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Rose McAndrew
Saint Louis University

Amanda L. Wilson
Encompass Health

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Abstract

Many occupational therapy programs use hybrid instruction methods that include virtual learning. To ensure active learning techniques, instructors must alter and adapt traditional instruction methods to the virtual environment. This article explores the use of a virtual Makerspace to create adaptive equipment used throughout online intervention course experiences. Thirty-seven first year occupational therapy students participated in an exclusively online, synchronous course focusing on interventions for adults with physical disabilities. A Makerspace was created to allow students to have access to adaptive equipment (AE) and teach students how to fabricate low-cost AE for future clients. During class, guided instruction was provided to fabricate a sock aide and a universal cuff. This AE was then used throughout the course to provide hands on learning opportunities. Summative assessments were used at midterm and at the conclusion of the course. Students noted enjoyment and preference for hands on activities such as Makerspace, acknowledging how this connected with roleplaying and client interactions. Students were observably engaged throughout the course and integrated AE into learning scenarios throughout. Student feedback supported the use of a virtual Makerspace and reinforces the notion of the maker movement as shared ideas and space to build community. This not only provides a learning opportunity but offers connection in virtual environments. Makerspace activities can also be used to build competence and confidence in OT intervention. A Makerspace is an active learning opportunity that can be successful in person or virtual environments.

Keywords

Online learning, adult intervention, makerspace, experiential learning

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Rose McAndrew, OTD, OTR/L, CHT[1]

Amanda Wilson, MSOT, OTR/L[2]

Saint Louis University & Washington School of Medicine, St. Louis[1]

Encompass Health[2]

United States

ABSTRACT

Many occupational therapy programs use hybrid instruction methods that include virtual learning. To ensure active learning techniques, instructors must alter and adapt traditional instruction methods to the virtual environment. This article explores the use of a virtual Makerspace to create adaptive equipment used throughout online intervention course experiences. Thirty-seven first year occupational therapy students participated in an exclusively online, synchronous course focusing on interventions for adults with physical disabilities. A Makerspace was created to allow students to have access to adaptive equipment (AE) and teach students how to fabricate low-cost AE for future clients. During class, guided instruction was provided to fabricate a sock aide and a universal cuff. This AE was then used throughout the course to provide hands on learning opportunities. Summative assessments were used at midterm and at the conclusion of the course. Students noted enjoyment and preference for hands on activities such as Makerspace, acknowledging how this connected with roleplaying and client interactions. Students were observably engaged throughout the course and integrated AE into learning scenarios throughout. Student feedback supported the use of a virtual Makerspace and reinforces the notion of the maker movement as shared ideas and space to build community. This not only provides a learning opportunity but offers connection in virtual environments. Makerspace activities can also be used to build competence and confidence in OT intervention. A Makerspace is an active learning opportunity that can be successful in person or virtual environments.

Introduction

Adaptive equipment (AE) is well-established as an evidence-based intervention for adult clients with myriad disabilities to help improve their occupational performance and participation (American Occupational Therapy Association, 2020; Dorsey & Bradshaw, 2017; Smith, 2017). For example, a client with standard hip precautions uses AE to independently complete lower body dressing. Occupational therapy (OT) students are required to "*assess the need for and demonstrate the ability to design, fabricate, apply, fit and train in assistive technologies and devices*" (Accreditation Council for Occupational Therapy Education, 2018) relevant to clients and their occupational needs during their didactic coursework. Instruction can be accomplished through role-playing, trying to use the AE themselves, teaching AE to clients in student clinics, or using standardized patient encounters where AE would be relevant. While partial face-to-face and part online (hybrid) OT education is not new and many schools offer at least some instruction online (Pucillo et al., 2020), clinical skills, such as selecting AE and educating clients in usage, is typically accomplished through various in-person and hands-on experiences. (Eberth et al., 2019; Erickson, 2018; Henderson et al., 2017; Knecht-Sabres, 2013; Sakemiller & Toth-Cohen, 2020). However, the sudden pivot to full online learning due to COVID-19 in March 2020 forced faculty to considerably modify all in-person, and therefore, hands-on instruction, including the variety of ways to teach AE available in current literature.

Active learning techniques are methods that require more than just students listening to the instructor teach (Griffiths & Ursick, 2004). These methods may require students to engage with material using other senses like touch (Griffiths & Ursick, 2004), use cooperation and collaboration with each other (Khan et al., 2017; Milton & Landon, 2019), or teach others (Godinez Castellanos et al., 2021). Instructors who incorporate active learning cite improved motivation among students (Godinez Castellanos et al., 2021) and exam performance (Entazarri & Javdan, 2016), with students giving overall positive feedback to this method of instruction, even when novel (Milton & Landon, 2019). Lab experiences in OT education can be considered an active learning technique, where students are able to touch and move, cooperate and collaborate with each other to practice and give feedback, or role play teaching others, a skill needed in practice. The abrupt move to online coursework proved challenging to OT faculty to maintain the rich nature of these experiences without access to lab space or equipment (Benaroya et al., 2021; Eglseder & Littleton, 2021). Faculty, regardless of discipline, had already cited difficulty implementing active learning techniques online prior to the emergency of the COVID-19 lock-down (Khan et al., 2017). Moreover, research showed that college-aged students felt isolated and bored during the shift to emergency online learning in 2020, across disciplines and throughout the world (Bhowmik & Bhattacharaya, 2021; Male et al., 2020). Overall, students were not satisfied with their online learning experience during COVID-19 lockdowns (Cui, 2021).

The *Maker Movement* or *Maker Culture* involves a sense of collegiality working toward a common good through shared knowledge during the creative process (Gierdowski & Reis, 2015; Taylor et al., 2016). Makerspaces grew out of this culture and are an evidenced-based means of experiential, hands-on learning common in science and

mathematics disciplines (Hsu et al., 2017). A Makerspace includes parts, components, and pieces that students may use in any way they choose (Gierdowski & Reis, 2015; Hsu et al., 2017). Students engage in project-based learning using creativity and problem-solving to build solutions by creating something new or improving on what already exists (Hsu et al., 2017). Colleges and universities are successfully implementing Makerspaces to use in instruction in a variety of formats including fixed location (Hilton et al., 2020) and mobile Makerspaces (Gierdowski & Reis, 2015). Faculty create Makerspaces by first deciding what material to include that facilitates an outcome related to that field, e.g., 3-D printer in an engineering Makerspace (Keune & Peppler, 2019). Recently, Makerspaces are moving beyond the science and mathematics fields and are successful in coursework for health sciences career students (Ludwig et al., 2017) and, specifically, OT education (E. Hawkins-Chernoff, personal communication, April 1st, 2021).

We desired to continue the active learning environment in the community spirit of Maker Culture for our students to decrease isolation and boredom and increase satisfaction with their online learning experience. Using the evidence-based idea of Makerspaces, we created a hands-on learning experience for a 100% online OT Intervention-centered course. The purpose of this paper is to outline the community fabrication (Makerspace) and usage (two additional teaching modules) of the fabricated AE by OT students.

Description

Thirty-seven first year entry-level doctorate in OT students participated in an online, synchronous course focusing on interventions for adults with physical disabilities at a private west coast university in the Summer of 2021. The class was designed as an in-person, synchronous course, but was taught 100% online due to COVID-19 restrictions implemented by the university. As this was the inaugural cohort for this doctoral program, we created all new content instead of needing to translate an in-person course to online.

We recreated an online Makerspace, with two goals: 1) allow each student to have access to two pieces of AE to practice at home and 2) teach students how to fabricate low-cost AE for their clients in the future, if their clients have limited resources. The Makerspace module occurred in the third week of class, after general introduction, theory, and review of previous semester's relevant instruction and tie-in with physical disabilities (e.g., range of motion). We elected to fabricate a sock aide and universal cuff with intention to use both at least one time throughout the trimester in regular instruction. We gave students a list of materials to bring to the Zoom meeting:

- Scissors and/or box cutter
- Large plastic bottle (big enough to fit your foot in once cut open. Examples include 2-liter bottle, cleaning wipes container, Gatorade bottle)
- Rope or thick yarn at least 62 inches in length
- Duct tape
- Sock
- 2 rubber bands or hair ties

Written and verbal instructions were provided to the students for in class AE fabrication and we fabricated along with the students. We recorded the Zoom meeting for students to reference as well. Instructions for each piece of AE are below:

Sock Aide

1. Using your pocketknife or box cutter, you will cut the top part of the bottle off. Next cut the bottom part off.
2. Next, using scissors, cut 2-3 inches of the bottle length so your foot can slide through it.
3. Make two holes using the box cutting near the ends of the bottle so you can put rope through them.
4. Cut your 62-inch rope in half so there will be two 31-inch individual ropes.
5. Put your different ropes through the hole and make a knot through the ends.
6. Using the duct tape, wrap it around the bottle.

Photo of student-made Sock Aide, credit Ellyette Lara

Universal Cuff

1. Place one rubber band or hair tie over the other so they overlap slightly. Take top rubber band and wrap fully around bottom one and pull through to make a loop.

We had the students try each piece of AE during this class session and instructed them to keep them accessible as we would use them later in the course.


Photo of student-made Universal Cuff, credit Diana Tsvor

During the Hip and Knee Orthopedic Module, we divided students into pairs (or one group of three) and placed in break-out rooms on Zoom. We provided the students a prompt to role play the following scenario:

> Student A- Patient, Student B- OT, Case Study: Taylor is a 59-year-old who is recovering from a L Total Hip Arthroplasty, posterior approach. They have been working with OT; however, still have not met their goal of lower body dressing. You decide to introduce the sock aide in your session. Instruct Taylor on sock aide use for lower body dressing using patient friendly language.

Students were given time to role play as well as debrief with one another in pairs. We then debriefed as a class and students were able to discuss and ask questions to each other and to us.

During the Spinal Cord Module, we elected to keep students in a large group to allow everyone to perform one or more activity of daily living (ADL). Prior to class we instructed students to bring one or more items necessary to complete an ADL. Examples included: toothbrush, spoon, make-up, or hairbrush. We provided the following prompt to students:

> *Don your universal cuff (u-cuff) and use it during an ADL task. You should simulate this task with no active range of motion in digits during task. Use the u-cuff as well as tenodesis grasp to assist. How was this different than you expected? What other strategies or intervention ideas could you use to increase independence with this task?*

We again debriefed all together so students could ask questions and discuss together.

Assessment

Since the fabrication of the AE during our online Makerspace was part of an in-class activity, it was marked as "participation" only, with all students successfully completing the fabrication within the parameters of the class time as measured by still photographs. Although we did not conduct specific assessment regarding this class session, we did conduct informal, summative assessments of the course two times during the semester, once at midterm, which was not anonymous, and once at the conclusion of the course, which was anonymous. At both times, students were provided with prompting questions and open text boxes to comment as they saw fit. Below are select supporting comments from students. No students provided negative comments towards this activity (see Table 1 and 2).

Table 1

Midterm Course Evaluation Survey

Question Prompt:	**Student Responses Citing Makerspace Activity**
Which aspects of the course (content, methods, organization) do you believe are the most beneficial to your learning, and why?	The in-class activities such as … making universal cuff + sock aide…help me feel more confident and competent in the material because it is more hands on.
	Making a sock aide and the universal cuff was great. I learn better with hands on activities.
	I really enjoyed the Makerspace and how [the instructors] implemented as much hands-on activity as they could for an online class.

Table 2

Final Course Evaluation Survey

Question Prompt:	**Student Responses Citing Makerspace Activity**
What knowledge or skills have you gained from this course?	I was able to make a sock aide and role play many scenarios
	I learned how to use adaptive equipment (sock aide & universal cuff).
	…making adaptive equipment (sock aide)

Discussion

We introduced an online Makerspace to fabricate two pieces of AE for students to use twice throughout the semester in an intervention course for adults with physical disabilities. Student feedback supported our use of this hands-on learning activity.

The idea that we would fabricate the required AE together in a Makerspace in a synchronous class, reinforced the notion of the Maker Movement and Maker Culture as a shared space and shared ideas and a means to build community (Taylor et al., 2016). Although much of the previous research involving Makerspaces describe in-person learning experiences, (Gierdowski & Reis, 2015; Taylor et al., 2016), we felt our online Makerspace also helped build a learning community. We knew fostering a sense of cooperation and unity would be integral to a class where we never met the students in person, and could help stave off boredom, cited earlier as a common complaint among students.

Although not required, several students also elected to use their newly fabricated AE for videos they submitted for virtual competencies in modules besides the two where we told them to use them explicitly. Selecting the AE without overt instructions demonstrated emerging critical thinking skills in these second-trimester students. The lack of critical thinking abilities among OT students is documented in the literature (Pitonyak et al., 2020), and OT educators use different approaches to hone critical thinking skills (Berg et al., 2019; Dashner & Berg, 2021; de Sam LeZaro & Riley, 2019; Grant, 2019; Sakemiller & Toth-Cohen, 2020). By making their own AE, students were interested and invested in these specific pieces of AE. They were able to make the connection to other instances where the AE could be used, outside of explicit instruction.

Occupational therapists in practice informally make assistive technology for their clients and are open to learning new techniques (Moraiti et al., 2015; Slegers et al., 2020). However, research focusing on high-tech intervention, such as 3-D printing, cites that enthusiasm toward do-it-yourself (DIY) assistive technology wanes once other factors are realized, such as cost of hardware and steep learning curve to mastery (Slegers et al., 2020). DIY assistive technology that is low-cost and low-tech may have promising utility by increasing access to AE for individuals when traditional, off-the-shelf AE is cost-prohibitive (Alve & Bontje, 2019; Mettler et al., 2020; Moraiti et al., 2015) difficult to obtain (Hurst & Tobias, 2011), or to simply address the millions of older adults in need (McGarry & Falvey, 2021). The AE fabricated by students in this course was low or no-cost and used materials the students may already have had on hand. They can easily use the directions and skills obtained while fabricating the AE in this course for future clients if the need arises.

Benaroya et al. (2021) noted the use of lab kits as an active online learning strategy for OT Assistant students during the move to virtual learning during COVID-19. The researcher mailed the lab kits to each student, allowing them to have immediate access to learn about and practice using the materials typically used in an in-person laboratory experience (Benaroya et al., 2021). Students in this study rated the lab kits high, earning the second-highest rating out of ten strategies used in terms of helpfulness in their virtual learning (Benaroya et al., 2021). These lab kits allowed students to try out tools and equipment commonly used in treatment. However, in our course, by allowing students to fabricate the needed equipment, we avoided the time and cost of creating and sending kits to every student, while still reaping the benefits of active learning techniques. Even though the researcher used the kits for a pediatric course, the outcome can be generalized for other intervention-centered courses, such as our course for adults with physical disabilities.

Limitations

Our online Makerspace did have some notable limitations. We implemented this at one university with a smaller cohort only one time. Because of loosening COVID restrictions at the university at the time of this writing, this class will be taught at least partially in person for the next cohort; however, we believe the key points of the Makerspaces and the Maker Movement in fostering community, skills in low-tech fabrication, and hands-on active learning could be brought forward with in-person instructions as well. We had limited ability to gather formal assessment and feedback on this activity and we would benefit from direct discussion of this assignment and how having the AE readily available improved future learning experiences both within this course and additional courses within the curriculum. We also provided instructions and materials list to students instead of a more traditional Makerspace where students used available materials to fashion a new or improved AE or other product using their own creativity.

Implications for Occupational Therapy Education

Do-it-yourself AE and the Makerspace are hands-on learning opportunities that could easily continue once students return to in-person or hybrid instruction in OT programs. While we only selected two types of AE, other AE, durable medical equipment, and assistive technology could be homemade and used by students. This experience not only teaches students on how to fabricate the equipment for the future for their clients, it also gives each of them their own piece of AE to practice with themselves, with peers, and with family members to increase competence with usage and instruction on usage. Several student participants demonstrated emerging critical thinking skills of where the AE has utility outside of explicit instruction, and additional Makerspace products may help foster critical thinking skills in OT students.

Although we only had students bring back the AE for the two pre-selected modules, there are other times during OT instruction where the AE has utility, for example the universal cuff during pediatric intervention or the sock aide as an energy conservation strategy. Students could share ideas via cloud-based programs or social media platforms, such as Pinterest. Future inquiry is needed to continue to investigate student perception, competence of using DIY technology, faculty perceptions, usage of DIY AE as a licensed clinician and difference between in-person and online or at-home Makerspaces.

Conclusion

This paper described the use of an online Makerspace to fabricate two pieces of AE: a sock aide and a universal cuff to be used by students in future modules within the same course. Makerspace is one method of active learning that worked well in an online platform; however, we recommend continuing to implement a multitude of active learning strategies throughout OT curricula regardless of an in-person, hybrid, or online delivery method.

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