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Interprofessional Teaching Teams: Addressing Emerging Areas in Biosystems Engineering Using a Client-based Learning Project*

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In January 2004, a Biosystems Engineering design elective entitled 'Design of Assistive Technology Device' was offered for the first time. The course was team-taught by one instructor from the Department of Biosystems Engineering and two instructors from the Department of Occupational Therapy. The course covered the application and design of technology for individuals with disabilities; emphasizing the development of the requisite knowledge, skills and attitudes to evaluate, design and implement client-centred assistive technology services. Students were involved in the clinical assessment process, designed an assistive technology device, evaluated a prototype of the assistive technology device and prepared a written report describing the assistive technology device. Overall, this was a positive experience. The engineering students enjoyed the novel course material and appreciated the input from the diverse teaching team. Based on the quality of the project reports submitted, it can be concluded that the students gained an understanding of the process associated with designing assistive technology for individuals with disabilities. The logistical issues associated with teaching a course involving resources and instructors from two separate campuses can be overcome. The collaborative model presented by this course suggests a way for former agricultural engineering departments to offer courses in areas outside the expertise of their own educational background.

Keywords: collaborative teaching; interprofessional teams; assistive technology; rehabilitation engineer; client-based learning project

INTRODUCTION

THE GROUP OF PROFESSIONALS with varying backgrounds who work in the field of assistive technology (including occupational therapists and engineers) have been labelled by Cook and Hussey [1] as *Assistive Technology Practitioners*. These diverse professionals work in an interprofessional team to provide a common service to the individuals who receive their assistive technology services (i.e., the clients). The term interprofessional suggests that individuals work to coordinate their activities to provide the highest level of services to their clients through an integration of their plans while maintaining their professional identity and responsibilities [2]. The benefits of an interprofessional model include effective use of faculty time by teaching subjects common to different disciplines, interaction between professionals leading to respect and cooperation of the varied backgrounds they each bring rather than disrespect or ignorance, and opportunity to work collaboratively on problem solving issues [2].

Stern and Trefler [3] described an interdisciplinary problem-based learning project where the student teams consisted of occupational therapists, mechanical engineers, computer scientists, assistive technologists and speech-language pathologists. This project was intended to give students a real-world perspective of assistive technology service provision. It was unique because the students were assigned a fictitious case and they were expected to prepare a report indicating the appropriate assistive technology solution. There were no formal lectures; the students were expected to identify the relevant issues and conduct the necessary research on their own. As expected with problem-based learning, students indicated that the experience was much more meaningful than book learning. In addition, the students recognized that they learned a lot from the other group members. The authors concluded that this project contributed to a respect for the skills and knowledge that other professionals can contribute to assistive technology service provision.

The article by Stern and Trefler [3] demonstrated that an interprofessional problem-based learning project is beneficial to student learning, however, there are also advantages to be gained by interprofessional teaching teams. Bush [4] argued that it will be difficult for a teacher to connect with students who are involved in an active, creative

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learning activity unless s(he) fully understands the experience the students are having. If the students are expected to collaborate, then is it not logical that the instructors should also collaborate? Schrage [5] defined collaboration as 'the process of shared creation—two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own'. The interaction that comes with true collaboration stimulates ideas and enthusiasm. When the collaboration is between individuals from different professions, the individuals will not only bring their own technical expertise, but also the thought processes typical of that profession. The team of instructors and students alike will benefit from both the wealth of technical expertise and the multiple approaches to solving problems.

In our case, interprofessional collaboration was used to teach a course entitled 'Design of assistive technology devices' to undergraduate biosystems engineering students. The professors came from different backgrounds and contributed a specific body of knowledge to the course, yet effort was made to coordinate the delivery of the material to provide the most comprehensive view of the field of assistive technology. Student interprofessional collaboration was achieved by requiring graduate students, registered in a separate course entitled 'Assistive technology', to serve as resource persons for the engineering students.

THE ROLE OF ENGINEERING IN ASSISTIVE TECHNOLOGY SERVICE PROVISION

Definition of an Assistive Technology Device

An assistive technology device is an item of technology that can be used by a person with a physical, cognitive or sensory disability to allow or assist him/her in carrying out a desired activity or function. The definition provided in Public Law (PL) 100–407, the Technical Assistance to the States Act in the United States is:

> Any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized that is used to increase, maintain or improve functional capabilities of individuals with disabilities [1].

The key element of the definition is that the device need not be custom-made for a specific purpose, but that it impacts on the functional capabilities of the individual with a disability. From the perspective of the assistive technology practitioner, it is essential that the capabilities of the individual client are understood and that the desired function is appreciated. The actual device may not necessarily be a new design or product; the appropriate selection, possibly with modification, of an existing product is also possible.

Definition of Assistive Technology Service Provision

Public Law 100–407 defines assistive technology service as ' Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device'. There are a number of elements that can be identified in a comprehensive assistive technology service provision programme, including:

(1) evaluating client needs and skills for assistive technology;
(2) acquiring assistive technologies;
(3) selecting, designing, repairing, and fabricating assistive technology systems;
(4) coordinating services with other therapies;
(5) training both individuals with disabilities and those working with them to use the technology effectively [1].

TEAM MEMBERS AND THEIR ROLES IN ASSISTIVE TECHNOLOGY PROVISION

The provision of assistive technology devices to persons with disabilities is best done with an interprofessional team. This team would, at minimum, consist of a technology-orientated individual (typically an individual with an engineering background) and an individual with a rehabilitation background (often an occupational therapist). Engineering design and problem solving skills are as applicable to the area of assistive technology as they are to other engineering areas. Perhaps one of the most important contributions of the engineer is the ability to envisage the application of existing technology in innovative ways to solve a client's particular problem.

An occupational therapist is a university-trained, regulated professional whose primary focus is on enabling the occupations (activities that one needs or wants to be able to do) of a person when a situation arises or exists that one has difficulty in performing them [6]. The situation may be a result of an injury, an illness, a disability or a development-related issue. Occupational therapists may be involved in facilitating participation in occupations with individuals in various settings, including healthcare facilities, communities, schools or the workplace. Occupational therapists have a long history of providing assistive technology solutions to people to facilitate their independence [7], and thus, are natural partners in the assistive technology clinical field.

COURSE 34.461 DESIGN OF ASSISTIVE TECHNOLOGY DEVICES

Rationale for introduction of the course

Like many former agricultural engineering departments, the Department of Biosystems Engineering at the University of Manitoba has made changes to its curriculum to attract students with interests beyond the boundaries of traditional agricultural engineering. One such area is the broad field defined as biomedical engineering. Broadening the scope of an academic programme from agricultural engineering to biomedical engineering offers significant challenges for academic members expected to teach courses in an area far-removed from their areas of expertise. Collaboration with other instructors within the University of Manitoba was seen as a way to offer courses in this new area. The course 'Design of Assistive Technology Devices' was seen as a perfect fit because, in the practicing world, occupational therapists work with engineers to design assistive technology devices.

One role of engineering in the delivery of health care services was described above. The participation of engineers in the design and provision of assistive technology devices is not new, although the participation by biosystems engineers is new. Typically, electrical engineers have been involved due to their expertise related to electronics, also mechanical engineers given their expertise in the design of mechanical systems. Biosystems engineers, due to their knowledge of biology and their appreciation of people in relation to engineered systems, can also make a contribution to the design and delivery of assistive technology devices.

Course curriculum

The content for the course was framed around the Human-Activity-Assistive Technology (HAAT) model [1]. This model describes the interrelationship between the person using the assistive technology, the device itself and the activities that the person would like to perform using the technology. Inherent in this model is the understanding that the contextual situation of each person is unique, thus the importance of understanding the physical, social and institutional environment of the individual user is emphasized. The HAAT model stresses that the relationship between the components is dynamic, so the change in one aspect will influence the other components. The course curriculum was developed with the recognition that the engineering students would need to have a clear understanding of each of the four components comprising the HAAT model, as well as understanding the dynamic relationship between the components.

To understand the first component, the human user of the assistive technology, the students needed to know the physical, sensory, cognitive and affective components of a person. Students learned interview and other person-assessment skills in labs dedicated to those topics. Additionally, students needed to develop an appreciation of conditions causing impairment or disability in a person that would necessitate the use of an assistive technology. Discussion, videos and an experiential activity were used to help students understand some of the issues related to having a disability. In the experiential activity, students simulated a disability and used the required assistive technology to perform some common activities (such as navigating around the campus and eating lunch). Discussion of issues that arose helped to integrate the experience for the students.

To develop knowledge of the second device-specific component, the assistive technology, students were taught about each of the primary categories of assistive technology including control interfaces, computer access, augmentative and alternative communication devices, wheeled and power mobility, seating and positioning devices, self-care devices and environmental aids to daily living. These sections were taught by providing a didactic lecture on the device category and then allowing students to explore a question of interest that arose related to that particular category. Students were encouraged to use Web-based, print and instructor resources to answer the questions that they had self-generated.

The third component of the HAAT model relates to the activities that the individual wants to perform. To develop their comprehension in this area, students were taught methods of task analysis and practiced application of the methods by performing task analyses of selected activities shown on videotape. To understand the final component, the environment, students were sent out to scan and record aspects of the university environment that met or failed the principles of 'universal design' [8].

Additional topics in the course included discussion of the history of assistive technology, issues associated with funding assistive technology, current and future trends in assistive technology and employment opportunities for engineers in assistive technology. The content in each of the HAAT component areas was pulled together in discussion and examples of the application of the clinical assessment process and in the design project.

CLIENT-BASED LEARNING PROJECT

The client-based learning project replicated the process that occurs in clinical practice; it was a large component of the course. Students were grouped in teams of three members each. Each team was assigned a client; a user of assistive technology who had identified a real and specific assistive technology need. Each team worked with their assigned client through the assistive technology service delivery process.

To begin the process, teams met with their client for an interview and assessment in the client's own home (in this case the clients lived in extended care facilities). The purpose of this initial meeting was to gain consent from the client for participation in the process, to gather information on the particular issue, abilities and barriers to performing the desired activity, to develop an appreciation for the environment, and to discuss clients' past experiences with technology.

Following the initial stage of information gathering, the student team clarified the client issue and performed a task analysis of the activity that the client wished to perform using assistive technology. The teams then identified possible solutions that would match client abilities and meet activity requirement. Students were encouraged to consider whether they could modify the clients' existing assistive technology, whether they needed to locate and adapt an existing assistive technology, or as a final option, whether they should develop a new assistive technology.

Several considerations were required of the team; all of them had to appreciate issues that might have arisen in an actual clinical setting. For example, students needed to consider: the availability of the assistive technology from local or Web-based suppliers, the funding options available to the client to pay for the materials needed for modification and/or the new device and environmental factors such as positioning of the device on a wheelchair tray. They needed to ensure that the suggested solution would not interfere with other devices the client might be using (e.g., a power wheelchair joystick) and that it would integrate with all other technology the client might choose to use (e.g., that it would work with both Macintosh and Windows-based operating systems).

Once the teams had identified several possible solutions, they again contacted their client to gain the client's opinion of the options. As the possible solutions were presented, the client had the opportunity to raise other issues or constraints that might affect the design. The issues included those related to the aesthetics of the device; these were considered equally important in developing the overall solution. Feedback from the client was used to modify their design ideas and a final prototype design was developed.

This client-based learning project required that the students work closely with the end user of the assistive technology to meet actual needs rather than work with hypothetical clients provided through case studies. The project expanded on the philosophy behind problem-based learning (i.e. that the use of real-life problems would assist the students to develop the skills they would need to address within their professions [3]) by working with clients who have existing assistive technology issues.

Once completed, teams presented their solution and created a client user manual for the device. The length of the course did not allow time to teach the client to use their new device or to follow the client's use of the device for a prolonged period of time. Thus, teams needed to communicate with practicing clinicians on how to implement, train and follow up with the client.

Further benefit was gained through the involvement of graduate students enrolled in a graduate-level 'Assistive Technology' course through the Department of Occupational Therapy. Although undergraduate and graduate students were brought together for some common lectures, the greatest benefit was from their role as mentors to the undergraduate students. The engineering students were able to experience some interprofessional collaboration themselves in a manner that would not have occurred if the instructors had served as the mentors (because of the student-teacher relationship).

ISSUES TO CONSIDER

Identification of clients

Out of necessity, a client-based learning project depends on the availability of clients willing to participate. The client must be made aware that participating means spending time in a learning environment, and that there is no guarantee that an acceptable solution to his or her problem will be identified by the student team. Despite these requirements, we did not experience difficulty in identifying clients willing to participate. However, it is not recommended to procrastinate on this detail!

Meeting with clients

To fully benefit from the client-based learning project, students must interview the client, preferably in the clients' environment. It may be difficult to schedule such meetings around both the clients' care needs and the class schedules of the students. Some class time was allocated for these meetings to eliminate one of the constraints. Also, because of the limited experience of the engineering students in clinical assessment, it was necessary for the instructors from the Department of Occupational Therapy to be present at all meetings. One of the teams faced the sudden illness and death of their client part-way through the semester. They first learned of his illness when they arrived at the extended care facility for their meeting with him. Although obviously not a planned component of the client-based learning project, this experience added to the realism of the entire project.

Funding

As is the case in real life, funding (or lack thereof) is also an issue for a client-based learning project. Clients may not always have access to funding to purchase the assistive device recommended by the student team. The students found it frustrating not to be able to complete their project; they felt they were letting down the client. To address this issue in the future, we hope to secure a small amount of money from the Faculty of Engineering Endowment Fund. For example, each team would have access to \$100 to purchase a device, or materials to modify an existing device. Provision of a budget gives each student team an opportunity to provide something tangible to their client.

Availability of devices

Closely linked with the issue of funding is the issue of availability of devices. One of the teams identified a device that, according to their analysis, was a perfect solution for their client. Cost was not prohibitive, but the device was back-ordered, and therefore, not available within the time constraints of the course. The students would have preferred to evaluate their client with the new device, and include this evaluation in their written report. This was an issue of great frustration for the students. Unfortunately, we (as instructors) have no control over the availability of commercial products.

Course content

To allow the students adequate time to fully understand the assistive technology service provision process, it would be desirable for students to have basic knowledge in human anatomy and human physiology before registration in the 'Design of Assistive Technology Devices' course. For the initial offering, students did not have this prerequisite knowledge and lecture time was devoted to providing the information. Such knowledge is necessary for any subsequent courses related to biomedical engineering. To address this issue, students intending to take this course are now encouraged to complete courses in

(i) human anatomy;
(ii) human physiology;
(iii) ethics and biomedicine.

These are allowed as substitutes for existing courses in the curriculum.

INTERPROFESSIONAL TEACHING TEAM

An interprofessional teaching team shares some of the characteristics of a committee. On the positive side, there are several people to share the work. On the negative side, the committee members must decide how the work will be shared. We observed both of these characteristics within our team of three instructors. From the perspective of each individual, less time was required for preparation of lecture materials than would have been the case if the course was taught by a single instructor. That being so, all three of us made every effort to be present at each lecture. We also shared the task of grading examinations and the final written reports. This provided an excellent opportunity to compare and discuss our impressions of the work submitted. If there is a negative aspect to a teaching team, it is that every detail needs to be agreed to by each member of the team. Nevertheless, the quality of the course was undoubtedly improved by the involvement of each member of our teaching team.

The interprofessional nature of the teaching team was also a tremendous benefit. Class discussions were enlightening for the students because they heard the perspectives from both an engineer and an occupational therapist. In addition, we as instructors, modelled the interprofessional collaboration that was being discussed in the class (i.e. we were teaching by example).

Student maturity

The students in this course were primarily final year students in Engineering. The level of maturity of the students allowed a higher level of discussion to take place; students felt comfortable enough to question and challenge the instructors on different topics. Student maturity also contributed to the success of the client-based learning project because the students already knew how to interact with clients in a courteous manner. Treating a client with respect and sensitivity is essential for the client to be open and honest with the students about the assistive technology issue. Because of the maturity of the students, we could focus on teaching the subject matter rather than developing suitable social behaviour.

Logistics

The Departments of Biosystems Engineering and Occupational Therapy are located at separate campuses at the University of Manitoba. Consequently, there were issues related to the transportation of instructors, students and/or laboratory equipment. To minimize travel, a three-hour lecture was scheduled once a week at the main campus (during regular class hours) and a two-hour laboratory was scheduled once a week at the medical campus (in the evening). Unfortunately, several students chose not to take the course when they learned that laboratories would be held during the evening. The next time the course will be offered, laboratories will be scheduled during regular class hours to accommodate all interested students. Laboratories will be scheduled in three-hour slots to allow time for transportation between campuses using the University shuttle service.

REACTION TO THE COURSE

From the instructors

This course mirrored the interprofessional team collaboration that happens in the clinical practice of assistive technology. This collaboration was positively received by students and speaks to the benefits of interprofessional collaboration in teaching where the different perspectives brought by instructors from the different disciplines balanced one another. The design project was also chosen to emulate the process and the issues that occur in the actual application of the knowledge in clinical practice. This was seen as a good learning experience for students as simulation would have lost its real-life meaning. For instance, having to deal with issues such as scheduling meetings with clients around their care needs, having to deal with the untimely death of one of the clients before completing the project and feeling involved in the actual outcome—would their solution work?— added another dimension to the course that classroom work alone would not have done.

Offering this course also brought on some difficulties. As there were three instructors for the course, and only six students for the first offering, it could appear that this course was extremely resource intensive. The benefits gained by the interprofessional collaboration need to be weighed against the resources required to implement a course such as this. Obviously, there is a tremendous benefit to the Department of Biosystems Engineering. There is no direct benefit to the Department of Occupational Therapy, although the potential contribution of the students to the field of assistive technology may be of future benefit. The future success of the course in the current format will depend on the continued ability of the instructors from the Department of Occupational Therapy to be involved with the teaching of this course.

From the students

Unfortunately, there were only six engineering students registered in the course. The limited student reaction is based on comments received from the students on course evaluations received at the end of the semester. Students were most impressed with the 'hands-on' nature of the course and the practical knowledge to be gained from the instructors from the Department of Occupational Therapy. Complaints received about the course related to the scheduling of the evening labs. The students were genuinely interested in the client-based learning project. They indicated that they felt a sense of personal investment in the project and were committed to ensuring that the end product would meet the needs of the client.

CONCLUDING COMMENTS

Overall, the positive benefits of offering this course have outweighed the potential limitations. An understanding of the value that assistive technology has to individuals with disabilities and a strong belief in interprofessional collaboration (both in the clinical setting and in the classroom) helped to make this type of course both possible and positive for those giving and those receiving the course. From all accounts, the biosystems engineering students were interested in learning about assistive technology service provision. They were keen to apply their knowledge of engineering fundamentals and the engineering design process to products that would directly enhance the lives of individuals with disabilities. As instructors, we were enthused by the enthusiasm of the students. The interprofessional collaborative teaching team worked well. It is our opinion that the team we modelled as instructors was both well-received by the students and contributed to their understanding of the process of assistive technology service provision. Next time the course is offered, we hope to attract more engineering students (and possibly engineering students from other disciplines) and more graduate students in the graduate course offered simultaneously to enhance the interprofessional experience for all students involved.

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