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Insights from an inaugural eight-month interprofessional collaborative co-design educational experience between occupational therapy and industrial design

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INSIGHTS FROM AN INAUGURAL EIGHT-MONTH INTERPROFESSIONAL COLLABORATIVE CO-DESIGN EDUCATIONAL EXPERIENCE BETWEEN OCCUPATIONAL THERAPY AND INDUSTRIAL DESIGN

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Abstract: The design of the built environment greatly impacts how all types of individuals and populations actively participate in their daily lives. Lack of access in the built environment for disabled populations remains a daily reality, negatively impacting engagement and life satisfaction, leading to isolation, loneliness, and depression. A university in the Northeastern United States sought to expand current constructs of the end-user and environment within a universal design (UD) perspective. On an eight-month inaugural interprofessional collaborative co-design experience, third-year occupational therapy doctoral (OTD) students were embedded in a first-year masters of industrial design (MSID) curriculum, which ran the course of the academic calendar (two consecutive semesters: Fall and Spring). Primary aims wanted to determine, via an interrupted time-series quantitative design, if embedding OTD students within the industrial design curriculum influenced the MSID students' prior assumptions, understanding of disability and enhanced their willingness to create more inclusive final products. Quantitative findings indicated that it was difficult to capture the meaningful change that occurred in the doctoral capstone program experience with the existing psychometric tools available.

Anecdotal mixed-method findings indicated that informal interprofessional learning experiences in the classroom, such as lectures and learning activities created and facilitated by the OTD students and delivered in real-time, broadened and enhanced the MSID students' knowledge surrounding disability and accessibility in a more nuanced way than the chosen quantitative survey tools were constructed to capture. A detailed literature review and description of the program have been provided, along with suggestions to capture meaningful outcomes for longer-term interdisciplinary collaborations.

Keywords: Industrial design, occupational therapy, interprofessional education, disability, co-design.

Introduction

The design of the built environment greatly influences how all individuals interact and function with their immediate surroundings (Amiri, Wagenfeld, & Reynolds, 2017; Hitch, Larkin, Watchorn, & Ang, 2012; Larkin, Hitch, Watchorn, Ang, & Stagnitti, 2013). Internationally, about one billion individuals worldwide have a disability (Medola, Sandnes, Ferrari, & Rodrigues, 2018). Lack of access in the built environment for disabled populations remains a daily reality, negatively impacting engagement and life satisfaction, leading to isolation, loneliness, and depression (Rigby & Letts, 2003). Frequently, design solutions do not take into account the needs of disabled populations, limiting independent performance during necessary tasks and meaningful activities despite the inherent abilities existing within the person to function if the design in the built environment was different (Rigby & Letts, 2003). Laws such as the Americans with Disability Act (United States Department of Justice Civil Rights Division, 2020) became federally mandated in the United States in 1990, with the aim to provide more inclusive and accessible environments for all individuals, regardless of health condition or level of function. (Medola et al., 2018; Watchorn, Larkin, Hitch, & Ang, 2014).

Starting in the 1970s, designers began to play a role in implementing broader end user-accessible design solutions for all abilities, leading the way in creating more collaborative and end user-centred buildings and products (Amiri et al., 2017; Sanders & Stappers, 2008).

Universal design (UD), a seven-point methodology introduced during the latter 20th century, aims to provide guidance for designing for all individuals regardless of abilities and capacities (Center for Excellence in Universal Design, 2020). Successful UD application requires interdisciplinary skills, knowledge in human conditions and factors, and close collaboration during various planning and design stages for built environments and product development (Altay & Demirkan, 2014; Hitch et al., 2012; Lid, 2014).

One example of a collaborative approach that can be combined with UD methodology is co-design, which is defined as a diverse group of individuals interacting during the design process, such as the designer, stakeholder, researcher, and end-user (Amiri et al., 2017; Sanders & Stappers, 2008). End users can be defined as those individuals who experience and engage with a product and/or environment. Interprofessional collaboration, particularly between allied healthcare and design professionals, has become more common and has been implemented via a co-design approach to support the growing need for creating products and environments that are more functional for a wider variety of end-users (Amiri et al., 2017; Goodman-Deane, Cassim, Langdon, & Clarkson, 2007).

Occupational therapists are one type of allied healthcare professional who supports individuals to build, recover, and/or maintain daily activities (also known as occupations). Occupational therapists have knowledge in both the medical and therapeutic view of human diagnostic and developmental conditions, which can be important factors to consider when designing for all individuals (Amiri et al., 2017; Hitch et al., 2012; Lid, 2014). Furthermore, occupational therapists are emerging as key collaborators with designers; their professional training offers a holistic and functional perspective regarding the needs and wishes of end-users in their daily lives (Amiri et al., 2017). The Person-Environment-Occupation (PEO) model, a theory often used by occupational therapists and developed by Law et al. (1996), asserts that an individual's performance in their daily life is impacted by the person, environment, and their occupations (Rigby & Letts, 2003). The PEO model suggests that the occupational therapist can intervene by making changes to the environment, reducing environmental barriers and demands to facilitate end users' greater performance (Rigby & Letts, 2003). Research has purported that rehabilitation professionals, such as occupational therapists, who are well-versed in impairment, needs, preferences, and abilities of the end

user, and are trained in UD, could be valuable collaborators to inform design solutions for varying individuals (Lid, 2014; Medola et al., 2018).

In an effort to expand current constructs of the end-user and environment within a UD perspective for designers to make design solutions more inclusive for those with disabilities in the built environment, a university in the Northeastern United States embarked on an eight-month interprofessional collaborative co-design experience with third-year occupational therapy doctoral (OTD) students embedded in a first-year master's of industrial design (MSID) curriculum which ran the course of the academic calendar (two consecutive semesters: Fall and Spring). The primary aims of this experience initially sought to determine, via an interrupted time-series quantitative design, if embedding OTD students within the industrial design curriculum influenced the MSID students' prior assumptions, understanding of disability, and enhanced their willingness to create more inclusive final products that could be used by all individuals. However, as the collaboration progressed, it became increasingly clear that the chosen quantitative survey tools were not constructed to fully capture the informal interprofessional learning experiences in the classroom. The lectures and learning activities created and facilitated by the OTD students and delivered in real-time, broadened and enhanced the MSID students' knowledge surrounding disability and accessibility in a more nuanced way than the chosen quantitative survey tools were constructed to capture. With this in mind, this paper will take a mixed-methods approach. First, the authors will aim to present the reader with a comprehensive literature review of interdisciplinary collaborations between design, healthcare, and occupational therapy, followed by detailed descriptions of the OTD/MSID curriculum learning experiences that occurred throughout this eight-month collaboration. We will conclude with the quantitative survey findings, descriptively enhanced by informal participant interviews and observations, and suggestions for future co-design collaborations within the design professions.

Literature Review

A search of the literature identified barriers to interdisciplinary work between allied healthcare and design, directly related to limited understanding of the respective professions' roles and skills (Amiri et al., 2017; Hitch et al., 2012; Wagenfeld, Reynolds, &

Amiri, 2017). Findings suggested that interprofessional education can increase interest and success in the partnership between occupational therapy and design (Altay & Demirkan, 2014; Hitch et al., 2012; Larkin et al., 2013). As Altay & Demirkan (2014) asserted, "The education of a novice designer plays a significant role in how he or she finds solutions to the requirements of end-users with differences in age, gender, race and abilities, later in professional practice" (Altay & Demirkan, 2014, p.196).

Several studies have investigated the interprofessional collaboration between design and occupational therapy professions (Amiri et al., 2017; De Couvreur, Detand, Dejonghe, & Goossens, 2012; Hitch, Dell, & Larkin, 2016; Hitch et al., 2012; Larkin et al., 2013; Wagenfeld et al., 2017; Watchorn, Larkin, Ang, & Hitch, 2013) but details remain limited regarding the type of settings involved and the purpose of these collaborations outside of the academic setting (Amiri et al., 2017; Hitch et al., 2012; Wagenfeld et al., 2017). While the evidence demonstrates the potential benefits of the interdisciplinary relationship, such as developing creative solutions to meet the needs of all end-users, challenges of professional collaboration have also been identified, such as a misconception of the respective professions' skills, language, and values (Larkin et al., 2013; Wagenfeld et al., 2017). Additionally, there is an emerging body of literature exploring both the impact of UD education and how students may benefit from an interdisciplinary approach (Chang, Tremblay, & Dunbar, 2000; Hitch et al., 2016; Lid, 2014; Mulligan, Calder, & Mulligan, 2018; Watchorn et al., 2013). Findings demonstrate a positive impact of both collaborative and educational modules on students' understanding and awareness of disability and the needs of all end-users (Hitch et al., 2016; Medola et al., 2018).

Evidence of collaborative initiatives between design and occupational therapy within the academic setting identified students working together during week-long to semester-long projects to create solutions for a particular individual with a disability or a population (Chabot, 2017; De Couvreur et al., 2012; Dong, 2010; Larkin et al., 2013). While the collaborative projects varied in terms of objectives, design professions, and length, common themes regarding the values and challenges emerged (Larkin et al., 2013). Chabot (2017) described fifth-year architecture and third-year occupational therapy students working together to redesign a local train station to make it more accessible for the community. Benefits for the architecture students included a clearer understanding of

occupational therapy and an increase in awareness of design's impact on disability and participation. The occupational therapy students gained skills in communicating their profession's value and expertise. Similar to findings in Wagenfeld et al. (2017), challenges of the collaboration were identified and included a difference in shared language and interests. Findings from the literature are informative in helping to understand the complexities of interprofessional education between design and occupational therapy; yet, with this in mind, there remains an unmet need to explore these types of collaborations further (Chabot, 2017; Larkin et al., 2013; Wagenfeld et al., 2017).

In other examples of interdisciplinary projects between occupational therapy and design professions, outcomes indicated that having an allied healthcare professional on the team aided in filling the knowledge gap between the end user and designer and advanced the design student's understanding of disability (De Couvreur et al., 2012; Dong, 2010; Medola et al., 2018). De Courvreur et al. (2012) illustrated a co-design team involving multiple stakeholders, including an industrial design student, an occupational therapy student, an individual diagnosed with ankylosing spondylitis, a caregiver, and another rehabilitative expert. Similarly, Dong (2010) described a summer-long course involving two co-design teams of engineering design students, individuals living with multiple sclerosis, and an occupational therapy student. Lastly, in an inclusive design collaboration, industrial design, architecture, urban studies, and visual art students collaborated with rehabilitation professionals to learn more about the needs of individuals with disabilities (Medola et al., 2018). Results from these co-design collaborations identified that including the end-user greatly benefitted the design process (De Couvreur et al., 2012; Dong, 2010). Furthermore, the engineering design students who collaborated with the occupational therapy student commented that the design students increased their understanding of the rehabilitation profession and valued occupational therapy's perspective on the end user's needs and expectations.

Methodology

Participant Demographics

Participants in this eight-month interprofessional collaborative co-design experience included two third-year occupational therapy doctoral (OTD) students with undergraduate educational backgrounds in neuroscience, psychology, human biology, and occupational science and 10 first-year MSID students with undergraduate educational backgrounds in mechanical engineering, architecture, bioengineering, fine arts, mathematics, graphic design, civil engineering, and aerospace. Five of the ten MSID students were non-United States citizens. Demographically, the OTD and MSID student participants were comprised of six females and six males with an age range of 23 to 32 years of age. Two occupational therapy faculty mentors had prior and ongoing careers in design (landscape architecture, industrial design, and graphic design; 15+ years), and the two remaining course faculty were seasoned industrial designers (30+ years). See Table 1.

Table 1. Collaboration Participants.

Professional Background	# of Participants
Occupational Therapy Doctoral (OTD) Students	2
First-year Masters of Industrial Design (MSID) Students	10
Occupational Therapy Faculty Mentors	2
Industrial Design Faculty	2

Collaboration Design

Within Month 1 of the eight-month interprofessional collaborative co-design experience, the two OTD students first completed a "SOAR" Analysis (strengths, opportunities, aspirations, results) (Group Map Technology, 2019) with extensive input from both the industrial design faculty and the MSID students. Under the guidance of the occupational therapy faculty mentors, the OTD students also concurrently completed a comprehensive literature review of healthcare and design collaborations related to occupational therapy. Those findings, as reported earlier in this paper, served to frame and context the informal learning experiences that would eventually be created and delivered throughout the

collaborative experience. In line with the embedded interprofessional co-design model, the occupational therapy faculty mentors arranged for the OTD students to attend multiple MSID courses weekly over the entirety of the eight-month collaboration. While in the program, the OTD students continually consulted and collaborated directly with designers while also receiving direct mentorship from the industrial design faculty and MSID peers for the duration.

Project Descriptions and Timeline

In Month 1, the first collaborative design project involved a design competition for drinkware conducted by a well-known international glassware corporation. Here, MSID students sought consultation from the healthcare perspective regarding form, usability, and function of the glassware products. In turn, the OTD students gained initial insight into MSID design thinking and iterative processes. In Months 2 to 4, a six-week toy project commenced between the OTD, MSID, and UX/UI students in a design research class. Here, toys containing digital interface for the four-to-eight-year-old pediatric population were co-designed. The OTD students, using end user-research principles, delivered informal lectures on typical play, physical, social, and cognitive development for this age range to support MSID and UX/UI students' understanding of the end-user.

Following these introductory collaborative projects, in Month 3, the OTD and MSID students embarked on a six-month-long caregiver project. Here, the MSID students were tasked to design a product for the caregiver of an individual diagnosed with either autism spectrum disorder, stroke, neurocognitive disorder, or intellectual disability. In Month 3, OTD students researched, designed, and led informal learning experiences for the MSID students and industrial design faculty by stimulating living situations in which a caregiver may face and also presented background information on the specified health conditions through the caregiver lens (Dong, 2010; Ergenoglu, 2013; Medola et al., 2018). From month 5 to 8, the OTD students also facilitated multiple end-user research experiences, thus exposing the MSID students and industrial design faculty to various end-users and stakeholders. This included volunteer caregivers and/or individuals with the assigned conditions to allow the MSID students and industrial design faculty to experience first-hand about end-user needs and to discuss the scope of potential design solutions. Additionally, beginning in Month 5,

after close consultation with industrial design faculty and occupational therapy faculty mentors, didactic learning modules on the occupational therapy perspective through UD principles were created and inserted into the MSID curriculum by the OTD students, which was content not addressed previously in the MSID students' current curricula (industrial design faculty member, personal communication, October 18, 2018). See Table 2 for timeline and Table 3 for a comprehensive list of collaborative co-design experiences.

Table 2. Collaborative Co-Design Timeline

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Rapport								
Needs								
	IRB Process and Approval							
Consultation with Design								
	User Research							
				Data Collection				
Glassware Comp.								
		Toy Project						
				Independent Project				
		Caregiver Project						
			Medication Packaging					

Table 3. Description of Experiences.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 1 (September): Rapport Building and Needs Assessment.	Occupational therapy doctoral (OTD) students arrived on-site to the industrial design program. OTD students completed a SOAR Analysis and attended ID coursework. OTD students attended and observed year 1 & 2 MSID studios. OTD students met with the MSID students individually and offered consultation on design projects including for the glassware design competition on as-needed basis.	OTD students attended courses in curricula: Cross-disciplinary course in ergonomics with occupational therapy & industrial design: *Health Factors & Ergonomics* User Research courses with industrial design and user experience/user interface design students.	OTD students Interviewed ID faculty and students to complete SOAR Analysis.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 2 (October): Toy Project, Literature Review, & Consultation.	OTD students continued to attend and engage in courses in the curricula, started literature review for scholarly capstone and began the Institutional Review Board process. OTD students attended and observed year 1 & 2 MSID studios. OTD students met with MSID students and started consulting design projects on an as-needed basis.	OTD students attended courses in curricula: Health Factors & Ergonomics in which the students attended field trips and consulted on an as-needed basis; In the User Research course: the students began the Toy Project; the OTD students delivered a formal lecture on child development.	OTD students consulted on a Medication Packaging Project in an undergraduate graphic design course

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 3 (November): Introduction to Caregiver Project.	OTD students implemented education modules, based on needs presented by design instructors, literature/evidence, and perspectives from the faculty mentor. OTD students attended and observed year 1 & 2 MSID studios. Along with the Design faculty members, the OTD students introduced the Caregiver Project Brief. The OTD students provided formal lectures on occupational therapy practice framework, occupational therapy theory, disability etiquette, and experience. In addition, the year 1 MSID studio took a class trip to the occupational therapy Activities of Daily Living (ADL) suite to discuss the impact of health conditions on occupations and surveyed AT/AD (assistive tech/assistive devices).	OTD students attended courses in curricula: In the Health Factors & Ergonomics course attended field trips and consulted on an as-needed basis. The students continued to work on the Toy Project in the User Research course.	OTD students continued to work on the medication packaging project in the undergraduate graphic design course. OTD students began exploring design areas for independent project.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 4 (December): Problem Identification of Caregiver Project & Narrowed Focus for Independent Project.	In the last month of the semester, the OTD students continued to attend classes in the curricula, aided in identifying problem areas for "Caregiver Project" & continued with independent project by starting CAD tutorials. OTD students attended and observed year 1 & 2 MSID studios. The OTD students continued with the Caregiver Project, facilitated disability simulation, gathered a compilation of resources for students, and started reaching out to volunteers for caregiver/user visits. OTD students consulted on other projects on an as-needed basis.	OTD students attended courses in curricula: In the Health Factors & Ergonomics course, the OTD students attended field trips and consulted on an as-needed basis The students finalized the Toy Project in the User Research course.	OTD students finalized independent project focus through user research. OTD students began learning computer-aided design software (CAD) through online tutorials and practice.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 5 (January): Data Collection Time 1 (RIPLS & ADTP-A) & User Visits.	The team received Institutional Review Board approval for scholarly projects and began data collection. OTD students attended and observed year 1 & 2 MSID studios. The OTD students continued facilitating the *Caregiver Project*. The OTD students continued to reach out to volunteers and coordinate for caregiver visits. OTD students consulted on other projects on as-needed basis, including wheelchair use for *Circular Economy Project* and needle management for *Safety Project*.	OTD students attended courses in curricula: In a *Healthcare + Design* course: attended field trips and continued to work on independent projects. In the course, the OTD students also gained exposure to architecture field (one of the OTD students collaborated with architecture student for independent project). OTD students also attended the undergraduate *OT/ID Junior Collaboration* course and consulted on an as-needed basis.	OTD students continued to work on independent projects.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 6 (February): Continued User Visits & Design Phase	OTD students attended and observed year 1 & 2 studio: Continued with "Caregiver Project:" facilitated user visits with caregiver and individuals; Consulted on other projects on an as-needed basis.	OTD students attended courses in curricula: In a *Healthcare + Design* course: attended field trips and continued to work on independent projects. OTD students continued to attend the undergraduate *OT/ID Junior Collaboration* course and consulted on an as-needed basis.	OTD students continued to work on independent projects. Created "big ugly" prototypes with feedback from 1 & 2-year students and faculty mentors.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 7 (March): Universal Design, User Visits, Design Phase & Data Collection Time 2 (RIPLS & ADTP-A).	OTD students continued to assist with *Caregiver Project*, completed data collection for scholarly projects, and continued to work on independent projects. OTD students attended and observed year 1 & 2 MSID studios. In year 1 MSID studio, continued working on the *Caregiver Project*. The OTD students provided a formal lecture on the occupational therapy perspective of Universal Design. Continued with caregiver visits. OTD students continued to consult on other projects on an as-needed basis.	OTD students attended courses in curricula: In a *Healthcare + Design* course: attended field trips and continued to work on independent projects. OTD students continued to attend the undergraduate *OT/ID Junior Collaboration* course and consulted on an as-needed basis.	OTD students continued to work on independent projects. OTD students continued to explore and work with prototypes and deliverables- including CAD modeling.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 8 (April): Caregiver Project, Independent Project & Scholarly Project Wrap-up.	OTD students continued to consult on the *Caregiver Project* and facilitated follow-up visits with caregivers as-needed.	OTD students attended courses in curricula: In a *Healthcare + Design* course: attended field trips and continued to work on independent projects. OTD students continued to attend the undergraduate *OT/ID Junior Collaboration* course and consulted on an as-needed basis.	OTD students presented their independent projects in the *Healthcare + Design* course. OTD students presented their scholarly projects in Occupational Therapy course.

Timeline for OTD	MSID Program Participation	MSID Courses	Additional Experiences
Month 9 (May): Completion of Caregiver Project & Completion of Time On-Site	MSID students gave their final presentations of the *Caregiver Project*.		

Quantitative Procedures

Exempt approval was obtained from the university's Institutional Review Board for data collection later than anticipated (Month 5). Data were collected at two points via an interrupted time series design format. Two self-report questionnaires were provided to the MSID students at Time 1 (Month 5) and Time 2 (Months 7 and 8) to access MSID student attitudes towards interprofessional learning and individuals with disabilities. Microsoft Excel and Statistical Package for the Social Sciences (Version 25.0) were used to analyze findings. Because of the small sample size, nonparametric statistics were used. A Wilcoxon signed-rank test was used to compare students' responses for both questionnaires over two time periods.

RIPLS

The *Readiness for Interprofessional Learning Scale (RIPLS)* by McFadyen et al. (2005) is a 19-item self-report questionnaire that accesses both students' and professionals' attitudes towards interprofessional learning in the healthcare fields. The questionnaire is a revised version of the original report developed by Parsell & Bligh (1999) and shows good test-retest reliability on three out of the four subscales (McFadyen, Webster, & Maclaren, 2006). While the survey is intended for individuals in the healthcare field, no other instruments that assess interprofessional learning in other professions are currently available (Larkin et al., 2013).

The MSID students were instructed to insert "industrial design and occupational therapy" when coming across the phrase "healthcare students." Participants were asked to rate their responses using a five-point Likert Scale with responses ranging from "strongly disagree" to "strongly agree." Participants received a score ranging from 19 to 95, with a higher number suggesting a more positive attitude towards interprofessional learning (A. McFadyen, personal communication, November 7, 2018; Larkin et al., 2013).

ATDP-A

The *Attitudes Toward Disabled Persons – form A (ATDP-A)* (Yuker, Block, & Younng, 1970) is a 30-item self-report questionnaire that assesses a person's attitude and understanding

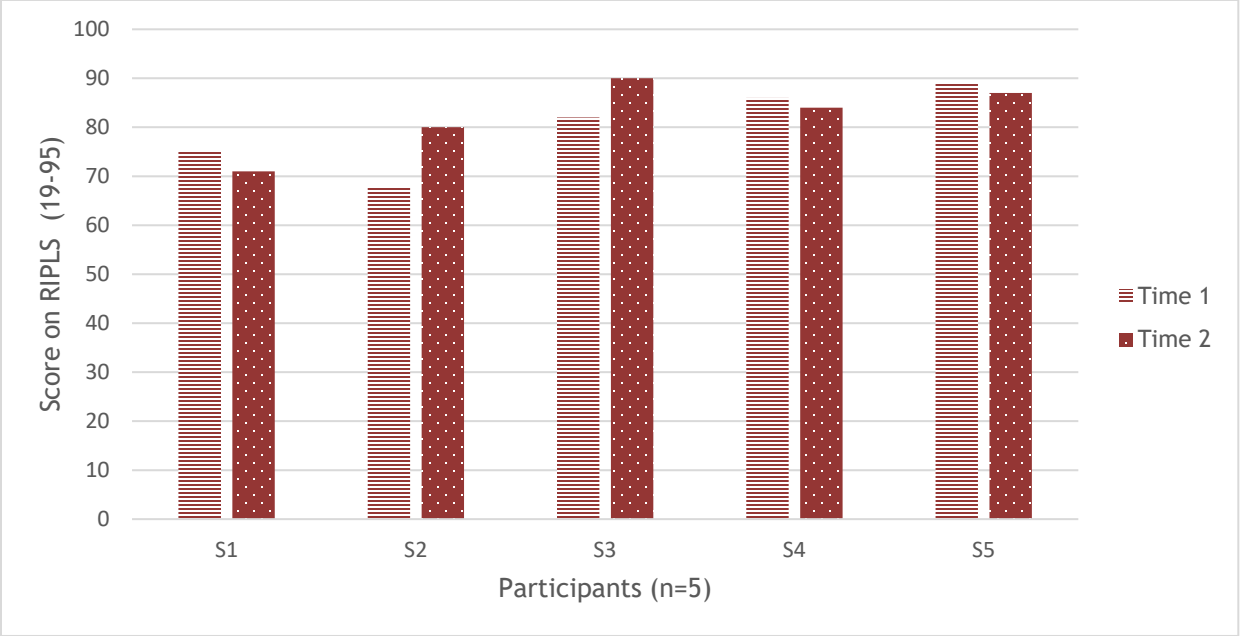
towards individuals with disabilities (Chang et al., 2000). The results of the test-retest reliability for ATDP-A was .78, which the authors of the questionnaire assert were comparable to other instruments (Yuker, Block, & Younng, 1970). The MSID students were asked to rate their response using a Likert Scale format of six options from -3 (strongly disagree) to +3 (strongly agree). Students received a score ranging from 0 to 180, with a higher number suggesting a more positive attitude (Chang et al., 2000).

Assessment Tool Results

RIPLS

Across two time periods (Month 5 and Month 7), five (50%) MSID students accurately completed the RIPLS questionnaire. Responses of MSID students who did not completely fill out the questionnaire and/or who did not accurately code their questionnaire were not analyzed. A Wilcoxon signed-rank test showed that from Time 1 to Time 2, there was not a statistically significant change in student responses for the RIPLS questionnaire ($Z= -.406$, $p=.684$). Two of the MSID students had a slight increase in score at Time 2, while three of the MSID students had a slight decrease in score at Time 2. Itemized analysis of the questionnaire revealed a statistically significant change in MSID student responses from Time 1 to Time 2 for question 17: “The function of nurses and therapists is mainly to provide support for doctors” ($Z=-2$, $p=.046$). See Figure 1.

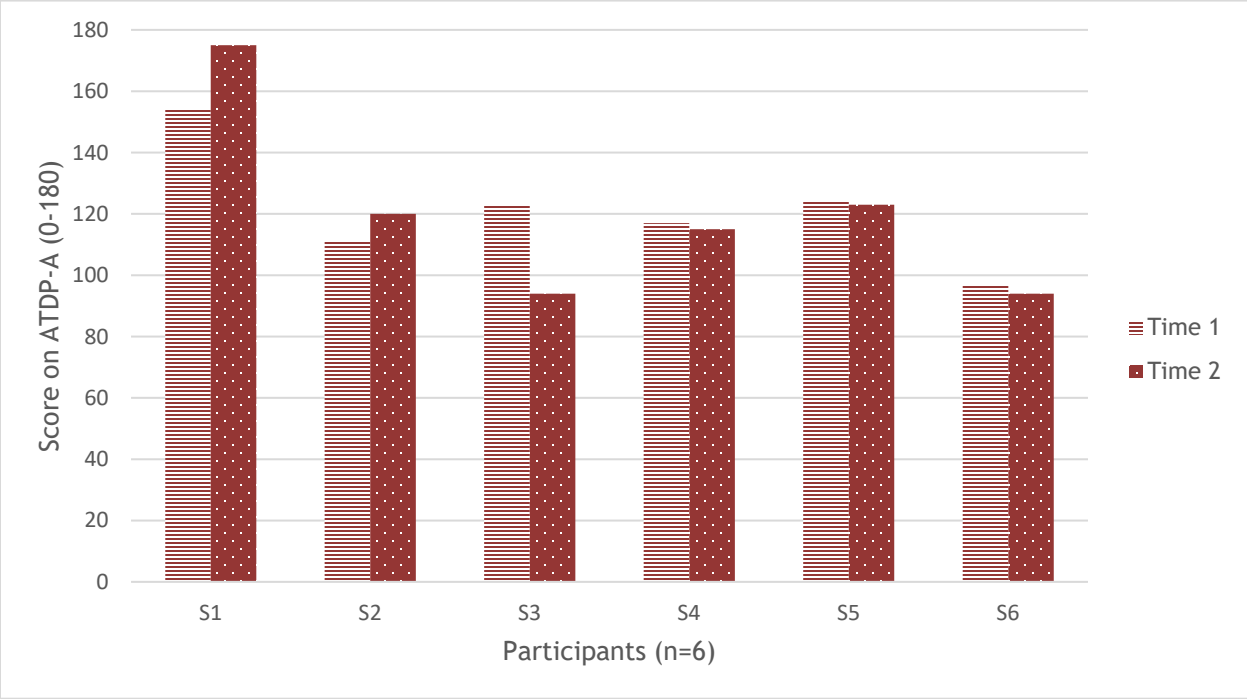
Figure 1: Student Scores on the RIPLS Questionnaire at Time 1 and Time 2.



ATDP-A

Over the two time periods (Month 5 and Month 7) of data collection, six (60%) MSID students accurately completed the ATDP-A questionnaire. Responses of MSID students who left more than 10% of the items blank and/or who did not accurately code their questionnaire were not analyzed (Yuker, Block, & Younng, 1970). A Wilcoxon signed-rank test showed that over a six-to-eight-week period that there was not a statistically significant change in student responses for the ATDP-A questionnaire (Z=-.314, p=.753). With a score range of 0 to 180, the median ATDP-A score was 117.0 at Time 1 and 121.0 at Time 2. Two MSID students had a slight increase in score at Time 2, while four MSID students had a slight decrease in score at Time 2. Itemized analysis of the questionnaire revealed a statistically significant change in MSID student responses from Time 1 to Time 2 for question 2: "Disabled people should not have to compete for jobs with physically normal persons" (Z=2.060, p=.039). See Figure 2.

Figure 2. Student Scores on the ATDP-A Questionnaire at Time 1 and Time 2.



Discussion

The primary aims of this experience initially sought to determine, via an interrupted time-series quantitative design, if embedding OTD students within the industrial design curriculum influenced the MSID students' prior assumptions, understanding of disability and enhanced their willingness to create more inclusive final products that could be used by all individuals. Over two consecutive semesters, the OTD students established a professional and collaborative relationship with the MSID students and industrial design faculty. The results for the RIPLS questionnaire at Time 1 were high, showing a positive attitude towards interprofessional collaboration. While the results for the ATDP-A questionnaire did not produce statistically significant results, overall findings suggested that the students had a relatively positive attitude towards individuals with disabilities, which may have occurred secondary to the OTD students spending considerable time within the design program observing and building rapport with both MSID students and industrial design faculty members prior to Time 1 data collection.

The formal and informal educational modules on child development, occupational therapy theory, disability experience, UD, and the specified health conditions for the caregiver project provided an additional, outside, non-design perspective to the industrial design curriculum. These components arose spontaneously in the collaboration, broadening and enhancing the MSID students' knowledge surrounding disability and accessibility in a more nuanced way than the pre-selected quantitative survey tools were constructed to capture. Informal meetings with both individuals with various disabilities and their caregivers also broadened the MSID student's view of the end-user. As one student noted, "No matter how many things I read online or watched YouTube clips of, nothing compared to the actual experience of speaking with an [end] user" (Industrial design student, personal communication, March 7, 2019). This anecdotal evidence is consistent with findings, highlighting the importance of including end-users in the design process (De Couvreur et al., 2012; Dong, 2010; Goodman-Deane et al., 2007; Medola et al., 2018).

The addition of both the occupational therapy and caregiver perspectives to the design curriculum enhanced the MSID student's design process, which supports the literature on the co-design approach (De Couvreur et al., 2012). When MSID students did not have access to various end-users, they were able to obtain input from the OTD students regarding the needs of the end-user (Dong, 2010). As Dong (2010) asserts, including the end-user is not always feasible due to ethical and time constraints, and thus having insight from a professional, such as the occupational therapist, can offer insights regarding the health conditions. Furthermore, during the informal end-user visits, the OTD students facilitated the conversation between the caregivers and the MSID students, helping bridge and translate the communication between both parties (Dong, 2010; Lid, 2014). In these instances, the role of the occupational therapist became critical. As Lid (2014) asserts, "Knowledge derived from rehabilitation professions and from people with disabilities are both necessary in order to expand upon the individual dimension in UD" (Lid, 2014, p.1347). Evidence suggests that using a co-design approach, knowledge, and insight from both the caregiver and the occupational therapy perspective benefits the MSID students' design process in framing and defining the needs of the end user (Amiri et al., 2017; Lid, 2014).

Previous collaborations found in the literature between occupational therapy students and design students consisted of singular projects over shorter time frames (Chabot, 2017; De

Couvreur et al., 2012; Dong, 2010; Larkin et al., 2013); however, this eight-month interprofessional collaborative co-design experience aimed to go one step further in creating a multifaceted exposure of interprofessional collaboration through various longer-term projects and educational modules. The OTD students had ample opportunities to work and consult with the MSID students, occupational faculty mentors, and industrial design faculty on many projects throughout their eight-month tenure in the industrial design department. Additionally, while some of the design projects may have focused primarily on individuals with disabilities, the OTD students had the opportunity to provide insight on other design projects, such as a design competition for drinkware conducted by a well-known international glassware corporation. The MSID students sought consultation from the occupational therapy perspective regarding form, usability, and function of the glassware products and their impact on the scope of various end-users, which is important to consider as there is variability in the needs and wants of all end users. It is possible that not only did the OTD students' presence serve to educate and advocate for end-users with disabilities, but their outside perspective may have helped to broaden the MSID students' knowledge of end-user diversity (Lid, 2014).

In addition to furthering the MSID students' notion of the end-user, the eight-month collaboration in turn also greatly benefitted the OTD students. As a result of the symbiotic relationship between occupational therapy and industrial design, the OTD students learned about the design process through three avenues:

- Observation and attendance of various design courses, including an end-user research course;
- The completion of an independent design project led by the OTD students requiring the acquisition of skills in computer-aided design programs, prototyping, and sketching; and
- Collaborations on various design projects, including the caregiver project and the toy project.

In addition to learning more about another profession's culture, similar to findings described in Chabot (2017), the OTD students further developed their skills in

communicating the values and mission of occupational therapy to a broader community. Lastly, by advocating for the end-user, the OTD students were able to pursue the goal of the American Occupational Therapy Association's (2017) Vision 2025 mission, in that occupational therapy "maximizes health, well-being, and quality of life for all people, populations, and communities through effective solutions that facilitate participation in everyday living" (American Occupational Therapy Association [AOTA], 2017, p. 7103420010p1).

Limitations: Lessons Learned

Good research design purports that baseline measurements should be implemented early in any collaboration in order to fully capture participant attitudes from the beginning of the collaboration. Using accessible and validated assessment tools already described in the literature was the chosen approach decided by occupational therapy faculty mentors during Month 3 of the experience to ensure reliability and validity. The expectation that the OTD students would also independently draft and submit their own IRB submission did not commence on this project until Month 4. Approval from the Institutional Review Board was not granted until Month 5 (a direct result of the newness of the experience and the challenges with launching an inaugural OTD third-year program within the confines of an academic year), which further prevented the OTD students' ability to capture a true baseline measure, as the relationships between the MSID students and OTD students had been already established by the time IRB approval was granted. Due to the novelty, uniqueness, and organic nature of this eight-month interprofessional collaborative co-design experience, the varied backgrounds of the MSID students (including language barriers experienced by the five international students), difficulties with capturing outcome approaches with the RIPLS and the ATDP-A tools became readily apparent as soon as data collection commenced. In the end, these requirements proved to be too constrictive and posed a significant barrier to the OTD students' ability to capture meaningful outcomes for this type of longer-term interdisciplinary program experience. While the ATDP-A grasped the basic aspects of the disability experience, the tool proved to be too simplistic in its ability to assess and portray the students' attitudes and awareness of human diversity or the ongoing novel, interdisciplinary collaboration occurring within this specific program

experience. While the RIPLS was a tool commonly used to assess students within the healthcare fields, the MSID students reported difficulty with contextualizing the questions in relation to their own understanding as designers.

Conclusion

This inaugural eight-month interprofessional collaborative co-design experience aimed to engage OTD, MSID students, and their concurrent department faculty in an embedded collaboration between occupational therapy and industrial design to promote more accessible design solutions that better addressed the needs of disabled populations. As noted by Altay & Demirkan (2014), the opportunity to educate and broaden design students' understanding of disability during their curricular experiences can greatly influence who they become as future professionals regarding having the skills necessary to problem-solve successfully for a variety of end-users. Our findings had hoped to significantly quantify the positive impact of both collaborative and educational modules on MSID students' understanding and awareness of disability and needs of all users in a longer-term interprofessional co-design experience as purported by Hitch et al. (2016) and Medola et al., (2018). While this was not the case, anecdotally, a few of the MSID students reported that the OTD students were helpful in advancing their understanding of disability, which supports the findings of De Couvreur et al. (2012), Dong (2010), and Medola et al. (2018). As these interprofessional collaborations continue to broaden and develop, it is recommended that future experiences utilize qualitative approaches such as interviews or invest time in developing a tool that can be more flexible towards accommodating other types of professions beyond the scope of healthcare. Queries and/or tools designed to accommodate the fluid nature of the design process and that allow for data collection at multiple points in longer-term experiences would allow for a richer understanding and improved captures of student learning outcomes.

By breaking down the professional silos, exposing both disciplines to one another, and introducing the lived experience for those with disabilities, the OTD students, MSID students, occupational and industrial design faculty appeared to have anecdotally benefitted from partaking in this longer, eight-month inaugural interprofessional

collaborative co-design experience. The hope is that future professional trajectories have been influenced as they will carry the concepts learned and experiences into future employment scenarios. Our mixed-method qualitative findings hinted of richer opportunities moving forward. Future interprofessional collaborative co-design experiences should aim to focus on the impact on students from both professions in a bi-directional manner. Programming may want to examine and explore the long-term effects through longitudinal studies of the collaborations' impact on occupational therapy and industrial design beyond academia and into professional employment; including, but not limited to nursing, physical therapy, speech therapy, exercise science, architecture, landscape architecture, interior design, graphic, and the fashion design fields. There is great potential for upcoming studies to investigate the process of knowledge translation and how the interdisciplinary relationship impacts both attitudes of the students and faculty and later professional outcomes of design solutions in relation to end-user experience for those living with a disability.

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