A Community Partner's Role During a First-Year Service Learning Project

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Abstract

There are 3 primary roles in a service learning (SL) project: student, teacher, and community organization representative (COR). It has been established that students enjoy and benefit from SL experiences.[1-5] Teachers benefit as well, in their ability to meet educational objectives.[1] For the community organizations, the advantage appears to be obvious; their problem is resolved. However, the benefits for the COR must be more fully explored. This paper will examine the advantages as well as the inconveniences experienced by one of the authors while participating in a SL project.

In the 2011 – 2012 academic year, 45 first-year engineering students at the University of Prince Edward Island in Canada were introduced to a need from a remote village in Kenya. Though it would have been preferable to work directly with the villagers, poor internet quality and the extreme distance made this impossible. As a result, people from the local community, who regularly travelled to the village, identified the need and acted as the COR during the 15-week long project. In groups of 3, the students designed charcoal presses to convert agricultural waste into charcoal briquettes more efficiently than the current process.

The COR was involved in the design process during the problem introduction, a hands-on demonstration of the process, question and answer sessions, reviews, and the design exposition. Also, while in the Kenyan village, the COR facilitated an exchange of information and performed an experiment designed by the students. The time demand, though great, gave the students a better understanding of the needs of the villagers.

This paper will consider a qualitative assessment of the COR's involvements. This will be achieved through an examination of activities between the students and the COR, including a firsthand account of the events that took place in the remote village. Finally, the accomplishments and deficiencies that the COR experienced will be analyzed, and recommendations will be made to ensure that all participants' expectations are achievable.

Introduction

Service learning (SL) is a pedagogy that attempts to balance the needs of a non-profit organization from the community, while providing academic credit for students.[1] Through this experiential learning style, students have the opportunity to apply their engineering skills to a real-world problem for a community organization.[1-3] Students who participate in SL projects better realize an engineer's role to help society[2, 4] and are forced to examine their beliefs on social issues they may not have previously considered.[5] As a part of SL projects, students reflect on the project throughout the design process to activate their meta-cognitive abilities; they become aware of what they are learning through active reflection.[5] Students are expected to communicate with the community organization representative (COR) in meetings, at formal presentations, and through design reports. Students practice the skills that are required to produce a design with teammates, rather than working on their own. This, more than anything, simulates a real working environment. Students, then, benefit academically by enhancing their problem-solving and designing skills, inter-personally by improving their communication and teamwork skills, and personally by being forced to grapple with social issues.

A second role to consider in SL is the faculty member. Substantial research has been conducted to assess the impact and viewpoint of faculty members in SL projects.[6-10] Faculty members reported that compared to traditional lecture-based courses, SL courses were more time-consuming and required significant consultation with the COR.[6-7] However, they agreed that learning objectives were more effectively met in SL projects while students simultaneously gained the aforementioned skills, than in traditional lecture-based courses.[6-7] Faculty members concluded that the benefits of SL projects outweighed the limitations.[6-10]

After examining the impact of SL on students and faculty members, one must consider the effects on the remaining participant: the COR. No studies were found evaluating the COR's perspective for an engineering SL project. However, literature focusing on the COR was found within the greater SL community, from the business, education, psychology, law, computer science, occupational therapy, and sociology faculties.[11-16] Projects included (a) event planning, (b) researching, (c) developing programs, (d) mentoring youth to build self-esteem, (e) training animals, (f) tutoring, and (g) providing occupational therapy.

The following criteria were identified as critical in determining whether a COR developed a positive or negative view of the SL experience[11-16]:

- whether objectives were clearly aligned and defined;
- level of communication and preparation between the COR and faculty member;
- amount of student motivation and conduct; and
- whether the COR's problem was resolved.

Two of the studies that focused on the impact of the COR were from universities with mandatory experiential learning requirements, one of which specifically required SL projects.[13, 15] COR's reported a positive experience with SL projects when students displayed a desire to learn and demonstrated responsibility.[13] COR's were most satisfied when clear expectations were set and the university provided support.[15]

One study reviewed COR satisfaction for SL projects where student participation was mandatory compared to voluntary.[16] COR's admitted hesitation in accepting assistance from the students who were required to take the course. While both groups of students provided meaningful contributions, a stronger commitment was desired from the students whose participation was mandatory. This indicated that students who take the course voluntarily are more committed to resolving the COR's problem than students who are required to take the course.

The literature describing COR perspectives of SL projects in fields outside of engineering is a meaningful starting point but does not provide the full picture. Many of the projects from the greater SL community contained in this literature review are focused on the process, such as tutoring and mentoring the youth or training animals. Engineering SL projects have a need that is almost exclusively focused on the product, such as designing a ramp for a person with disabilities or producing water filtration system for people in Ghana. Engineering students are required to use the problem solving process to produce a design. Therefore, the COR perspective for an engineering SL project is very dependent on the outcome and success of the product. This focus is not reflected in the literature and should be studied.

This paper will provide the perspective of the author (Osgood), who participated as the COR during a first-year engineering project. The events that occurred during the 15-week project will be described and an evaluation of the products of the project, both the physical and abstract will be analyzed.

Background Information

Mikinduri Children of Hope (MCOH) is a non-profit organization that helps a remote village in Kenya called Mikinduri and the surrounding towns. MCOH provides job training, feeding programs in primary schools, scholarship programs for students in secondary schools, instruction in farming techniques, and annual medical, dental, and vision clinics. The goal of MCOH is to help the poorest of the poor through instruction and training, not to offer handouts. The people of Mikinduri set the priorities. One such priority was for MCOH to help solve the problem of firewood scarcity.

As the only source of energy for cooking, firewood is a highly sought after commodity in rural Kenya. Women walk long distances to retrieve firewood and carry large bundles of wood on their backs to sell or use in their homes. The effect of burning wood in the houses is detrimental to the rural Kenyans' health. A typical rural Kenyan house is one square room with a clay floor that is between 8 feet and 12 feet wide. The roof is thatched or made of tin. There is no ventilation source in the houses, so when the wood is burning, smoke from the fire hangs in the air, and adversely affects the eyes and lungs of the villagers

Realizing the great amount of agricultural waste in the area was in the form of corn stalks, MCOH suggested turning this available unused resource into charcoal by carbonizing the corn stalks, adding boiled cassava root to act a binding agent, scooping the mixture into a section of angle iron, and compressing the mixture into briquettes. The compression is manually applied by repeatedly striking a plunger (a flat plate welded to a metal rod) with a hammer.[17] MCOH demonstrated the process to a pilot community called Kagwuru. Initially, the response was favorable; the community embraced the technique. After only weeks of implementation, however, the new process was abandoned, because compressing the mixture into briquettes was too time consuming and labor intensive. A mechanical device was desired to compress the mixture.

At the University of Prince Edward Island (UPEI), in order to receive a diploma in engineering, students take 24 classes, consisting of design, engineering science, math, physics, chemistry, and humanities. After this, the students transfer to Dalhousie University or the University of New Brunswick to complete their degree. Engineering students at UPEI are enrolled in a design course every semester. During the first semester, the course was focused on communication. After 9 weeks consisting of multiple introductory design projects, a SL design project was assigned to the students. They spent the final 3 weeks of the first semester focused on project definition for the SL project. The second semester was focused on analysis, using the SL project as an active learning model to teach analysis techniques to the students. The design problem that was selected by the faculty member (Trivett) for this 15-week project had to meet all of the following criteria:

- have a problem focused on the community and a COR willing to participate;
- result in an inexpensive proof of concept product for students to build and analyze;
- be of appropriate technical complexity for a first-year student; and
- be designed, built, and tested in 15 weeks.

The first constraint informed the students of the need for engineers to help people within their community. Ultimately, the role of an engineer is help society; early and repeated exposure to this concept solidifies the idea for the student. Additionally, community projects tend to have very specific user needs. This requires the student to recognize that he or she has preconceived notions, put them aside, consider the user needs, and design something for the user. It is important to correct the misconception that engineers design devices. While it is true that devices and other products are created, in actuality, engineers solve problems for users.[18] The focus must be on the user and not the device. SL projects are very effective methods to embed this knowledge.

The SL project between UPEI and MCOH commenced in November of 2011 once it was determined by the faculty member (Trivett) and COR (Osgood) that the proposed project scope and schedule met the criteria for the SL design project. A limitation of the project was that the students did not interface directly with the end users, the Kenyan farmers. The students' perception of the users, the problem, and the rural Kenyan environment was reliant upon the experience relayed by the COR and background research. While direct contact between the students and the end users was preferred, poor internet quality and the extreme distance made this impossible. A COR who shares his/her experience can still provide a positive impact and facilitate meaningful learning[3], however direct contact would have been more desirable.

The COR travelled to Kenya on 2 occasions, for a total duration of 6 weeks, which allowed the COR to confidently relay the needs of the users to the students, as accurately and unbiased as possible. Three additional members of MCOH briefly participated in the project in order to validate the information through sharing their own experiences. Although the students were aware that the COR was a faculty member, any interaction outside of the project was limited to orientation day and 2 design lectures, before the project commenced. The COR did not participate in any faculty-related activities for the first-year students, such as defining course content, grading, giving lectures, etc. With these distinctions, the COR's capacity to the first-year student was as the COR and not as a faculty member.

Project Execution

The faculty member and COR met to define the project objective, scope, and schedule. The design challenge was to build a device to compress charcoal powder and cassava paste more efficiently than the previous process, utilizing materials available to the villagers of Kagwuru. The objective of the SL project from the COR's perspective was to obtain a solution, generate cultural sensitivity and global awareness in the students, and to raise awareness for the organization.

The COR presented the design challenge to the class using pictures and a description of rural Kenyan life. Photos of the local people, buildings, schools, and the surrounding environment were shown. A description differentiating the average day for men, women, and children was provided. The typical income, dwellings, and health level was explained, in an attempt to show the disparate standard of living between the end users and students. Next, the need for an alternative energy source was relayed, followed by a description of the current charcoal production process.[17] The COR answered questions throughout the presentation and noted the students' varying levels of comprehension of the problem.

Later that day, the COR provided a hands-on demonstration of the charcoal production process at a local potato farm. The demonstration explicitly showed the amount of labor involved in producing briquettes and provided context for the step the students were to improve within the whole briquette production process. Only the tools and processes that were available to the end users were utilized in the demonstration, with a single substitution of potatoes instead of cassava root. This required the COR to learn how to replicate the briquette production process, find a site for the demonstration, collect the material, enlist a machine shop to alter the steel drums to burn the corn stalks, transport the materials to the site, and perform a trial run. This was a very time consuming process, consisting of nearly 50 hours of preparation, but the demonstration was deemed necessary to ensure the students thoroughly understood the problem and became immediately engaged with the design challenge. An additional member of MCOH attended this demonstration to provide background information, answer questions, and validate the COR's information.

One week after the project began, the COR attended an additional question and answer session. The content of the questions altered from the previous week, suggesting that the students performed background research. In order to ensure a high level of accuracy and credibility, the COR clearly stated when an answer was unknown and distinguished between events that were witnessed compared to information that was imparted from end users or members of MCOH.

Approximately 3 weeks after the project began, the COR attended the first design review; students presented their understanding of the design challenge, initial device ideas, and computer-aided models of the proposed designs. The COR was asked to rate the students' presentations based on how well the students understood the problem statement and presented the information. There was an opportunity to ask the students questions about their designs and provide feedback based on clarity of design, material availability, manufacturing complexity, and potential for a more efficient production process.

At the end of January, as the COR was preparing to return to Kenya, a meeting was held with the faculty member to determine how to integrate the SL project with the trip. The students developed a list of questions for the end users that the COR was unable to answer, inquiring about the following:

- proportion of ingredients;
- number of briquettes produced per batch;
- number of briquettes consumed per day for a typical family;
- local material and machining costs; and

- interest level in manufacturing briquettes as a business.

Ideally, the COR's trip to Kenya would not only answer these questions but provide a meaningful connection between the students and the end user. It was concluded that the students would provide a technical memo to the COR, outlining the experiments needed to collect the data and the precise steps defining how the data would be collected, in addition to interview questions. The students were informed that the data would be collected in the field in front of Kagwuru Primary School, where the charcoal was typically produced, limiting the available equipment. The discussion illuminated the students' preconceptions and not yet refined ability to consider the problem from the end users' perspectives.

The COR departed for Kenya on February 7th, and the memo was emailed on February 10th. Limited technology in the rural town prevented the COR from printing the memo, which complicated the data collection. The instructions were read from a laptop in the middle of the field, and due to the bright sun, visibility was low. Also, some steps were not performed due to a limited amount of time to collect materials, perform the experiments, and hold interviews. Only 2 hours were available to complete all tasks, so the steps were prioritized by the COR.

First, the COR gathered data on the containers while a charcoal production demonstration was taking place. Photos and videos were taken to document the process. The UPEI students suggested that the COR enlist the help of the Kenyan students to collect the data. A group of 8th grade students gathered and a description of the project was given and translated by the teacher into the local language of Kimeru. The Kenyan students stated their excitement to participate in a project with university students from across the world. The Kenyan students took measurements of the mixing bowl, drum to burn the corn stalks, and angle-iron mold for compressing the charcoal. Then, with the help of their teacher, they calculated the volume of each container.

The next priority was to ask the end users the list of questions from the university students. The questions and responses were translated by a local villager to a farmer and a businessman, then recorded by the COR. After 80% of the questions were asked, the interview was cut short when the last vehicle was about to depart for the main village.

The charcoal production process was not completed, as it was over a year since the process was last attempted. Some of the equipment was lost and the expertise on how to produce the charcoal briquettes diminished. Since a sample briquette was not available to bring to the university students, similar briquettes were purchased in town, though they were produced using a different process.

There was not a sufficient amount of time available for the COR to accomplish all that was requested while in Kenya, but the information that was collected was received well by the students. The COR presented the videos, photos, calculations from the Kenyan students, and responses to interview questions.

One month later, at the end of March, the COR witnessed the students testing the devices they built. Designs ranged from extruders to screw presses and vice clamps. The COR provided feedback on the design considerations based on feasibility to manufacture in Kagwuru, ability to store the devices, ease of use, and amount of improved efficiency. A second design review was held after the devices were manufactured and tested, but the COR was unable to attend. Two members of MCOH attended in the COR's absence, asked questions about the designs, and provided feedback to the students.

The final interaction between the COR, students, and faculty member was during the exposition where the students demonstrated the operation of the devices. The COR and a member of MCOH reviewed the designs, asked each group of students questions, and provided feedback. One design was chosen based on likelihood to be implemented by the end users and improved efficiency. The design that was awarded second place was more efficient than the winning device, but it required more material and was more complicated to manufacture. The devices demonstrated the design concepts, though none were ready for implementation in Kagwuru, as each required design modifications. The design drawings and final reports were provided to the COR.

Discussion

The experiences and perceptions of the COR can be grouped into 3 themes: (a) time constraints and scheduling, (b) the perceived development of students' cultural sensitivity and global awareness, and (c) the influence of the COR on the students and devices.

Time Constraints and Scheduling

Consistent with the literature, the SL project required a substantial time demand on the COR. In total, the COR devoted approximately 100 hours to the SL project. Twenty hours were spent with the students: (a) introducing the problem, (b) answering questions, (c) in design reviews, and (d) at the conclusion of the project. Eighty hours were expended on all of the other tasks: (a) meeting with the faculty member, (b) defining the problem statement, (c) collecting information and pictures for the problem introduction, (d) preparing the hands-on demonstration, and (e) collecting data while in Kenya. By the end of the first day that the students were involved, the COR had invested 80% of the total time that the project would take, implying that most time-consuming portion of the project was in the preparation. These tasks are represented by the dotted portions of Figure 1.

The COR's involvement was spaced out over the duration of the project to provide opportunities for review and feedback. It was necessary to assess the status of the designs to ensure that the priorities of the COR were being met. It was not explicitly stated to use sustainable materials, but during an early question and answer session, the COR alluded to the scarce material availability. If the students chose a specific metal that was not readily available or cost effective, the COR could provide feedback on reducing the cost or changing the material. Without this inspection point, the design for that group could evolve into something the end user would not be able to manufacture. The most common feedback that the COR provided was inquiring how the briquettes would be removed from the device after compression. Upon reflection, the COR would have liked an opportunity to review the design a second time before manufacture occurred. A small number of the projects were not feasible to bring to Kenya because briquettes could not be removed, the device was too large to be easily stored, or the device did not provide enough compression. A second review point may have corrected these issues.

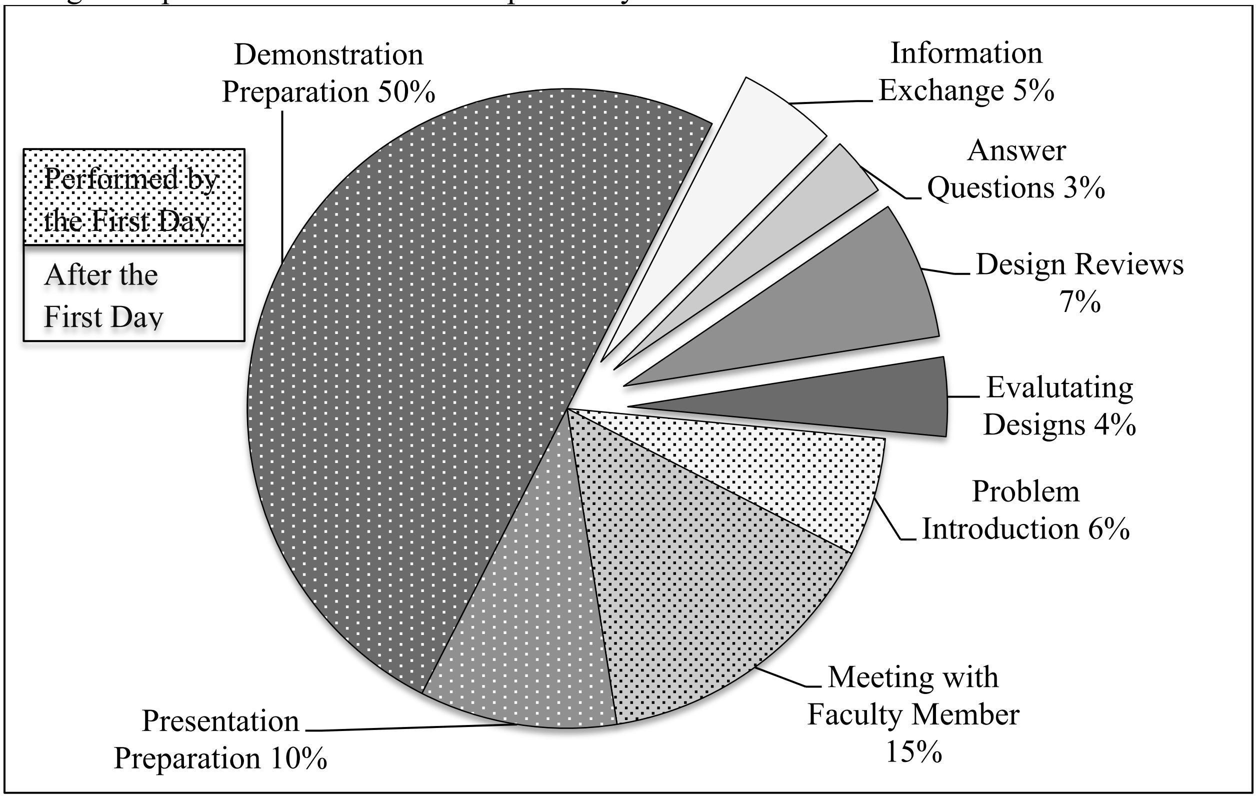

Figure 1: Allocation of Time

Students were only available during set class and lab times. The COR's schedule had to be reorganized on a few occasions in order to meet with the students. In one instance, the COR was unable to attend the final design review because of the rigidity of the schedule. If that happened during a project between an engineering firm and a client, the meeting would be rescheduled. Fortunately, there were members of the organization who could attend the presentation, but the COR would have preferred to attend, if possible.

In addition to the limited availability, students could only devote a few hours a week to the project. While this might be a project that could be completed in 2 weeks with an engineering firm, working with the students required a longer project duration. The project was proposed in August of 2011, and the final exposition occurred in April of 2012. Between November and April, there were 7 meetings or reviews between the COR and the students. In between those meetings, there were long breaks with no communication. This required the COR to be patient and to suppress any curiosity in the progression of the designs. Consistent with the literature, regular communication between the faculty member and COR was desired. Though meetings were held, communication could have been enhanced through progress reports from the students, additional design reviews, or interim student work.

The largest impact on scheduling was in the exchange of the technical memo. The idea for the memo was conceived only 2 weeks before the COR left for Kenya. While the faculty member and COR agreed that the memo would be ready before the COR departed, the student schedules did not allow this to occur. The students needed time to understand the assignment, submit a draft memo, receive feedback, and refine the memo. While in Kenya, the COR's time was a very precious commodity. Only 2 hours were available to collect the numerical and verbal data. Since the COR was not able to print the memo after arriving in Kenya, complications arose, and ultimately, the data was not fully collected due to a combination of limited student time and poor planning. As stated in the literature, the level of preparation between the faculty member and the COR can impact the success of the project. If an exchange of information between the end user and students was stated as an objective at the onset of the project, it is possible that more data could have been collected and the last minute reorganization for the faculty member and COR could have been avoided.

The limited time available to design the device did not include any time for a redesign. In order for the winning device to be incorporated in Kenya, more steps needed to be performed to complete the prototype. Despite receiving 15 paper designs, there was not a completed device that was sent to Kenya at the end of the project. Possibly a longer schedule would allow for the device to be tweaked and completed or a multiple project sequence would require the next group of students to develop the designs into a working prototype.

Time is a constraint that should not be overlooked. The COR must budget time to prepare for the SL project, spend with the students in class and the faculty member in meetings. The COR's schedule must also be flexible to adapt to the students' schedule. When planning the major events in the project, multiple points should be made for review of the design and objectives must be clearly defined.

Perceived Student Development of Cultural Sensitivity and Global Awareness

While it is difficult to measure the cultural sensitivity or global awareness of anyone, the COR perceived a development of these 2 intangible qualities in the students through questions and presentations. During the first opportunity the students had to ask questions, the COR perceived the students' questions to be superficial. The topics focused on the mechanical device rather than on the circumstances of the user. As time progressed, the questions eventually focused on the user and the students began to show an understanding of the constraints of the project.

At the second question and answer session, a student suggested that the environmental impact of burning agricultural waste to produce charcoal was too great. While this is a fair statement in Western society, many people in rural Kenya are struggling to survive each day. They are concerned with the most basic necessities: food, water, and shelter. They need an effective, inexpensive way to cook their food and are not concerned with the impact that might have on the environment. While the student was thinking of possible global implications, it was clear that the student's level of global awareness was not yet fully developed, as the student did not yet comprehend the end user's reality.

Without intending to, some students asked questions that could be considered culturally taboo. These comments were not as prevalent by the end of the project, suggesting that the students acquired some level of cultural sensitivity. When discussing how the COR should collect data in

Kenya for the technical memo, a student suggested using a bucket of water to determine the mass of the charcoal. This shows an intermediate level of development, as the student understood that a scale and power source were unavailable in the field where the charcoal was produced. However, the student did not consider how wasteful and shocking it would be to use a bucket of water that people walk miles to collect, in order to measure the mass of the charcoal and dump the water out afterwards. The discussion that ensued helped students put themselves in the mindset of the rural Kenyan people.

During the first design review, the range of students' cultural sensitivity and global awareness became very clear. The most perceptive students stated that sustainable materials would be best. Some students focused on the longevity of the device. For other students, the primary concern was the amount of space required to store the device. The most astute statement was that regardless of the device design, there must be a plan developed to ensure the end users accept the device and want to implement it. This shows that the student considered that the previous design was rejected and looked beyond the immediate mechanical problem to define possible reasons that the previous design was unsuccessful. However, it should be noted that an assessment was not performed to determine whether these students started the project with a high level of global awareness or whether it developed during the project.

During the data collection in Kenya, the COR was informed that the 8th grade students were 18 years old, the same age as some of the university students. The Kenyan students delayed starting school until they were 10 years old because of the great distance between their home and the school. This information more effectively communicated the limited opportunities for Kenyan students than if the university students had merely read that Kenyan students have limited opportunities. The 8th grade Kenyan students were empowered to help university students and were involved in the design of the device for their town. The 2 groups of students, connected by the project and their age, were able to become more globally aware.

The university students displayed an increased awareness in cultural sensitivity and global awareness. The way the students spoke about the village changed throughout the course. By the exposition, every student could explain: (a) why new energy methods were required in a remote village in Kenya, (b) the way people in Kagwuru lived, and (c) what constraints were included in the design of the product.

Influence of COR on Students and Devices

During every discussion about life in rural Kenya, the COR attempted to speak as honestly, neutrally, and unbiased as possible. However noble this goal, the COR influenced the students and even the devices. Additionally, there were questions that the COR was not able to answer. When this occurred, it was plainly stated. It is possible that this lack of knowledge changed the design result.

The COR unwittingly injected biases while trying to be neutral. For example, the COR spoke about how hard the women in Kenya work and the students translated this to mean that the men in Kenya were lazy. The COR stated that women typically collected the firewood and water, did the cooking, and raised the children. When asked what the men do, the COR responded that they spent much of their time in groups talking, when not working. During the first design review, nearly every group mentioned how the women do all of the work and the men are lazy. The COR found these statements shocking and culturally insensitive but recognized that the statement stemmed from the COR praising the women for their amazing work ethic. What was not said about the men was heard as loudly as what was said about the women.

One method to combat injecting biases included having additional community organization members speak to the students. In addition to providing validation for the information that was shared, showing the students multiple members of the organization stressed that the overarching problem of poverty and lack of opportunities was a community concern, not just the COR's concern. An additional form of validation was through the exchange of information with the technical memo. The end users were eager to share their opinion about their village, available materials, need for an energy source, and constraints for the design. This helped to engage the end users and give them a role in the design of the device. The villagers would be more likely to use the new device if they felt they had a role in its development.

The influence of the COR was exhibited in the design of some of the devices. Initially when considering the problem, the COR envisioned a proposed solution that used a vice action to compress the material on a gear that rotated. One person could fill the containers and remove the compressed briquettes while a second person performed the compression. Two of the designs were very similar to this idea. Unwittingly providing ideas on how to solve the problem for the students could limit the range of ideas and creativity.

Although the COR had an influence on the students and the design, it does not necessarily imply that the impact was purely negative. Additionally, an intermediary person (the COR) provided a cultural sensitivity filter. Had some of the unintentionally offensive comments from the students been made directly to the end users, it could have been negatively received. However, the COR was able to filter the information, not take offense with the statements, and instead, try to make the student aware of the impact of the statement. Additionally, the information exchange engaged the university students and elucidated the reality of life for someone their age in Kenya. In regards to learning global awareness and cultural sensitivity, it was better for the students to speak with an intermediary person than to work on a typical industry project; the students became more aware of the poverty gap between first and third world countries.

Conclusion

The SL project was deemed a success. A solution to the problem was provided; there are multiple drawing packages and design reports for devices that could be implemented, though the COR would have preferred a working prototype to immediately implement. The students displayed more global awareness and cultural sensitivity. The public awareness for MCOH was raised; there are 45 students who now know about MCOH, as well as the people with whom the students are connected, and the people that attended the exposition.

Although the project was not completed, it was encouraging for the COR to see the high level of excitement of the Kenyans to be included in the design process. It was also comforting to see how shocked the university students were that the entire class of 18 year olds in Kenya were in the 8th grade. This level of emotional impact shows how engaged the university students were in the project and that a connection was formed between the 2 groups of students. One of the requirements of SL is for the students to spend time in reflection. Discussions with the students since the completion of the SL project demonstrated to the COR that the students became very familiar with the lifestyle of the end user and spent time reflecting about the experience. When the students describe the SL project, they state the town name and forget to contextualize that it is a poor rural community in Kenya. The students are now so familiar with talking about the town that they do not realize that everyone else knows about the town.

The limitations encountered during this SL project were threefold. The first limitation was the distance between the end user and the student. Second, the view of only one COR was discussed in this paper, despite having 4 community partners involved in the project. Since the roles of the other organization members were more limited, their views were excluded. A further-reaching study could be conducted to assess the impact on the university students, 8th grade students, end users, and other organization members. Finally, it is possible that the COR was perceived primarily as a faculty member rather than as the client, and a different community partner would have had a larger impact.

Further integration with the end user could be implemented. Ideally, an international SL project incorporates the end user regularly to ensure that the organization providing the aid does not step in as a hero. It is important for the end users to be partners in the problem solving process and not recipients of aid, dependant on the organization. This increases the likelihood of acceptance. For this project, the problem was identified by the community and end users provided input into the design. The drawings should now be brought back to the community for review and possible redesign before final manufacture by local craftsmen.

After completing the design project, it is recommended for future SL projects that the COR and faculty member:

- Discuss any potential costs for the COR at the start of the project;
- Explicitly state objectives and expectations;
- Define the schedule, review dates, and method of communication in the interim; and
- Outline the maturity of project outputs: design reports, drawings, proof of concept, fully functioning prototype, etc.

The 4 criteria for COR satisfaction discussed in the literature were confirmed through this SL project. Student motivation and engagement played a role in the satisfaction of the COR as the COR appreciated when the students became more engaged. The amount of communication and planning between the COR and faculty member impacted the outcome of the project, and thus influenced COR satisfaction. The objectives were not explicitly defined as design maturity should have been discussed. The COR assumed a fully functioning prototype would be the product, but only a proof of concept could be developed during the 15 week schedule. It is also recommended that the COR understand that a heavy time commitment is unavoidable, but advanced planning can mediate any last minute scrambling. Additionally, it is advised for a COR to take pictures of the output of the projects and request the design documents.

The final recommendation is to perform a more expansive study of the impact of engineering SL projects on the COR. By discovering and evaluating COR expectations and satisfaction, future SL projects can inform the COR of necessary information before a project commences. This will ensure smoother project operations and realistic expectations of the COR. In addition, the COR comprises a third of the roles in a SL project. By neglecting to study the perception of the COR, a holistic view of engineering SL projects cannot be achieved.

In addition to solving the problem, advantages for the COR included greater public awareness, publicity, and influence in widening the social consciousness of students. Unfortunately, a fully-functioning device was an unrealistic expectation for a project with a fixed duration. Though not polished or complete, the COR was satisfied with multiple ideas for implementation and having participated in the educational process.

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