JOTE

Journal of Occupational Therapy Education

Volume 8 | Issue 4 Article 16

2024

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Recommended Citation

Berner, K., Buxton, J. C., & McMahon, L. F. (2024). Outcomes from an Intercollegiate Client-Centered Interprofessional Occupation-Based Assistive Technology Hackathon: A Pilot Program Evaluation. *Journal of Occupational Therapy Education, 8* (4). Retrieved from https://encompass.eku.edu/jote/vol8/iss4/16

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Abstract

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Keywords

Assistive technology, hackathon, occupational therapy, accessibility, interprofessional, maker movement, design

Acknowledgements

The authors acknowledge funding from nonprofit organization Cecropia Strong for purchase of raw materials, design supplies and team awards. The authors acknowledge Kathleen D. Lyons, OT, ScD for expertise and consultation on qualitative analysis.

Volume 8, Issue 4

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ABSTRACT

Assistive technology (AT) supports engagement for individuals with disabilities by improving independence in daily living tasks, work and productive activities, learning activities, and societal participation. However, for many individuals, access to AT is limited due to high costs, device availability, and inability to be customized. The Maker Movement and hackathons provide an opportunity to educate health profession students, design students, and community members about AT while engaging these stakeholders in addressing unmet AT needs for individuals with disabilities. The current study examines outcomes from an Intercollegiate Assistive Technology Hackathon. Nine co-designers (community members with disabilities) and 36 students from three universities participated in a seven-day hybrid voluntary hackathon to develop a client-centered and contextually relevant custom solution for a daily living challenge. Students, co-designers, and stakeholders gathered virtually to review the ten project pitches. Student preferences were identified, and event co-chairs curated teams. Hack teams collaborated virtually and in person at university-sponsored maker spaces to further define the challenge, ideate possible solutions, develop a prototype, test the prototype, and, in some cases, create a final product. Each team developed a collaborative solution. Personal and professional growth was reported by 95.2% of the student respondents. Solutions and additional outcomes are discussed and recommendations for future hackathons are shared.

Introduction

It is estimated that 1.3 billion people worldwide have a disability, which represents 16% of the world's population (World Health Organization [WHO], 2023). Disability has been described as "a natural part of the human experience" and should not reduce opportunities for living independently, learning, working, and participating in society (United States Technology-Related Assistance Act, 2004). Assistive technology (AT) is defined as "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" (US Technology-Related Assistance Act, 2004). Assistive technology is essential for optimizing independence and promoting participation for individuals with disabilities in necessary and meaningful daily activities. Although the WHO characterizes access to AT as a "human right and a prerequisite for equal participation and opportunities," they also identified several barriers to acquiring AT globally, including high costs, low availability, and lack of support (WHO, 2022, p. 5).

Most AT solutions must be individualized for the user. To be an effective tool, AT must appropriately accommodate or compensate for an individual's limitations, complement their strengths and capacities, match the task demands of the activity or occupation, and be supported by elements of an individual's context (Cook et al., 2020). The Human, Activity, Assistive Technology (HAAT) model describes the individualized nature of assistive technology selection and use (Cook et al., 2020). This client-centered approach is further supported by the Matching Person and Technology (MPT) model and the Student Environment Task Tools (SETT) framework (Scherer, 2007; Zabala, 1995). These models place the individual with a disability at the center of the AT evaluation, trial, selection, and implementation process (Cook et al., 2020; Scherer, 2007; Zabala, 1995). AT is an essential part of occupational therapy practice in a variety of contexts. The Occupational Therapy Practice Framework 4th edition categorizes AT both as an environmental factor that may impact functioning and as an intervention that can enable participation in meaningful occupations (American Occupational Therapy Association [AOTA], 2020). Occupational therapy practitioners face the same challenges that individuals with disabilities experience globally: assistive technology products and services are not readily available for those who need them.

An AT hackathon involving students from health professions and design and fabrication professions can address challenges for people with disabilities to access AT devices. An AT hackathon can 1) improve awareness regarding assistive technology and local assistive technology resources, 2) help identify everyday occupation-based challenges individuals with disabilities experience, and 3) foster collaborative problem-solving and innovation in order to address a challenge with daily functioning. In this paper, we will review the outcomes of an intercollegiate and interprofessional client-centered assistive technology hackathon that was held in the spring of 2023. We aim to determine how this experience impacted the learning process of occupational therapy, health professions, and engineering students.

Literature Review

Hackathons

Hackathons are brief, intense events that can foster collaboration between individuals from diverse backgrounds to solve a problem (Lyndon et al., 2018). In the late 1990s, hackathons emerged as a method for computer programmers to collaborate and innovate to address a problem or dilemma over a short period (Benham, 2017). Over the past ten years, hackathons have transformed into a tool for individuals from diverse professional and personal backgrounds to collaborate to address challenges and problems in public health interventions, personal health outcomes, and health technology (Lyndon et al., 2018; Shin et al., 2020; Soliz & Young, 2020).

Hackathons are maker events that are often concentrated to a brief period of time, may have a competitive element and focus teams of designers to address an unmet need. This hackathon format may provide value in supporting interprofessional education objectives (Aungst, 2015; Pathanasethpong et al., 2020; Wang et al., 2018). Pathanasethpong et al. (2020) described outcomes from a two-day hackathon they ran with 20 teams in Thailand with support from the Massachusetts Institute of Technology (MIT) and Harvard Medical School faculty. These teams combined students from engineering, computer science, business, and design disciplines with faculty members who represented a variety of health professions. In interviews with three mentors and three students, participants expressed that the hackathon helped break barriers to working with other professions while improving their knowledge and perspectives (Pathanasethpong et al., 2020).

The ATHack at MIT in Boston was an annual two-week assistive technology hackathon that engaged over 75 co-designers with 400 students (computer science and engineering). In a survey of 48 respondents, Narain et al. (2020) found this community-wide hackathon engaged students and sparked client-centered innovation with 75% of respondents reporting they learned about disability and user-centered design. Narain et al. (2020) reflected on the lessons learned from their five years running the MIT ATHack, providing suggestions for enhancing outreach to co-designers and student hackers, setting expectations for the sophistication of the requested solution, and managing resources for during and following the event. They concluded elements for a successful hackathon included high engagement between co-designer and student hacker teams, minimizing technical complexity of the project, and ensuring the project team has the required skills and experiences to address the co-designers' request (Narain et al., 2020). Hackathons have been successful with engineering and computer science students (Pathanasethpong et al., 2020), high school students (Lyndon et al., 2018), and a mix of students with early career professionals and university faculty (Wang et al., 2018). Each hackathon reflected in the literature was unique.

Wang et al. (2018) described one to two week expanded hackathon “courses” with curated teams of students from health, engineering, design, and business fields in Beijing, Hong Kong, the United States, and Brazil. These regional hackathons had significant operating budgets to cover materials, mentorship, and workspaces, ranging from $25K to $80K for each event. Each participant completed a pre- and post-survey to measure their perceived competence in ten domains related to medical innovation, such as design thinking, healthcare regulation, and stakeholder analysis. All cohorts demonstrated significant increases in self-perceived knowledge in these areas (Wang et al., 2018).

Maker Movement

The Maker Movement is a do-it-yourself approach to invent, design, and tinker, and provides an opportunity to engage stakeholders in addressing unmet assistive technology needs for individuals with disabilities. While this approach has been present for generations, the movement was formalized and coined in the mid-2000s with the development of maker spaces in communities and universities, the holding of maker-faires, the launch of a magazine, the emergence of internet-based maker communities, and the holding of hackathons (Bajarin, 2014).

Community-based maker spaces removed barriers to accessing equipment and devices that had previously been available to individuals in engineering and design fields. In a study of public colleges and universities, Melo et al. (2023) found that of the 784 public colleges reviewed, 214 (27.3%) had at least one makerspace. At university-based maker spaces, students from various backgrounds can work collaboratively with individuals with disabilities to prototype and build with hand tools, 3D printers, circuit boards, laser cutters and sewing machines (Morgan & Schank, 2018). Co-design is a method of user-centered design where designers work on teams with people who will be using their product; a process of designing with, rather than designing for. Co-designing allows users to become part of the design team as ‘experts of their experience’ (Sanders & Stappers, 2008), and encourages participants to take action through exploring the design space to develop a user-centered solution (DeCouvreur et al., 2013; Luck, 2018).

Description of Hackathon

The current initiative involved an expansion of an AT Hackathon previously chaired by a faculty at Tufts University (Tufts) to include co-chairs from Boston University (BU) and MGH Institute of Health Professions (MGH IHP). The goal of this Intercollegiate AT Hackathon was for health profession and engineering/design students to collaborate with a community member with a disability (known as a co-designer) to design and fabricate a low-tech AT device that could address a daily living need identified by the person with a disability. The Intercollegiate AT Hackathon was conducted over a one-week timeframe with a budget of $100 per team (provided in kind by a local non-profit). Planning, execution, mentoring, and judging were performed by volunteer event co-chairs, volunteer judges, and volunteer mentors. An anonymous web-based participant feedback survey was administered during the final virtual presentation event. The current inquiry consisted of an observational analysis without a control group. The institutional review board (IRB) of Mass General Brigham (the parent organization of the MGH IHP) was consulted, and it was determined that the participant feedback survey was not human subjects research and therefore was exempt from full IRB review. Quantitative and qualitative data from this participant feedback survey were examined in this analysis.

Community members with disabilities and their families were made aware of the hackathon through outreach from the three event co-chairs. These individuals were invited to complete a web-based survey to share their lived experience, the activity they were having trouble participating in, and ideas for a possible AT device to address the challenge. These individuals were asked to volunteer their time to attend the virtual launch and conclusion events and participate with their student teams at a level with which they were comfortable during the week-long event. Co-designers prepared a two-minute pitch video describing their daily living needs and ideas for a custom low-tech assistive technology device. These pitch videos were shown during the Intercollegiate AT Hackathon virtual launch event.

Student participants were recruited with digital and printed flyers distributed through university-sponsored maker spaces, contacts at health profession and engineering academic departments at BU, Tufts, and MGH IHP, and faculty contacts at other Boston-area colleges. A web-based sign-up form was linked that listed event dates and expectations for participation and collected background information such as major, year in school, and past experiences with hackathons and fabrication. Students completed a form ranking their top three project preferences after viewing the pitch videos at the Intercollegiate AT Hackathon virtual launch event. The Intercollegiate AT Hackathon Co-chairs reviewed student participant preferences and curated team assignments. Efforts were made to diversify teams based on design experience, college major/profession, and school of enrollment.

Three local university-sponsored maker spaces donated their spaces and provided on-site mentoring for hack teams. Each team was provided a $100 budget for raw materials. Three volunteer judges with backgrounds in engineering, AT, and lived experience as a disabled person who uses AT, were present during the virtual showcase night. The judges selected three teams for awards: most innovative, most collaborative, and most functional. Hackers and co-designers were informed that prizes would be awarded to the winning teams. After the event, each member of the winning teams received a $15 Amazon gift card, funded by the non-profit supporter.

Outcomes

Co-Designers and Projects

Outcomes from the Boston-area 2023 Intercollegiate AT Hackathon were analyzed. A total of nine co-designers completed the intake form (or had a surrogate complete it on their behalf). Two co-designers had multiple project ideas, resulting in 11 total project pitches. Co-designer respondents included individuals with disabilities, a parent of a child with a disability, and providers writing on behalf of their service recipients with disabilities. Project ideas were reviewed by the three event co-chairs and analyzed as to whether they 1) had a clear scope, 2) met participation/daily living needs for an individual with a disability, and 3) could reasonably have a solution or prototype developed within 1 week. Following the screening, 10 projects were selected as having met the criteria.

Each project pitch was unique and met the needs of the co-designer, respondent, or surrogate who submitted the proposal. Some proposals already had potential solutions ideated by co-designers. A co-designer who reported having trouble controlling their power wheelchair suggested "*either create a grip for my joystick or create a device where my arm doesn't slip*." A co-designer parent who described the challenge of moving an augmentative communication device within the home safely did not have a solution but elaborated on previous strategies that had failed: "*If I mount my daughter's device in her room, she is not able to bring it with her when she goes to a different room. But my daughter is a thrower - so leaving it unmounted is not an option*."

Student Hacker Recruitment

In March 2023, 36 students completed the registration form and were provided the link for the virtual launch event. A total of 27 students attended the launch event and completed the team preferences form, and one additional student with a schedule conflict participated asynchronously and expressed team preferences. Of the 28 students who participated, 10 (35.7%) of the students were from BU, 9 (32.1%) were from MGH IHP, and 9 (32.1%) were from Tufts. Project pitch videos were shared, and student participants completed an online preference survey. Each of the 10 proposed projects had interest from student hackers, so all projects were matched with teams of 2-4 student hackers plus their community-based co-designer.

Of those who participated, 20 (71.4%) identified themselves as occupational therapy students, 2 (7.1%) as engineering psychology students, 2 (7.1%) as human factors engineering students, 2 (3.6%) as mechanical engineering students, 1 (3.6%) as a speech language pathology student, and 1 (3.6%) as a physician assistant student. Three students (10.7%) described being enrolled in an assistive technology certificate program in addition to their other enrollment identities.

Each AT Hackathon team was assigned a co-chair as a mentor and was provided with the contact information for their co-designer. Hacker teams were encouraged to meet in university-supported design maker spaces, in collaboration spaces on campus, or in the community at a site convenient for the co-designer to engage in the hack. All ten teams produced either the final product or meaningful prototypes. Nine of the ten teams had products that were delivered to the community-based co-designers and device users.

Hack Team Solutions

Hacker team solutions varied in complexity, materials, and design techniques. Team A, who sought to develop a joystick topper that better met the co-designer's needs, developed a prototype out of clay and used digital tools to design a second prototype cut out of acrylic (see Figure 1). Team D used fabric and a sewing machine to create a weighted device protector for transporting an augmentative communication device in the home (see Figure 2). Team F used computer-aided design (CAD) software and a 3-D printer to develop a bracket that helped the co-designer tow exercise equipment with her wheelchair while at her day program (see Figure 3). Some teams, such as teams A and D, had completed final products delivered to the co-designers after the final event. Other teams, such as team F, developed prototypes, engaged in testing, and shared recommendations for next steps.

Figure 1

Team A's Joystick Topper Second Prototype

Figure 2

Team D's Device Protector

Figure 3

Team F's 3-D Printed Equipment Tow Bracket

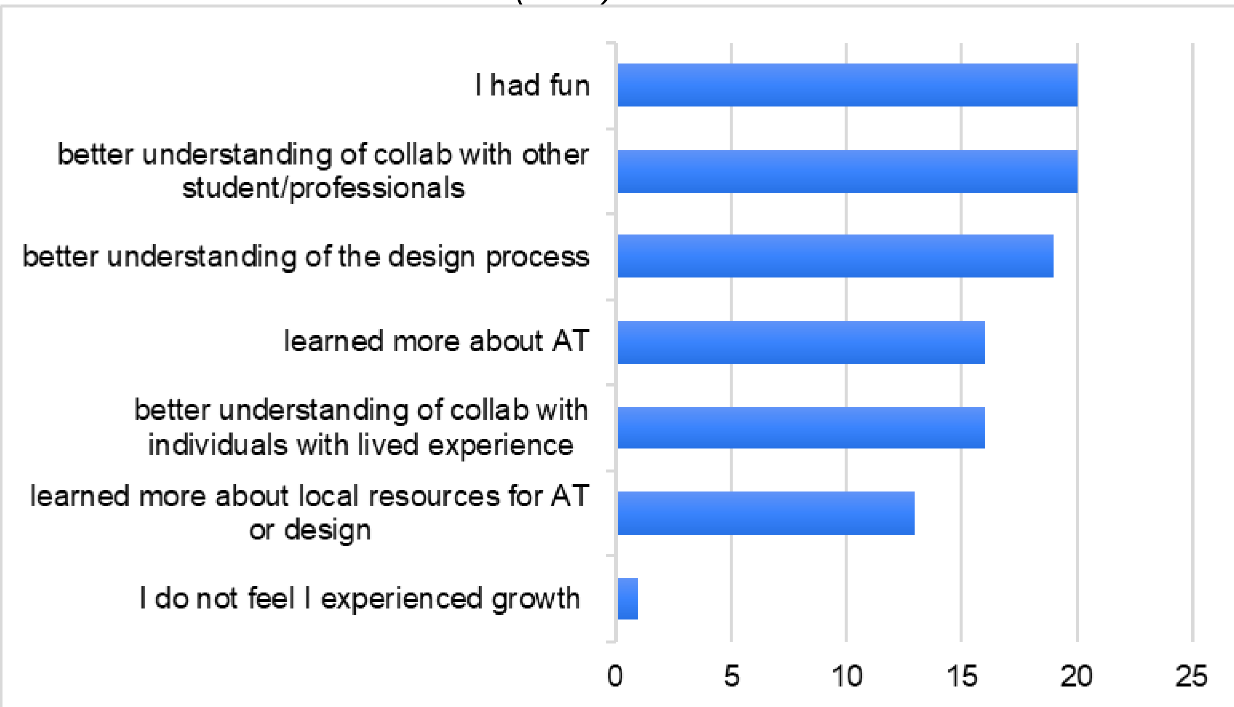
A feedback survey was developed that included checkbox multiple-choice questions, open-ended long-response questions, and Likert scale ratings. Questions collected information on demographics/background (i.e., identity as a student hacker or co-designer, college major), takeaways from the event (i.e., I learned more about AT, I developed a better understanding about collaborating with other student/professions), overall personal experience (i.e., how would you rate your overall personal experience). Survey questions were developed and revised by hackathon co-chairs based on assumptions of hackathon outcomes and co-chairs' experiences of facilitating prior hackathons and interprofessional learning activities. A link to the voluntary online feedback survey was provided during the hackathon's closing ceremonies following team presentations while hackathon judges were deliberating team awards. Surveys collected timestamps but did not require personally identifying information such as names or email addresses.

Student Hacker Experiences

Of the 28 participants assigned to teams, 21(75%) student participants completed the voluntary anonymous post-hackathon feedback questionnaire. All 21 of the post-hackathon feedback questionnaires responded to a survey question that asked how they grew from the event that allowed for multiple selections of items from a list of 7 items. Of this, 20 (95.2%) students selected "*I developed a better understanding of the collaboration process with other students/professions*" and "*I had fun.*" Nineteen students selected "*I developed a better understanding of the design process*." Sixteen students selected "*I developed a better understanding of the collaboration process with individuals with lived experience*" and "*I learned more about assistive technology*." One student selected, "*I do not feel I experienced growth from this event*." Full results from this question can be reviewed in Figure 4.

Figure 4

How Did You Grow from the Event? (N=21)



All 21 student respondents provided a narrative response to the open-ended survey question. "*How was your team collaboration experience working with students, co-designers, and community partners with differing backgrounds and experiences/ perspectives*?" Student responses varied in length, from 10 words with the shortest response to 111 words with the longest response (average response 41.0 words, median response 33.0 words). All anonymous responses were reviewed by the authors, and a content analysis was performed. This response reflected on the participation of the co-designer in their brief response: *"Our team was excellent! Our co-designer was SO involved and really provided excellent feedback at every point in the process."*

This student hacker incorporated their growth in understanding assistive technology and how different levels of experience were able to foster collaboration:

> *"Fantastic experience, learned so much about AT and the wide spread of ways it can be applied through working with the other students and co-designers. Everyone brought a different level of experience and understanding, and we collaborated very effectively to find solutions (even if they weren't perfect) to move our ideas forward."*

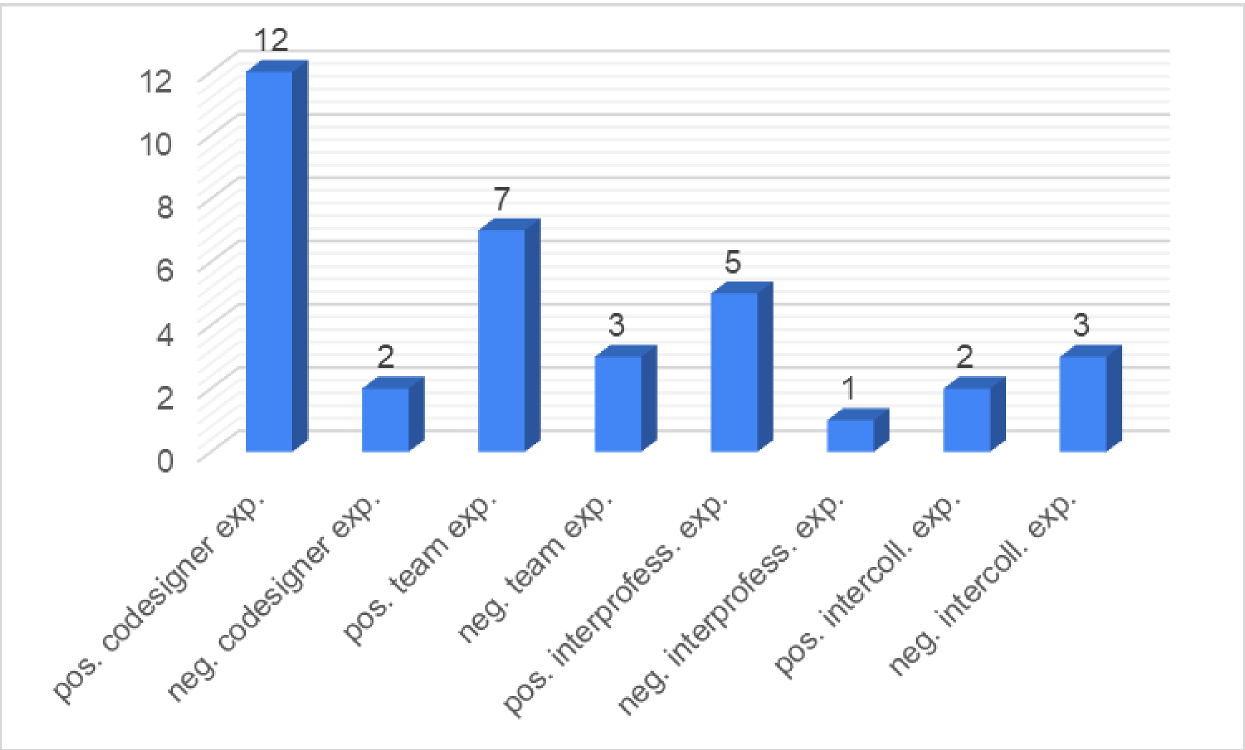
This student hacker commented on the challenges presented by the timeline:

> *"It was great! I thought one week would be too short but I was surprised how much we got done. I liked that I got to work directly with community members and got to see a diverse population from the different presenters."*

Narrative responses were analyzed using NVivo qualitative analysis software (QSR International, 2020). A codebook of eight unique codes was developed based on a review of student responses. Twelve students (57.1%) described a positive experience with their co-designer, while 2 (9.5%) described a negative experience. Seven students (33.3%) described a positive experience with their team, while 3 (14.3%) described a negative experience. Five students (23.8%) described a positive experience working in an interprofessional team, while 1 student (4.8%) described a negative experience. Two students (9.5%) described the intercollegiate interaction as positive, while 3 students (14.3%) described it as negative. The frequency of each code that emerged from the content analysis can be seen in Figure 5.

Figure 5

Content Analysis for "*How Was Your Team Collaboration Experience Working with Students, Co-Designers, and Community Partners with Differing Backgrounds and Experiences/Perspectives?"* (N=21)



Discussion

The Intercollegiate AT Hackathon experienced excellent sustained participation from student hackers, co-designers, and the administrative and support team. The event was voluntary, as program co-chairs, project mentors, and co-designers were not paid for their time, and student engagement did not result in any grade or extra credit. Personal and professional growth was reported by 95.2% of the student respondents. Authors attribute the high response of student participants reporting they "had fun" to the voluntary nature and novel experience. There was one team that experienced miscommunication between the co-designer and student hackers, and this became apparent to team members immediately preceding the administration of the questionnaire. This may account for the outlier of one respondent that “did not grow from the event.”

Student impressions of the interprofessional and intercollegiate collaboration were generally positive. The constructive feedback about student collaboration described the logistical challenges of collaborating with students from other institutions or programs that had varying class schedules, study habits, and meeting locations. Although the three schools were geographically close (within an eight-mile radius of each other), travel between campuses by public transportation can take 45-60 minutes.

Nine of the student open responses did not separate their experience collaborating with the student hackers or community-based co-designer but referred to the “team.” This suggests an inclusive perception of the team, considering the individual with the disability as an integral collaborating member. Strengthening client-centered collaborations and valuing the input of the individual with a disability as an expert participant is consistent with best practices and a vital objective of this hackathon experience (Narain et al., 2020; Sanders & Steppers, 2007).

The authors had several takeaways from this analysis. The post-hackathon survey had good student participation (75%) but only experienced a fair response (38%) from co-designers. Reduced participation from co-designers may include web form completion as an obstacle or decreased availability of co-designers when the web-based form was launched. Understanding how this experience impacted community-based co-designers is described as a best practice in the literature, and additional methods for collecting this information will be prioritized (DeCouvreur et al., 2013; Luck, 2018). Attending to the co-designer experience will also be a priority. Team advisors will enhance screening and preparation for co-designers to ensure that co-designer outcome expectations are reasonable considering the skill level, budget, and timeframe for the hack projects. In the 2023 hackathon, it was learned that co-designers did not join hack teams at the community design spaces. The literature describes that public availability and accessibility of community maker spaces are a strength (Morgan & Shank, 2018). The co-chairs aim to review this phenomenon and see if obstacles prevent co-designers' participation in these spaces.

This analysis has several additional limitations. As a quality improvement analysis, the current study lacked a comparison group of students who participated in “typical” educational programming related to assistive technology and design (such as a didactic classroom experience). This absence of a comparison group was also seen in hackathons reviewed in the literature (Pathanasethpong et al., 2020; Wang et al., 2018). The current event also included a convenience sample of student participants from the three colleges where the co-designers teach, as well as a convenience sample of co-designers from the authors’ personal networks in the greater Boston community. Finally, while the feedback survey data was anonymous, the analysis of and interpretation of data was performed by event co-chairs. While the authors made conscious attempts to analyze data in a fair and balanced way, the presence of unconscious bias cannot be ruled out.

Implications for Occupational Therapy Education

In occupational therapy, interprofessional practice typically considers members of the healthcare team such as speech and language pathologists, physical therapists, nurses, and others (McNaughton et al., 2021). In practice, occupational therapists may need to collaborate with those from the design professions if they are engaging in the development of adaptive equipment or customized client-centered solutions. This interprofessional learning event invited students outside of healthcare education, including mechanical engineering, human factors, and engineering psychology. Further, identifying the client, patient, and/or end user is a valuable contributor to the team that emphasizes a client-centered practice.

The Intercollegiate Assistive Technology Hackathon engaged students from multiple institutions with community members whom they have never met and facilitated opportunities for learning and growth. The authors acknowledge the challenges for graduate students from different institutions coordinating schedules and locations for collaboration over a one-week event. Several student hackers cited difficulty in coordinating conflicting academic schedules and increased travel between institutions. The authors will plan to collect each student's preference for working with an intercollegiate team during the launch event and consider this preference when assigning teams in future hackathons.

Conclusion

This current inquiry sought to determine if a volunteer intercollegiate assistive technology hackathon is a suitable method for learning about assistive technology and the design process, fostering interprofessional collaboration and client-centered practice, and developing a valuable community of practice. Analysis suggests that such an event can meet these expectations.

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