

Chapter 8

Use of Living Systems to Teach Basic Engineering Concepts

Kausar Jahan
Rowan University, USA

Jess W. Everett
Rowan University, USA

Gina Tang
Rowan University, USA

Stephanie Farrell
Rowan University, USA

Hong Zhang
Rowan University, USA

Angela Wenger
New Jersey Academy for Aquatic Sciences, USA

Majid Noori
Cumberland County College, USA

ABSTRACT

Engineering educators have typically used non-living systems or products to demonstrate engineering principles. Each traditional engineering discipline has its own products or processes that they use to demonstrate concepts and principles relevant to the discipline. In recent years engineering education has undergone major changes with a drive to incorporate sustainability and green engineering concepts into the curriculum. As such an innovative initiative has been undertaken to use a living system such as an aquarium to teach basic engineering principles. Activities and course content were developed for a freshman engineering class at Rowan University and the Cumberland County College and K-12 outreach for the New Jersey Academy for Aquatic Sciences. All developed materials are available on a dynamic website for rapid dissemination and adoption.

DOI: 10.4018/978-1-61520-659-9.ch008

INTRODUCTION

An aquarium is an exquisite combination of interacting systems which can be analyzed using multidisciplinary engineering principles. Children typically have personal aquariums for their pet fishes and visit some large aquarium as part of a school field trip or as part of their family outing. Movies such as Disney-Pixar's "*Finding Nemo*", *Epcot's Living Seas* also make tremendous impact on a young audience. While these activities apparently raise the knowledge base in terms of nature and the environment, children seldom make a connection to the engineering principles playing out in the maintenance of a natural, commercial or personal aquarium. Thus the idea of using an aquarium to promote engineering concepts for a wide audience is innovative and exciting. A creative initiative between the College of Engineering at Rowan University, Cumberland County College (CCC) and the New Jersey Academy of Aquatic Sciences (NJAAS) to enhance STEM (Science, Technology, Engineering, Mathematics) education at all levels has been undertaken by receiving support from the National Science Foundation. There is a growing realization among engineering faculty that a new vision for the education of engineers needs to evolve to keep this country at the forefront of technology. Science and engineering are essential for paving the way for America's future through *discovery, learning and innovation*¹. A recent report² indicates that the United States lags behind the world in technological innovation because of its poor performance in teaching math and science. This eliminates many of the best and brightest schoolchildren from the ranks of future scientists and engineers. Many students who do undertake science and engineering studies in college are unprepared and drop out in frustration, while other potentially capable students never consider these subjects in the first place. In both cases, precious human and institutional resources are squandered. Enhanced engineering education

in our K-12 classrooms can provide students at an earlier age with a more specific understanding of what a technical career entails.

The College of Engineering at Rowan University is always seeking innovative teaching methods to excite freshman engineering students about engineering design (Jahan, K., Hesketh, R. P., Schmalzel, J. L. & Marchese, A. J., 2001; Harvey, R., Johnson, F., Marchese, A. J., Newell, J. A., Ramachandran, R. P., & Sukumaran, B., 1999; Hesketh, R.P., Farrell, S., & Slater, C.S., 2003; Schmalzel, J. L., Marchese, A. J., Mariappan, J., & Mandayam, S., 1998; Hesketh, R. P., Jahan, K., & Marchese, A. J., 1997; Marchese, A. J., Newell, J., Ramachandran, R. P., Sukumaran, B., Schmalzel, J. L. & Maraiappan, J. L., 1999; Jahan, K., & Dusseau, R.A., 1998; Jahan, K., Marchese, A. J., Hesketh, R.P., Slater, C.S., Schmalzel, J.L., Chandrupatla, T.R., & Dusseau, R.A., 1998; Jahan, K., & Dusseau, R.A., 1998; Ramachandran R. P., Schmalzel, J., & Mandayam, S., 1999; Marchese, A. J., Ramachandran, R. P., Hesketh, R., Schmalzel, J., & Newell, H. L., 2003; Farrell, S., Hesketh, R. P., Newell, J. A., & Slater, C. S., 2001). The aquarium project was selected to expose K-12 students/educators, freshman students in engineering at Rowan and CCC to basic science and engineering concepts. Students can easily be introduced to chemical, mechanical, electrical, civil and environmental principles such as mass and energy balances; fluid flow; work, energy, and efficiency; forces and levers; material strength and stresses; water quality and treatment; and electrical signal processing via this project. The aquarium theme also adds to the need for an understanding of biological systems, ecosystems, pollution and sustainable development. These are concepts that have been absent in typical traditional engineering courses.

10 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/use-living-systems-teach-basic/44730

Related Content

Architectural Web Portal and Interactive CAD Learning in Hungary

Attila Somfai (2010). *Web-Based Engineering Education: Critical Design and Effective Tools* (pp. 20-29).

www.irma-international.org/chapter/architectural-web-portal-interactive-cad/44724

Leveraging Community-Based Service Learning Experiences into Academic Credit in Engineering Curricula

John Tharakan (2012). *International Journal of Quality Assurance in Engineering and Technology Education* (pp. 77-85).

www.irma-international.org/article/leveraging-community-based-service-learning/63641

Integration of Moodle and Electronic University Systems at BMSTU

Alexander Sergeevich Chernikov, Ravil Shamilievich Zagidullin and Alexander Alexandrovich Chibisov (2019). *Handbook of Research on Engineering Education in a Global Context* (pp. 418-429).

www.irma-international.org/chapter/integration-of-moodle-and-electronic-university-systems-at-bmstu/210339

Framework of Competencies for Internationalizing Engineering Curriculum

Fola Michael Ayokanmbi (2015). *International Journal of Quality Assurance in Engineering and Technology Education* (pp. 22-32).

www.irma-international.org/article/framework-of-competencies-for-internationalizing-engineering-curriculum/134423

Strategies to Remove Barriers and Increase Motivation to Use the Tablet PC in Formative Assessment

Antony Dekkers, Prue Howard, Nadine Adams and Fae Martin (2015). *International Journal of Quality Assurance in Engineering and Technology Education* (pp. 44-55).

www.irma-international.org/article/strategies-to-remove-barriers-and-increase-motivation-to-use-the-tablet-pc-in-formative-assessment/147416