AC 2007-1535: LEARN AND SERVE – DESIGN PROJECTS FOR THE COMMUNITY

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Learn and Serve - Design Projects for the Community

Introduction

Learning can be engaging and meaningful if the joy of discovery and learning context are incorporated into the instructional method. In this highly competitive business and complex social environment, our approach to teaching must be based on sound pedagogy that helps our students to "uncover" the principles instead of being told of them. Research indicates real learning occurs when learners are immersed in realistic situations in which they are forced to perform, get feedback, take action, and given chances to correct or adjust their responses. There are many ways to simulate such situations using approaches such as scenario-based learning[1-2] and project-based learning. However, the most effective approach for learning is learn-by-doing real projects for real people.

Real projects that can directly benefit communities we live in offer a unique way to *Learn and Serve*. Design for community provides a meaningful context to address real problems in complex settings rather than simplified problems in isolation.

This paper describes how design projects for community provides authentic learning experiences for the students and challenges in implementing such projects as well as the benefits of these projects to the community. The projects described include design of devices for people with developmental disabilities as well as products designed for use in developing countries.

Authentic Learning Experience through Design projects for the Community

In general discussions, engineering educators would agree with the concept of authentic learning experiences and tend to think that a modified version of the traditional project based learning approach would do it all. This may very well be true in some cases, but it is incorrect in general. In order to develop a truly authentic learning experience, the theoretical underpinnings between the two approaches must be clearly understood. Traditional instructional strategies typically link curriculum and teaching methods such that an educator can deliver knowledge to as many students possible within a short period of time.

According to NCREL[3], *this approach assumes that properly managed instruction enables most students to acquire the skills and knowledge needed to continue to learn. Practice and repetition, with frequent tests of recall and recitation, characterize this approach. This approach is the only one that many parents and educators have ever known, and their level of comfort with this model will make it very difficult to supplant.*

Thus the predominant, pedagogical model today is based on a teacher-centered, didactic approach to instruction. This is mostly due to the fact that educators, parents, as well as administrators have never encountered a learning experience in which they constructed meaning from the experience. Learn and serve projects, involving local communities, by its nature provide an authentic learning experience[4].

* Authentic learning strategy invariably involves the learners in activities that deal with a real-life problem.
* Design projects for community involves real people in real time, and therefore, it contains certain elements of drama and dilemma, just like in real world.
* Content knowledge usually is embedded in the situations.
* Clear engineering specifications are usually not given as opposed to class projects or industry based projects. This unstructured environment enables the learners to construct new knowledge using their old knowledge and their interaction with community partners.
* Construction of knowledge is accomplished through the completion of the project.
* Community projects create value beyond the classroom which is an important requirement for authentic learning.
* Community projects are meaningful and fulfilling personally.

By carefully planning using the basic premises of constructivism, design for community can be effectively used to provide authentic learning experiences.

Challenges in Implementing Design projects for the Community

Developing long-term sustainable relationship with the right partners is the key for successful implementation of community based projects. However, finding such partners, developing relationships, and identifying suitable projects are very difficult in reality. We have found that not every community organization is suitable for partnership. Organizations that seem like perfect fit from a pedagogical perspective may not also be the right partners if there are no serious or relevant needs.

Another challenge in developing partnership is the fact that these community organizations are usually unable to clearly define their needs. This is distinctly different from industry-sponsored educational and research projects that engineering schools are used to, where problems are well defined. In addition, the requests from community organizations are often vague and unstructured giving a misleading impression that there may not be a need (engineering) and even if there is one, it probably wouldn't satisfy the educational objectives. Hence, one of the first tasks in implementing design projects for community is to educate the community partners.

The process of identifying partners, cultivating relationships, performing needs analysis, and developing specifications for a product or service itself is an important learning process and it teaches students valuable real-world skills. However, implementing all these tasks along with the product development within reasonable time frame of two or three quarters is very difficult.

Finally, there are risk management issues related to having students in partner sites. Typically most partners are non-profit and can not provide workers compensation insurance. The potential risks embedded in such projects must be carefully assessed before they begin. Otherwise, the embedded liability could restrain the development and frustrate faculty, students and the partners with every potential risk. In some cases, legal advices are needed to ensure that all practices are fully compliant with the law as well as the university requirements.

Current Projects

At Cal Poly Pomona, a broad range of community projects have been identified with the help of partnering organizations. Cal Poly Pomona students will be able to choose from this pool and work with the community partners to develop engineering specifications, design and build prototypes. A brief description of various projects that are currently underway is given below:

Picture Exchange Communication System (PECS):

One of the current projects is the design and development of a portable, Picture Exchange Communication System. PECS is a training package that allows children with autism and other communication deficits to initiate communication. PECS that is currently in use (shown in Fig. 1) is limited and uses static pictures. Pictures are attached to a pad using Velcro. Since every child requires his own PECS, it is difficult for care-providers to manage different PECS for different students and organize all the pictures. A new microprocessor controlled PECS is being currently designed. The proposed design is easy to use and it comes with an LCD display and allows care providers to download personally meaningful pictures for each child onto their PECS.

Fig 1 – Picture Exchange Communication System

Spoon that Doesn't Fall when not Held

Many people with developmental disabilities can not feed themselves due to lack of motor skills. In cases, where there is limited mobility, it is important to encourage them to feed themselves as it engages them and provides some form of activity (exercise). However, it is difficult for them to hold on to their spoons for too long. After a bite or so they usually drop the spoon and the care providers have to pick up the spoon, wash it and hand it back to them. This happens several times during one session and typically there may be as many as fifteen such children to be cared for. Obviously this is a tremendous burden for the care providers and a spoon that doesn't fall when not being held has been designed and a prototype of a proposed solution is shown in Figure 2.

Fig. 2 – Spoon Holder for Developmentally Disabled

Exercise Bicycle for the Developmentally Disabled

Global Awareness Projects

A number of entrepreneurial opportunities are available around the world especially in developing countries that can make serious impact on peoples' life. Identifying and developing these projects must be done in partnership with local and international agencies. After careful consideration and interaction with partners, a number of relevant projects have been identified. One of them is the development of a foot operated water pump.

Foot Operated Water Pump

The objective is to improve upon the current cast-iron style, hand-operated water pump that is used in many developing countries as a primary means to pump well water. While few improvements have been made in the last 200 years to the current design, the goal of this project is to create a more efficient means by which water will be pumped out of the well. The main problem is that in order to use the pump, a heavy lever has to be operated which can become awkward to use and cause fatigue after pumping water for long durations. Because these pumps are used in developing countries, it is imperative to create an efficient pump that is both cost effective and easily distributable across the world. The most important considerations in creating this pump is the ability to easily retrofit current pumps in remote locations, requiring very few tools to install the device, not requiring electrical or other power, and being able to quickly install the device for little down time. At the root of the project is the goal to create something that will help these people in developing countries who use these pumps regularly make pumping well water less of a chore and increase their quality of living in some way by doing so.

Fig. 3 shows a traditional water pump. Fig. 4 and Fig. 5 show two variations of the new design developed at Cal Poly Pomona. The benefit of a new design is obvious, as it would increase the user's ability to pump for long durations, and would make pumping for short durations easier and less straining. There are many viable designs that can be used, but it seems that the simpler it is, the better it will be. Anything too complicated is likely to break down and not be serviced, while the people who typically use it would be without drinking water.

Fig. 3 - A Typical Hand Operated Water Pump

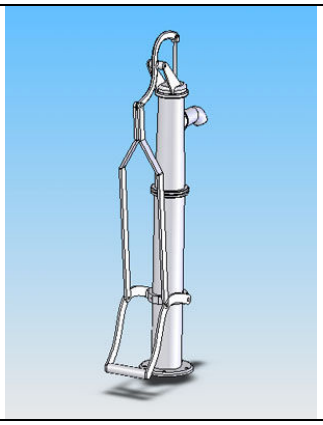

Fig. 4 - Foot Operated Sprint Return Pump

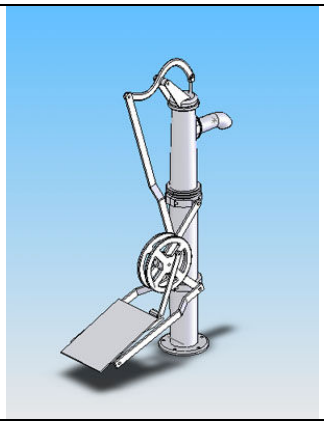

Fig. 5 - Singer Sewing Machine Style

Prosthetic Leg Design with Improved Shock Absorption Properties

Many people around the world currently require artificial leg prostheses. The design of a prosthetic leg requires knowledge in human anatomy as well as engineering modern design. In the past two decades, prosthetic limb design has advanced significantly, with an emphasis on a very active lifestyle that includes sport activity as being one of the normal ones. As a result prosthetic technology has needed to improve to minimize subsequent injuries of the spine and other joints. The objective in this design project is to analyze the existing devices for shock absorption for a prosthetic leg and re-design the shock absorbing system[5-6]. Using 3D modeling, Finite Element Method (FEA) and 3D printing technology available in our department students are able to improve these models and come up with the new improved designs. Fig 7 shows one of the models developed by the students and being under study to improved shock absorption characteristics of the existing device.

Fig. 6 Existing device

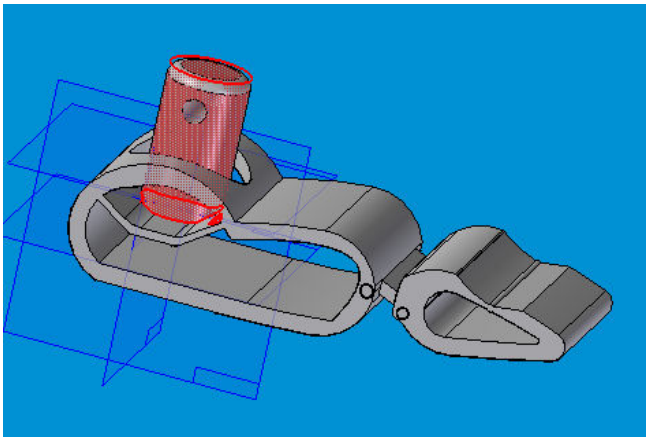

Fig. 7 – Improved foot design for better shock absorption

Conclusion

Real projects that can directly benefit communities we live in offer a unique way to *Learn and Serve*. Design for community provides a meaningful context to address real problems in complex settings rather than simplified problems in isolation.

Design projects for the community require constant interaction and involvement with the partners. Unlike regular class projects students tend to be passionate and get emotionally involved in these projects as it involves real people with real needs. These projects for community provide authentic learning experiences to the students.

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