Research Center's Education and Outreach Program. Results from these assessments found an equal or greater percentage of students answered the questions correctly on the post-assessment. This approach has impacted more than 65 undergraduate students from NC A&T with one veteran undergraduate student and one middle school science teacher with veteran status.

for use in clinically relevant tissue engineering applications.

Assessment methods & IRB approval:
Each phase of the undergraduate student's learning experiences were assessed using multiple measurements. Content learning for objective (i), the learning modules in BMEN220 and BMEN310, was assessed using an instructor designed content assessment and student satisfaction was assessed using a student satisfaction survey. Content learning for Objective (ii), the course BMEN570, was assessed with a pre and post-test using an instructor designed content assessment and student satisfaction was assessed using focus groups. Content learning for objective (iii), the course BMEN570, was assessed with a presentation review process involving nine independent reviews, while course satisfaction was assessed using a student satisfaction survey.
All assessments were administered by assessment personnel independent from the instructor and data were also analyzed by these personnel. All research was conducted in accordance with the policies of the Institutional Review Board (IRB), which granted approval for this research design and methodology.

Project activities and outcomes:
To assess the effectiveness of the content learning models, students were assessed on their content knowledge and satisfaction with the experience. Content knowledge from the learning modules was measured using a brief content assessment developed by the instructor and researcher who developed the lectures. The items were derived directly from the concepts covered in the modules.
Example of three content assessment items for one of the bioengineering courses e.g. BMEN 220 are shown below as well as the results indicating percentage of students who answered each item correctly.
1) Nanotechnology allows researchers to work on a sub-cellular level. (True/False)
2) Name one application of nanotechnology in biomedical engineering. (Short Answer)
3) Which one of the following has nanoscale dimensions: a) muscle, b) nephron, c) ribosome

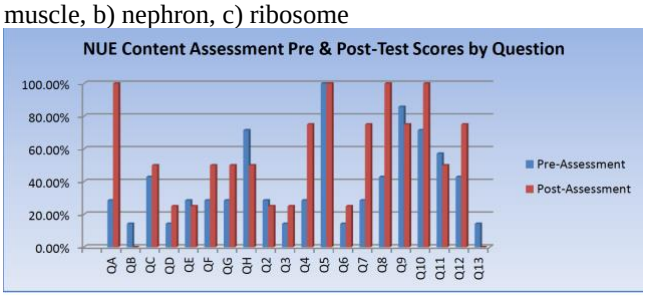

Figure: Graph shows the the results from project contents assessments

Acknowledgement
The author would like to thank the Engineering Education and Centers (EEC) Division of the US National Science Foundation for providing funding via Nanotechnology Undergraduate Education (EEC 1242139). Authors also acknowledge Veteran Research Supplement VRS Program NSF 13-047 for providing support for REV/U and REV/T.

References: Narayan Bhattarai, Courtney Lambeth, et. al., "Enhancing Undergraduate Students' Learning and Research Experiences through Hands on Experiments on Bio-nanoengineering" Proceedings of 122nd ASEE Annual Conference & Exposition, June 14-17, *2015*