



Quick Guide: Service-Learning in Engineering Education

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For additional resources on these and other service-learning topics visit the National Service-Learning Clearinghouse Website at www.servicelearning.org

Service-Learning in engineering education is gaining ground throughout the country and throughout the variety of disciplinary focuses within engineering education. Examples of service-learning exist in mechanical engineering, construction science, computer science and engineering, electrical engineering, and other forms of related education. Engineering is uniquely situated for the integration of service-learning into the curriculum because of its emphasis on experiential education, problem solving, and working in groups.

While service-learning in engineering education is gaining ground, there is a sense from educators engaged in this work that engineering lags behind some other disciplines in its embracing of the service-learning model (Oakes, 2004). Service-learning has the potential to engage students in a real life application of the theoretical engineering models they learn in the classroom, to introduce engineering to students who may not have initially been drawn to engineering, and to reinforce models of learning that will be useful to engineering students as they enter the professional workforce.

The power and potential of service-learning in engineering education is demonstrated through successful programs such as EPICS (Engineering Projects in Community Service) and Engineers Without Borders™. These programs, linked to within the web resources, provide outstanding examples of integrated, interdisciplinary service-learning within engineering education.

Web Resources

Campus Compact Discipline Association Fund—American Society for Engineering Education

<http://www.compact.org/faculty/disciplineassociation/ASEE.html>

This site details the work done by the ASEE as part of a grant from Campus Compact to advance service-learning in engineering education. Includes a link to a searchable

database of engineering education courses, including service-learning as search criteria. The database is available at <http://www.learnon.org/>

Campus Compact Syllabi Project—Service Learning syllabi in Engineering

<http://www.compact.org/syllabi/>

Link to the site listed and then search under Engineering. Provides links to service-learning syllabi in engineering education.

Engineering Projects in Community Service (EPICS) National Program

http://epicsnational.ecn.purdue.edu/public/program/national_program.php

This web site details the Engineering Projects in Community Service (EPICS) program, providing an overview of EPICS, as well as evaluation data regarding the effectiveness of the program. EPICS “integrates highly mentored, long-term, large-scale, team-based, multidisciplinary design projects into the undergraduate engineering curriculum...teams work closely with a not-for-profit organization in the community to define, design, build, test, deploy and support projects that significantly improve the organization’s ability to serve the community.” This site provides links to each of the current 10 EPICS sites.

Engineers Without Borders™

<http://www.ewb-usa.org/>

Engineers Without Borders™ – USA (EWB-USA) is a non-profit organization established in 2000 to help developing areas worldwide with their engineering needs. Engineers Without Borders™ works closely with students, with a goal of “involving and training a new kind of internationally responsible engineering student.”

ProCEED (Program for Community Engagement in Engineering Design)—University of Michigan

<http://www.engin.umich.edu/soc/pts/ProCEED/>

ProCEED is a student organized program that brings together community based projects with engineering students. Through design courses, small groups of 3 to 5 engineering students work closely with community organizations and faculty on individual projects and take them from design through implementation. “As a result, community service organizations are provided with alternatives for solving important technical problems.”

Penn Engineering: Undergraduate Student Service Learning Activities

http://www.seas.upenn.edu/under/studenta_slo.html

Provides links to three service-learning programs for undergraduate engineering students at the University of Pennsylvania; 1) CommuniTech (non-profit student organization that seeks to "bridge" the digital divide both locally and globally), 2) Technology for Education Program (K-12 education in both West Philadelphia and West Africa by introducing and enhancing computer and Internet technology), and 3) Puente (non-profit

student organization that seeks to "bridge" the technology gap in low-income areas throughout the world by enabling all persons to gain access to computers and the Internet).

Service-Learning in Engineering: A Resource Guidebook Developed by William Oakes.
http://www.compact.org/publication/SL_and_Engineering-WEB.pdf

This resource guidebook, published by Campus Compact, provides an introduction to service-learning in engineering education, and program models from the EPICS (Engineering Programs in Community Service) program. Sample syllabi, course descriptions, forms and evaluation tools are provided. The guidebook can be downloaded directly from the Campus Compact web site.

Service-Learning and Engineering Ethics--Paper presented by M.S. Pritchard at the International Conference on Ethics in Engineering and Computer Science, Case Western Reserve University, Cleveland, Ohio.
<http://onlineethics.org/essays/education/pritchard.html>

Discusses accreditation requirements for engineering programs, including helping students acquire "an understanding of the ethical characteristics of the engineering profession and practice," and provides a context for linking a service-learning experience to the curriculum to meet current accreditation requirements.

Service-Learning in Engineering-- Paper presented by William Oakes, et. al at the ASEE/IEEE 2002 Frontiers in Education Conference.
http://epics.ecn.purdue.edu/papers/FIE_2002_service_learning.pdf

The paper provides an overview of a panel discussion on several successful models of service-learning in engineering education, benefits and outcomes of service-learning in engineering, and how service-learning fits within the context of undergraduate engineering education.

Service Learning: Engineering, Construction Science and the Experiential Curriculum.
Paper presented by J.W. Martin and M.E Haque at the ASEE/IEEE 2001 Frontiers in Education Conference.
<http://fie.engrng.pitt.edu/fie2001/papers/1028.pdf>

This paper examines the status of service-learning in the construction science curriculum at Texas A&M University and proposes a service-learning project for students in the construction science curriculum.

Service-Learning in Introduction to Engineering at the University of San Diego: First Lessons. Paper presented by S. Lord at the ASEE/IEEE 1999 Frontiers in Education Conference.
<http://fie.engrng.pitt.edu/fie99/papers/1212.pdf>

Describes a project in which first year engineering students worked with 6th grade students at a local middle school. Reports on the project outcomes for engineering students, 6th grade students, and the faculty member's reflections on the experience.

Print Resources

Duffy, J.J. (1998) "Using Service-Learning to Promote Solar Learning," *Annual National Solar Conference Proceedings*, American Solar Energy Society.

Provides an example of a service-learning experience used to teach about solar design in an engineering course.

Jamieson, L.H. (2002) *Service learning in computer science and engineering*. SIGCSE Bulletin (Association for Computing Machinery, Special Interest Group on Computer Science Education), p 133-134.

Abstract: Attention is increasing on the need to educate students in areas that extend beyond the traditional technical basis for their field: The Kellogg Commission's mandate for a "scholarship of engagement" 3; the Engineering Deans Council report's emphasis on teamwork, communication, and the need for students to "understand the economic, social, environmental and international context of their professional activities" 2; the CSAB Criteria 2000 requirements in written and oral communication and "coverage of social and ethical implications of computing" 1; the growth of broad IT programs and schools. Service learning offers the opportunity to broaden the educational experience by engaging students in "real-world" projects. However, it also poses new questions: Should students earn academic credit for courses in which a significant portion of their time is spent on "soft" skills? Are students gaining valid technical experience on projects defined by an outside customer rather than by CS and E faculty? How can curriculum structures support projects that aren't constructed to fit within semester boundaries? The panel includes faculty and students from service learning programs, the chief technical officer for a software company, and a community "customer."

Lima, M.B., Oakes, W. (2004). *Service-Learning: Engineering In Your Community*. Great Lakes Press, Wildwood, MO.

This new Service-Learning textbook helps faculty "link design methodology and engineering analysis with an understanding of the way engineering principles can be applied to benefit society in tangible, practical ways. Teaming skills, project management, communications, and ethical considerations also play an integral role in the process."

Linos, P.K., Bailey-Kellogg, C. (2003). *Service Learning in Software Engineering and Maintenance*. Conference on Software Maintenance, Institute of Electrical and Electronics Engineers Inc. p 336.

Describes an EPICS program that focuses on computer science and software engineering and maintenance.

Piket-May, M., Avery, J. (2001) *Service learning first year design retention results*. Proceedings - Frontiers in Education Conference, Institute of Electrical and Electronics Engineers, v 2, p F3C/19-F3C/22.

Abstract: The College of Engineering and Applied Science at the University of Colorado at Boulder has operated a first-year engineering design course for six years now. The course is required in some curricula in the college, recommended in others, and accepted for credit by all departments. The course stresses teamwork and design, culminating in a 7-9 week team design project. The projects vary with instructor, and usually each of the 4-5 teams per class works on a different project. This paper will first discuss the service learning sections of the course. The paper will then discuss the results of statistical analysis regarding retention and major selection between students who took the first year design course compared with those who did not. We now have six years of experience with the course so we will present data from entry to graduation for the students who entered in the first two years. In addition we have included preliminary statistics to study the effect of using service learning projects as a part of the first year design experience. We will encourage the audience to make this an interactive oral presentation, and work with participants to help identify service learning possibilities in their environment.

Saha, S. (2003). *Service Learning Experience: Design of Devices to Aid Children with Disabilities*.

Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, Institute of Electrical and Electronics Engineers, Inc. v 4, p 3469-3470
Service learning programs in Engineering Education are discussed in terms of how they meet educational and cognitive goals for students. These programs play a critical role in teaching students to conduct experiments, design a system, function on multi-disciplinary teams and broaden education necessary to understand the impact of engineering.

Smith-Ritter, K. (1998). *When Community Enters the Equation: Enhancing Science, Mathematics and Engineering Education through Service-Learning*. Campus Compact, Providence, R.I. (72).

This anthology includes essays related to service-learning in the sciences, including why service-learning is an effective teaching methodology and strategies for incorporating service-learning into course content.

Tsang, E. (Ed.). (2000). *Projects that matter: Concepts and models for service-learning in engineering (Vol. 14)*. Washington, D.C.: American Association for Higher Education.

This edited volume on service-learning in engineering education is part of the American Association for Higher Education series on service-learning in the disciplines. Chapters

focus on the theoretical basis for service-learning in engineering education, course and program models in engineering, and resources for engineering faculty.

Tsang, E., Newman, E.J. (1998) *Service-Learning's effect on engineering students and K-12 teacher partnership in an 'Introduction to Mechanical Engineering' course*. Proceedings - Frontiers in Education Conference, Institute of Electrical and Electronics Engineers, Inc., v 3, p 1279-1282.

Abstract: This paper describes the engineering student and K-12 teacher partnership and impact on student learning from the four elements of Service-Learning: identify community need and form partnership; design and implement solution; evaluation; and reflection. Service-Learning is a method in which students learn and develop through active participation in thoughtfully organized activities that are integrated into and enhance academic learning for students while meeting a community need. Results based on evaluation of 83 students and 44 teacher partners over a two-year period indicate that the partnership in ME 125, 'Introduction to Mechanical Engineering,' has a positive impact on meeting the engineering education needs for a majority of students as well as meeting a community educational need for a majority of the teacher partners.

Zitomer, D.H., Johnson, P. (2003). *International Service Learning in Environmental Engineering World Water and Environmental Resources Congress*, American Society of Civil Engineers p 1917-1924.

Published Abstract: Educational experiences that relate social and technical subjects offer students the opportunity to reflect on the broad significance of environmental engineering. Although it is often difficult to join social and technical subjects in a classroom setting, the link may be more easily made through service learning projects in which students use classroom knowledge and hands-on service to implement solutions for a given community. As an example, a senior civil and environmental engineering student project to design a sanitary sewer for an in-need community in San Benito, Guatemala, is described. Students traveled to the site, performed a land survey, and gathered other design data while also learning about Guatemalan history and culture. The students apply knowledge from required courses and the humanities/social science class "Latin American Health, Infrastructure, and Environment" to arrive at an appropriate final design. The international design project is described as an approach to increase student appreciation of the engineering profession and support educational goals, such as increased understanding of engineering solutions in a societal context, and the ability to function on a multidisciplinary team.