WIP: Kaden's Car: An Interdisciplinary Project for Technology and Occupational Therapy Students

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***Abstract*—This innovative practice WIP paper describes an interdisciplinary collaboration of computer science, engineering technology, and occupational therapy faculty and students focused on improving the lives of children with disabilities. In the spring of 2023, an occupational therapy student was approached by a friend of a young boy who had lost both of his legs due to infection to see if she knew of anyone who could adapt his drivable car to hand controls. A group of students from the Innovators and Makers Club and occupational therapy program met together to adapt the car. Funded by monies from the College of Innovation and Technology, the car was adapted with hand controls and the young boy was able to have his car for the summer. The authors completed virtual interviews with the students involved in the process in Fall 2023. The students shared their views on this uncommon learning exercise and how they thought the experience may enhance their careers. The information provided by the initial group of students allowed the car to be brought back to campus in Winter 2024 and students from Digital Manufacturing Technology & Automation and Occupational Therapy are working together in combined class times to further adapt the car. The collaboration between two distinct disciplines, DMT (Digital, Manufacturing, and Automation) and OT (Occupational Therapy), to enhance the design and functionality of a car represents a groundbreaking approach to problem-solving and innovation. By merging their diverse expertise, these classes are able to tackle challenges from multiple angles, incorporating both technical and human-centric perspectives. This interdisciplinary collaboration fosters creativity and encourages outside-the-box thinking, leading to more comprehensive solutions that address not only the technical aspects of car design but also considerations of usability, accessibility, and user experience. By bridging the gap between engineering technology and healthcare, this innovative partnership demonstrates the power of interdisciplinary collaboration in driving forward progress and creating products that better serve the needs of diverse populations. In concert, the professional development component of these activities helps validate several of the concepts presented in both courses. Just as importantly, employers are seeking candidates who possess these real world experiences and working knowledge.**

***Index Terms*—interdisciplinary; team work; STEM; community engagement; project management**

I. Introduction

When parents are confronted with the diagnosis of their child having a disability, the first challenge faced by them is dealing with confirmation of their worst fears and wondering what life will be like for their child, and the second challenge is the required skills to navigate the labyrinth that is the U.S. healthcare system. In addition to this, they must adapt to and thrive within a community that might present challenges related to services, mobility, or engaging opportunities in their communities [1]. These challenges are also more severe for vulnerable families or minority groups, especially those with limited income or with cultural barriers because of the access to unequal treatment with the healthcare system [2]–[4]. In 2019, an estimated 2.6 million American households had at least one child with a disability. This represented 7.2 percent of the 36.7 million households in the United States that had children under the age of 18 in 2019.

In this context, innovative problem-solving and collaboration emerge as crucial avenues for navigating the complexities of the U.S. healthcare system and fostering inclusive communities. Inter-professional collaboration has many challenges. These include difficulties understanding the differences in each discipline's vocabulary, limited opportunities for collaboration, and difficulty understanding the lens by which the problem is determined and solutions determined [5]–[8]. Bringing college students together, and taking advantage of their collective creativity and energy is a way to reach that. They can propose creative approaches to enhance accessibility, advocate for equitable treatment, and foster supportive environments where all children, regardless of ability, can thrive.

In 2023, an Occupational Therapy (OT) student was approached by a friend asking if they knew anyone who could adapt a ride-on car for a young boy who had lost both legs due to infection. A group of students from the Innovators and Makers Club and OT program collaborated to adapt the car using funding from the College of Innovation and Technology (CIT). The result was a car equipped with hand controls, allowing the young boy to enjoy his vehicle for the summer. During winter, the adapted car came back to the research lab and it was used as a class project for an interdisciplinary effort between two courses in the Digital Manufacturing Technology (DMT) and OT programs. They worked together throughout the semester and delivered the newly modified car to the young child to ensure he can once again enjoy a ride-on car that is more adequate to his needs.

The paper introduces an innovative approach to problem-solving and innovation. By merging the students' diverse

expertise, they were able to tackle challenges from multiple points of view, incorporating both technical and human-centric perspectives. Also, the approach led to more comprehensive solutions that address not only the technical aspects of car design but also considerations of usability, accessibility, and user experience.

The main preliminary contributions of this project are as follows:

- A pioneering effort to bring together students from computer science, engineering technology, and occupational therapy programs to design and develop assistive technologies.
- An interdisciplinary course design and collaboration enhanced the students' learning outcomes and promoted more effective problem-solving skills.
- Provided professional development opportunities in the classroom with real-world impact.

The remainder of this paper is organized as follows: the next section provides background and related work to our study, setting the context for our contributions to car adaptation. Following this, Section III elaborates on the criteria and process adopted for modifying the rind-on car. In Section IV, we present the preliminary findings from our quantitative and qualitative analyses. Finally, Section V concludes the paper.

II. Background

Children learn about the world and themselves through play. Children with disabilities do not have the same opportunities to learn through play as their peers without disabilities [9]. This often leads to social, physical, cognitive, and communication deficits leading to difficulty in school and throughout the child's lifespan. Adaptive equipment for children with disabilities is expensive and often not paid for by insurance. The use of adaptive equipment calls attention to the child's disability and may make it difficult for them to interact and play with typically developing children. Modifying existing products allows children with disabilities to play with typically developing children. In 2012, Cole Galloway at the University of Delaware began the Go Baby Go program. This program focuses on modifying ride-on cars for young children with mobility disabilities to provide alternative modes of movement. This program has been reproduced around the world and involves individuals from engineering and physical therapy fields [10], [11].

Products are improved when the perspectives of different disciplines are applied to common problems [9]. Occupational therapists' skill sets facilitate them becoming involved in the design or redesign of products and environments that allow their clients to become more independent in meaningful activities [5]. Occupational therapy students learn about humans and the effects of disability upon individuals throughout the lifespan. The Accreditation Council for Occupational Therapy Education (ACOTE) standards for occupational therapy educational programs require that students learn to modify environments and equipment [12]. Often optimal modifications for specific types of disabilities require more skills than most occupational therapists possess. Conversely, engineering technology students learn about processes and technology for designing a solution to an engineering problem. ABET's Criteria for Accrediting Engineering Technology Programs standards for engineering technology educational programs require students to demonstrate competency in components, systems, and processes to solve broadly-defined engineering problems [13]. Both accrediting standards have requirements to work with individuals from other disciplines.

It can be difficult to collaborate with individuals from such diverse educational backgrounds. Reasons include lack of: i) opportunities in meetings, ii) a common vocabulary, iii) awareness of the skills of other disciplines, and iv) development of relationships with individuals from other disciplines [5]–[8]. Providing opportunities for engineering technology, computer science, and occupational therapy students and faculty to learn from each other and help children with disabilities by modifying ride-on cars allows team members to meet, develop a common vocabulary, and gain appreciation for the skills of all members.

III. Methodology

Students from the Innovators & Makers Club housed in the College of Innovation and Technology (CIT) and two students from the clinical doctoral Occupational Therapy (OT) program worked together in the summer of 2023 (see Figure 1) to adapt a ride-on car for a seven-year-old male who had both lower extremities amputated in winter 2023.

Fig. 1. Students adapting the ride-on car during Summer 2023.

He desired to play with his friends in his ride-on car but lacked the means to activate the acceleration pedal with his feet. The students, along with faculty from both programs, adapted the car so the child could play during summer break from school (see Figure 2).

The students participated in virtual semi-structured interviews with the three researchers. The interview consisted of twelve open-ended questions in five areas: overall remembrances of the project, how previous coursework supported the project, what was learned from working with individuals not from their own area of study, what they might take with them into their future career and any previous experiences in working with children with disabilities.

Since this is a pilot project, we developed questions to guide us in beginning to understand the benefit to the students.

Fig. 2. Kaden trying the newly modified car.

Fig. 3. Car modification during Winter 2024.

Questions may be refined to get a deeper understanding of how this project enhanced the students' inter-professional collaboration as the research continues. Some questions in the survey included:

- How were you able to communicate ideas with individuals who were not from your college or department during this project?
- Share your opinion of working in the future with others from the disciplines you experienced during this project.

Transcription was provided via Zoom with each researcher taking notes throughout the interview. The researchers reviewed the transcripts independently after which the first researcher provided suggested coding themes. The themes were agreed upon by all researchers with specific information from each interview placed into the themes. The themes gathered were utilized to develop course assignments between courses in OT and Digital Manufacturing Technology (DMT) programs.

The original car was brought back to campus with additional modifications requested by the child and his mother (see Figure 3). The two courses met four times throughout the semester to divide into work projects: battery life, steering wheel placement and throttle, and steering wheel redesign and work in and across groups. In the final meeting, the students presented their work to the now 8-year-old child, his mother, colleagues, and community stakeholders. The meeting ended with the child receiving his renovated car, a new battery, and taking it home. Students from both courses were invited to participate in a Qualtrics survey once grades had been posted for the courses using the same twelve open-ended questions and agreeing to participate in the research project.

IV. Preliminary Results

It is important to note that the students working on this project were all volunteers in the spring as the winter semester ended. They committed to modifying the vehicle before the class project was created in a subsequent semester. The act of volunteering, self-selects willing participants without the element of pressure for grades or other types of compensation. The survey instrument was composed of five multi-part open-ended questions about the experience of modifying the vehicle and collaborating with students outside of their discipline. The most notable finding was the students' acknowledgment of the different types of training they had each received in their academic programs and the different communication styles. Although both groups take a hands-on approach to their work, they acknowledge that working with people with disabilities is different than creating inanimate objects. Each group stated that they noticed different working styles in terms of planning, execution, and refinement.

The students from CIT highlighted the coursework in previous semesters that required them to use the engineering laboratory to build objects they designed using CAD software. They also spoke of problem-solving in applicable settings, using things they learned in class to help someone in the community. Specifically, they stated the courses in their freshmen year, CIT 100 and ITI 150, were helpful with wiring and electrical components. A student stated:

> "*At the beginning of CIT 100 we worked on electrical currents and we did some of this. Foundational skills. We were talking about a battery and that applied. Some people had ideas about GPS trackers which we learned in ITI 150, a introductory cloud course. ITI 150 - if we implement a GPS tracker I can use skills learned in this class.*"

The OT students remember learning how to use tools that they had not used before. These students had completed an innovation in healthcare course and had basic soldering skills but this project challenged them to expand their use of tools and manufacturing equipment. Their experience as occupational therapists gave them great insight into material selection that the technology students did not possess. One student shared:

> *"We learned how to do the correct measurements - make it safe for Kaden - learning about the diagnosis in coursework. We learned about it (I) but never worked with someone with an amputation - not rubbing the skin and things were fit for him and safe".*

Both groups of students gave detailed feedback on ways to improve the project experience for students and impact the vehicle modification in future similar explorations. All of the participants noted that they were able to practice concepts that they normally only hear about in the classroom. One OT student stated,

"I do wish all of my classmates could experience this - Doing something like this in OTP 785 Innovation and Technology".

The data collected from students via surveys and interviews mirrors current literature and best practices in engineering education. Problem-solving and communication skills are foundational in most accredited occupation therapy, engineering, and technology/applied engineering curricula. Students reported evidence of these learning outcomes that are outlined by ABET and ACOTE, leading accrediting bodies in higher education. This project creatively approached these goals in an interdisciplinary, community-grounded structure. The course design for both of the classes engaged centers on student impact and transferable skills [12], [13].

After the winter semester ended, the car was returned to Kaden again. A survey of the students in both classes working on the vehicle was distributed. For ethical reasons, this survey could not be given until after final semester grades were submitted by both instructors. The survey instrument was the same as the one used for the students who volunteered in the previous summer. At the time of this writing, the surveys have yet to be completed. The research team plans to have these results before the conference in October for analysis and inclusion in the final manuscript.

V. Conclusion

Although this study focuses on the learning outcomes and impact on students provided by participating in an interdisciplinary community-based project there were several lessons learned for the instructors as well. These lessons were garnered via project review in the closing phases and aligning student comments with observations. Three major themes emerged. First and foremost, the need to verify safety training. The students in engineering technology had safety training in their freshman year as a requirement to access the engineering lab. This requirement was announced to the combined class with the OT students along with the CIT students. The instructors let the students schedule this training at their convenience before the building phases of the project began. Unfortunately, not every student completed the safety training. This was not apparent until the end of the project. In future offerings of this experience, there will be a mandatory scheduled group training with the lab manager for everyone involved. It may be the first training for some students and a refresher for others, but they will all be working from a common knowledge base and understanding of best practices in the lab.

The next iteration of this project will have a greater emphasis on design before decomposition to create modifications. Phase gates will be inserted to ensure that everyone is in agreement with any major structural changes made to the vehicle. The CAD system will be utilized to create a visual representation of the proposed finished product to be approved by the project sponsors and team members before actual construction. Most of the students in the technology class have taken a project management course (DMT 230), so adding this structure will be a natural development along with managing the critical path. In addition to this, we intend to implement a systematic evaluation process to assess the impact on participating students, such as learning outcomes, personal and professional development, and workforce preparation.

Finally, the team concluded that this is a highly impactful project to help prepare students for the workforce. Students developed transferable skills in time management, problem solving, collaboration, communication (every student realized their vocabulary has expanded), and leadership skills.

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