

Program Case Study: Aquaculture Development to Address Nutritional and Economic Needs in the Central Plateau of Haiti

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Abstract

This paper describes a case study of an effective interdisciplinary international humanitarian development project, including project goals, the setting within which it takes place, and project progress. The goal of this student-led research project is to identify key constraints to increasing tilapia production in Haitian aquaculture systems and develop solutions to address these constraints. The research team is working to combine engineering principles, agricultural expertise, and economic analysis to develop a feasible solution for a specific region of rural Haiti. The paper discusses the benefits of engaging diverse disciplinary backgrounds and how insights of economic development and social resilience help students consider the relevance of their applications in context. Likewise, the technical knowledge gained through engineering perspectives gives a concrete approach to more abstract social challenges. By routinely presenting the project to varied audiences, the student team has learned to effectively plan, compose, and integrate verbal, written, and graphical communication. This interdisciplinary partnership has pushed students to develop their own expertise, communicate and collaborate more effectively with peers, faculty, and stakeholders, and critically evaluate their research in a fuller context.

Keywords

Education, Project Management, Experiential Learning, Interdisciplinary, Professional Development

Program Structure and Goals

At Clemson University, there has been a school wide push for students to engage in experiential learning to supplement their classroom studies. As a result of this initiative, the Clemson University program, which allows students to engage in undergraduate research for classroom credit, was founded in 2005. As an outcome of this initiative, as well as a few motivated students, Clemson Engineers for Developing Countries (CEDC) was formed in 2009. CEDC's mission is to work with local communities in the Central Plateau of Haiti to develop sustainable solutions that improve the quality of life through interdisciplinary student-led initiatives². In so doing, students have the opportunity to apply the knowledge they gain in the classroom to real-world problems in a corporate-structured environment.

Perhaps the most defining aspect of CEDC is its commitment to making an impact on the developing world. Implementing projects in developing countries brings about an abundance of complexities and nuances that students would not be exposed to through their standard coursework. The opportunity to think critically about not only the theoretical design aspect of a solution, but the logistics of its construction and completion is a rare opportunity for an undergraduate student. Beyond the engineering obstacles that accompany project work in developing countries, social, economic, and ethical issues arise as well. When developing

solutions, students must consider both the direct and indirect implications of their solution to ensure that the problems facing the developing communities are not compounded or exacerbated. Similarly, students must consider the long-term sustainability of their solutions. CEDC aims to empower the locals in developing communities rather than simply providing for them. In order to accomplish these goals, students maintain regular communication with locals through the CEDC interns. CEDC interns are a group of two to four students that spend 7-12-month periods on the ground in Haiti, living and working alongside the local community. The interns provide an avenue for project groups like the aquaculture team to ensure that their work aligns with the needs of the people. Furthermore, interns help communities prepare for the implementation of projects, giving them the proper training to maintain the solution upon its completion.

CEDC's motto reads, "Serving the Developing World. Developing those who serve."³ Not only is CEDC committed to implementing projects in the developing world, it seeks to prepare students for their professional life. Throughout each semester, CEDC requires its students to fulfill several professional assignments in order to meet this objective. Students are required to update the class on their projects through formal presentations, collaborate with industry and academic partners, and attend conferences across the region. Furthermore, CEDC is structured such that it models a traditional corporate organizational structure. From project members and project managers, to the program and faculty directors, CEDC has a clear organizational structure. Students have the ability to take the associated CEDC class every semester during their four-year undergraduate experience, allowing them to work their way up the chain of command as they gain experience within the organization. After developing specific project-related skills as a project team member, students can develop leadership and management skills as they take on new roles.

Research, Partnerships, and Interdisciplinary Cooperation

At project initiation, the aquaculture group was tasked with identifying solutions to enable Haitian farmers to increase their tilapia production. This challenge presented itself when local aquaculture farmers in the Central Plateau of Haiti expressed a desire to expand their operations. Through analysis of background research and interviews with the local fish farmers in the region, the group determined that the simplest and most effective means of intervention will be through access to fish food. Sourcing manufactured fish food can be unreliable and expensive, as most of it is being imported from the United States. Plant-based food is a viable alternative that some farmers have tested, but the results have been mixed, as there are a variety of variables that need to be refined, primarily related to availability of materials, ensuring an adequate nutritional profile, and what mix of components will most effectively increase the growth of tilapia. This group is currently working to develop a fish food mix, setting up an experiment to test feed mixes, and determining the best system for fish food production and use to increase production in aquaculture farms.

Students in the project have represented a variety of disciplines, including industrial engineering, biomedical sciences, economics, and anthropology. The focus on multidisciplinary approaches has not been confined within the university, and the team has discussed future partnership with Haitian organizations. The emphasis on cross-disciplinary collaboration has been critical for the progression of the project, as well as the development of the students.

Particularly with regards to the economic aspects of the project, students have been successful at engaging others outside of CEDC. Early in the project, the team explored their project through an economic perspective through an initiative with the Hayek Center for the Business of Prosperity in Clemson University's College of Business. The HERO competition, which was focused on projects that had economic and social impact, had extensive opportunities to develop their economic focus on the project. The students critically evaluated their projects through written proposals, interviews with the Economics student directors and with challenging economic-oriented critical-thinking problems. Later, the competing teams were brought together in a larger workshop where they were able to hear from Economics faculty, industry partners, and department heads. They also had round table meetings with economics doctoral students to discuss different factors in their projects and to gain new insights. The teams also practiced professional development, particularly in presenting their projects in the form of elevator pitches. Lastly, the teams had a final meeting where the teams each gave a final presentation of their project, this time considering the perspectives they gained from their experiences through the program. There was a heavy emphasis on the consideration of the cultural and social contexts of the regions of operation and making sure that the solution that makes sense in the US is applicable in the Central Plateau of Haiti.

The team has also collaborated extensively with the College of Agriculture, Forestry, and Life Sciences at Clemson University. Initially, this was through discussions with a faculty member specializing in aquaculture, who has extensive experience in tilapia farming. The faculty member has tilapia in recirculating tanks and has experience with mentorship in undergraduate research through Clemson University's program. The students spent multiple days with the faculty member and with the tilapia, learning about their behavior, how to weigh and feed the fish, housing and tank setup, and general experimental design especially relating to feeding trials. Currently, the students are working with faculty at the on-campus Aquatic Animal Research Laboratory who have extensive experience in conducting experiments and have been supportive in the growth of the students and helping them foster independence.

Within the Central Plateau, and not far from the host community, an agricultural school, Centre de Formation Fritz Lafontant (CFFL), trains Haitians in sustainable agricultural practices. The CEDC aquaculture team have been working to establish a long-term partnership on the ground through CFFL. The aquaculture team is currently in discussions with the director of the agriculture program at CFFL, over the potential for use of agricultural byproducts, especially from peanut production, in the use of tilapia feed. CFFL is currently installing an aquaculture pond, and the team anticipates future collaboration and experimentation initiatives.

Broader Program Impacts

As an interdisciplinary, yet engineering-centric organization, CEDC, and particularly the aquaculture team, has an exceptionally large proportion of women. This is demonstrated by the 50% representation of females as group members within aquaculture. Additionally, for the three semesters that the aquaculture team has been in place, the project management directors have all been female. Of the 19 leadership positions within the CEDC organizational structure in Spring 2019, 57.9% were filled by females. In a field where females make up just 14% of the engineering workforce⁴, CEDC has created a space where females are encouraged to pursue leadership roles.

Being that CEDC is an undergraduate research organization, CEDC is open to all students from freshmen to seniors. From their very first day on campus, students can engage in experiential learning and design in CEDC. As students begin to get more involved with their projects and see the direct applicability of their studies, they begin to gain a deeper understanding and appreciation for the field of engineering. The students build comradery amongst their team and the organization, and better recognize the value of interdisciplinary collaboration.

References

- 1 "About Creative Inquiry." CEDC Creative Inquiry, Clemson University www.clemson.edu/centers-institutes/watt/creative-inquiry/about/.
- 2 Bargar, Dylan & Gordon, Aaron & Plumblee, Jeffery & Ogle, Jennifer & Dancz, Claire & Vaughn, David (2016). Increasing Student Development Through Multi-Level Immersive Learning: CEDC Case Study. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*. 11. 55-71. 10.24908/ijlse.v11i2.6395.
- 3 "Serving the Developing World. Developing Those Who Serve." CEDC, 24 Mar. 2019, cecas.clemson.edu/cedc/.
- 4 "Women in Architecture and Engineering Occupations in 2016." *U.S. Bureau of Labor Statistics*, U.S. Bureau of Labor Statistics, 10 Mar. 2017, www.bls.gov/opub/ted/2017/women-in-architecture-and-engineering-occupations-in-2016.htm.

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David Vaughn is a Professor of Practice at Clemson University and has a dual appointment as the Director of Clemson Engineers for Developing Countries (CEDC) and Director of Global Engagement for the Risk Engineering and System Analytics Center. He has 27 years of Industry experience, is a former Fluor Fellow, and served on numerous national / local committees.