It's all about relationship - expanding relational learning opportunities

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It's all about relationship – expanding relational learning opportunities in a community engagement project experience

Introduction

It pays to think big for student project experiences - not in terms of project scope but in terms of learning opportunities and overall impact. A diverse body of research, as well as 15 years of personal experience with capstone projects and extracurricular student projects, has shown that the overall impact of a student project grows through the establishment of relationships that transcend boundaries. In our ongoing program development, we have worked to create a range of relational learning opportunities for students in the Mechanical Engineering program at Ohio University, starting in freshmen year and continuing through the senior capstone project, and even beyond graduation for select alumni. Some of these relational learning opportunities include mentoring relationships between senior capstone design students and freshman design students, mentoring relationships between alumni project mentors from industry and senior design students, coaching relationships between faculty and senior design students, customer 'partnerships' between community partners and senior design students, long-term relationships between the department and select community partners, intra-team relationships within a team of senior design students, and profession-level relationships at the student – student, faculty – student, and alumni-student levels. All of these relationships are meant to both create and communicate the reality that we are all 'better together' and to provide opportunities for potentially perspective altering dialogue.

The experience used as a case study in this paper is an example of Community Engagement in Engineering Education, which is defined by the ASEE Division of that name as "an umbrella term for community-based research, humanitarian engineering, service learning, civically-engaged learners, and more." The Carnegie Foundation for the Advancement of Teaching, in describing their Community Engagement Classification, states that community engagement "describes collaboration between institutions of higher education and their larger communities (local, regional/state, national, global) for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity. The purpose of community engagement is the partnership of college and university knowledge and resources with those of the public and private sectors to enrich scholarship, research, and creative activity; enhance curriculum, teaching and learning; prepare educated, engaged citizens; strengthen democratic values and civic responsibility; address critical societal issues; and contribute to the public good."[1]

We have incorporated the theme of community engagement as an important aspect of the educational experience for all students in our program. One reason is that the community engagement context reinforces for our students the message that all good relationships are two sided - each party has something to give and something to receive. For example, the needs of the

community are in fact a gift that provides an authentic learning opportunity for students, and the time and creative energy of the students is likewise a gift to the community when applied to addressing the community's needs. A grounding in this perspective leads to many opportunities for mutually beneficial relational learning opportunities in a university-based community engagement project experience.

Relational learning background

In order to help characterize relational learning, an attempt is made in Figure 1 to show various modes of learning in an arrangement that shows both hierarchy and overlap or common ground. For example, collaborative learning is a type of relational learning, and cooperative learning is a subset of collaborative learning. In terms of partial overlap, experiential and self-reflective learning has some aspects in common with relational learning (especially when considering relationship with self), but also has aspects that are distinct from relational learning. A note is made in the figure that all learning is contextual, so the relationship of the learner with the context of the learning situation applies in all learning modes. Further, this diagram is not exhaustive in its presentation of learning modes, but is meant to help frame the following discussion in terms of relational learning opportunities.

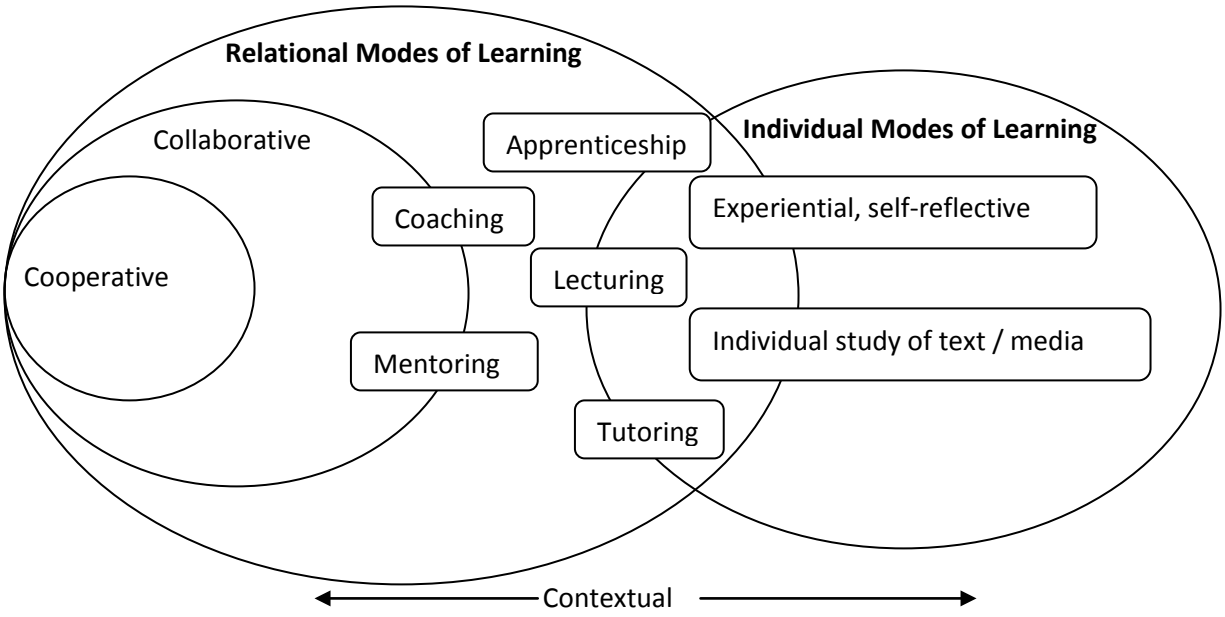

Figure 1: Overview of Some Relevant Relational Modes of Learning

The term relational learning as used in this paper carries a dual meaning, as described in an article in Education Revolution: "There is the idea of learning within relationships, and then of learning about relationships."[2] This dual meaning is very relevant for engineering education in

that students are learning to do engineering in the context of a team project, and simultaneously are learning to be a member of a team and to navigate the complex relationships inherent in a self-managed team. The Center for RelationaLearning™ proposes a relational learning model that charts progress through four levels of relationship, from isolated learners becoming aware of facts, to engaged learners understanding and analyzing concepts, to interactive/introspective learners able to assign value and discuss ethics, to global self-regulated learners who grasp their relation with the world, evaluate options for positive action, and share their learning with others.[3] For engineering education program development, it is important to see that students need to reach the level of interaction if they are to have the capacity and the desire to consider the value of a project, to decide what really matters and to answer the question - for what good purpose (cui bono?).

Several recent publications from The National Academies Press are useful in setting the educational context for the relational learning approach discussed in this paper. The study *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century* helps to define important aspects of undergraduate education in terms of what is important for graduates to know and be able to do. In this publication, the term "deeper learning" is used to talk about learning that persists or changes us, especially in relation to transferable skills.[4] In engineering education, skills that should be transferable include technical skills (doing engineering) and professional skills (being an engineer). The *Education for Life and Work* study found that deeper learning often involves shared learning and interactions with others in a community, and states: "It is the way in which the individual and community structures and organizes the intertwined knowledge and skills—rather than the separate facts or procedures per se—that supports transfer." [4] Further, the study found that "deeper learning and complex problem-solving involves the interplay of cognitive, intrapersonal, and interpersonal competencies." [4] These findings are supportive of the need to connect students to others to create conditions for relational learning.

Another publication from The National Academies Press titled *Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering* makes several important points about effective educational practices that are consistent with a relational model of learning, such as "effective instruction involves a range of approaches, including making lectures more interactive, having students work in groups, and incorporating authentic problems and activities." [5] And in terms of assessment, the study claims: "Much of the engineering education research on professional skill-related process …largely describes "how to"—for example, how to build and use teams—rather than studying what works for developing students' professional skills and how those strategies work." [5] In terms of supporting the importance of dialogue with more experienced mentors, the study states that students need help identifying the critical characteristics of problems in order to establish mental connections that enhance transfer of knowledge and skills to other contexts. Additionally, the study highlights

metacognition as an important contributor to transferable learning, and claims that the aspects of evaluation and self judgment that come into play when interacting with a mentor or mentee provide a context for "the self-explanation effect, which is the benefit to learning and problem solving that accrues from attempts by learners to explain to themselves or another person concepts that are unclear."[5] Conclusions from the study relevant to this paper are that a sustained approach involving multiple occurrences is more effective for effecting change than a single experience, and the use of multiple types of relationships across an academic program is a better model than one that relies solely on relationships within a capstone experience.[5]

Relational modes of learning in a relationally-enhanced community engagement experience

Community engagement project experiences, including service learning (SL) and community based learning (CBL), by definition include relationships involving students and community 'partners.' However, the most talked about and studied relationships involving faculty, students and community are not often treated explicitly as relational learning opportunities. In their paper on *Partnerships in Service Learning and Civic Engagement*,[6] Bringle et. al. present a five component CBL model that treats the university as three connected but separate entities (students, faculty, and administrators), and the community as two connected but separate entities (community organizations and community residents). They also present a relationships continuum to provide a common language for differentiating different levels of relationship between the various entities involved, and make the claim that to rise to the level of 'partnership' a relationship must be characterized by closeness, equity and integrity. This is clearly the goal, but is not necessarily the reality in all university community relationships. Further, the authors present a useful scale for characterizing CBL interactions: Exploitative (the people on at least one side of the interaction incur net costs rather than benefits), Transactional (results in task completion - something good happens, but that is where it ends) or Transformational (people on both sides of the interaction grow and change, in addition to the task being accomplished).[6] Expanding on the work of Bringle et. al., this paper chronicles the integration of a multi-mode and multi-level relational approach to learning in a community engaged project experience. The term 'relationally-enhanced community engagement experience' will be used to describe a community engagement experience that extends beyond the basic requirements for SL or CBL to include a number of intentional relational learning opportunities to enhance the overall educational experience. Figure 2 is a diagram of a relationally-enhanced community engagement experience, in the style of the five component model in Bringle et. al. The important focus on relational learning opportunities are intra-team, project team to freshmen students, project team to project mentors, the inclusion of the ME profession and other resources as part of the overall relational experience and context, the characteristics of the relationship between faculty and student teams, and the overall role of the faculty / staff in terms of orchestrating the relational connections.

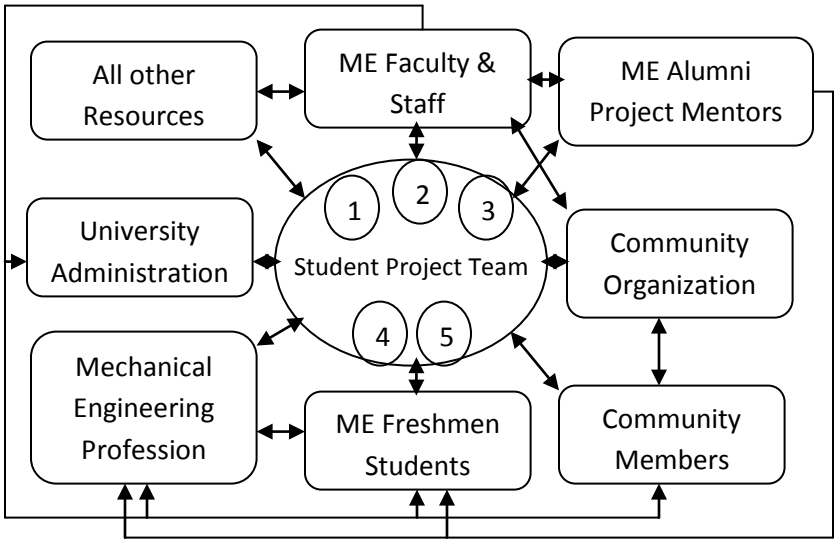

Figure 2: Relationally-enhanced community engagement experience

Some aspects of this relational and integrative educational approach were discussed in an invited chapter in the recently published book *Connected Science.*[7] The term *connected capstone* was used in that book to describe the Designing to make a Difference (DMAD) community engagement capstone experience which is central to the mechanical engineering student experience at Ohio University. In a connected capstone, intentional connections are made to integrate doing engineering with being an engineer with the intent of increasing student appreciation of the transcendent purpose of engineering, providing authentic situations for students to experience the value of professional skills and having structured opportunities to develop and demonstrate those skills, and maintaining or increasing the overall quality of the technical work that students complete on the capstone projects. In the connected-capstone, a long term process of developing more and more relational modes of learning was undertaken, with the goal of putting the students in a variety of roles within learning relationships, spanning from learner to peer coach to mentor.

The decision to apply a relational approach to the DMAD community engagement experience is supported by the study of *Program Planning in Service Learning* by Sandmann et. al.[8] They characterized traditional program planning approaches on a scale from technical rational through relational, and summarized the characteristics and the faculty role in each approach (see Figure 3). Their study "emphasizes the key role of relationship building for program planning in service-learning contexts" and provides some guidance for "faculty who must grapple with the technical, political, practical, and social dimensions of planning service-learning programs in their institutions and with diverse communities."[8]

Approach	Dominant Planning Practice	Characteristics	Faculty Role
Technical Rational Approach	Character Based Curriculum	Linear, formulaic, acontextual	Instructor
Service Learning Approach	Reflective Experiential	Curriculum based, student-centered, project based outcomes, neglects negotiation	Reflective Facilitator
Adult Education Approach	Interactive	Practical decision making, recognizes context, planner-centered	Deliberative Practitioner
	Democratic	Managing the planning context, recognizes social and political factors, acknowledges power structures	Negotiator
Relational Approach	Dialogic	Links technical, practical, and socio-political dimensions, recognizes stakeholder resources, needs, and interests. Facilitates developmental and on-going dialogue and reflection.	Nurturing

Figure 3: Service Learning Program Planning Approaches[8]

Some resources from the field of sociology also help to characterize the DMAD experience and the decisions made during its development. First, the article *Experiential Learning in Sociology: Service Learning and other Community-Based Learning Initiatives*[9] identifies six types of Community-Based Learning and lists curricular benefits for students from each type. The lowest level is out-of-class activities, then volunteering or service add-ons, internships, service learning, and finally service learning advocacy. Some of the characteristics that differentiate service learning from internships are "develops important social and intellectual linkages," "synthesizes information from class and "real world"," and learns lessons of civic responsibility.[9] Since the goal of the DMAD experience is to simultaneously develop professional skills and technical skills, it fits their definition of service learning. The full level of advocacy which includes acting as an agent of social change and becoming empowered are beyond the scope of the DMAD experience, but there is an intent to plant the seeds that will lead graduates down that path as they reflect on the experience and continue to grow and mature.

Another resource helpful in designing the DMAD experience is the paper *Teaching Sociology, Designing Your Community-Based Learning Project: Five Questions to ask about your Pedagogical and Participatory Goals*[10], which not only lists relevant questions but provides a summary of advantages and disadvantages of the primary options related to each question from the perspectives of instructors, students, and community organizations. The article addresses mandatory or voluntary student participation, uniform or variable participation, one site or many sites, and the centrality of direct student interaction with the community members.[10]

Relational learning opportunities associated with the DMAD community engagement experience

The relational approach used in the DMAD experience has been developed over the last 12 years as a natural expansion of a capstone experience that at one point was based on individual projects but has grown through stages to incorporate team projects, then additional mentor relationships, then community engagement, then interactions with freshmen students, to the present state where there is an intentionality about effectively making use of the many potential learning relationships presented in a relationally enhanced community engagement experience. The DMAD experience is no longer an isolated project but is viewed on a much broader program level. Details on some of the relational learning opportunities are briefly presented below, with a focus on the educational purpose of the relationship and any key factors related to establishing and supporting the relationship. It is important to note that the interactions between the participants in a learning-centered relationship should be as clear and focused as possible to encourage appropriate dialogue, but with some room for teachable moments to spontaneously emerge. But it is also important to remember that deep learning can be both messy and hard (in terms of effort and openness to change), and relational learning is inherently messy since it involves people instead of clean 'textbook' problems.

Student – self relationships

Self reflection on meaningful experiences is a necessary component of personal growth and development, and the DMAD experience helps student develop habits of reflective practice through repeated performance evaluations focusing not only on professional skills but also on self awareness and self improvement. This ongoing dialogue encourages the type of transformative learning described by Dilworth: "It takes time and practice to unlock the ability to reflect…However, once the impasse is breached and reflection starts to occur naturally and routinely, the individual can feel empowered and in control of their own life. That can be a liberating experience... It can become transformative learning. The individual is elevated to a new plateau of self-awareness. At this point, it becomes what can be called emancipatory learning - throwing off the self-imposed, and frequently externally imposed, chains that have been constraining clear thinking and advance. Reflection in the end is a dialogue with self." [11]

Intra-team peer relationships

Although not shown by arrows in Figure 2 due to space limitations within the team circle, the fundamental student-student relationship type is the intra-team relationships students form within their senior design project team. These intra-team relationships provide rich opportunities for development of professional skills, but almost all students need mentoring to make the most of these opportunities. In the DMAD experience, the instructor engages in an ongoing dialogue with each team and team member about team member diversity in cognitive styles and communication styles, using written assignments and face-to-face meetings. These dialogues help students grow in both self knowledge and their ability to communicate and work

collaboratively with a diverse team. The fact that it is a year-long team experience and that it is high stakes (they have to be successful together in order to graduate) makes the depth of relationship with other student something students often report as a new experience for them. These aspects of the DMAD experience are consistent with findings in the article *Toward a Social Approach to Learning in Community Service Learning*[12], which claims that "communication is not only the outcome of learning an individual skill (through which one's competence in society can be measured) but is also central to the process of learning," and "communication is the central process creative of, and created through, learning. CSL scholars who place interaction at the center of the process of meaning-making are well situated to make the connections between learning as an individual skill, a relational process, and structurally and ideologically wedded to the political and cultural institutions that maintain social hierarchies." [12]

An important contextual aspect of good relational education is the promotion of peer collaboration, not competition. Promoting peer mentoring and collaborative learning not only within the team but amongst all students engaged in capstone design projects creates a high quality learning environment by making use of the multiple perspectives and experiences of the students to help each other develop and grow. The educator's role in this is to organize, coach, advise and act as an overall 'conductor.' In the DMAD experience actions are taken to build a collaborative rather than a competitive culture. We intentionally avoid competition style projects for the capstone and instead strive to have all teams take on meaningful projects that everyone wants to see be successful. We also set up an in-class peer feedback process around student presentations where other teams are rewarded for providing helpful recommendations and support for other teams. There is also a question on the performance review that asks students to describe how they have participated in helping other teams or other students learn new skills or with problem solving ideas.

Senior student – freshman student relationships

One of the more recent and most successful student-student relationship types in the ME program is the mentoring relationship between senior design students and freshman design students. One of the multiple purposes for these relationships are to connect the freshmen to the engineering program by ensuring that they know some upperclassmen. The seniors make formal presentations at the Problem Definition stage of their capstone design projects to an audience that includes all of the freshmen, and the freshmen are given the opportunity to write out conceptual ideas for solutions of the problems, thereby engaging the freshmen in the solution of real engineering problems early in the ME program. The seniors also serve as mentors for the 'simpler' design-competition style freshmen design projects that the freshmen are engaged in, with multiple class periods devoted to pairs of seniors working directly with the freshmen teams on both team effectiveness and technical aspects of the project. Further, there are structured activities between seniors and freshmen that include academic advising related discussions, what I wish I knew as a freshmen, and discussions of quality / excellence / integrity using excerpts

from the book *Zen and the art of motorcycle maintenance* to frame the discussion. From a practical perspective, concurrent scheduling of the classes is used to enable the regular interactions between seniors and freshmen. Seniors report a recognition of the growth that has occurred in their development, as well as experiencing the benefits of reflecting on their college experience and the "learning by teaching" effect. We have experienced increased retention rates since implementing these interactions, and though possibly unrelated to these changes we are experiencing record enrollments in our program. As we continue to develop and expand on these senior – freshman learning opportunities, the work of Cooks et. al. in relation to Community Service Learning is informative: "Using a social approach to learning, identity always stands in relation to others, and is thus only understood in and through our interactions with others. In a CSL context, we learn about ourselves and others through use of language and the stories we tell about what we are doing….Community…emphasizes the ways meanings for groups of people are created within and through interaction." It is this concept that is the basis for our efforts to create an engineering identity for our freshmen engineers through relationships with senior engineers. [12]

Faculty – student relationships

The focus of this paper is not on faculty – student relationships, since much study has been done on that front and no new developments are offered here. However, it is important to note that from my own DMAD experiences and consistent with the study *Educating Engineers* (from the Carnegie Foundation Preparation for the Professions Series), the apprenticeship model is a preferred model for engineering education. According to *Doing science at the elbows of experts*, apprenticeship includes: "(1) the development of learning contexts that model proficiency, (2) providing coaching and scaffolding as students become immersed in authentic activities, (3) independent practice so that students gain an appreciation of the use of domain-related principles across multiple contexts."[13] The educator in a relationally-enhanced community engagement experience should strive to fulfill these apprenticeship requirements in order to create the "deep learning" that creates transferable skills. Further, a lesson learned and applied in the DMAD experience is that a teacher's role in experiential learning goes beyond designing the experience to include mentoring, coaching, and providing formative feedback that is timely and personal. In addition to having an experience, learners need appropriate reflection and processing to derive lasting learning and wisdom. The educator's role is to clarify the lessons and encourage students to assimilate the lessons in a way that deepens their understanding or broadens their perspective. Establishing habits of reflective practice is a key to lifelong learning, which is an important learning outcome for engineering education. Empowering students to draw their own lessons from experience helps them to transition from student mode (where they often fall into the habit of doing exactly what the instructor says without thinking or wondering why) to professional mode, where they have confidence and take initiative and responsibility for their learning. A lesson learned from the performance review meetings that are a part of the DMAD experience is that relational learning is strengthened by reflecting on and talking about

relationships, which is consistent with studies that show the quality and depth of reflection are correlated to level of learning.

Industry/profession – student relationships

The primary mode of Industry/Profession – Student Relationships is the mentoring relationships that are set up between project mentors from industry and senior design students. We have some very committed advisory board members that volunteer a significant amount of time to be project mentors for the capstone design projects. The mentoring relationship is structured through a tollgate review process, with a series of checklists that the team has to have approved by their mentor before being able to submit their work to the instructor for final review and approval. The industry project mentors helped create the checklists and use them primarily to encourage a meaningful dialogue with the design teams, often in person but via electronic means when necessary. The checklists include aspects of project management and team organization as well as technical details appropriate for each stage of the design process. The mentors from industry are able to use their experiences to enlarge the perspectives of the students, especially in areas of professional skills. It is encouraging that every year some of our top students request the privilege of being project mentors for future senior design teams, in effect "giving back' some of the lessons that they learned from the experience.

Profession level alumni-student relationships

In accord with calls to create a professional spine throughout an engineering program in studies like *Educating Engineers*, we have continued to expand our series of engineering colloquia from one term, to two terms to the current requirement for one term per year for a total of four terms. Each year of the colloquia series has a different emphasis, but the basic purpose is to link what students are experiencing in the classroom to the profession of engineering. One of the primary ways to do this is to have alumni return to campus to share with the current students some problems or situations that they have encountered in their professional lives, and how they used some of the content of the engineering program to help solve the problem or deal with the issue. We have found that local and regional companies are happy to support this type of activity by their employees. These colloquia are also used to continue some aspect of the profession-level student-student relationships, since we are using overlap scheduling to create interactive experiences between freshmen and seniors (around co-op experiences and ongoing interactions around the senior capstone design projects) and sophomores and graduate students (related to research opportunities and to introduce the idea of graduate school to undergraduates).

Community - student relationships

The customer / design team relationships between community partners and senior design students have been mentioned previously, and are central to the authentic nature of the design experience. Designing to Make a Difference (DMAD) is the unifying theme for the capstone design projects. Teams of five or six students partner with individuals or groups that have a real

need that can be addressed by an engineering project and that the customer cannot easily solve by some other means. Local and regional partnerships are encouraged and are the norm. Individuals with disabilities or physical challenges are common partners. Other projects focus on regionally appropriate technology to promote economic development. The relationships begin with representatives from a community business or a local farm coming to class to pitch their potential projects to the student design teams, then meeting individually with interested teams to further define the problem and the possibilities for a feasible student engineering project. After problem definition is approved, the teams generate a number of creative alternative solutions, present them to the partner and solicit feedback that is used in the selection of the final design concept. The teams then design and build a working prototype that is delivered to the partner for testing, and they continue to work with their partner to provide product support so that the partner will have a usable solution before the end of the academic year. Example projects include a pop-nozzle assembly jig to allow more individuals with low physical functioning to participate in an assembly operation at SW Resources (a sheltered workshop employing individuals with disabilities), a community-scale thresher and de-huller to help the Appalachian Staple Food Collaborative in its mission to develop field-to-food systems within local communities, and a basketball shooting device to enable a wheelchair–bound high school student with limited arm mobility to participate in wheelchair basketball.

Program/college/university – community relationships

Consistent with the literature on service learning, we have found that in order to make an impact on a community it is important to build long term relationships with project partners. The primary community partners for the DMAD experience are local farmers, small businesses without technical staff, and sheltered workshops that employ individuals with disabilities. These partners work well since they often have ongoing needs, projects of appropriate scale, and are committed to building up the community. Community-university partnerships are especially important at Ohio University due to our location in the Appalachian foothills and our university's vision to be "recognized for its extensive network of partnerships … and for its commitment to addressing society's educational, economic, and cultural challenges."

One example of a significant impact on a community partner is the engineering services provided for SW Resources, a non-profit, community based rehabilitation facility that provides employment opportunities to 145 client employees with disabilities. DMAD projects with SW Resources have improved a cardboard cutting operation to improve safety and open up the work to more employees, created a labeling template to increase the independence and productivity of a blind mailroom employee, and produced a torque-controlled pop-nozzle assembly jig that simplified the assembly process, reduced strain on the employees' hands, and corrected an over-tightening problem that had previously resulted in over 400,000 rejected assemblies .

The DMAD projects have received positive press in the local newspapers, university publications, and in the Rehabilitation Services Commission regional magazine. This awareness within the community has spurred phone calls and emails from individuals thanking us for providing this service and emphasizing the importance of any small increase in independence for individuals living with a disability. In a university town where the town / gown relationships are often strained, these partnerships have led to improved relationships of at least some members of the community with Ohio University students, and an overall improvement in the reputation of our university as a friendly neighbor and member of the community.

Conclusion

A relational approach to engineering education has been found to be an important factor in creating conditions that connect students to an educational program (increased retention) and to the engineering profession (increased sense of what engineers do and their capacity to do the same), that promote transformation in perspectives (from student to engineer) and learning (transferable skills, especially professional skills), and that enhance university-community relations. The programs described in this paper have been recognized with community engagement award nominations, with recognitions at the college, university and state level, and with student team success – four nationally competitive awards won in the last four years. Engaging engineering students in multiple well structured relationships can impact their educational experience positively and prepare them to continue to engage the community and the profession throughout their careers.

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