

Academic Support for Engineers Without Borders–USA Student Chapters: The Lafayette College Experience

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Abstract

The Lafayette College chapter of Engineers Without Borders–USA (EWB–LC) is a multidisciplinary service-learning organization focused on sustainable water distribution and sanitation infrastructure development in rural Honduras. Its mission is to create sustainable, community-oriented solutions to meet the needs of the communities and, secondarily, to train students to be globally and environmentally aware professionals. Because EWB–LC is organized at Lafayette as a student club, it predominately operates outside of the academic programs of Lafayette’s Division of Engineering. In addition, EWB–USA policies regarding the mentoring of student work have evolved considerably since 2003, becoming more rigorous but also more restrictive. For example, EWB–USA requires student chapters to have at least one professional mentor with direct professional experience who participates in both the design and implementation of project work. Because not all faculty advisors are qualified to serve as the professional mentors or willing to travel on implementation trips, chapters must rely on non-college-affiliated professional mentors. This creates challenges in both supporting and assessing the service learning occurring. This paper describes those difficulties and recent efforts to formalize the academic aspects of the program at Lafayette College.

Introduction

Engineers Without Borders–USA (EWB–USA) was founded in 2002 by Dr. Bernard Amadei, a Professor in the Department of Civil, Environmental, and Architectural Engineering at the University of Colorado at Boulder. Its mission is to support “community-driven development programs worldwide through the design and implementation of sustainable engineering projects, while fostering responsible leadership”.¹ Since its inception, EWB–USA has grown to over 12,000 members, organized into 250 student and professional chapters, who work on 350 projects in over 45 developing countries.² The projects are completed in collaboration with the local communities and nongovernmental organizations, and include water sanitation and distribution, renewable energy, and other sustainable infrastructure.

The project work completed by EWB–USA student chapters has been described in detail by many others.³⁻¹⁰ We will briefly describe the history, organization, and funding of the Lafayette College chapter of EWB–USA (hereafter abbreviated EWB–LC) before discussing the broader issue of professional mentoring and academic support faced by all student chapters.

EWB–LC was founded in 2003 by two civil engineering students with the support of Prof. David Brandes and Prof. Sharon Jones of the Department of Civil and Environmental Engineering. It is organized on campus as a student club, and is not directly supported by any of the engineering departments within Lafayette’s Division of Engineering. Currently, there are approximately 40 to 50 student members of EWB–LC of all academic years, led by a leadership board (president, vice president, etc.) of 9 students. While a majority of the students are majoring in one of the engineering disciplines offered at Lafayette College (which include chemical engineering, civil & environmental engineering, electrical & computer engineering, mechanical engineering, and engineering studies), students of other majors (such as government & law, economics, Spanish, policy studies) also participate.

EWB–LC focuses its efforts on sustainable water sanitation and distribution systems for small (populations of 100 to 200 residents), rural communities in Yoro district of Honduras. From 2004 to 2006, the chapter installed its first a gravity-driven water distribution system in the village of Lagunitas. From 2006 to 2009, the chapter installed a gravity-driven, potable (slow sand filtered) and non-potable dual-pipeline water distribution in the village of La Fortuna. Since 2007, it has also been working in the village of El Convento to assess and design a gravity-driven, single-pipeline potable water distribution system, which will be implemented beginning in 2010. Each system required one or two assessment trips to assess the physical and social resources of the communities and to gather technical information, such as sources of water and pollutants and surveying data. After completing the major design work at Lafayette, the systems were implemented over two to three years by a joint effort of Lafayette students and the community members, with teams of students traveling two to three times per year. Critically important in this process is the input and participation of the community in design and construction (overseen by a local construction manager hired by EWB–LC) both during and between implementation trips. In addition, students conduct educational workshops for the community members on the need for source protection, water conservation, and long-term maintenance of the system.

On average, EWB–LC spends approximately \$25,000 per year on its activities, with a majority of the expenses being construction materials, travel for implementation trips and EWB–USA conferences, and on-campus activities (such as monthly workshops in which students train each other on surveying, WaterCAD, and other technical skills necessary for the current project work). As a student organization, the only financial support EWB–LC receives from Lafayette College is its annual allocation from Student Government, which for the 2009–2010 academic year was approximately \$9,000. The other most significant sources of financial support has been grants through EWB–USA and the Environmental Protection Agency, from corporate donations such as Air Products and Chemicals, Inc., from local charities such as the Easton Rotary Club, and from generous alumni.

Faculty Advising and Professional Mentoring of EWB–USA Student Chapters

Each student chapter is required to have a faculty advisor who is the main point of contact with EWB–USA and who is “responsible for overseeing the chapter projects and chapter members”.¹ Currently, Prof. Joshua Smith of the Department of Mechanical Engineering, serves as the

primary faculty advisor to EWB–LC, while Prof. Brandes serves as the primary technical advisor to the chapter.

EWB–USA also requires a professional mentor who “provides technical expertise to a student program from design through implementation”.¹ This professional mentor may be the faculty advisor or another faculty member, but may also be a practicing engineer not directly affiliated with the college or university.

The following work outlines the requirements of EWB–USA for professional mentoring of student chapters. We then describe reasons for which the faculty advisors may not serve as the professional mentors. Finally, we explore the challenges in supporting EWB activities, especially for those chapters for which the professional mentor is not a member of the faculty, and provide information about how we plan to enhance our ability to support and assess student learning through EWB–USA in the future.

Professional Mentoring Policies of EWB–USA

EWB–USA policies regarding the mentoring of student work have evolved considerably since 2003, seemingly becoming more rigorous but also more restrictive. Currently, depending upon the complexity of the project work, which is defined based on the impact of the failure of the project component, a professional mentor is required to have between three and seven years of “direct professional experience in design and construction of infrastructure similar to that proposed in the project”.¹¹ For projects, such as buildings or bridges, whose failure would have to potential to result in death, severe illness, injury, or significant damage of property, the professional mentor is also required to be licensed. It is the responsibility of the student chapters to find professional mentors to meet the needs of their project, but EWB–USA requires potential professional mentors to submit their résumés for review by the EWB–USA project manager assigned to oversee the project. As this requirement of direct professional experience for professional mentors is relatively new, it is not clear whether there are any acceptable alternatives.

The responsibilities of the professional mentor include:¹²

1. Project design. Specifically, “EWB–USA requires that you sign off on all designs prior to implementing the project in the field.”
2. Compliance. The professional mentor is “responsible for making sure the project goes through all the design reviews. You are also responsible for ensuring that all EWB–USA paper work has been submitted to EWB–USA on time and that all project design reviews have been completed and revisions made to the design prior to making any travel arrangements or implementing the design. You are required to travel with the team to assess and implement the project.”
3. Student learning. The professional mentor is “there to guide the project and teach the students ... to help the students learn these necessary skills by doing such things as

arranging for training, teaching them yourself, or by asking other professional members of EWB–USA to help with the project.”

Note that professional mentors must be involved with assessment and implementation trips, which for our chapter have occurred at least twice per year, for typically two weeks per trip. However, different professional mentors may be associated with different components of the same project, so one professional mentor need not be responsible for every assessment and implementation trip.

Because of the requirements for direct professional experience and the time commitment associated with travel, not all faculty advisors are qualified or willing to serve as professional mentors. In this case, the chapters must rely more heavily on non-college-affiliated professional mentors than upon their faculty advisors or other interested faculty. While this may provide the students with access to real-world experience than their faculty may be able to provide, it also means that the student chapter may be predominately operating outside of the academic programs of the school. This creates challenges in both supporting and assessing the student learning occurring, as described in the following section.

Academic Support for EWB–USA Student Chapters

In addition to faculty involvement with EWB–USA student chapters outside of the classroom, colleges and universities may choose to support chapter activities and student learning through courses tailored to issues of sustainability and infrastructure development in developing countries. In general, such support will fall within a spectrum ranging from no courses whatsoever to minors or tracks within majors dedicated to such knowledge. In what follows, we discuss three such possibilities and the advantages and disadvantages of each model.

No course support

For student chapters for which the faculty advisor serves as the professional mentor, the advisor must take responsibility for educating the students on the technical and non-technical knowledge necessary for the success of the project. In this case, the advisor has the ability to assess student learning, if he or she deems such assessment to be important. However, for student chapters for which the faculty advisor does not serve as the professional mentor, the responsibility for student learning falls then to the external mentor who has joined the chapter. Without existing courses or developing courses to teach appropriate material, this outsourcing of educating the students greatly diminishes, if not eliminates, the school’s ability to monitor, control, or assess the learning. However, in this case, since students participate in their EWB–USA student chapter solely as an extracurricular activity, such assessment may be unnecessary.

Ancillary course support

Whether or not the faculty advisor serves as the professional mentor, required or elective courses within a department of civil and/or environmental engineering, or other engineering departments, may include teaching of surveying, water system analysis and design, sanitation systems, structural design (such as for reinforced concrete water storage tanks), and other relevant

technical topics and include discussions on issues of sustainability. In this case, students of those departments may be exposed to issues that are directly pertinent to their EWB activities. However, EWB–USA promotes multidisciplinary systems approaches to projects, and student chapters are often composed of students whose majors are often non-civil engineering disciplines and, sometimes, not even engineering. These students are less likely to have direct classroom exposure to important technical skills and to concepts on sustainable development. While these students may be exposed to such concepts through their activities with the student chapter, it is often by peer education and the quality control of such teaching may be questionable.

Direct course support

Some colleges and universities currently have courses directed toward international environmentally-friendly or sustainable development at the freshman, sophomore, junior, and/or senior levels.¹³⁻²⁰ Some courses are even tied to EWB projects.^{5,10,21-24} These courses serve as a concrete way in which specific learning objectives are attained and can be assessed. Unfortunately, as described above, these courses may not be appropriate for the range of majors of students who participate in EWB activities. Furthermore, students often participate in EWB activities for multiple semesters, with some students joining EWB–LC as freshman and participating extensively during each of their four years on campus. If EWB project-design work is predominately relegated to these courses, it has the potential to create disinterest in the chapter activities for those students who are not enrolled in the courses. Most importantly, this option may be inconsistent with or in violation of EWB–USA’s policies if the instructor of the course is not serving as the professional mentor for the in-country trips during which the designs are implemented.

Academic Support for EWB at Lafayette College

While these three models described in the previous section do not comprehensively present the ways colleges and university support EWB–USA student chapters, they serve to illustrate the range of such support and to describe what we believe to be advantages and disadvantages of each. In this section, we describe existing academic support for EWB–LC and our considerations for future course development.

Current course support

There are no regularly scheduled courses that directly support EWB–LC student activities. However, one course, EGRS 480: Sustainable Solutions, is offered on an ad hoc basis when the chapter requests the course to be offered and when it can be staffed. Its course catalog description is:²⁵

Sustainable solutions developed for a complex, real-world project by small groups of multidisciplinary students directed by a faculty advisor, or team of faculty advisors. All projects include significant technical and non-technical challenges, and do not have a well-defined solution procedure.

This course has served to engage students broadly on the issues of sustainability. It was also used to develop the community-oriented framework for sustainable infrastructure and development that EWB–LC uses for its project work, and also to do design work for the community of Lagunitas and to develop feasibility studies of design solutions from which the community of El Convento choose the design it would liked implemented.²⁶ Unfortunately, our current staffing resources are not sufficient to offer the course on a yearly basis, and it was last offered on behalf of EWB–LC in Fall 2007 using adjunct instructors. In addition, since this course is not exclusive to EWB chapter members, students not affiliated with EWB–LC are sometimes more intimately involved with project work, which has created some resentment from those students who wish to be involved but, for whatever reason, could not enroll in the course.

Detailed design work can be supported through 300-level independent study courses. This approach was taken in Spring 2009 when the authors were joined by two colleagues to supervise four sophomore and junior civil engineering students on their designs for the system in El Convento. While this was a beneficial experience for the four students involved, it is not suitable as a long-term model for how project design work should be conducted by the chapter. First, the faculty members taught the course out-of-load and received no compensation for their time. Second, while one of the four faculty members did plan to supervise the implementation trip in August 2009 for the component of the system he oversaw, the other three independent study advisors were overseeing design work for which they did not intend to supervise during the associated implementation trips. This is in conflict with EWB–USA’s policies on professional mentoring, and may led to design work having to be reviewed and redone under the supervision of the professional mentors who will lead those implementation trips, solely to satisfy EWB–USA’s requirement that the mentors be involved in both design and implementation.

Lafayette also offers a sophomore-level course VAST 203: Sustainability of Built Systems that serves as a non-technical introduction to sustainable development. Its course catalog description is:²⁵

This interdisciplinary seminar introduces students to a process for evaluating the sustainability of built systems in both the industrialized and developing worlds. The course addresses the historical, moral, and ethical foundations for the current sustainability movement as well as frameworks that can be used to determine the economic, environmental, and social-equity components of sustainability across the life-cycle of built systems. Throughout the course, we highlight large-scale examples of sustainable built systems.

While this course is open to all majors, unfortunately it does not necessarily fulfill the associated course requirement for some departments. Furthermore, it considers issues of sustainability that are not pertinent to the developing world, and does not go into great technical detail on some issues that are more pertinent.

While these two courses would fulfill certain educational objectives related to EWB activities, they are inadequate for several reasons. First, student members of EWB–LC are not required to take either of these courses. Second, while the courses include discussion of some important issues, they do not include all topics relevant to the current EWB project work. Third, students

can only take these courses once, and therefore are still doing significant learning for the, up to, six semesters in which they participate in EWB activities but are not enrolled in these courses.

Proposed course support

We have found the need for a course specifically directed toward those students who desire to be actively involved with EWB–LC’s sustainable development projects in Honduras. We have a proposal before the faculty for a 0.5-credit practicum course (each course at Lafayette College counts 1 credit). Its proposed course catalog description is:

This 0.5-credit course is available to students actively participating in either the management of or the development of technical or socio-cultural solutions for Engineers Without Borders service-learning projects. For the former, students should be members of the leadership board and participate in weekly board meetings and other EWB activities. For the latter, significant work on a technical or socio-cultural project must be completed. This course may be repeated up to four times for credit.

This practicum course is intended for those students who are most dedicated to EWB–LC activities, either in the development of technical designs, socio-cultural solutions, or the management of the project or the Chapter. Our goal is to formalize instruction by including the faculty advisor directly within the educational process with specific learning objectives. Furthermore, because of the importance of the project work being undertaken which affects the lives and livelihood of the community members, we believe having students earn course credit will help ensure that they make regular progress on project work with appropriate oversight.

While the course may be appropriate preparation for those students who will travel on an implementation trip, student travelers are chosen by the student leadership board, not by the faculty advisors, based on a variety of factors, such as participation in on-campus EWB-LC activities, involvement with or knowledge of the design of the project component to be implemented, and Spanish language skills. Participation or non-participation in the course may influence the student leaders’ decisions, but we expect only as so far as those students would be the ones most involved and familiar with the project.

It could be argued that this proposed course illustrates the need for a 200-level independent study course (similar to the current 300-level independent study courses that are offered on an ad hoc basis). With independent study courses, the instructor and the student establish learning objectives on a case-by-case basis. In contrast, the proposed course catalog description provides explicit objectives, which are expanded upon in the proposed syllabus. For example, these objectives include the ability to

- Explain issues of public health in developing communities and the role of development works and engineers in developing solutions.
- Explain issues of sustainability in infrastructure development in developing countries.

In addition, the objectives include specific deliverable products:

- Develop project schedules, cost estimates, proposals, communication aids, and other associated project management materials for the overall project (management track).
- Develop a complete, detailed plan for the chosen solution (technical and socio-cultural tracks).

Since students usually participate in EWB projects across semesters, it is important that students can enroll in this practicum multiple times to continue the learning experience. Consistent with students being able to take 0.25-credit, 100-level music ensemble courses up to 8 times for a total of 2 credits toward their graduation, it is proposed that students be able to take this 0.5-credit course up to 4 times, for a total of 2 credits (note, this is still being negotiated with the College's curriculum committee and may be reduced to 2 times, for a total of 1 credit). However, students would need to have different technical, socio-cultural, or management focuses in order to repeat the course.

Relationship between Professional Mentoring and Academic Support of EWB at Lafayette College

We, the faculty advisors of EWB–LC, are not always qualified technically or available to oversee all aspects of project design and implementation. This has led us to seek non-college-affiliated professional engineers who are willing to do so. However, this has created challenges for us and other interested faculty members in supporting the students' design efforts. It is our hope that the introduction of the 0.5-credit EWB practicum course described above will allow us to retain some involvement in the design work that will need to be mostly overseen by the professional mentor in order to satisfy EWB–USA's requirements. Furthermore, by awarding course credit for activities that have thus far been purely voluntary, we anticipate being able to increase the quality and timeliness of that work, and to develop more formal mechanisms for student evaluation and outcomes assessment.

While the independent design work completed by the four civil engineering students (described above in the section *Current course support*) was a very rewarding experience for the students and resulted in well developed designs for several of the components of the water treatment and distribution system, we do not anticipate being able to offer such a thorough experience in the future without conflicting with EWB–USA's professional mentoring requirements. It may be possible to have students conduct preliminary designs in independent study courses, with the final designs being supervised by the professional mentors who will supervise implementation of the designs. However, such an arrangement may compromise both the design process and the academic experience for the students.

Conclusion

Engineers Without Borders–USA provides students with a wonderful opportunity to learn first-hand about sustainability, to participate in community-oriented design, and to implement those designs in country. Because of the significance of the project work being undertaken that affects the lives and livelihood of the community members, EWB–USA has developed rigorous requirements for professional mentors, who are tasked with the responsibility to oversee both the design and implementation of the projects. At the same time, colleges and universities have or

may be interested in developing courses that, directly or indirectly, support EWB activities. However, if the instructors of those courses do not supervise the implementation of the designs developed during their courses, they will be creating a situation in which EWB–USA’s policies are being violated. At Lafayette College, we are faced with this challenge and are proposing an independent study course to award credit for the learning students do during their EWB activities, but also to maintain oversight as more design work is conducted under non-college-affiliated professional mentors.

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