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Service Learning for Community Engagement: An Interdisciplinary Approach for Engineering Education

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Abstract

Interdisciplinary teams of undergraduate students and faculty from different disciplines including civil, electrical, mechanical and chemical engineering as well as biology, business administration, chemistry, and social sciences has been working in communities in Puerto Rico since 2003 as part of an effort from the University of Puerto Rico at Mayagüez to engage into those communities with an innovative educational approach in service learning. The application of service learning in real world scenarios is guided through the use of the participative action research methodology that has been taught by the University Institute for Community Development. This methodology has been complemented with the engineering skills taught in undergraduate courses. Interdisciplinary teams are created to evaluate infrastructure as well as social and environmental conditions for the development and implementation of practical and feasible solutions to the needs of low-income citizens. The engineering students were also motivated in community service through the Engineering Projects in Community Service (EPICS) program. This paper describes the academic as well as the administrative structure developed by the faculty and students from the University Institute for Community Development and EPICS to accomplish interdisciplinary engineering education at the University of Puerto Rico at Mayagüez (UPRM). In addition, several types of projects are described to illustrate the extend of the approach and the challenges that interdisciplinary participants, both faculty and students, faced to achieve service teaching and learning.

Keywords
Engineering Education, Service Learning

1. Introduction

Engineering curriculum is facing new challenges due to the need for effective interaction with other professionals and the end users during design development. Accreditation boards are also including requirements for measuring the effectiveness of the education through outcome-based systems that requires more interaction between the university and the community. In addition, there is a great interest in focusing the academic activity into more realistic scenarios where students can learn in an environment beyond the university boundaries (Dahir, 1993).

For years the University of Puerto Rico has fulfilled many social needs including the development of a professional group of citizens. In addition, the university promotes and contributes with the formation of researchers that find jobs in highly competitive and global companies and organizations developing new technologies and creating new knowledge for products and engineering systems. The university has also contributed in the development of creative art and science throughout internal activities focusing mostly in the university community. However, sometimes the university activities of teaching, research and creative undertakings do not respond to the fundamental needs of the majority of our people. We often ignore the social environment of poverty and the lack of attention to the surrounding communities where the university is only simply a small piece.

In respond to those challenges the University of Puerto Rico has adopted a new strategic plan that applies to all of their units and colleges, including the College of Engineering, where one of the main parameters stands for "leadership in community investment and cultural initiatives" (Oficina del Presidente, 2005). However, that general goal can only be fulfilled by the creation of academic structures that interact directly with the students, the faculty, the administrative staff and the people at the communities.

In 2003 two programs were started and merged to create a unique academic structure that fulfilled the challenge of a strong leadership in community development. One of the programs was created by the faculty in the College of Arts and Science and mature as an institutional program known today as the University Institute for Community Development (UICD). The other program was the insertion of the University of Puerto Rico at Mayagüez into the National Engineering Projects in Community Service (EPICS) Program. EPICS was initiated in Purdue University in 1995 to develop a highly effective service learning environment for undergraduate engineering students (Coyle et al., 2005). EPICS is a program in which teams of undergraduate engineering students are designing, building, and deploying real systems to solve engineering-based problems for local community organizations and educational institutions.

From the merge of these two programs, where one was focused on community outreach including resources from the entire institution, and another that focused on design and engineering projects, born an interdisciplinary academic and research structure for undergraduate students that produce community service and real life engineering education. The following sections will describe the scope and the administrative and academic structure of the interdisciplinary approach for engineering education at the University of Puerto Rico at Mayagüez.

2. The University Institute for Community Development (UICD) and the EPICS Program

The University Institute for Community Development (UICD) is an institutional program at the University of Puerto Rico at Mayagüez that implements interdisciplinary projects to strengthen the central formation of the students. The UICD provides real world experiences to the students and the faculty using the participative action research methodology. The institute offers an opportunity to bring the resources of the public university into the communities.

Every semester the UICD makes an effort among the students and the faculty involved in the interdisciplinary projects to understand the purpose and the mission of the institute and to comprehend the scope of the term community.

2.1 The Definition of Community

The word community has different definitions in different context. However, the definitions that are more relevant in the context of interdisciplinary engineering education are the following (Ander –Egg, 1993):

- A group of organized people that see themselves as a social unit
- They share traits, interests, elements, objectives and common functions
- With a sense of belonging
- Situated in a similar geographical and functional context
- Diverse persons that interact more intensely within the group than with other groups

Also, the word *community* includes a strong emotional component that tied together everyone and some have concluded that their members have close relationships of profound emotions and social commitment (Lillo and Roselló, 2001).

Community development may emerge as a different construct from those that engineering students are familiar with. The term *community development* needs to be seen as a process to create the conditions for economic and social progress for the whole community, where active participation of all the persons in the community is important, not just the leaders' appearances and conduct. Engineering students involved in community service may produce a higher confidence in the initiatives of the members of the community and more active participation.

2.2 Purpose of the UICD

The purpose of the UICD is to serve as a link between the university, the community and the existing community outreach programs like the Sea Grant and the Agriculture Extension Service, such that the students can respond better to the social needs of the majority of the country.

The mission of the UICD is focused on four key areas that are:

- Bring the university into the community
- Interchange of ideas and knowledge: scientific knowledge is developed in the university while popular knowledge is developed in the communities
- Critical reflection about our reality

2.3 Institutional Support

The support from the administration of the university has been crucial for the success of the UICD and the EPICS program. Several areas of support can be highlight to show how the UICD has been able to implement an engineering interdisciplinary community service program. First, the Chancellor and his staff provide continuous support to the activities with different resources including release time for a program administrator, funds for activity expenses, office space, and a mini-van vehicle to allow the transportation of students and faculty to communities around the island of Puerto Rico. Also, the Chancellor as well as college's Deans participates in activities with student as well faculty to show commitment and support. The institutional approach for the UICD, instead of a departmental setting, has been the cornerstone to bring together faculty and students from different disciplines around campus to work together with engineering students and faculty.

Another form of support for the UICD is the academic recognition by the Dean of Academic Affairs by creating a variable credit course that can complement an existing course or developed into a three credit hours course fully submerge into community service and participatory action research.

3. Leading Values for Community Service

Community service is guide by moral and social values to respect the cultural and contextual character of the participants. These values are presented to each member of the teams before they visit any community. The values for community service followed at the University of Puerto Rico at Mayagüez are discussed in the following sections.

3.1 Community service has to respond to a legitimate and expressed need

Legitimate needs means those that contribute to the development of a better quality of life for the community once they are satisfied and those that help the community protected their natural environment, their cultural identity, or a human right such as health, safety, education, and productive work. The university should not impose or create their own idea of what the community need or what are the community's problems. Information has to be gathered on needs and expectations and that information should guide the efforts.

3.2 Participants from the university should work together with the community members as a team

The teams should make sure that they contribute to the continuous development of human skills that may appear from different backgrounds and sectors. A team approach is expected from the students and faculty involved in projects and the creation of the teams should include people from different disciplines, with different backgrounds and with the higher potential for contributing positively to the effort.

3.3 Strengthen the community bonding

The strength in the community bonding emerges from democratic participation and promoted by open dialogue among different groups.

3.4 Community service should take into account the well being of vulnerable sectors

Minority groups as well as those that are in disadvantage may include, children, elderly, woman, and disables. These groups should get more attention from the teams compare with others members of the community.

3.5 Community service should promote environmental awareness, conservation and sustainability

The natural and the built environments are an important element of the human' quality of life. They are finite resources and any proposed activity should respond to an efficient use of that resource with a significant reduction on adverse impact.

3.6 Community service should be safe and feasible for continuous improvement

The safety of the community members as well as the well being of the participants should be taken into consideration in all engineering alternatives. Feasibility will assurance continuity and progress.

3.7 The result of the interaction with the community can contribute to the aesthetic of the community

The members of the community as well as the participants must enjoy the use of their senses and their imagination. Any activity within the community should be multi-functional with aesthetic elements from inception.

3.8 Respect the identity of the community members and strengthen the human dignity

Every community service project should become a source of proud for the people involved. The solutions to the problems should take into consideration the scale and tastes of the community if the intention is to create an alternative that might represent them all.

3.9 Community service projects should come to a conclusion

It is important for the community to finish what the participants have started. Open ended projects may create an unwanted lack of thrust. When the community cannot see the end of the journey they become frustrated and unwilling to cooperate in future efforts.

3.10 Community service should insert hope

Hope for a better future, for better conditions, for better quality of life is expected from the efforts. Present and future generations should benefit and take advantage of today's decisions.

4. Curriculum and Operating Structure

The engineering students can register for one, two or three credits in an interdisciplinary course (INTD 3995) no matter what is the department or the area of study. This course can be complementary to an existing engineering course. In this case, the focus of the group project in the existing class is on community service. This structure will allow the student to learn engineering fundamentals and have at the same time a hands on experience in how to implement the methods, techniques and the engineering knowledge. Students will be able to assess the community needs and develop creative and feasible solutions to those expressed needs.

Teams will be created at the beginning of the semester based on the list of communities in the UICD's database. The database is created first as a result of information provided by community leaders that ask for help or communities with defined needs that are identified by other means. One of such means includes the insertion of communities to work with as part an ongoing effort from other organizations like the Pure Water Consortium. This is a non-profit organizations created to support communities with water supply systems that are not connected to the public service and have to satisfy regulatory requirements from US federal and state environmental agencies. In such case, the students from civil, mechanical, electrical, industrial, and chemical engineering work with students from other disciplines like business administration, agricultural, art and sciences to evaluate the existing infrastructure as well as the social and environmental conditions for the development and implementation of practical and feasible solutions to the needs of low-income citizens. The interdisciplinary approach and registration procedure allows the UICD to get full curriculum integration for engineering students.

4.1 Course Requirements

The requirements of the interdisciplinary course are based on the application of the participative action research methodology. This methodology consist of continuous process with the following steps:

- Problem identification
- Systematic information gathering
- Self and team reflection on the obtained information
- Analysis of the information
- Actions based on engineering design and real world judgment
- Evaluation of the actions taken
- Redefinition of the problem and contextual assessment

The intent of the participative action research methodology is to create a collaborative and active process between the community members, the participants from the university and any other stakeholder of the process, including organizations from the private and public sector.

Based on the participative action research methodology the students will follow a methodological guideline (Margoluis and Salafsky, 1998) that consists of a synthesis and the adaptation from other methodologies suitable for community development.

4.2 Methodological Guidelines

The methodological guidelines consist of a group of actions, activities and evaluations tools that the engineering students needs to fulfill during the semester. The guidelines begin with the development of a mission statement from the interdisciplinary team that includes the strategy and the values the team would like to pursue. Then the team will have to develop a conceptual model of the community by visiting and gathering information from the "street". The conceptual model will include the expressed needs and problems from the community. The next step is to develop an action plan with general goals and specific objectives for each goal, a schedule of activities and the evaluation process. The action plan must be followed by the implementation of the plan. Finally, the process should produce a solution to the problem including a process and product evaluation.

The deliverables of the process includes the following:

- The mission statement that includes the values and strategies to follow during the semester
- The conceptual model of the community that is based on the gathering of information from the "street"
- The plan of action, including the goals, objectives, the schedule of activities and the evaluation process
- Evidence of the execution of the plan that includes meetings logs and frequent reflections from the integrated experience with the members of the community
- The final product or solution to the problem based on the information gathered and the application of the engineering judgment combined with the knowledge from the other participants
- Process evaluation to assess the participation of the team members
- An essay that combines all the reflections and the experience in a "before-during-after" format.
- A poster with a summary of the project to share with the university community
- An oral presentation of the project at the workshop at the end of the semester and another presentation to the members of the community to disseminate and transfer the results

4.3 Supporting Activities

Several activities are conducted before, during and after the semester to support the community service activities and the academic tasks.

- First, the faculty is invited several workshops in the previous semester to describe the opportunities and to expand the number of courses involved
- Then the UICD will distribute the information regarding the communities, specific projects needs, and the application forms for registering in the interdisciplinary course

- The students interested in participate will register in the course and participate in a workshop at the beginning of the semester where interdisciplinary groups are created.
- The faculty will participate in several meetings to learn about the participative action research methodology, the methodological guidelines and other related administrative issues.
- The students and the faculty visit the community with the support and the coordination from the UICD, including the use of a vehicle for transportation
- Students will get information from previous semesters from the UICD
- The students participate in the workshop at the end of the semester to disseminate the results
- The faculty get together at the end of the semester to evaluate each project and the interdisciplinary effort
- The faculty will conduct several meetings to evaluate the activities of the semester and to define strategies for future semesters
- Presentations are developed by the UICD staff to show the results of the previous years to the Chancellor and the Deans
- Databases are updated to reflect the most recent effort

5. Types of Projects

The range of projects to involved engineering students on interdisciplinary teams includes, but is not limited to:

- Mentoring program for children
- Health programs
- Cultural and social activities
- Community organization and support
- Infrastructure assessment, analysis and design
- Sport activities
- Technical assistant in the development of water filters, road design and safety and construction management
- Support to elderly and children organizations

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