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Autism and Occupation: Video Modeling for Maker Activities

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Autism and Occupation: Video Modeling for Maker Activities

by

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Abstract

Understanding the lived experiences of individuals with Autism Spectrum Disorder (ASD) using video modeling (VM) while engaging in Maker activities is an essential part of occupational therapy research. Participants in this study were four individuals with ASD recruited from a project-based studio located in San Rafael, CA, and one staff member. The qualitative portion of this study analyzed the lived experiences and perspectives of the individuals with ASD and their service provider through qualitative semi-structured interview methods. The quantitative portion of this study analyzed the effectiveness of VM for Maker activities during the activity of making a box using a machine called a ShopBot®. Quantitative analysis included staff assistance and client performance during standard instruction and subsequent VM intervention. Researchers found that with the VM intervention, staff assistance decreased and client performance increased. Three themes pertinent to use of the VM for the ASD population emerged; what worked, what could be changed, and where else VM could be used. VM helps individuals with ASD learn Maker activities. VM is clear, consistent, and easy to understand for individuals with ASD. Occupational Therapists can utilize VM as another method to teach individuals with ASD new skills, Maker activities, and occupations.

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List of Abbreviations

Abbreviation	Explanation
VM	Video Modeling
ASD	Autism Spectrum Disorder
EBP	Evidence Based Practice
AT	Assistive Technology
OTs	Occupational Therapists
OT	Occupational Therapy

Introduction

As stated by Mary Reilly, a prominent occupational therapist, “Man, through the use of his hands, as they are energized by mind and will, can influence the state of his own health." (Mary Reilly, delivered in her 1961 Eleanor Clarke Slagle Lecture).

Occupational therapists (OTs) use their knowledge of the relationship between the person, context, and environment to help people develop the necessary skills to successfully participate in their daily occupations. According to Boyt Schell, Gillen, & Scaffa (2014), occupations are, “the things that people do that occupy their time and attention; meaningful, purposeful activity; the personal activities that individuals choose or need to engage in and the ways in which each individual actually experiences them” (American Occupational Therapy Association, 2014, S5). Occupations include activities of daily living (ADLs), work / vocational pursuits, school participation, socialization and recreation / leisure activities.

The Maker Movement emphasizes the personal, hands-on nature of making, saying that to make is ‘‘to build or adapt objects by hand, for the simple personal pleasure of figuring out how things work’’ (Martin, 2015; Peppler, Halverson, & Kafai, 2016, p. 4). Maker activities can be customized to meet each individual’s needs considering their interests and learning style. Individuals diagnosed with Autism Spectrum Disorder (ASD) tend to learn best when information is presented in a visual manner, as visual learning is an area of relative strength for most people living with ASD (Hong et al., 2015; Rao & Gagie, 2006). Visual information can be presented through the use of assistive technology (AT) such as videos that model a specific task, activity, and/or occupation. Video modeling (VM), a specific form of AT, is an evidence based practice (EBP) shown to support learning for individuals with ASD (Cox & AFIRM, 2018). OTs have the training, skills, and knowledge to connect individuals with ASD with VM to support them in participating in Maker activities.

Maker Philosophy

The Maker philosophy has become a movement that encourages and supports people in choosing and making projects that meet their individual needs and interests (Hatch, 2014). The "Do It Yourself" culture changes the way people learn about their environment. The Maker philosophy defines learning and the development of new of skills as an active, continual, and lifelong process (Hoover, 2014). With greater access to affordable technology, such as 3D printers and laser cutters, people have more opportunities to create their own products (Peppler, Halverson, & Kafai, 2016). The use of different technologies to assist in making provides people with more room to achieve their full creative potential (Hoover, 2014). The Maker Movement and philosophy has potential benefits to teach people with disabilities new skills thus affording further occupational engagement. Individuals with disabilities "are not only capable and competent designers, but have unique problems that the Maker Movement is primed to help solve" (Hansen, Hansen, Hall, Fixler, & Harlow, 2017, p. 4). Maker activities are tailored to appeal to people with learning differences, and yet they are continually left out of research (Miele, 2017). There is a significant lack of research surrounding individuals with disabilities, specifically ASD and their involvement in the Maker Movement and Maker activities. Research in this area can raise awareness about how VM is an effective instructional tool for helping individuals with ASD learn Maker activities, as well as appropriately supporting these individuals when learning new skills, creating Maker activities, and engaging in meaningful occupations. Therefore, establishing a Maker program for individuals with ASD while utilizing AT, specifically VM, can be very beneficial.

The Maker Movement utilizes projects that may be meaningful in both leisure and work occupations. People are given the freedom to pursue individual interests on their own time, and use preferred learning styles to creatively complete their own Maker activities. Maker activities have the potential to benefit people with intellectual disabilities such as ASD.

Autism Spectrum Disorder Prevalence and Characteristics

ASD affects approximately 3.5 million people in the United States (Buescher, Cidav, Knapp, & Mandell, 2014). According to the Center for Disease Control and Prevention (CDC), 1 in 42 males, and 1 in 189 females, have an ASD diagnosis (Christensen, et al., 2016). The prevalence rate has been increasing steadily over the last few decades (Centers for Disease Control and Prevention [CDC], 2017). The Diagnostic Statistical Manual of Mental Disorders-5 (DSM-5) characterizes ASD as, "persistent deficits in social communication and social interaction across multiple contexts," as well as, "restricted [and] repetitive patterns of behavior, interests, or activities" (American Psychiatric Association [APA], 2013, p. 50). Characteristics range from mild, moderate, and severe, and vary in type, intensity, and level of support needed for each individual. As stated in the DSM-5, individuals with ASD require varying levels of support, ranging from 'required support' to requiring 'very substantial support' (APA, 2013). These characteristics can result in significant social, communication, and behavioral challenges (CDC, 2017).

People who are diagnosed with ASD tend to learn, think, and problem-solve differently than people without an ASD diagnosis (CDC, 2017). Many individuals with ASD have difficulty with inherently learning and understanding social cognition skills because they may have difficulty relating to how other people think and feel (Kourkoulou, Leekam & Findlay, 2012; Low & Perner, 2012; Miranda, Berenguer, Roselío, Baixauli & Colomer, 2017).

Individuals with ASD tend to have deficits in executive functioning skills such as planning, executing, and retaining necessary information in order to complete different tasks (Van Eylen, 2015). Specific communication deficits observed in individuals with ASD include difficulties interpreting social interactions, nonverbal cues, and comprehending language (APA, 2013). Deficits in these higher-order cognitive and language functions often makes auditory input confusing and difficult to process (Dettmer, Simpson, Myles, & Ganz, 2000). Therefore, providing solely verbal instructions is not recommended when teaching individuals with ASD (Rao & Gagie, 2006). Temple Grandin (1995), a prominent speaker diagnosed with ASD, advocates for the ASD population by sharing her own lived experiences and expressing her opinions about ASD. Grandin notes that, "people with autism are visual thinkers," (Dettmer, Simpson, Myles & Ganz, 2000, p. 163). Visual supports are beneficial in helping people with ASD follow instructions and learn new content that will provide them additional assistance to help them engage in their occupations.

Assistive Technology and Occupational Performance

Assistive technology (AT) can be used to help people participate in various activities. The Individuals with Disabilities Education Act 20 U.S.C. § 1400 (2004) defines AT 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" (p.118).

Utilizing appropriate AT helps strengthen the individual's functional capabilities and in turn can lead to a deeper level of independence (ATIA, 2017). OTs combine AT with their understanding of the client's function, task or occupation, and environment to support the client's occupational performance (AOTA, 2016). AT, such as visual supports and video modeling, provide additional outlets for people with ASD to visually learn information.

Visual supports. The use of visual supports is a recognized evidence based practice (EBP) for people with ASD (Rao & Gagie, 2006). AT can be in the form of visual supports, such as pictures, symbols, and written explanations. Visual representations define clear and concrete expectations for specific situations and are much easier for individuals with ASD to understand than verbal instructions (Ogilvie, 2011). An environment that incorporates visual learning and visual aids can improve functioning and participation in activities for individuals with ASD (Rao & Gagie, 2006). Studies show that people with ASD tend to exhibit fewer behavioral problems and learn better when two or three-dimensional objects are presented to them in visual context (Dettmer, Simpson, Myles, & Ganz, 2000). Visual supports also help individuals with ASD increase their attention span, understand verbal language, and organize their environment (Dettmer, Simpson, Myles, & Ganz, 2000). People with ASD tend to respond well to predictability, order, and consistency, which are key features of visual supports.

Video modeling. Like visual supports, video modeling (VM) is also recognized as an EBP for people with ASD. According to Franzone & Collet-Klingenberg (2008), "video modeling is a mode of teaching that uses video recording and display equipment to provide a visual model of the targeted behavior or skill" (p.1). Different types of VM include using the subject (as in self-modeling), peers, or an adult as the model in the video. The learner may or may not personally know the adult or peer models in the video, but can learn by watching their actions in the video (Bellini & Akullian, 2007; McCoy & Hermansen, 2007).

For learners with ASD ranging from early childhood through high school, research shows that VM can help in areas of communication, social, academic/cognition, and play (Franzone &

Collet-Klingenberg, 2008). VM has also helped students with ASD follow instructions, understand expectations, organize and understand their environment, and learn new skills, further supporting VM as a powerful teaching and learning tool in ASD interventions (Murray & Noland, 2012; Reagon, Higbee & Endicott, 2006; West, 2008).

VM has a powerful impact on learning because the video itself is motivating and helps individuals maintain attention to the task (Murray & Noland, 2012). VM is also beneficial because it stays consistent each time, while live models may be unpredictable (Reagon, Higbee & Endicott, 2006). VM assists individuals with ASD in making "sense of their environment, predict scheduled events, understand expectations, and anticipate changes throughout the day" (Dettmer, Simpson, Myles, & Ganz., 2000, p. 163). Most research on VM for the ASD population occurred in school and home settings, but can be effective in any type of setting (Franzone & Collet-Klingenberg, 2008).

For adults with ASD and other intellectual disabilities, VM has also been used to teach daily living skills such as grocery shopping, cooking, work tasks, self-management (to-do lists, self-instruction) and utilizing transportation within the community (Hess & Chitwood, 2018). Goodson, Sigafoos, O'Reilly, Canella, & Lancioni (2007) found that when teaching adults with intellectual disabilities the task of setting a table, VM was effective when the learner was prompted by the video to complete the step again if the step was completed incorrectly at first.

VM instruction can also be used to teach adults with intellectual disabilities new job skills in employment settings. Finding a job can be an important step towards independent living and meaningful relationships for adults with intellectual disabilities. Goh & Bambara (2013) used VM instruction to train new learners on job tasks such as booking a room, cleaning shoes, storing shoes, compiling conference packets, shredding paper, and using a photocopier. Results showed that VM along with feedback from the trainer versus standard instruction and VM alone was effective in teaching adults with intellectual disabilities new job skills (Goh & Bambara, 2013). Use of visual supports such as VM has also been shown to reduce the learner's need for assistance from the staff, as well as help increase the learner's independence during vocational training (Hess & Chitwood, 2018). Previous research has primarily focused on the specific skills VM can help increase, yet the lived experience from the individual with ASD has not been prominent in the aforementioned studies.

Currently, people with ASD are underemployed. Effective employment training tools may help these individuals learn prevocational skills and, in turn, support their transition into the workforce. By using the visual learning strengths of learners with ASD, VM can help them learn new skills. Learning new skills can help individuals with ASD engage in meaningful employment and/or leisure activities such as student-led Maker activities. Using VM would allow for greater independence and self-motivation for completing such novel projects. By employing AT strategies such as VM, people with ASD are afforded a strength based intervention which also promotes more independence by reducing the amount of adult prompting needed to participate in meaningful tasks (Mechling, Ayres, Foster & Bryant, 2015). However, missing from the literature are the lived experiences of the people using the VM to learn Maker activities.

Statement of Purpose

More research is needed on the Maker Movement for individuals with disabilities, including ASD. Further, there is a lack of qualitative research about the lived experience of individuals using VM. Therefore, we conducted a comprehensive mixed method, single subject research study on the impact of VM for ASD and complex Maker activities.

In single subject design, the subject's performance before the intervention is compared to the same subject's performance during the intervention and/or after the intervention is complete (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). Systematic replication improves external validity. Single subject research is a systematic approach that has been used in a number of studies to be used as evidence based practice (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). Semi-structured interviews and qualitative analysis were added to include the perspectives of those with ASD who used the VM to explore their lived experiences from their own voices.

Research Questions

The research questions that guided this study were: (1) How does video modeling impact the learner's level of participation in complex Maker activities? (2) How does video modeling impact the assistance provided by the staff during complex Maker activities? (3) What is the participant's overall lived experience using video modeling as an assistive technology support?

Theoretical Frameworks

The theoretical frameworks that guided this study were the Model of Human Occupation (MOHO) and the Ecology of Human Performance (EHP).

Model of Human Occupation

Model of Human Occupation (MOHO), created by Gary Keilhofner in 1980, "provides a way of understanding how people choose, organize, and orchestrate their occupations and how occupations are refined and sustained over a lifetime" (Krupa, Kirsh, Pitts, & Fossey, 2016, pg. 136). The individual's level of motivation when initiating and completing tasks is also important in this theory. MOHO examines the relationship between an individual's volition, habituation and performance capacities in environmental conditions (Krupa, Kirsh, Pitts, & Fossey, 2016). Volition is defined as "an individual's motivation to participate in certain occupations" (Krupa, Kirsh, Pitts, & Fossey, 2016, pg.137). Volition is incorporated into this research study due to the client's motivation to work with their hands and learn the creative processes necessary to complete the project. Habituation is defined as how people, "organize their actions into patterns and routines" (Krupa, Kirsh, Pitts, & Fossey, 2016, pg.137). Additionally, habituation relates to this study because the use of AT support and practice over time, specifically the use of VM may help establish a routine. Performance capacities are the mental and physical capabilities that people integrate when completing tasks (Krupa, Kirsh, Pitts, & Fossey, 2016, pg.139). Furthermore, underlying bodily functions, such as sensory and neurological systems, can also affect performance. Performance capacities relate to this study due to occupational therapists' understanding of the unique needs presented by individuals living with ASD.

Ecology of Human Performance

The Ecology of Human Performance (EHP) also provided a theoretical framework for this research project. This framework discusses the important relationship between an individual and the context in which an activity occurs (Dunn, Gilbert & Parker, 1997). There are five specific strategies that target an individual's overall performance and shape the therapeutic intervention approaches. According to Dunn, Gilbert & Parker (1997), the intervention aims to *establish and/or restore* the individual's ability to perform an activity within his or her specific context. This study encouraged participants to attempt new projects and establish new skills with VM as support to aid them in their future endeavors. More specifically, the VM was implemented during typical programming and Maker activities at Autistry Studios. This VM intervention therefore became part of the naturalistic context for the clients at Autistry Studios.

Another intervention is intended to *modify and/or adapt* the contextual characteristics and task demands to support the individual's' performance. In this research study, VM was provided as the modification to teaching and learning in order for the clients to engage in complex Maker activities. Moreover, this approach includes *adapting* the context to better match the individual's skills and capabilities. Since individuals with ASD tend to be visual learners, this study was aimed at utilizing VM as an alternative to standard instruction, which was verbally presented by a staff member.

Another intervention approach provided by the EHP framework is *preventing* problems by anticipating difficulties. Given that VM is strength based, we anticipated that using VM would result in a reduction of auditory overload in participants with ASD. Also, given the complexity and demands of the Maker activities, we anticipated that the consistency, structure and concrete verbal instructions as provided by VM to be preventative of confusion.

An additional intervention approach is to *maintain* the individual's ability to engage in their occupations by providing them with appropriate support to continue those occupations. VM creates an easy mode of access to the instructions on how to complete Maker activities, and provides an effective method to more independently pursue and continue participating in occupations that are meaningful to them.

Lastly, an intervention approach is to *create* situations that promote new performance skills within a particular context. This intervention focuses on adjusting the activity based on the individual's level of performance capabilities. Again, VM is based on the learning strengths of individuals with ASD, thus creating a better matched teaching and learning scenario.

Ethical and Legal Considerations

The AOTA Code of Ethics were implemented throughout the research process. The principles of beneficence, non-maleficence, veracity, and autonomy were in the forefront when conducting this study. Beneficence is defined as, "concern for the well-being and safety of the recipients of their [OT] services" (Scott & Reitz, 2013, pg. 37). This principle was strictly followed when considering the safety and well-being of the participants in the study. Non-maleficence is defined as, "intentionally refrain from actions that cause harm" (Scott & Reitz, 2013, pg. 45) and was utilized in all parts of the study. More specifically, this principle was used when conducting interviews with the participants and staff members. The principle of veracity focuses on telling the truth while conducting research and reporting results in an accurate and timely manner. Lastly, the principle of autonomy and confidentiality states that, "occupational therapy personnel shall respect the right of the individuals to self-determination" (Scott & Reitz, 2013, pg. 55). Research participants signed a consent form that stated that they can take breaks during any of the interviews as needed, withdraw from the study at any point for any reason and that all of their personal information will be kept confidential. To ensure the confidentiality of the research participants, names were replaced with pseudonyms and letters and all data collected was removed from laptops within 24 hours and saved on a USB drives that were located in a locked office on the Dominican University of California campus.

Methods

Setting

Autistry Studios, located in San Rafael, CA, is a prevocational program that supports individuals, ages 13 and older with ASD and other learning differences, develop skills to become more independent as well as help ease the transition into adulthood (Autistry Studios, 2012). The mission at Autistry Studios is to "help teens and adults with Autism, Asperger's and other learning differences become successfully independent by leveraging their interests and talents while creating a community" (Autistry Studios, 2012). Utilizing a project-based therapy approach, some of the machines at Autistry include the laser cutter, 3D printer, sewing machine, and the ShopBot®. Utilizing an occupation centered and project based therapy approach at Autistry capitalizes on the client's motivation to participate in Maker activities. Autistry clients, who are paired with Autistry staff, participate in junior college courses, community travel, meal preparation, care for the studio, nutrition and fitness, and Maker activities. The individualized projects and meaningful activities that the clients participate in make Autistry Studios very occupational in nature. Engaging in such projects supports the individual's development and growth by allowing them to pursue projects that they are interested in (Autistry Studios, 2012). Autistry Studios is a highly unique program anchored in functional programming and the Maker philosophy. Their innovative approach has yet to include VM. Therefore, based on the limited research on VM for complex Maker activities and ASD, we proposed to conduct this research in collaboration with Autistry Studios. The Dominican research team collaborated with Autistry staff to design and create the VM and visual supports for the ShopBot®.

Participants

A purposive, convenience sample was utilized to recruit research participants from Autistry Studios in San Rafael, CA. Participants were selected by staff members at Autistry Studios, based on their participation in Autistry workshops. Inclusion criteria for this study included individuals who: (1) have been diagnosed with ASD and (2) are 18 years old and over and (3) had not previously used the ShopBot® (detailed description below) or if they had used the ShopBot® it must have been longer than 1 year ago. Exclusion criteria included individuals who (1) were not diagnosed with ASD; (2) under 18 years old and (3) used the ShopBot® within the last year.

Participants were not compensated for the study, as the project incentive was based on the participant's own self-interest in mastering their preferred activities/projects/occupations. The participants had time scheduled in their Autistry day to include time for the ShopBot® project in coordination with the researchers.

IRB and Informed Consent

A formal proposal of the research study was sent to the Internal Review Board for the Protection of Human Subjects of Dominican University prior to contact with all study participants. All subjects provided their consent to participate in the study (Appendix A). They were also provided consent for audio and video recording presentations and educational purposes (Appendix B). A formal letter was sent to Autistry to obtain consent to perform out research at their site (Appendix C). This research was approved by Dominican University of California (IRB# 10667 & IRB# 10696).

Mixed Methods Rationale

For our study, we collaborated with Autistry Studios to choose the activity of making a wooden box using the ShopBot®. The ShopBot® is a large woodcutting machine that allows the person to program specific woodcutting dimensions from a computer. The activity of making a box using the ShopBot® is the introductory activity that students are required to learn as a prerequisite experience before proceeding to other woodcutting activities. The Autistry staff recommended the ShopBot® activity for the study due to its introductory nature and motivating qualities for students who want to learn more complex woodcutting activities. We collaborated with Autistry Studios on multiple levels regarding the instruction and implementation of the VM to ensure that our project met the needs of the participants and their program. This research study utilized a mixed methods research design, in which both qualitative and quantitative data were collected. Our qualitative methods captured the lived experiences of the participants and the quantitative methods captured the impact of the VM itself. The data was analyzed into five different case studies.

Qualitative Methods

Qualitative data was also fundamental for this research project. Data collected from the staff and participant semi-structured interviews provided information that could not be gathered from quantitative data, such as the participants' personal experiences using the VM.

Qualitative design and methods. This in-depth case study utilized a phenomenological approach, which allowed the researchers to examine the participants' lived experience and understand their perspectives on using the VM while completing the task of making a box with the ShopBot®. At the beginning of the study, all of the participants completed an initial intake form (Appendix D) in order for the researchers to gain further insight into the typical instruction format at Autistry, as well as the participants' preferred learning styles.

Semi-structured interviews. Semi-structured interviews were completed at the end of the study. These interviews were designed to give the participants the opportunity to tell their stories, as well as reflect on their experiences and the meaning behind these interactions (Seidman, 2006). The semi-structured interview questions for participants and staff were informed by the ASD / VM literature and the OT theoretical frameworks of MOHO and EHP. Semi-structured interviews with participants (Appendix E) focused on personal experiences working on their tasks and with the VM. Semi-structured interview with the staff member (Appendix F) captured the personal perspectives on the usefulness of VM as well as provided insight into any observed changes in the participants' performance. Semi-structured interviews were designed to allow the participants an opportunity to verbally express their individual experiences using VM and provide narrative responses. However, the participants tended to provide short, single word answers. Therefore, the interview protocol was slightly adjusted to contain more direct questions to include "yes" and "no" answers, as well as short responses to meet the individual needs of the participants in order to maximize their opportunity to provide meaningful responses. Additionally, in order to reduce anxiety surrounding the interview process, participants were provided with a written copy of the interview questions prior to the in-person interview. They were also given the opportunity to prepare their answers before the interview, and to type or write their responses rather than verbally answer the questions.

Qualitative data collection. Qualitative data was collected through audio and video recorded interviews with participants and staff members. Researchers used handheld video cameras to record each of the interviews at Autistry Studios.

Qualitative data management and analysis. Interview data was transcribed verbatim by the research team and research assistants. The data was analyzed using a constant comparative method on Dedoose software (Dedoose Version *8.0.35*, 2018). Data was analyzed using a constant comparative method (Strauss & Corbin, 1990).

Data was stored on a password protected Google drive, which only the research team and faculty advisor had access to. Additionally, data was removed from all laptops within 24 hours after the data was collected, and stored on flash drives in a locked cabinet in a locked office on the Dominican University of California campus. The Participants' names were replaced with pseudonyms, which kept the participants anonymous throughout the study. In order to control bias in the data analysis process, researchers met as a group to review the transcripts, develop the code book, then coded via 100% consensus. Direction from the faculty advisor was also provided to the researchers to control any biases in the data collection process.

Qualitative coding process. Codes were informed by the ASD and VM literature, MOHO, and EHP. The coding process began with open coding, which was then turned into meaningful categories and themes. In order to code the information that was collected, the research team searched for words or phrases that related to the research questions. The first interview was compared with the other interviews to create a set of groupings in order to make notes for new sets of codes (Merriam & Tisdell, 2016; Seidman, 2006). From there, the researchers found common themes, patterns, and regularities across the interviews. These themes were then used to group together the open codes. Interpretation and reflection on the meaning of the data was then completed to 100% consensus between researchers.

Quantitative Methods

A quantitative design allowed the researchers to numerically determine whether the intervention changed the subject's behavior or the outcome of the study (Given, 2008). Quantitative data was fundamental to this research project, as it was used to show changes in the participants' performance capabilities and the amount of staff prompting required when using VM.

Single subject design. Single subject studies analyze one participant at a time, but include multiple participants in the same study. Single subject designs follow each individual in depth, documenting changes that occur within the individual instead of the entire population. The individual participant is assessed at different times throughout the study. The single subject study was used to determine the strength of the relationship between the independent and dependent variables (Burke, 2013). Due to logistics and scheduling with Autistry Studios, our final design included one trial of baseline, or "standard instruction", followed by three intervention trials of the VM per subject. Standard instruction refers to the typical set of instructions provided by the Autistry staff member when describing how to complete the task.

The single subject design provides experimental control within the study. Each subject act as their own control. The subject's performance before the intervention is compared to the same subject's performance during the intervention and/or after the intervention is complete (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). Systematic replication improves external validity. Single subject research is a systematic approach that has been used in a number of studies as part of EBP (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005).

Independent Variable: The independent variable in a single subject design is the intervention given to the participant that is being studied. The independent variable in this study is the VM intervention which occurred three times after standard instruction.

Dependent Variables: The dependent variables in a single subject design are given an operational definition and are oftentimes an observable behavior (Horner, et al., 2005). This research had two Likert scales measuring two sets of dependent variables: staff assistance and client performance. The quantitative scale for staff assistance was *1 = No Assistance* to *6 = Complete Assistance*. The quantitative scale for client participation was *1 = No Attempt* to *6 = Complete on First Attempt.*

Creating the video model. All four researchers observed the Autistry staff member complete the entire box-making activity using the ShopBot® one time from start to finish while also video/audio recording to analyze and review the task. The research team also reviewed written instructions for using the ShopBot®, created by the Autistry staff member. A detailed compilation of the aforementioned information of in person observation and review of written instructions informed our step-by-step in-depth task analysis of the box making activity. The researchers broke down the activity into 118 steps in the exact order of their occurrence in the sequence of making the box using the ShopBot®. After the researchers broke down the activity into steps, a storyboard was created that visually illustrated and explained specific areas that needed clear demonstration as well as steps that highlighted specific performance skills.

Making the video. The storyboard (Appendix G) informed how to portray each step, and then the researchers filmed the staff member completing each specific step of the activity. The research team planned exactly what visual angles, close ups, and still shots were needed to visually capture the step clearly in the video. A script was created with the intention of using concrete and succinct verbiage for each step. iMovie was utilized to edit the clips in order to organize the video into segments. For each step, the written step was initially presented and then the VM showed the staff demonstrating that specific step. The video was specifically formatted to provide multimodal learning opportunities to match the learning strengths for the participant population.

Quantitative data collection. Researchers collected quantitative data in-person during the sessions at Autistry Studios. The participants first completed the box-making activity under the typical standard instruction provided at Autistry Studios. Approximately one week after the standard instruction, participants completed the activity using the VM instruction. Each VM session was conducted approximately a week apart with a total of three VM interventions. Therefore, there was a total of four data sets for each subject upon conclusion of the study (see Table 1).

Table 1. Standard Instruction and Video Modeling Data Collection Schedule

Week 1	Week 2	Week 3	Week 4	Week 5
Standard Instruction	Video Modeling 1 VM1	Video Modeling 2 VM2	Video Modeling 3 VM3	Semi-structured Interviews

Each of the four sessions was attended by two researchers. Sessions were video recorded using handheld video cameras. During the session, researchers collected notes and preliminary observation data for the level of assistance that each participant required from the staff member, as well as client performance throughout the project on research data collection sheets (Appendix H). Likert scales were used to score outcome measures of staff assistance and client performance. The scales were used for each step of the task analysis for the specific activity (Appendix I).

Formal scoring was completed by the researchers based on the videos taken during the session to add rigor and reliability of scoring. All four researchers reviewed 25% of the videos and completed the detailed data collection and assignment of scores to 100% consensus. Additionally, the remaining 75% of the data was scored by pairs of researchers to 100% consensus for additional rigor and accuracy.

Quantitative analyses

Performance skill grouping. Upon completion of the Likert scoring for both the staff assistance and client performance scales for each of the four trials, the original task analysis of 118 steps was grouped into performance skills and further categorized based on the Occupational Therapy Performance Framework – OTPF (American Occupational Therapy Association [AOTA], 2014). This categorization grouped the 118 steps into like performance skills, which is unique to the VM research methodology. Operation of the ShopBot® and making the box required a range of fine motor, visual perceptual and bilateral coordination skills to name a few. Therefore, this aspect of the analyses provided critical information as to the type of skill captured rather than relying on the number of steps alone.

Operating the ShopBot®. Controlling the ShopBot® required calibration skills and included tasks such as pressing the arrow keys on the computer. Any task that required the use of the keyboard mouse was categorized under "Mouse Skills". OTPF performance skills used in "Mouse Skills" were fine motor, visual perception, visual motor integration, hand-eye coordination. We further broke down "Mouse Skills" into "Mouse Skills - Complex", "Mouse Skills - Medium", and "Mouse Skills - Simple". "Mouse Skills - Complex" included tasks that required four or more steps using the mouse such as clicking and dragging the mouse to highlight an object on the screen. "Mouse Skills - Medium" included tasks requiring three mouse steps such as inserting the x and y axis. “Mouse Skills - Simple” required less than two mouse steps such as clicking to select an object. The “Keyboarding” category required fine motor skills and included steps that involved any kind of typing.

Making and measuring the box. The task “Measure Box” required participants to use a tape measure to measure the sample box and then write down the dimensions. The Multi-modal Motor Planning - Complex” category included steps that involved bilateral integration skills, navigating the environment, and visual perception. Examples of these types of tasks include opening the garage door, vacuuming dust, clamping and unclamping wood, and putting a metal strip and sensor clip on the drill. “Multi-modal Motor Planning - Simple” included steps that required 3D visual perception such as walking around and visually looking at objects, ensuring the tracks are clear, and turning on the garage door fans.

Mean scores. Based on the aforementioned performance skill and OTPF groupings, we calculated the mean score for each category for each session. The average score of each category is represented by a dot on the graph and is based on the Likert scale score. The number of steps in each category ranged from 5 to 60 steps. The categories that included more steps gave the participant more opportunities to practice that type of step. For a further break down of task analysis refer to Appendix J.

Results

The questions guiding this research were: (1) How does video modeling impact the learner's level of participation in complex Maker activities? (2) How does video modeling impact the assistance and support provided by the staff during complex Maker activities? (3) What is the participant's overall lived experience using video modeling as an assistive technology support?

Our final sample consisted of four adults with ASD who participate in the Autistry Studios program. Participants' ages ranged between 22 to 37 years old. Three participants were male and one was female. To maintain confidentiality of the participants, each participant was given the option to create his/her own pseudonym for the study. The names the clients selected were: Beast Guy, Fashionista/Artist, Han Solo, and Mavis. Participant demographics are summarized in Table 2. Our sample also included one male Autistry staff member.

Table 2. Subjects with ASD Demographics, Pseudonyms, Ages, Genders

Pseudonym	**Age**	**Gender**
Beast Guy	37	M
Fashionista/Artist	28	F
Han Solo	22	M
Mavis	22	M

The results section is presented as four case studies with both the quantitative and qualitative analyses included. In addition, the Autisty staff member served as a respondent to qualitative staff semi-structured interviews. His results are presented as the 5th case.

On each chart, the mean score is plotted for each session per performance skill / OTPF category. Standard Instruction is represented by the red dashed line, Video Modeling 1 (VM1) is blue, Video Modeling 2 (VM2) is yellow, and Video Modeling 3 (VM3) is green. Our qualitative results were categorized into three main themes: (1) what worked, (2) what could improve, and (3) where else VM would be helpful.

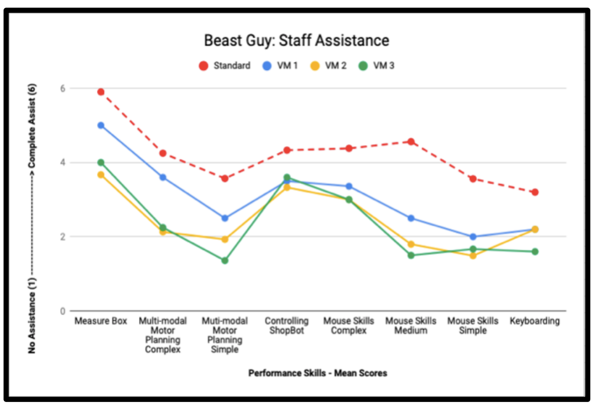
Case 1: Beast Guy

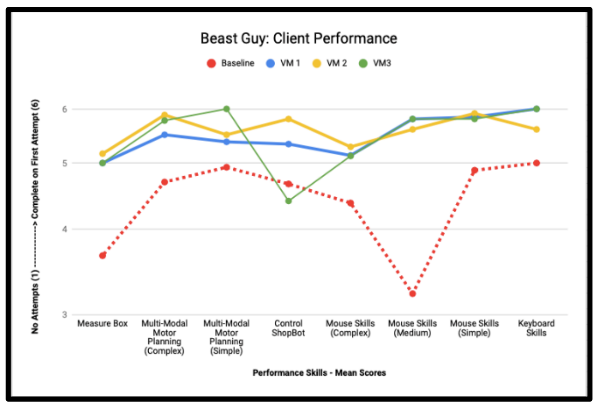
Beast Guy staff assistance. As shown in the staff assistance graph (Figure 1), the level of assistance decreased across each of the VM interventions when compared to standard instruction. During standard instruction, Beast Guy was provided with higher levels of assistance from the staff member for all performance skills. As the VM trials continued, the staff member provided less assistance across all categories.

Beast Guy client performance. As shown in the client performance graph (Figure 2) increased across the VM trials compared to standard instruction. The biggest increase in independence was demonstrated by Beast Guy's performance in the "Mouse Skills - Medium" category during standard instruction versus VM 1 and VM 3

Figure 1 Beast Guy: Staff Assistance

Figure 2 Beast Guy: Client Performance





Beast Guy lived experience. Within the theme of *what worked,* Beast Guy shared what was helpful about the video. Beast Guy stated, "It helped me understand things because it broke down certain parts. I think video is helpful with a lot of things because you can actually see what's going on besides just hearing. It makes things a lot easier".

Case 2: Fashionista

Fashionista staff assistance. During standard instruction, Fashionista required assistance at approximately level 3 from a staff member. As shown in figure 3, throughout the use of the VM interventions, the amount of staff assistance given to Fashionista decreased across all areas to a level 1 indicating no staff assistance.

Fashionista client performance. As shown in figure 4, Fashionista's independent skill completion increased across all VM trials in comparison to standard instruction and went from a 4-5 to a 6 in all measured areas. During VM 1, Fashionista chose to end the project early which explains missing data for "Mouse Skills- Complex".

Figure 3 Fashionista Staff Assistance

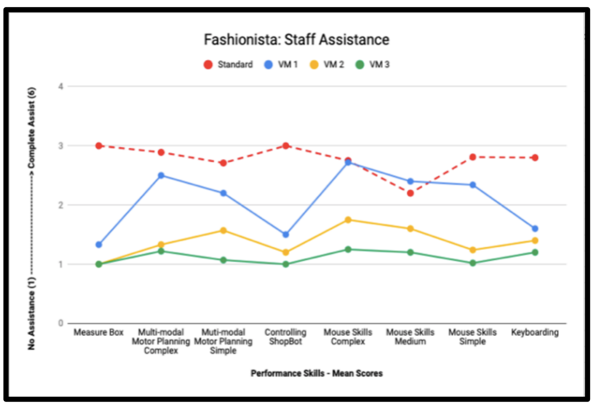
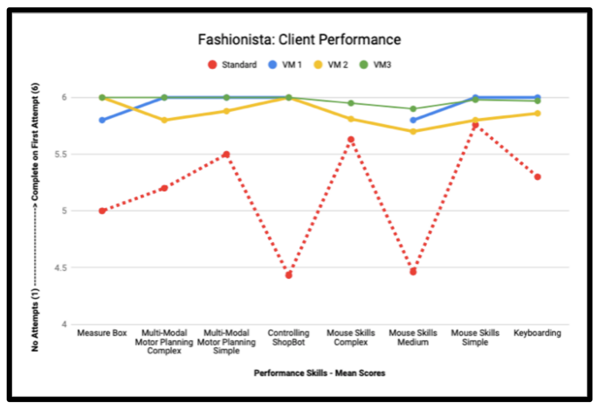


Figure 4 Fashionista Client Performance



Fashionista lived experience. Within the theme of what worked, when Fashionista was asked what she liked about the ShopBotⓇ video, she stated "Oh! It was great!". Within the theme of what could improve, when Fashionista was asked how she felt about the speed of the video, she replied "Too fast, kinda".

Case 3: Han Solo

Han Solo staff assistance. As shown in Figure 5, the staff assistance decreased from a 2-3 at standard instruction to a level 1 by VM3.

Han Solo client performance. As shown in Figure 6, Han Solo's level of performance was fairly high during standard instruction at approximately level 5 with the exception of the "Mouse Skills - Medium". He progressed to level 6 by VM 3 across all measured areas. The most notable increase in independence is in "Mouse Skills - Medium".

Figure 6 Han Solo Staff Assistance

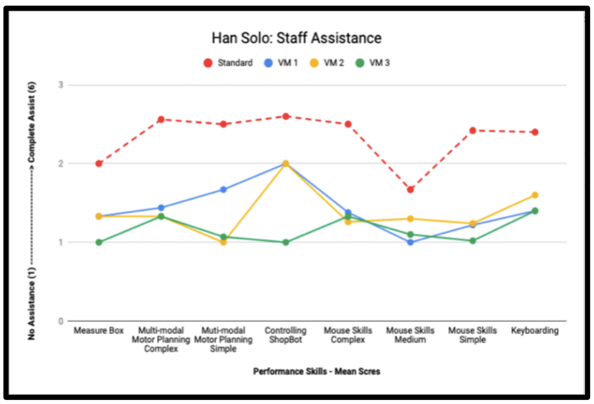
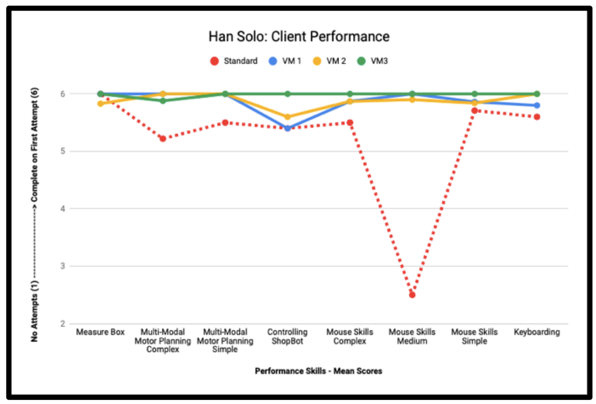


Figure 5 Han Solo Client Performance



Han Solo lived experience. Within the theme of what worked, when asked if it was easier to use the ShopBot® with or without the videos, Han Solo stated, "With the videos

Case 4: Mavis

Mavis staff assistance. As shown in Figure 7, the amount of staff assistance decreased throughout the VM sessions from the level of assistance provided during standard instruction. During the standard instruction session, the level of staff assistance was approximately 3, and by the final VM session staff assistance dropped to between 1 and 2.

Mavis client performance. As shown in Figure 8, Mavis's level of performance increased from standard instruction to the video model sessions. One important aspect of Mavis's

Figure 7 Mavis Staff Assistance

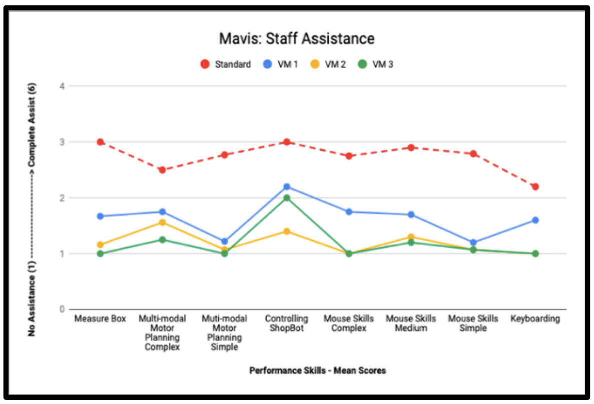
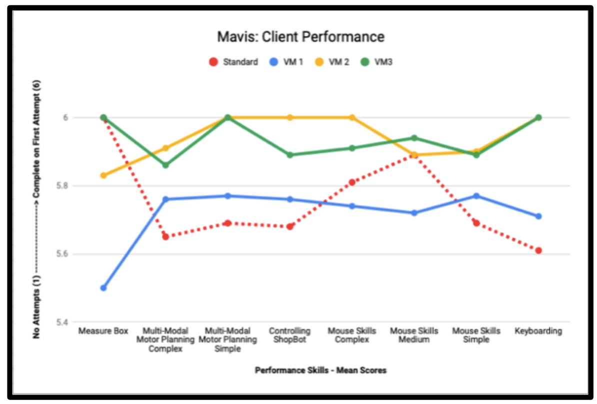


Figure 8 Mavis Client Performance



performance is that during all sessions, his level of performance was above a 5.4/6.

Mavis lived experience. Within the theme of what worked, when asked, how do you feel about using the videos, Mavis stated "Well it did help, it taught me how to use the ShopBot®".

Case 5: Staff Member

After VM intervention was completed, a semi-structured interview was conducted with the staff member. The staff member found that the VM was extremely helpful in teaching participants beginner woodcutting skills using the ShopBot®, especially for the straightforward computer steps and the steps that required gross motor skills.

What worked. The staff member explained that because the VM provided clear expectations for each step, the VM improved the participant's performance on the task. The visual representation of each step from start to finish made the instructions and expectations of each step very clear. The participant had a better understanding of what to expect in the step, which allowed the participant to successfully execute each step with greater accuracy. The staff member commented that by following the steps in the VM, "They know what's going to happen and are actually able to execute each step without being nervous because that nervousness can throw different people off in different ways". When the participants experienced greater rates of success, they also experienced an increase in self efficacy and a decrease in nervous feelings about inadequacy, leading to improved performance on the task.

The staff member also noticed that the VM instruction was more consistent than in-person verbal instruction. The staff member commented,

> I would wrongly assume that the person picked up on the first time around, then realize that I had to re-teach the step two or three times. With the video, the step would only be repeated once or twice. It's just more consistent.

During the standard verbal instruction, the staff member realized that sometimes he would only explain a portion of the step when instructing the participant. He did this because he had naturally assumed that the learner had intuitively picked up on that part of the step from previous sessions. This inaccurate assumption resulted in a misunderstanding of the participants abilities. These kinds of misunderstandings were time consuming and frustrating for the staff member and participants. On the other hand, the staff member stated that the videos "keep the baseline consistent level of explanation for each and every step". Therefore, VM kept the level of explanation consistent for every step and did not assume that the person had prior knowledge of the step.

The staff member further stated that the VM acted like "a failsafe of going through and checking and making sure that you're doing each step correctly and not pressing the wrong thing or if they forgot [to do the step]". The VM can be used as a reliable backup for participants to refer to and could also be used to phase out prompts as the participants learned more steps. He noted that some of the participants visually remembered sections of step sequences and completed steps before watching the instruction from VM. However, if the step was done incorrectly, the participant could refer back to the VM to re-do the step. Similarly, if the participant forgot how to complete a step, the VM would serve as a quick and easy method to find that information.

What could be improved. A noted barrier to using the VM was the participant's level of computer literacy at the time of using the VM. For participants who were not savvy with computers, the act of controlling the VM itself could add confusion and require additional learning to an already complicated task. The staff member stated, "Using a computer and computer proficiency is one of the things that is always surprisingly problematic." In this case, in-person instruction from staff member could be more beneficial than using VM. Based on the individual needs of each participant, VM should be used as a way to enhance the learning process, but should not be used as the only mode of instruction for adults with ASD when completing Maker activities.

Where else can VM be used. When asked what other projects the VM could be used for, the staff member thought the VM could be used to learn a variety of Maker activities and other life skills. He stated, "It [the videos] could be applied to most things in general. It's just a matter of figuring out which projects are repeated enough that would make it worthwhile to make a set video that could explain that particular project."

The staff member thought the VM could help the participants learn different Maker activities such as the sewing machine, laser cutter, and 3D Printer, as well as for other life skills such as how to cook. A benefit of using VM is that by using it to learn one type of skill, the VM created opportunities for learning other types of Maker activities and life skills. The staff member also emphasized that the VM could be developed for any activity and could be used to help individuals with ASD learn any Maker activity or develop skills necessary to participate in meaningful occupations.

Discussion

The results for use of VM for complex Maker activities were consistent with previous literature (Hess & Chitwood, 2018). EBP found that VM helps individuals with ASD process information and allows them to quickly learn new information (Cox & AFIRM Team, 2018). The results revealed that client performance increased while the amount of staff assistance decreased when learning a new complex Maker activity using the VM.

VM and individual differences

The results were consistent with previous EBP literature indicating that VM can reduce the amount of adult prompting and instruction needed. Use of VM can help participant depend on fewer prompts by allowing them to have more control, autonomy, and independence when learning Maker activities. The learner can use the VM at his/her own pace and can repeat steps if needed. In general, instructors tend to provide an excessive amount of verbal information when providing assistance, as was observed during this study. VM can reduce the amount of unnecessary verbal information provided by staff by making them aware of their tendency to provide additional information (Murray & Noland, 2012; Reagon, Higbee & Endicott, 2006; West, 2008).

Lived Experience. This study was one of the first to include qualitative methods to understand the lived experience of individuals with ASD and their perspectives about using VM. The semi-structured interviews conducted after the intervention gave additional insight into the staff and participants' experiences using VM. The researchers needed to adjust the semi-structured interview protocol based on the individual's needs, as many of the participants with ASD were not comfortable with the open ended, narrative style of interview questions. The participants tended to benefit from more closed-ended and structured questions, and provided succinct or single word responses. Most of the participants reported that VM was helpful and suggested it would be useful for other activities within the community. A common theme amongst the participants was that they thought VM would be helpful for learning math and completing math homework. VM may be helpful for learning other Maker activities and occupations out in the community, at Autistry, and for independent living skills.

Individual preferences for VM

When creating a video model, it is important to work with the client to customize the VM features to meet their individual needs and preferences. For example, some people may prefer that he video is presented at faster or slower speeds, the option to rewind to specific sections, and different verbiage. The staff may also find it beneficial to download the VM in a folder on a laptop or tablet prior to the session to avoid issues with internet connection or speed.

Implications for Occupational Therapy

VM is a helpful tool for individuals with ASD; however, it does not replace the need for an OT. This study was one of the first to combine an OT's perspective through use of the OTPF, as well as qualitative methods to learn about the consumer's lived experience and the potential impact that VM can have on occupations. OTs have the knowledge and expertise to analyze tasks, activities, and occupations. OTs also have the keen ability to provide the *just right challenge* and support to meet the individual needs of the client. Even with the employment of VM as a strategy, individual differences must be accounted for, and personalized assistance should be provided as needed. VM can be used to teach individuals with ASD vocational skills, activities that meet their own interests, including complex Maker activities. VM can be used as an additional tool for OTs and other healthcare professionals to use with their clients. VM can increase the client's independence while simultaneously decreasing the amount of assistance required. The VM can additionally create an opportunity to work on areas that require in person support (Murray & Noland, 2012; Reagon, Higbee & Endicott, 2006; West, 2008). Providing individuals with ASD with additional modes and options to learn from has major implications for employment and independent living options.

OTs can use VM to assist individuals with ASD learn vocational skills as VM removes the amount of prompting from a second person present during the actual on the job training. Allowing the individual to learn using the VM could increase their independence, self-efficacy, as well as their satisfaction with the work task. Additionally, VM gives individuals the opportunity to control how fast or slow they want to watch the video and perform the task, which allows the individual to be in control of their learning(Goodson, Sigafoos, O'Reilly, Canella, Lancioni, 2007).

Research explained the implications of executive functioning skills for individuals with ASD; however, this study was one of the first to apply the OTPF when analyzing VM (APA, 2013; Dettmer, Simpson, Myles & Ganze, 2000; Van Eylen, 2015). Individuals with ASD tend to think, learn, and problem-solve differently than others and Maker activities provide them with the opportunity to pursue projects that are meaningful (CDC, 2017). VM can be an effective learning and teaching tool for individuals with ASD because it provides concrete directions and clear expectations which can help them learn new skills (Murray & Noland, 2012; Reagon, Higbee & Endicott, 2006; West, 2008). Maker activities can be individualized to match the visual learning strengths of people with ASD through VM.

MOHO was one of two guiding frameworks used in this study. Individuals with ASD tend to be motivated by the use of technology and learn best without an excess of verbal and auditory information (Dettmer, Simpson, Myles, & Ganz, 2000). VM capitalizes on this area of relative strength, as most individuals with ASD are stronger visual learners and may be more motivated by video as a medium

(Murray & Noland, 2012; Reagon, Higbee & Endicott, 2006; West, 2008). OTs can use this information to support the learning strengths of individuals with ASD by providing them with visual information via VM instruction while simultaneously reducing the amount of verbal instructions.

Another guiding framework used in this study was EHP. OTs can use EHP to consider the person and the context in which they are participating in an activity or occupation, and use the five intervention strategies to incorporate VM into treatment and to support individuals with ASD (see Table 3).

Table 3. Ecology of Human Performance Intervention Chart

Create/ Promote	**Establish/ Restore**	**Maintain**	**Modify**	**Prevent**
Creating a better matched teaching/learning scenario	Attempt new projects Establish new skills with VM as support VM was implemented during the Autistry studios typical programming so it became part of the client's naturalistic context	Participation in leisure activities Maintain community engagement through leisure or work	VM was used as the modification to teaching and learning for the clients to engage in complex Maker activities	Anticipate difficulties Prevent overload of auditory information Consistency, structure and concrete verbal instructions as provided by VM to be preventative of confusion.

Limitations and Future Directions

There were several limitations in this study. The most notable limitation was the adjustment made to the original research design, from multiple baseline to a single baseline "standard instruction," with three VM trials approximately one week apart. The original design of the study included two baseline trials a week apart followed by four interventions a week apart. However, in order to accommodate the changes to Autistry's schedule we only had one baseline trial followed by three weeks of intervention. The interventions all took place one week apart from each other. The research design intended to flow seamlessly with the regularly scheduled programming, but Autistry Studios has been progressing as a program so it was essential that this research study was flexible with the community partner.

Another limitation was that the participants were on fairly different schedules when completing the project, due to their individual availability. For example, not all of the participants completed the task of putting the box together. This was due to client's preference of wanting to end the task early to work on different projects. Since this study added to the participant's daily schedule, conflicts with other commitments lead to frustration from some of the participants about unexpected changes to their routine. For future research, a visual schedule could be provided ahead of time in order to provide enough time for a change in routine to occur.

We recognize that the documented improvements through data collection cannot be solely based on learning from the VM since the participants were systematically learning and there are of course practice effects across trials. Therefore, the researchers were unable to compare the outcomes of completing multiple attempts from in-person instruction versus VM instruction.

While we did not deviate from our inclusion and exclusion criteria, some of the participants had previously been introduced to the ShopBot® prior to the study. However, since each participant was measured against himself/herself, participants who fit the inclusion criteria but had experience prior to the study did not have an advantage when learning how to make a box with the ShopBot®.

Another limitation to our study was that only one staff member was included in the entire research process. Utilizing one staff member maintained the consistency of in-person instruction since the staff member was fully aware of the changes we made in regard to the VM instruction and could have changed instructions during baseline and intervention periods. We cannot attribute all learning to the VM; however, we can say that the staff was keenly aware of the amount of instruction provided and became less present throughout the learning process in order for the participant to refer to the VM as a prompting tool as needed.

Using the OTPF, we categorized meaningful performance skills, identified steps that fit into that category, and found the average steps for each OTPF category. We recognized that on the task analysis, certain categories had more opportunities for practice so not all categories had equal opportunities for practice. The amount ranged from 5-60 opportunities. The category with the least opportunities to practice was "Mouse Skills - Simple" with 5 opportunities, while the categories with the most amount of opportunities were Keyboarding and Controlling the ShopBot® with 60 opportunities. Therefore, the categories that included more steps gave the participant more opportunities the to practice that type of step, which could show improvements in certain categories merely due to the participant's ability to learn from more practice completing that step. This limitation was taken into consideration during data analysis, and quantitative results were interpreted using mean scores to account for differing number of skills in each category.

In the qualitative portion of our study, we hoped to bring out more information from the participants from the interview about their lived experiences. With the ASD population in mind, we tried to reduce any anxiety associated with the interview by providing participants with the written questions a week before the interview so they could have time to reflect on their experience and prepare answers in writing if necessary. During the interview, we gave participants the option to provide a verbal, written, or typed response to the questions. The original interview protocol utilized open-ended questions, however the interviewers transitioned to more closed ended questions as needed to accommodate the communication preferences and needs of each individual client. Clients provided succinct responses or one word answers to the questions. Yet, we feel this part of our design was important as it is not prominent in the literature and is very important to learn about the lived experiences from those with ASD whenever possible.

Conclusion

VM is an EBP that decreases the amount assistance needed from the staff member to complete the task while simultaneously increasing client participation. Furthermore, VM may be used to help individuals with ASD learn new skills and increase participation in leisure and work occupations. Prior research on VM did not include teaching complex Maker activities, empirical examination of the lived experience from the consumer or specific analyses from an occupational therapy perspective, particularly a complex break down of performance skills. In this study, we were fortunate to accomplish all of the above and provide further details to the EBP literature on the impact VM can have on adults with ASD.

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Appendix A: Consent Form to be a Research Participant

1. I understand that I am being asked to participate as a Participant in a research study designed to assess the benefits of video modeling when applied to Maker activities. This research is part of the **"Autism and Occupation: Video Modeling for Maker Activities"** thesis project at Dominican University of California. This research project is being supervised by ___________, Dominican University of California.

2. I understand that participation in this research will involve taking part in a **series of activities,** which will include questions about projects and experiences at Autistry Studios.

- Complete the Intake Form.
- Participate in a maker activity as part of typical instruction and the video modeling activity and data collection which will be audio and video recorded.
- Participate in a semi-structured interview that will be audio and video recorded, transcribed and analyzed.

3. I understand that my participation in this study is completely voluntary and I am free to withdraw my participation at any time.

4. I have been made aware that the interviews and video modeling activities will be audio and video recorded. I have been made aware that use of video recordings of my image will be used in research dissemination for any research related presentations. I can opt out of having my image used in presentations. I can notify the Dominican research team and choose to have my video used for research analysis purposes only and not in any presentations. **All personal references and identifying information will be eliminated when these recordings are presented and transcribed**, and all participants will be identified by numerical code and/or pseudonym only; the master list for these codes will be kept by _______. The data will be stored in a locked file and in a location that is separate from the transcripts. Coded transcripts will only be seen by the researchers and their faculty advisors. One year after the completion of the research, all written and recorded materials will be destroyed**.**

5. I am aware that all study participants will be furnished with a written summary of the relevant findings and conclusions of this project. Such results will not be available until after **December 31, 2018**.

6. I understand that I will be discussing topics of a personal nature and that I may refuse to answer any question that causes me distress or seems an invasion of my privacy. I may elect to stop the interview at any time. I may elect to stop the video modeling activity at any time.

7. I understand that my participation involves minimal physical risk, **but may involve some psychological discomfort, given the nature of the topic being addressed in the interview**. If I experience any problems or serious distress during my participation, I can ask to take breaks, and/or ask that any of the aforementioned activities be stopped.

8. I understand that if I have any further questions about the study, I may contact _____ or her research supervisor, _______. If I have further questions or comments about participation in this study, I may contact the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with the protection of

volunteers in research projects. I may reach the IRBPHP Office by calling _____ and leaving a voicemail message, by FAX ______or by writing to the IRBPHP.

9. All procedures related to this research project have been satisfactorily explained to me prior to my voluntary election to participate.

I HAVE READ AND UNDERSTAND ALL OF THE ABOVE EXPLANATION REGARDING THIS STUDY. I VOLUNTARILY GIVE MY CONSENT TO PARTICIPATE. A COPY OF THIS FORM HAS BEEN GIVEN TO ME FOR MY FUTURE REFERENCE.

____ _____________

Signature Date

Appendix B: Consent for Audio and Video Recording

I, ___________, agree to be photographed or videotaped by Dominican University of California.

I fully understand and agree that any statements I make or any photographs taken of me may be displayed in public places, duplicated, distributed and/or published by Dominican University of California in a manner including, but not limited, to the following:

- Photographic display
- Audio recording
- Video tape
- Newspapers
- Via internet
- Website

I release Dominican University of California and their officers, agents, employees, volunteers and/or students from any and all claims that might arise from use of such statements and/or photographs.

Date______________________________
Signature__________________________

Appendix C: Letter of Permission for Agency Directors

To Whom It May Concern:

This letter confirms that you have been provided with a brief description of our capstone thesis research project, which concerns the examination of the lived experiences of individuals with ASD using video modeling to create maker tasks. *By signing this form, you give your consent for the research team to visit your facility, interview staff and clients, and have them participate in video modeling activities*. After our research project is complete by December 2018, we will gladly send you a summary of our research results. This project is an important part of our graduate requirements as occupational therapy graduate students, and is being supervised by _________, Assistant Professor of Occupational Therapy at Dominican University of California.

As we discussed we will make every effort to ensure that our data collection does not interfere with your regularly scheduled classes and workshops, and that your clients and staff are treated with the utmost discretion and sensitivity. If you have questions about the research you may contact ______ at _________. If you have any further concerns you may contact our research supervisor, ________ at _______or the Institutional Review Board for the Protection of Human Participants at Dominican University of California by calling ________.

If this request to visit your establishment and to interview your clients meets with your approval, please sign and date this letter below and return it to me in the enclosed self-addressed, stamped envelope as soon as possible. Please feel free to contact me if you have any questions about this project.

Thank you very much for your time and cooperation.

Sincerely,

I agree with the above request

______________________________ ____________________ _______

Signature **Date**

Appendix D: Initial intake and Demographics Form

Age ______________________________

Gender: M F

(Please check all that apply and/or provide additional information)

How many years have you been coming to Autistry?

0-1 years	2-3 years	4-5 years	5+ years

What machines have you used at Autistry?

ShopBot®	Sewing machine	3D printer	Laser cutter
Camera	Computer		

What methods have you used to learn the machines?

Demo/modeling	Verbal Instructions	Written Instructions	Practice
Visual/Pictures	Videos	Read instructions on own	Instructions read by staff
Other:			

Based on the above, which methods are most helpful?

Demo/modeling	Verbal Instructions	Written Instructions	Practice
Visual/Pictures	Videos	Read instructions on own	Instructions read by staff
Other:			

What makes it difficult for you to learn?

Fatigue	Frustration	Need more help	Not advancing
Other:			

Please provide any additional comments/thoughts you feel are necessary for the research team to know:

____

____

Appendix E: Client Interview Protocol

Please think about your experience using the videos to make a box with the ShopBot. Next week, we will schedule a time to ask you these questions. Feel free to take notes, write out or type your responses. You can use your notes as a guide during our talk next week if that would be helpful. We want to learn from you, your opinions, and your experiences. Specific examples and stories of your experiences would be very helpful. We have some specific questions for you, but you are welcome to add anything else you would like us to know.

1. Tell us about your experience using the video modeling? What did this mean to you?
2. What did you like about the ShopBot videos? What was helpful?
3. What did you not like about the ShopBot videos? What was not helpful?
4. Is there anything you would change about the ShopBot videos?
5. Was it easier to do the task with or without the video?
6. What other activities would you like to have video modeling to help you learn?
   a. At Autistry
   b. At home
   c. At school
   d. At work
   e. Out in the community
7. What do you want other people to know about video modeling?
8. Is there anything else you would like to share (about your experience using video modeling in this project)?

Thank you taking time out of your day to talk about your experiences with video modeling. We will see you next week to hear more about your experiences!

Appendix F: Staff Interview Protocol

"Thanks for joining us today. We are going to be discussing video modeling (VM) and your experiences as a staff member using VM. As you know, VM and visual supports (VS) are evidence based practices (EBP) for people with autism (ASD), but what is missing from the literature is the meaning and lived experiences from the end users' perspective as well as from those supporting the ASD community with VM/VS. Additionally, the literature does not provide information about using AT for maker projects, so your opinions are essential here. Please share your stories and examples as we go through the questions."

1. Overall, how would you describe your experience using video modeling - VM with the ShopBot.

2. Remember when we did the intake for you at the start of the study, we asked you to indicate all the teaching methods you typically use (including demonstrations, practice, written directions, visuals/pictures, videos, etc.…)? When you're using those methods with your clients, how do you navigate barriers or frustrations demonstrated by the client during the activity?

3. On the intake form, you had mentioned potential benefits of video modeling and barriers of video modeling. How would you compare having access to VM versus other teaching strategies you typically use here at Autistry? What are the benefits? Barriers? Now that we have used the VM what are your thoughts?

4. Did you notice any changes in the *client's* use of the machine/making the project following access to the video modeling? If so, please describe.

5. What do you think was meaningful for the *client* when watching the *client* use VM? (Let's split this into mechanics of VM and also what may have been motivating about VM).
    a. Mechanics (Being able to replay? Replay whole sections, portions, replaying alone without staff help?)
    b. Motivation (seeing yourself, friend, or other in the video?)

6. What if anything would you change? Improve upon?
    a. What was difficult for the *client* when using VM?

7. Now that you have used VM do you think it would have a similar effect on other projects? If so, which ones?

8. Anything else would you want to share about VM that we have not covered that you feel is important for others to know?

Thank you taking time out of your day to talk to us about your experiences with video modeling.

Appendix G: ShopBot® Storyboard

S - Subject
SB - SB

Operate ShopBot®	Shot	Original Instructions	VM Script
1. Check/open garage door	Wide shot - S opening garage door	Use both hands to pull on the chain to open the garage door. Stop when the bottom of the garage door is just above the top of the fans (2 feet from the ground, knee height)	Use both hands to pull down the chain. Stop when the door reaches the latch for the chain and insert the chain in the latch.
2. Turn on garage door fans	Follow S to outlet - plug in to wall - cut to fans turning on	Walk over to the outlet. Plug in the fans to turn them on.	Plug fans in outlet.
3. Turn on Switch	Wide shot of S standing next to/in front of SB switch. Cut to close-up of hand on switch. Turn on.	Walk over to the SB. Find the red ON/OFF switch. With your thumb and index finger, grip the switch and turn it so the lever is pointing down.	Walk over to the SB and find the red ON/OFF switch. Turn the knob to the on position. The lever should be pointing down.
4. Open ShopBot ® Program	Wide shot S standing in front of computer. Close-up of computer on button. Close-up of hand on mouse. Screenshot of opening program.	Walk over to the computer. Push the on button with your index finger to turn on the computer. Use your right hand to control the mouse. With the mouse, click to open the SB program.	Use mouse to put cursor on SB program icon. Double click to open the program.
5. Ensure Tracks are Clear	Wide shot of S standing far away from side where cut wood	Make sure everyone is standing away from the SB tracks – no fingers, arms or anything near or around the tracks while the drill is in motion. Ask the instructor to center the SB's drill for you, and place a tissue box on one end of the SB's work area, but off-center from the drill.	Make sure everyone is standing away from the SB.
6. Select Yellow Controller / Activate monitors	Wide shot of S standing at computer. Close-up of screen.	Now it is your turn to control the SB. To access the controller for the SB, click on the yellow controller icon that has a keypad image on it on the middle right part of the red box of the SB	Now it is your turn to control the SB. With the mouse, click on the yellow keypad icon that is in the middle part of

		computer program. This will activate the motors that move the drill around the work area and allow you to control it with the computer keyboard arrow keys. → "Click yellow controller icon"	the red box.
7. Move Drill (Up/Down/ Left/Right)	Close-up on S hand on controller. Wide shot of S at computer moving SB drill.	Using the keypad on the computer, move the drill around the work area, aiming for the tissue box, and push it off the work area onto the ground. [Note: we want to avoid moving the drill so far that it hits the sides of the tracks.] The controls for the SB are easy once you get used to them: UP sends the drill away from where you are standing, DOWN moves the drill towards you, and RIGHT and LEFT move the drill right and left across the work area.	Use the arrow keys on the keyboard to move the SB. When you hit the up arrow, the SB will move away from you. When you hit the down arrow, the SB will move towards you. When you hit the left arrow, the SB will move to the left and when you hit the right arrow, the SB would move to the right.
8. Knock Tissue Box Over with Drill (back drill)	Wide shot of S and SB moving tissue box.	Now have your instructor put the tissue box in the middle of the work area. Again, move the drill so that you knock the tissue box onto the ground, but this time, push the tissue box off the opposite side of the worktable, using the back of the drill.	Control the SB using the arrows. Practice moving the drill by knocking the tissue box off of the SB table.
9. Esc → On/Off	Close-up of S hand clicking Esc. Screenshot of ending program. Wide shot of S walking to switch. Close-up of switch turning off.	To make it so the drill can no longer move, and the controls are disabled, simply click Esc on your keyboard. End the program on the computer, Now you can move on to learning how to use VCarvePro!	Now, hit the escape button which is in the top left corner of the keyboard. This will turn the SB off.
Operate VCarvePro	Shot	Original Script	Video Modeling Script

0.5 Measures Sample Box	Close-up (top view) of S measuring each side of box.	Our project goal is to create a 5-panel box with specific dimensions. Before we learn how to use the VCarvePro software, we first need to measure the sample box. Use a tape measure to find out the base board dimensions, the dimensions of the two long pieces, and the dimensions of the two short pieces. [Note: You will find the dimensions to be 8in x 11in on the base, and the side pieces are 3in tall (not the overall height!)] Base: 8in x 11in Side pieces: 3 in. tall	You will now make a box. The first step is measuring the different sides of the sample box. Make your tape measure look the same as this tape measure. Write down the number you see. Make sure you don't measure the extra wood on each side. Bring your measurements and walk over to the computer.
1. Open VCarve Pro	Screenshot of program opening.	Open VCarve Pro – SB Edition on any of the workshop computers	Now that we have the sizes of the box, open VCarve Pro. To do this, click on the VCarve Pro icon on the desktop. ‘
2. Create New File	Screenshot of "create new file"	Click "Create a new file" to begin a new project. A "Job Setup" tab will appear on the left-hand side of the screen.	Click the icon for create new file. .
3. Change Size (12"x24")	Screenshot of changing job size	Change the dimensions of the "Job Size" so that the Width (x) is 12 inches, and the Height (y) is 24 inches. This will provide enough working area to fit all of your box panels.	You will now change the "Job Size". Make sure the width (x) says 12in and height (y) says 24in.
4. Change Thickness (0.5")	Screenshot of changing thickness, click OK.	Change the Material (Z) so that the Thickness (z) is 0.5 inches. Then Click the "OK" button. This will replace your "Job Setup" tab with the "Drawing" tab. [Note: We may go back and change the (z) value for the wood, after we measure the wood we are going to use]	Now, change the Material (Z) to 0.5 in thick. Click "OK"

5. Open "Draw Rectangle Tab"	Screenshot of mouse moving over drawing tab, create vectors title, and click draw rectangle.	Our goal is to create a 5-panel box, with base dimensions of 8in by 11in, and 4in tall. On the "Drawing" tab on the left-hand side of the screen, under the bold title "Create Vectors", there is a rectangle icon on the first row of icons labeled "Draw Rectangle". Click this icon, and it will open the "Draw Rectangle" tab.	Now, click the tab that has a picture of a small rectangle and says, "Draw Rectangle".
6. Create Rectangle (11'x8") x 2	Screenshot of mouse moving to draw rectangle tab, insert dimensions. Screenshot of click apply, click close, & repeat.	Since we know what dimensions we want our box to be, we will start by creating the base panel of our box. In the Size section of the "Draw Rectangle" tab, change the Width (X) value to 11in, and the Height (Y) value to 8in. Click Apply, and then click Close.	Change the anchor point to 0 and 0. For the base, change the width (x) to 11in. [*pause]* and the height (y) to 8in. Click "Create" then Click "Close"
7. Create Rectangle (7"x3") x 2	Screenshot of mouse moving to draw rectangle tab, insert dimensions. Screenshot of click apply, click close, & repeat. Screenshot of moving rectangles.	Repeat Step 6 for the two long side pieces for your box, and then repeat Step 6 again for your short side pieces. [Note: you may have noticed that the length of the small side pieces depends on the width of the wood being used. Until we have measured the depth of the wood we are actually using, let's estimate the short side lengths to be 7in – this will likely be slightly too short] Once you've made the 5 pieces of your box, make them all nicely fit within your 12x24in work area, rotating them 90 degrees if needed.	You need to create 2 more rectangles for the short side pieces. Change width (x) = 7in. [*pause}* and height (y) = 3in. Click "Create" two times. Then click close. Use the mouse or keyboard arrows to move the rectangles so they are not overlapping or touching.
Create rectangle (11x3)			You need to create 2 more rectangles for the long side pieces.

			Change width (x) = 11in. [*pause]* and height (y) = 3in. Click "Create" two times. Then click close. Use the mouse or keyboard arrows to move the rectangles so they are not overlapping or touching.
8. Save Project	Screenshot of saving (click file, save as, .crv, name it)	Before moving into the next steps, save your VCarve project by clicking File on the top of the screen, and then click Save As from the dropdown menu. Save your .crv file into your personal folder, and name it "5-panel box" or something similar.	Click "File" Click "Save As" Select desktop, SB, my projects. Select DU Video Instructional Project Name it with your name.
9. Open Toolpath Tab	Screenshot of click toolpath tab, click show toolpaths tab.	Now we will create the toolpaths for the SB to cut. We will create 1 toolpath for all 5 pieces. To get started, click the "Toolpaths" tab at the top of the screen, and then click "Show Toolpaths Tab" from the dropdown menu.	Now you will create the toolpaths for the SB to cut. Click the "Toolpaths" tab and then click "Show Toolpaths Tab"
10. Make Toolpath x5	Screenshot of click profile toolpath, highlight rectangles, mouse over 2D profile toolpath tab, mouse over depth (set at 0). Screenshot of cut depth (C) to .54in, select "¼ in. down cut (57-285), Edit Passes, change number of passes to 2, select "OK," click "Add tabs to toolpath" , Click "Edit Tabs...", Click on each side of the rectangle, Select "Close"	To make the single toolpath for the 5 rectangles, click the top left icon titled "Profile Toolpath" under Toolpath Operations. Highlight all 5 rectangles so that their black outlines become dotted pink lines. You can highlight all at the same time either by dragging and selecting all at same time, or by holding down shift and clicking each individually. Under the 2D Profile Toolpath tab, make sure the Start Depth (D) is 0in, and change the Cut Depth (C) to be just slightly	Click "Profile Toolpath" icon Use the mouse to highlight the 5 rectangles. Click and drag to highlight the workspace until black outlines become pink dotted lines. Make sure the Start Depth (D) is 0in Change "Cut Depth" (C) to .54in.

		deeper than the thickness of the wood we are using – in this case make it 0.54in. Make sure the Tool selected is the 1/4" Down-cut (57-285). Then click "Edit Passes…" button. Change the number of passes to 2, and click OK. Now, under the Tabs section, check the "Add tabs to toolpath" box, and then click "Edit Tabs…". With your cursor, click once on each side of each rectangle on your project screen to add a tab to each of the sides, and click Close (since there are 5 rectangles, there will be a total of 20 tabs, one on each side of each rectangle). Lastly, change the name of this toolpath to: "Profile", and click Calculate. A WARNING box will pop up on your screen saying that you will cut through your material. It is fine because the profile toolpath is meant to go all the way through the wood – so click OK Before continuing, save your VCarve project again. The more you save your project the better!	Make sure "¼ in. Down Cut" is selected. Make sure the machine vector "outside/right" is selected. Click "Edit Passes..." Change number of passes to 2 Select "OK" Click "Add tabs to toolpath" Click "Edit Tabs" to create 3D tabs. Click on each side of the rectangle to add a tab. Select "Close" Change the name of the toolpath to "your name" Click "Calculate". A warning box will appear on the screen. Select "OK"
11. Preview Toolpath	Screenshot of preview all toolpaths & animation. Mouse over piece of wood between pieces.	Now we can preview how our final product will look like by pressing "Preview All Toolpaths" in the Preview Toolpaths tab that just appeared. Click it to see a quick animation of your name plate being cut. If there is a sliver of wood left between each of the rectangles, our toolpath is satisfactory and we can move to the last step.	Click the "3D View" tab at top of workspace. Click "Preview All Toolpaths" Check to see that the pieces are not overlapping. If the pieces are overlapping or

			touching, click "Close", then click the tab with your project name at the top of the workspace. Use the mouse to move the rectangles away from each other, and away from the edge of the workspace. Click "Calculate", then click "OK" Click "Preview all toolpaths"
12. Save Toolpath	Screenshot of profile, save toolpath, save toolpath to file as .sbp, open file in SB.	Finally, we need to save our toolpath file, which will be saved as a .sbp file. Under your Toolpath List in the Toolpath tab, check the box next to your "Profile" toolpath. On the bottom row of the icons, there is an icon with a big floppy disc, labeled "Save Toolpath". Under the part that says, "Toolpaths to be saved…" it should show your 1/4" Down-cut toolpath. If it indeed does, click "Save Toolpath(s) to File" and save this .sbp file in your personal folder. Since all of your rectangles were selected within the single toolpath file, this single .sbp file will instruct the SB to cut out all 5 box pieces at the same time. Now you are ready to open your toolpath/.sbp file in the SB, and cut out your box pieces!	Click box next to "Toolpath List" Click "Save Toolpath" icon Click "Save Toolpath to file". Save in your "DU Video Instructional Project". Minimize VCarvePro Open SB program Move drill out of the work area.
Cut Pieces	Shot	Original Script	Video Modeling Script
1. Turn on SB 1a. Move drill out of area	idk	Go through the beginning steps you learned to turn on and mobilize the SB. Move the drill out of area you're going to put the wood you're using.	

2. Measure wood depth with micrometer	Wide shot of S putting wood on SB. Close-up of using micrometer, close-up of writing measurement. Screenshot of changing measurements.	Take the wood you want to use for your box and place it on the work area close to the bottom corner closest to the control computer. Before anchoring the wood to the work area, use the micrometer to get the exact measurement of the wood's depth. Write this number down, as we will go back and make minor changes to our project file if need be.	Use the micrometer to measure the depth of the wood. Pull down to open the micrometer, place it on the wood, and close it so it is pinching the wood. What number do you see? Write this measurement down .
3. Clamp wood to edge of table	Wide shot then close-up of putting on clamps.	Take heavy clamps to mount the wood to the work area	Now, you are going to use the clamps to attach the wood to the SB. When you pick up the clamp, place your thumb on top and curl the rest of your fingers around the bottom of the clamp and push down. Continue attaching the wood until you have attached all 6 clamps around the SB.
4. Set Drill Location to Zero	Wide shot and close-up of setting zero, draw X, move drill over X. Screenshot of click (x.y)0.	Now we want to zero the location of the drill relative to your piece of wood. Find the spot of your wood you want to make your (x,y) 0 location. It might help to draw a small "X" on this location. Turn on the controls to the drill of the SB (the yellow controller button), and manually position the drill bit directly above your "X", and then press Esc to turn off the controls to the drill. Now, next to the yellow keypad on the SB computer program,	Now you are going to zero the drill location. Find the spot on the wood where you want to make your 0 location and make a small X. Turn on the yellow control button on the computer screen. This will let you control the drill. Use the arrow keys on the keyboard to

		there will be an "(X,Y) 0" button. If you are over the correct place you want to zero, then click this button. You will notice the (X,Y) coordinates on the SB program have now changed to (0,0). *For the purposes of this project, we will assume that the drill bit you want to use (1/4" Down-cut (57-285)) is already installed in the drill. However, if it is not in place, have a mentor show you how to change out the bit. This process will be tested for certification while making a personalized name plate. This step will be written out at the end of the Part 3 instructions in the event the drill bit needs to be changed to the correct one.	move the drill over the "X" you made Now, next to the yellow keypad on the SB computer program, there will be an "(X,Y) 0" button. When the drill is over the x, click this button. You will see the (X,Y) coordinates change to 0 and 0. Now, press Esc to turn off the controls to the drill.
5. Set Drill Bit to Zero (x, y, z)	Screenshot of zero drill bit, lift drill. Close-up on connecting clip and placing metal strip on wood. Screenshot of zero coordinates.	You also need to zero your [Z] coordinate for the drill bit. Next to the yellow keypad button on the program, there will be [Z] up and down buttons. Click the UP button so that the drill is raised up in the air. Next, take the electric sensor clip from the top of the drill track, and connect it to any metal part of the drill bit. Now place the long metal strip below the drill bit, and on top of your wood, and have someone hold it firmly in place. Have a second person click the "zero [Z] coordinate" option in the program. The drill bit will lower and touch the metal strip TWICE, so don't move it will the drill bit is moving and done touching the metal strip both times. Place the metal strip and the electric sensor back to their	Next to the yellow keypad button on the program, there are [Z] up and down buttons. Click the UP button to lift the drill up. Pull out the metal strip and place below the drill bit. Unclip the electric sensor clip from the top of the rubber drill track. Clip it to the top of the drill bit. It should look like this. Ask someone to hold the metal strip in place for you. Walk over to the

		appropriate places. You have now zeroed your [x,y,z] coordinates with the correct drill bit for the engraving of your name plate.	computer. Click “Zero [Z] Coordinate”. The drill bit will lower itself and touch the metal strip twice, so don’t move the metal piece until it is done.. Walk back to the drill. Place the metal strip back in the holder and connect the electric sensor back onto the rubber drill track.
8. Turn on SB with key, switch, and vacuum	Wide shot of pulling headphones and goggles out of drawer and putting on. Close-up of pulling key off hook and putting in and turning on. Close-up of flip switch on. Close-up of set bit speed. Wide shot of walking to vacuum, close-up of turning vacuum on. Wide shot of opening drawer and close-up on checklist.	Now before we load the .sbp file into the program, let’s prepare the SB to cut into the wood. Find a pair of headphones and protective goggles/glasses for everyone working around the SB. Next, put in and turn the key next to the big, red knob to its ON position (it will stay in while it is turned to on), and flip the switch on top of the drill to ON and make sure the drill bit speed is set to 16,000RPM. Have everyone put on their headphones and goggles, and turn on the vacuum connected to the drill. All of these necessary steps are listed on the “SB ‘Go’ Checklist” in the top drawer of the SB cart.	Get the headphones and safety glasses from the drawer under the computer. Put the headphones around your neck and put on your safety glasses on. Get the key out of the drawer from under the computer. Insert the key and turn it to the ON position Walk over to the drill and flip the switch to the ON position Walk to the back of the SB and turn on the vacuum Walk over to the outlet and plug in the garage door fans. Open the top drawer to look at the“SB

			'Go' Checklist". Make sure you have done each step.
9. Select "Cut Part"	Screenshot of press cut part button, open file, press start, click OK.	In the computer program, press the big yellow "CUT PART" button. Locate your .sbp file titled "Profile Cut" on the local computer's hard drive, and open it. Now your VCarve Pro toolpath is loaded into the SB and ready to be used! Finally press "START". You will receive a message that the drill is going to begin and other warnings – click OK to all of these. Finally, the drill will start, lower and go through the process of engraving into your name plate. At any time during the process you need the drill to stop immediately, simply press the SPACE BAR. Everyone should stay at least 3ft away from the drill bit, and away from the tracks of the SB when it is going.	Make sure everyone is at least 3 ft. away from the SB and tell them you when are about to start cutting. Now put your headphones ON Go to the computer and press the yellow "CUT PART" button Go to the computer's local hard drive and open your project. Press START When the messages pop up, click OK If you need to stop the drill while it is cutting, press the spacebar
10. Move the drill out of way	Screenshot of open controller. Wide shot of moving drill to center.	Open the keypad controller, and move the SB drill out of the way, into the middle of the working area	Once the pieces are cut, turn off the drill. Walk back to the computer. Open the SB keypad controller Use the arrow keys to move the drill to the middle of the table, away from your wood pieces.
11. Vacuum up dust	Wide shot of walking to vacuum, close-up of turning vacuum on. Wide shot of vacuuming up	Bring over vacuum, plug in, turn on, vacuum dust along cuts in wood	Turn the Vacuum ON and pick up all the dust from the wood.

	dust.		
12. Turn Drill and Vacuum Off	Close-up of turn drill off. Wide shot of walk to vacuum, close-up of turn off vacuum.	When the cutting process is finished, flip the switch of the drill to OFF, and turn off the vacuum.	Turn the vacuum OFF
13. Get Finished Wood Piece	Wide shot of unfasten clamps. Wide shot of pushing out wood.	Unfasten the clamps (or unscrew the wood), and pull your piece of wood closer to you. Pick it up off the table with one hand, and with your free hand, pop out each piece (the tabs are holding them in place). You may want to saw or use a chisel to pop break the tabs for the pieces instead of popping them out.	Place your thumb on top of the clamps and the other fingers on the bottom of the clamp. Then press your fingers together to open the clamp. Remove the clamps from the wood. Use one hand to pick up the wood off the table and the other to pop out the wood pieces. Pull out each piece. You are ready to assemble your box.

Appendix H: ShopBot® Data Collection Sheets

Participant Name ________________________ Date________

Session Number (circle one):
Standard Instruction VM1 VM2 VM3

Step	**ShopBot® Skill**	**Staff Assistance**	**Client Participation**	# of Times Watched Step
1	Open Garage Door			
2	Turn on Switch			
3	Open ShopBot® Program			
4	Ensure Tracks are Clear			
5	Select Yellow Controller / Activate monitors			
6	Move Drill (Up/Down/ Left/Right)			
7	Knock Tissue Box Over with Drill			
8	Click Escape			
9	Measure Base Height (y)			
10	Measure Base Width (x)			
11	Measure Long Piece Height (y)			
12	Measure Long Piece Width (x)			
13	Measure Short Piece Width (x)			
14	Measure Short Piece Height (y)			
15	Open ShopBot® Program			
16	Open VCarve Pro			
17	Create New File			
18	Set Width (x) to 12 inches			
19	Set Height (y) to 24 inches			
20	Set thickness (z) to .5 inches			
21	Click ok			
22	Click "Draw Rectangle"			
23	Set Anchor Points to 0 and 0			
24	Width (x) = 11 inches Height (y) = 8 inches			
25	Click Create			

26	Move Rectangle			
27	Click "Draw Rectangle:			
28	Width (x) = 11 inches Height (y) = 3 inches			
29	Click "Create" Twice			
30	Click "Close"			
31	Move Rectangles			
32	Click "Draw Rectangle"			
33	Width (x) = 7 inches Height (y) = 3 inches			
34	Click "Create" Twice			
35	Click Close			
36	Move Rectangles			
37	Click File			
38	Click "Save As"			
39	Select "Desktop"			
40	Select "ShopBot® My Projects"			
41	Select "DU Video Instructional Project"			
42	Change Project Name			
43	Click "Toolpaths" and "Show Toolpaths" Tab			
44	Select "Profile Toolpath"			
45	Highlight Rectangles			
46	Cut Depth (c) = 0.5 inches			
47	Click "Select"			
48	Select 1/4" Down Cut Bit			
49	Click "Ok"			
50	Select "Outside/Right" Machine Vector			
51	Select "Add Tabs to Toolpath"			
52	Length = 0.25 inches			
53	Thickness = 0.2 inches			

54	Select "Create 3D Tabs"			
55	Click "Edit Tabs"			
56	Add 4 Tabs to Each Piece			
57	Click "Close"			
58	Change Name to "Box Profile"			
59	Click "Calculate"			
60	Click "Preview All Toolpaths"			
61	Check for Overlapping pieces			
62	Click crv.Tab			
63	Move Rectangles			
64	Click "Box Profile"			
65	Click "Calculate"			
66	Click "Reset Preview"			
67	Click Preview All Toolpaths			
68	Check Pieces			
69	Click "Close"			
70	Click "File" and "Save"			
71	Click "Box Profile"			
72	Click "Save Toolpath" Icon			
73	Click "Save Toolpath To File"			
74	Select "ShopBot® My Projects"			
75	Select "DU Video Instructional Project"			
76	Click Save			
77	Minimize Vcarve Pro			
78	Clamp wood to table			
79	Select yellow controller			
80	Mark X on wood			
81	Move drill over X			
82	Press escape key			
83	Open Zero Tab			
84	Select (x.y) axis			
85	Click yellow controller			

86	Move drill			
87	Click escape			
88	Place metal strip below drill			
89	Clip sensor to drill			
90	Raise drill			
91	Click OK			
92	Replace metal strip			
93	Replace sensor clip			
94	Get out headphones & goggles			
95	Get key from drawer			
96	Insert key & turn on			
97	Turn on drill			
98	Turn on garage door fans			
99	Turn on ShopBot® vacuum			
100	Review ShopBot® Go Checklist			
101	Click cut part			
102	Select DU Instructional Video Project			
103	Select ShopBot® My Projects			
104	Click your project name			
105	Click open			
106	Click start			
107	Put headphones on			
108	Click OK			
109	Remove headphones & goggles			
110	Turn off drill			
111	Turn off ShopBot® vacuum			
112	Click yellow controller			
113	Move drill away			
114	Click escape			
115	Vacuum dust from between pieces			
116	Unplug garage door fans			

117	Unclamp wood			
118	Remove wood pieces			

Appendix I: Likert Scales

Staff Assistance

1 No Assistance (0 verbal, tactile, or visual cues/prompts)
2 Supervision (1 verbal, tactile, or visual cue/prompt)
3 Minimum Assistance (2-4 verbal, tactile, or visual cues/prompts)
4 Moderate Assistance (5-7 verbal, tactile, or visual cues/prompts)
5 Maximal Assistance (8+ verbal, tactile, or visual cues/prompts)
6 Complete Assistance (hand over hand, verbal, tactile, or visual cues/prompts)

Client Performance

1 Incomplete (No attempts)
2 Incomplete (5-7 attempts)
3 Incomplete (2-4 attempts)
4 Complete (5-7 attempts)
5 Complete (2-4 attempts)
6 Complete on First Attempt

Appendix J: ShopBot® Skills, Tasks Examples, OTPF Breakdown, Steps Per Category

ShopBot® Skills (# of opportunities for this skill in the task analysis)	Task Examples	OTPF Breakdown	Pertinent Visual and Motor Skills
Measure Box (6)	Tape measure, look at number, write it down	Align, stabilize, position, reaches, grips, manipulates, coordinates, moves, lifts, calibrates, chooses, uses, handles, initiates, terminates, sequences, coordinate, adjusts	Bilateral integration Fine motor Visual perception Hand Eye Coordination
Multi-modal motor planning (Complex) **(9)**	Open garage door Vacuum dust Clamping/ unclamping wood Hit wood pieces Put metal strip and sensor clip w/drill	Align, stabilize, position, reaches, bends, grips, manipulates, coordinates, moves, lifts, walks, transports, calibrates, flows, endures, attends, chooses, handles, initiates, terminates, searches/locates, gathers, restores, navigates, adjusts	Bilateral integration Navigate the environment Visual perception
Multi-modal motor planning (Simple) **(14)**	Walk around & look at ShopBot® tracks Turn on Switch Ensure Tracks are Clear Turn on garage door fans Get out headphones & goggles & put on Get key from drawer	Align, stabilize, position, reaches, bends, grips, manipulates, coordinates, moves, walks, transports, calibrates, initiates, terminates, searches/locates, gathers, restores, navigates, adjusts	Proprioception Visual perception

	Insert key Turn on drill Turn on garage door fans Turn on ShopBot® vacuum		
Controlling ShopBot® **(5)**	Arrow Keys on the keyboard Move Drill (Up/Down/ Left/Right) Knock Tissue Box Over with Drill Move drill over X	Aligns, calibrates, chooses, initiates, terminates, searches/locates	Visual perception
Mouse skills (Complex=4+ skills) **(8)**	Click and drag, move, or highlight shapes on computer Add 4 tabs to each side Check for overlapping pieces	Aligns, moves, calibrates, attends, initiates, sequences, terminates, searches/locates, adjusts	Fine motor Visual perception Hand-eye coordination
Mouse skills **(**Medium = 3+ skills) **(10)**	Click on mouse to select item + set width measurement Double click on item	Align, moves, calibrates, attends, initiates, sequences, searches/locates	Fine motor Visual perception Hand-eye coordination
Mouse skills (Simple = <2 skills) **(60)**	Click on mouse to select item Open ShopBot® Program or VCarvePro Select "Add Tabs to Toolpath"	Align, moves, calibrates, initiates, searches/locates	Fine motor Visual perception Hand-eye coordination

	Click "Create" Click "Save"		
Keyboarding (5)	Type project name Input measurements	Align, stabilize, calibrates, chooses, initiates, searches/locates	Fine motor Visual perception Hand-eye coordination