Addressing Societal Trends Impacting Occupational Therapy: Technology Integration and Cultural Diversity

A commentary on prior publications submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy from Kingston University
London, England

Nathan Short

Volume I

January 2020

Acknowledgements

I am thankful firstly, for the grace of God, followed closely by the grace of my wife and daughter who have supported me in my research endeavors and intellectual pursuits. I would also like to thank those with whom I have had the privilege to collaborate – participants, co-authors, and students. Additionally, I want to express sincere gratitude to Dr. Jane Cronin-Davis and Professor Nan Greenwood, my research advisors, for their professional perspective and support throughout this process.

Abstract

This commentary presents a critical analysis of prior published work by the PhD candidate within the field of occupational therapy. Occupational therapy is a discipline which promotes participation in daily life activities (occupations) across the lifespan, from children with developmental delay to older adults managing the functional impact of chronic disease. The integration of technology and increased cultural diversity among patient populations are two major trends impacting teaching and practice, representing the themes of this commentary. The studies regarding technology highlight effectiveness of specific technologies, perceptions of specialty clinicians regarding technology-based clinical resources, as well as the physical impact of mobile technology use. The studies regarding cultural diversity focus specifically on international service learning (ISL) as pedagogy for the development of cultural competence for future occupational therapists. The collective findings of the studies make a novel contribution to the literature, evaluating the efficacy of a specific app-based technology, analyzing the musculoskeletal impact of mobile technology use, exploring clinician' perceptions of technology integration in clinical settings, as well as providing support for ISL as a pedagogy for culturally-competent practice.

Contents

Table 1. Glossary of terms and abbreviations used within the thesis

Term	Definition
2nd grade students	A student in the 2nd year of formal education in the U.S. typically between the ages of 7-8
Capstone project	Culminating learning experience for a doctoral occupational therapy (OTD) student in the U.S.
Certified hand therapist (CHT)	An occupational or physical therapist who holds a specialty credential indicating advanced expertise in the assessment and rehabilitation of the upper extremity
Client-centered	Approach to healthcare delivery that "incorporates respect for and partnership with clients as active participants in the therapy process" (Boyt Schell, Gillen, & Scaffa, 2013, p. 1230) The term "patient" is used synonymously when referring to individuals receiving occupational therapy services as this term is more common in the candidate's clinical practice
Competency check-off	Demonstration of the ability to perform a specific clinical skill under the supervision of a licensed occupational therapist
Cultural competence	"…a culturally-skilled professional who "…values diversity, has a sense of his or her own culture….to offer sensitive and appropriate systems of care for his or her clients". (Wittman & Velde, 2002, p. 454).
Culture	"…the sum of the experiences, values, beliefs, ideals, judgements, and attitudes that shape and give continuous form to each individual" (Royeen & Crabtree, 2006, p. 3)
Elementary-aged children	Primary school typically including the first 4 to 6 grades for children typically from 5 to 11 years of age in the U.S.
International service learning (ISL)	Goal-oriented, cross-cultural service learning taking place in a country other than the students' country of origin
Lab section	Complimentary experiential learning component of a college-level course in the United States
Occupation	"Daily life activities in which people engage" (American Occupational Therapy Association [AOTA], 2015b, p. 43)
Occupational performance	The act of engaging in purposeful activity meaningful to the individual (e.g. ADLs, IADLs, work, leisure)
Occupation-based	Centered on purposeful daily activity
Physical therapist	Rehabilitation professional synonymous with physiotherapist

Partner organization	Institution which has formally agreed to collaborate with another institution on a specific project
Physician	General term for a medical doctor
Abbreviation	**Term**
ADLs	Activities of daily living
AMA	American Medical Association
AOTA	American Occupational Therapy Association
ASHT	American Society of Hand Therapy
CIVIC	Comprehensive Inventory of Virtuous Instantiations of Character
CMC	Carpometacarpal (joint)
CTD	Cumulative trauma disorder
CQS	Cultural Intelligence Scale
EBP	Evidence-based practice
HTCC	Hand Therapy Certification Commission
IADL	Instrumental activities of daily living
IRB	Institutional Review Board
ISL	International service learning
MCT	Moral Competence Test
NHPT	Nine-hole peg test
OT	Occupational therapy
OTD	Occupational therapy doctorate
OTPF	Occupational Therapy Practice Framework
SOTL	Scholarship of teaching and learning
UK	United Kingdom
US	United States
VMI	Visual-motor integration

1 Introduction

Two predominant trends impacting practice and education within the profession of occupational therapy are technology integration and increasing cultural diversity among patient populations. The following is a reflective commentary on prior published works by the candidate within these overarching themes. The included studies are critically analyzed in retrospect by the candidate, a clinically active occupational therapy academic working in the United States (U.S.). The collective results of the studies relating to technology provide various perspectives regarding the practical, clinical, and educational impact of technology integration. Technology integration is critically examined from multiple angles while the studies regarding cultural diversity focus on pedagogical methods to promote culturally competent occupational therapists. Implications of the findings regarding scholarship, education, and clinical practice are presented. Additionally, reflection on the candidate's development as a researcher, informed by clinical practice and formal occupational therapy education, is provided.

2 Context and purpose of research

The candidate is an occupational therapist academic and practitioner based in the U.S.; the published studies and this commentary reflect these perspectives. The research questions, methodologies, findings, and conclusions in the presented studies represent a blend of applied scholarship grounded in occupational therapy theory. The overarching purpose of occupational therapy is to promote engagement in meaningful activity for individuals across the lifespan (Hinojosa & Kramer, 1997, p. 864) and the included studies are imbedded in this framework.

Some terminology (e.g. capstone project) and concepts (e.g. occupation-based) are used in keeping with professional standards in the U.S. and spellings reflect American English in many instances. A glossary of terms is included to provide operational definitions for discipline-specific concepts or terms unique to American English for clarity (section v). From the outset, the candidate's research agenda outlined a general interest in cross-cultural practice and technology. Retrospective analysis has clarified these general topical interests, linking the prior works under the more specific themes of technology integration and cultural diversity as predominant trends impacting practice and education. The theme regarding technology integration is broader, examining the impact of technology from many different perspectives, while the theme regarding cultural diversity is focused on international service learning (ISL) as pedagogy to develop cultural competence.

Identified by practitioners as a core skill necessary for effective practice, cultural competence has become a professional priority along with examination of pedagogy to promote culturally competent practitioners (Suarez-Balcazar *et al.*, 2009). Additionally, Smith (2017) recently emphasized the metaphysical linkage of technology and occupation. The stated importance and immediacy of these topics within the

profession, as well as their identified impact on clinical practice, provided the candidate's initial motivation for critical analysis. Furthermore, there is a general paucity of specific research regarding these topics in the occupational therapy literature which indicated the need and opportunity for studies included in this thesis.

A retrospective PhD was chosen as the candidate is a mid-career academic with significant prior published work. This approach provided an opportunity to synthesize related studies into a single body of work, avoiding potential redundancy of prospective studies regarding similar topics and methods. Moreover, the synthesis of the studies combined with formal academic advice from my supervisors has identified further value from prior works, deepening the level of understanding regarding methodologies and improving the candidate's research skillset for future studies. Practically, this format allowed for the concurrent pursuit of an advanced research degree without interruption of valuable teaching and clinical practice.

3 Theme development

The candidate's initial research agenda developed from real-world clinical challenges within the broader context of the aforementioned trends of technology and cultural diversity within clinical practice. Novel technologies in the form of app-based interventions and methods of communication are rapidly being introduced into clinical settings and daily life. However, the occupational therapy literature regarding specific technologies is still limited, suggesting clinical integration of new technologies may be outpacing the evidence for its potential impact and efficacy (Proffitt *et al.*, 2019). As a clinician, use of specific technologies (e.g. Dexteria™; virtual educational resources), which seemed beneficial, led to an interest in their empirical examination. An initial pilot study (Short *et al.*, 2017a) regarding a specific app-based technology led to a broader applied study within a specific population as well as examination of clinician perceptions regarding technology. More broadly, the musculoskeletal impact of hand-held mobile technology was examined, highlighting related postural issues and their potential contribution to cumulative trauma disorders (CTDs).

Working clinically among different cultures (e.g. Native Americans) and in different countries (e.g. Mexico, Romania, Haiti, Guatemala, China, Peru) led to an appreciation of the deep impact of culture on occupation and clinical practice. For example, Asian and Hispanic families often emphasize the role of younger family members in caring for the elderly, using non-familial respite care less than non-Hispanic families (Miyawaki, 2016). A more communal approach to daily life requires a shift in emphasis from that of individual function, prevalent within occupational therapy, toward a more family-inclusive approach. Sensitivity to these types of cultural differences requires deliberate, conscious self-examination and awareness of one's own cultural background. Having practiced in various countries and among different cultures as an ethnic minority has challenged the candidate's ethnocentric assumptions regarding

culture, developing an appreciation for the impact of cross-cultural interaction (Sue, 2004). As an occupational therapy faculty member working with students primarily of the white majority in the U.S., this prior cross-cultural experience led to the prioritization of cultural competence for future occupational therapists at the academic level. Some research suggests that authentic culturally competent practice is best achieved through experience, often requiring years of practice to obtain (Suarez-Balcazar *et al.*, 2009). However, experiential learning is advocated within the field of occupational therapy, suggesting integration of cross-cultural learning may be beneficial at the academic level (Gitlow & Flecky, 2005). Transitioning to the role of an academic from clinical practice led to the analysis of international service learning (ISL) as pedagogy to encourage future occupational therapists to practice with cultural awareness and sensitivity.

The included studies were implemented as individual efforts with specific aims, however, retrospection has revealed clear, interconnected themes within the works. Increasing cultural diversity among patient populations and the integration of technology into daily life represent major trends among patient populations which warrant critical inquiry. Published research selected for this thesis highlights varied methodologies and findings regarding the stated themes, creating a stronger summative work with multiple, complementary perspectives. The individual and collective contribution to occupational therapy literature is emphasized.

3.1 Impact of technology on daily life and occupational therapy practice

As technology becomes more ubiquitous and integrated into daily life, occupational therapy as a profession is well-positioned philosophically and practically to lead scholarly investigation into its societal impact and potential therapeutic benefit within clinical practice. A recent Nielsen Total Audience Report (2018) found that American

adults spend more than 11 hours per day interacting with media, with approximately 2.5 hours of smartphone and tablet use. From integration of mobile technology into activities of daily living (ADLs) to healthcare and patient interface, technology that once *facilitated* occupation is arguably *becoming* a predominant occupation for many individuals considering the proportion of time spent using technology relative to other daily activities. This trend supports the need for occupational therapy as a profession to critically analyze the impact of technology from multiple perspectives. As technology is further integrated into clinical settings, occupational therapy practitioners must critically appraise technology-based interventions. This knowledge has the potential to inform occupational therapy practice and keep pace with other health care professionals, promoting interdisciplinary practice. The holistic investigation of the impact of technology on occupation, occupational therapy education, and practice is warranted for the profession to stay abreast of societal trends.

3.2 International service learning (ISL) as pedagogy to promote culturally-competent occupational therapy practice

Increasing global immigration and multiculturalism requires a nuanced understanding and awareness for healthcare providers to provide effective service delivery, particularly in the client-centered profession of occupational therapy. The Brookings Institute projects the U.S. will be “minority white” by the year 2045 based on current immigration trends and minority growth (Frey, 2018), highlighting the increasing diversity U.S. healthcare practitioners will encounter over the next several decades. Future immigrants and those having lived in the U.S. for generations represent distinct cultures with unique values, norms, and expectations regarding healthcare and occupational therapy services.

Ambiguity and divergence exist regarding terms related to culture and ethnicity (Dein, 2006). For the purposes of this commentary, *culture* is defined as "…the sum of the experiences, values, beliefs, ideals, judgements, and attitudes that shape and give continuous form to each individual" (Royeen & Crabtree, 2006, p. 3). In essence, not focusing on biological differences, but *experiential* differences that shape thought processes, perceptions, interpersonal relations, and behaviors which impact occupation and intervention. Additionally, the conceptual definition of *cultural competence* varies (Fisher-Borne, Cain, & Martin, 2015); for purposes of this commentary, in the context of occupational therapy, the term is used to reflect a culturally-skilled therapist who "…values diversity, has a sense of his or her own culture….to offer sensitive and appropriate systems of care for his or her patients" (Wittman & Velde, 2002, p. 454). This definition highlights the need for self-awareness of the practitioner's own cultural identity and potential bias to provide truly culturally competent care. It is important to note that the end-goal of cultural competence, based on the definition provided, is "sensitive and appropriate (p.454)" care, not stereotypical or assumptive care. Future occupational therapists should not make assumptions about cultural identity or behavior based on a patient's physical appearance (Naumann *et al.*, 2009), but rather be sensitive to the *possibility* that cultural differences between practitioner and patient may exist. This is particularly pertinent for the profession of occupational therapy, for as global diversity increases, ethnicity among future occupational therapists remains relatively homogenous within the U.S., with more than 80% of enrolled students identifying as "white" (American Occupational Therapy Association, 2018). Research targeting healthcare providers, including occupational therapists, suggests an inverse relationship between the constructs of cultural competence and ethnocentrism, which may be present among students of the majority ethnic group (Capell, Dean, & Veenstra, 2008). Students who have lived and studied within the white population majority may have had less

opportunity for cross-cultural interaction to develop an appreciation and sensitivity to cultural differences.

The American Occupational Therapy Association (AOTA) Code of Ethics upholds equality as a core value and autonomy as a Standard of Conduct, mandating impartial treatment based on the patients' preferences (American Occupational Therapy Association [AOTA], 2015a, p. 2). Culture is identified by the Occupational Therapy Practice Framework (OTPF), which outlines the scope of practice for the profession, as a contextual factor, highlighting the cultural influence on occupation (American Occupational Therapy Association [AOTA], 2015b, p.28). Therefore, as cultural diversity increases globally, occupational therapy academics and practitioners must prioritize culturally-competent practice to remain consistent with its core values and provide effective care. Body language, communication style, religious beliefs, and family dynamics are all examples of potential cultural differences which may impact service delivery (Murden *et al.*, 2008). Lived experience, in the form of cross-cultural service learning, may encourage the development of an appreciation for these cultural nuances and their impact on practice.

However, critical inquiry is warranted to examine the efficacy of various pedagogical methods to promote cultural competence during formal education for future clinicians. As Wittman and Velde (2002) noted, development of cultural competence requires intentionality in developing learning experiences which address cognitive, attitudinal, and behavioral components. With this goal in mind, an international service learning (ISL) experience was developed at the candidate's institution which included clinical service provision and professional reflection. Critical analysis of the short-term and long-term impact of these experiences is described in a series of three studies (Short & St. Peters, 2017; St. Peters & Short 2018; Short, *et al.,* 2020b).

3.3 Guiding theory, design, and methodology

The inquiry and methodologies for this body of work were guided by the theoretical underpinnings of the profession of occupational therapy, adhering to a holistic, multi-dimensional view of *occupation,* or "…activities people engage in throughout their daily lives to fulfill their time and give life meaning" (Hinojosa & Kramer, 1997, p. 864). As occupational therapy is distinctly client-centered and evidence-based with a focus on functional outcomes, both quantitative and qualitative methods are warranted to examine quantifiable variation as well as the meaning individuals ascribe to phenomena. Nearly 30 years ago, Krefting (1991) noted the need for qualitative research in the occupational therapy literature at a time when quantitative research was more dominant in healthcare. Since that time, qualitative research has become more prevalent and valued within the profession. Frank and Polkinghorne (2010) found increased frequency and impact of qualitative studies within the occupational therapy literature. The studies described in this thesis used a variety of methods and data, including standardized test scores, survey responses, journal responses, and focus groups.

The methodologies, or strategies, employed for the studies in this thesis were based primarily on specific research questions, however, methods of data collection were also guided by logistical parameters. For example, the cross-cultural studies (Short & St. Peters, 2017; St. Peters & Short, 2018) were limited in scope by the number of available participants and length of the service-learning experience which were predetermined by the partner organization. A culminating study (Short *et al.*, 2020b) combined student cohorts to increase the sample size, with the addition of qualitative methods, to examine the perception of participants regarding the perceived impact of the experience.

In retrospect, pragmatism is evident as the primary research paradigm for the study designs, using whatever methods seemed logical to answer the proposed research question (Onwuegbuzie & Leach, 2005). Further study of the scholarly debate over quantitative and qualitative research has solidified this pragmatic approach, emphasizing the complementary nature of mixed-methods to illuminate phenomena from multiple perspectives, thereby enhancing description and understanding. This dual perspective has allowed a combined empirical and perceptual analysis, aligning with the evidence-based (empirical) and client-centered (perceptual) principles of occupational therapy (Mortenson & Oliffe, 2009). For example, a patient may regain fine motor control after a stroke using a specific intervention, a verifiable physical improvement, which may have specific, intrinsic importance to the patient. Mixed-methods have the potential to couple parametric empirical examination of the specific intervention with an open-ended exploration of the patient's perceptions and experiences (e.g. motivation or enjoyment). Appropriate analysis and interpretation of the unique data sets may facilitate clarification of the results through examination of convergence and corroboration (Onwuegbuzie & Leach, 2005). For example, quantitative support for the efficacy of a particular intervention may be enhanced by the individual's description of the experience as enjoyable, highlighting potential underlying motivation. In both instances, evidence is provided, though varying in type, to support the use of the specific intervention. Affirming the illuminating value of both qualitative and quantitative research reflects a positivistic approach which is also evident with retrospective analysis of the included studies (Golafshani, 2003). While a strictly quantitative researcher may point out the exegetical subjectivity inherent to qualitative data, quantitative methods may also yield results which are impacted by subjectivity within the study design. As Onwuegbuzie and Leech (2005) noted, the selection and development of various instruments used within quantitative studies, though yielding quantitative data, involve subjective decisions and linguistic constructs (e.g. fine motor control) which are open to interpretation. In summary, the theoretical

underpinnings of occupational therapy research represent a blend of empirical and social science which, in the opinion of the candidate, are ideally suited to a mixed-method approach. Quantitative, qualitative, and mixed-method approaches were used as warranted by the specific research question and aim of the included studies.

The majority of studies included in this thesis were entirely quantitative with descriptive and statistical analysis of numerical data (Short *et al.*, 2017a; Short *et al.*, 2017b; Short & St. Peters, 2017; Short *et al.,* 2018; Short *et al.,* 2019a; Short *et al.*, 2020a). The clinical significance of the studies, less well-defined in the literature, is also described regarding the practical implications for clinical practice (Page, 2014). For example, two studies were solely descriptive in nature, providing information that may be useful for program development, administrative purposes, or policy (Short *et al.*, 2017b; Short *et al.*, 2017c). Informal or secondary findings of other studies provided insight into the practicality and logistics of implementing specific technologies in clinical settings (Short *et al.*, 2017b; Short *et al.*, 2018). These findings, though not empirical, may have some value in designing future studies or guiding clinical application.

A mixed-method approach was used in several studies (Short *et al.*, 2017c; Short & St. Peters, 2018; Short *et al.*, 2020b), in the literal sense, in that quantitative and qualitative data collection and analysis were completed within the same study (Hesse-Biber, 2010). One study in particular obtained quantitative and qualitative data with separate analysis (Short *et al.*, 2017c) and minimal integration. However, two studies (St. Peters & Short, 2018; Short *et al.*, 2020b) present deeper integration and analysis of quantitative and qualitative data, providing a more in-depth perspective of the open-ended meaning attributed to phenomena by participants. Both of these studies followed a sequential, explanatory design (Fraenkel, Wallen, & Hyun, 2011), with qualitative data (i.e. findings from focus group) as a supplement to provide a deeper

understanding of measured impact (i.e. standardized assessment scores). In essence, the mixed-method design was chosen to gain understanding of the "what" and the "why" of the observed phenomena. To reiterate, the methods were chosen based on their suitability to answer the proposed research question, or pragmatism, an approach advocated by Tashakkori and Teddlie (2003) specifically for mixed-methods research.

As a clinician-scholar, the research questions for the selected studies developed naturally, in response to practical clinical and academic interests. For example, using the Dexteria™ app clinically led to the question of efficacy as well as generalizability of fine motor skills from a 2-dimensional environment (tablet) to the 3-dimensional environment of daily function (Short *et al.*, 2017a; Short *et al.*, 2018). Additionally, hearing students describe the personal and professional impact of serving cross-culturally provided the impetus to examine international service learning (ISL) as a pedagogy and its specific impact. Findings and discussion of the initial research naturally led related avenues of inquiry.

The advent of research software such as SurveyMonkey™ and Qualtrics™ has provided an efficient method to reach participants and receive responses for survey-based research. Survey-based methodologies were implemented when the research question warranted the perspective of a large, geographically diverse sample (Short *et al.*, 2017b; Short *et al.,* 2017c). This avenue facilitated access to diverse participants with an efficient, timely method of participation, perhaps contributing to increased participation and sample size, and subsequently, generalizability of findings.

While each study design features both benefits and limitations, the varied approaches provide a broader understanding of the impact of technology and cultural diversity on

occupation and practice. The next section presents individual analyses of each study with concise overview in table 2 below for reference.

Table 2. Concise overview of included studies in order of analysis within the manuscript

Study	General Overview
Short, Harmsen, Kjellgren, O'Neill, Pinney, Rivera & Warnaar (2017a)	Quantitative; single group pretest posttest; examined impact of Dexteria™ app use on the fine motor coordination of the non-dominant hand in a healthy sample of young adults (*n*=38). Found statistically significant improvement based on performance on the Nine Hole Peg Test (NHPT) (Oxford *et al.*, 2003).
Short, Best, Bhowmick, Brenner, Cundall, Farmer, Patel & Ross (2018)	Quantitative; nonrandomized control trial; compared use of Dexteria™ app and traditional methods for developing visual-motor integration (VMI) in a sample of 2nd grade students (*n*=43). Results were not statistically significant based on Beery VMI (Beery & Beery, 2010) scores. Clinical significance is discussed.
Short, LaRowe, Treherne, Francis, Garau, Schutt & Wei (2017b)	Quantitative/descriptive; cross-sectional survey; surveyed preferences for content and likelihood of use of an app-based technology geared towards a sample (*n*=341) of certified hand therapist clinicians.
Short, Cool, DeLay, Lannom, O'Donnell & Stuber (2020a)	Quantitative/observational; examined the time spent using mobile technology as well as biomechanical posture based on goniometric measurements among a healthy sample of young adults (*n*=46). Provided an operational definition of "mobile tech posture" for further study.
Short, Blair, Crowell, Loewenstein, Lynch, & Warner (2019)	Quantitative/observational; described the prevalence of mobile technology use and cumulative trauma disorder (CTD) symptomology among a group of healthy young adults (*n*=42).
Short, Sample, Murphy, Austin & Glass (2017c)	Mixed-method; cross-sectional survey; explored barriers and solutions regarding student fieldwork experiences in the specialty practice area of hand therapy based on responses of an international sample of specialist clinicians (*n*=2080). Open-ended responses were analyzed for theme clarification
Short & St. Peters (2017)	Quantitative; single group pretest posttest; examined the short-term impact of an international service-learning experience on the cultural competence on a sample (*n*=10) of doctoral occupational therapy students based on the Cultural Intelligence Scale (CQS)

	(Ang et al., 2007). Statistical significance was found on all four factors of the CQS.
St. Peters & Short (2018)	Mixed-method; single group pretest posttest supplemented with journal responses; explored the impact of an international service-learning experience on the character development of a sample (*n*=10) of doctoral occupational therapy students. Statistical significance was found for several character traits using the CIVIC (Ng, Tay, & Kuykendall, 2017) assessment with qualitative data integrated to highlight perceived impact of participants.
Short, St. Peters, Almonroeder, Bolomope, Daller, Deaton, Kreill (2020b)	Mixed-method; pretest posttest with qualitative open-ended responses; examined the short-term and longer-term impact of international service-learning the cultural competence on a sample (*n*=42) of doctoral occupational therapy students based on the Cultural Intelligence Scale (CQS) (Ang et al., 2007). Thematic elements of reflective open-ended responses regarding perceived impact are presented.

4 Synthesis of publications: context, description, & discussion

The following provides a retrospective analysis of individual studies including the synthesis of findings within the identified themes and reflections on the overall contribution of the body of work to the occupational therapy literature.

4.1 Use of Dexteria™ application to improve fine motor coordination in the nondominant hand (Short, Harmsen, Kjellgren, O'Neill, Pinney, Rivera & Warnaar, 2017a)

As an active clinician and researcher, this initial study originated from the clinical use of the app, Dexteria™, working with individuals with neurological pathologies (e.g. stroke) to recover fine motor skills. The app provides progressively more difficult moving targets, requiring high-repetition fractionation of the digits to "tap" the targets on a tablet screen. The target population includes individuals of all ages with fine motor deficits with enough visual-motor control to participate. The literature reports potential advantages of app-based "touch" technology for neuro-rehabilitation including increased motivation and engagement, portability of the intervention, potential integration into home programs, as well as quantifiable assessment of performance (Confalonieri *et al.*, 2013; Proffitt & Lange, 2015; Saposnik *et al.*, 2014). However, as app technology varies widely, each technology must be examined independently for efficacy as an intervention. When the study (Short *et al.*, 2017a) was undertaken in 2015, Dexteria™ had yet to be empirically tested by independent research, providing a unique opportunity for an original study.

As is often the case with a novel intervention, efficacy was investigated on a healthy, adult population prior to working with individuals with specific pathology or underlying impairment. A sample of occupational therapy doctoral students, with no known

neurological limitations, were therefore recruited as participants in the initial pilot study. The study focused on the non-dominant hand, which typically scores lower on standardized tests of fine motor control as compared to the dominant hand (Mathiowetz *et al.*, 1985), assuming there may be a greater margin for improvement. The Nine Hole Peg Test (NHPT), a standardized and widely used measure of fine motor control (Oxford *et al.*, 2003), was selected as the assessment for the single-group pre-test, post-test design, with each participant serving as their own control. Several other fine motor assessments were considered (e.g. the Minnesota Test of Manual Dexterity), however, the NHPT was selected due to its reliability, validity, as well as the minimal time required for its administration (Mathiowetz et al., 1985).

Statistically significant results, as measured by an improvement in score on the NHPT, after two weeks of consistent app use, suggested Dexteria™ does have the potential to improve fine motor coordination. However, the generalizability of the results was limited by a small, homogenous sample of healthy adults, warranting further inquiry. Perhaps the broader thematic implication regarding technology integration, is that the use of app technology, with its two-dimensional environment, translated to improved performance of a fine motor task on a three-dimensional assessment. As occupational therapy practice focuses on restoration of daily activity, it is not sufficient to demonstrate improved ability to “tap” or “swipe” on a tablet; rather, interventions must translate to the “real world” of function. As various technologies are rapidly being developed and implemented in clinical settings, occupational therapists must assess appropriateness and efficacy for various patient populations. Describing the role of the profession in the mass-market technology environment, Proffitt *et al.* (2019) noted few occupational therapists work in technology research and development and called for a more active role in developmental consulting and empirical research on practice-based technologies. More clinician input is needed to guide development of these potential treatment tools based on clinical efficacy and practicality.

The findings of this study were used to develop an additional, experimental study, described in the next section, and were cited by Pitchford and Outhwaite (2016) in a study regarding use of tablet technology for assessment of cognitive and motor skills (Short *et al.*, 2017a was published online in 2016, hence the chronological discrepancy). Encouragingly, their study was in the field of psychology, demonstrating cross-disciplinary application and relevance of the original findings. Interestingly, the study involved cross-cultural use of app technology as a potential assessment method on children in a primary school in Malawi, demonstrating an intersection of identified themes. Further research may examine user interface and efficacy of specific technologies within different cultural contexts for comparative analysis and contribute to more culturally relevant technologies.

Results are also being used by the developer of Dexteria™, BinaryLabs, to promote efficacy of the app as an intervention for improving fine motor control. The app description on the iTunes platform cites the study as demonstrating an impact on fine motor control generally (https://itunes.apple.com/us/app/dexteria-fine-motor-skill-development). The researchers were not compensated or incentivized by the developer, maintaining integrity of the results, and the findings are appropriately cited as "independent" in their marketing. To avoid real or perceived bias, the developer was contacted initially to get permission to study the app technology but was not consulted on methodologies or otherwise contacted until the study was concluded. The use of the results by the developer for marketing purposes demonstrates one dimension of the impact of the study; the use of occupational-therapy based research to support app-based clinical interventions.

Retrospection provides insight into modification of methodologies which would have strengthened this nascent examination of the clinical impact of technology. Expanding

the research timeline to allow recruitment of additional participants and increasing the duration of app use may have significantly strengthened the results. Additionally, a randomized control trial would have provided a comparative perspective for individuals receiving traditional interventions to improve fine motor control. Nonetheless, the pilot study yielded results from which to build further inquiry and these identified methodological improvements were incorporated into the study described in the next section (Short *et al.,* 2018).

4.2 Impact of Dexteria™ application use on visual-motor integration in elementary-aged children (Short, Best, Bhowmick, Brenner, Cundall, Farmer, Patel & Ross, 2018)

Encouraged by the results of the initial Dexteria™ study (Short *et al.*, 2017a), additional populations were considered for further critical analysis. While fine motor control is often impaired after neurologic injury (e.g. stroke, traumatic brain injury), it is difficult to identify and access a sample with similar impairment and severity to provide an equivalent comparison. A healthy pediatric population, however, while not addressing specific neurologic impairment, provided a sample with typically-developing, age-based neuromuscular skills for more homogenous comparison. Therefore, elementary-aged children (6-7 years of age) were chosen as the target population for the subsequent study (Short *et al*., 2018).

Visual-motor integration (VMI) was chosen as the focus of assessment, as VMI has demonstrated correlation with academic achievement as well as legitimacy as a measurement of fine motor abilities in children (Sortor & Kulp, 2003; Cui *et al.*, 2012). Specifically, the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery & Beery, 2010) was selected as a standardized assessment tool with strong empirical evidence for reliability and validity (Brown, Chinner, & Stagnitti, 2011; Coallier, *et al.*, 2014; Mao, Li, & Lo, 1999). Furthermore, an experimental design was

chosen to examine efficacy of app use in comparison to traditional instructional methods only, employing a non-randomized control trial with inferential statistics for hypothesis testing.

The publication of the initial pilot study (Short *et al.*, 2017a) provided an evidence-base from which to engage potential organizational partners. A local elementary school agreed to participate along with two 2nd grade teachers, providing access to the target population as well as logistical support. The organization selection was one of convenience based on proximity to the researcher's institution, however, the 2nd grade class was recommended by the school administrator as optimal for its curricular focus on the development of visual-motor skills. The app developer, BinaryLabs, provided downloads of the app on school iPads at no cost (but provided no other financial support or incentives for the study). This arrangement provided an ideal opportunity to implement the study in a control and experimental classroom of children at a similar stage of motor development.

Many lessons were learned during data collection. The elementary students had difficulty staying focused consistently for the entire 15-minute sessions. They were initially engaged and excited about the novel teaching method, however, the observing teachers reported that the students' engagement diminished with each session. Additionally, the app use took place right after lunch, a period of time in which the students may have been more excitable and active, potentially limiting engagement. Some of these limitations were logistical and related to the participant's availability and scheduling conflicts. Ideally, the app could have been implemented for an entire semester, providing a longer intervention period to assess its potential impact.

Data analysis (paired-samples *t* test) revealed no statistically significant difference in Beery VMI (Beery & Beery, 2010) scores as an assessment of visual-motor integration between the control group and experimental group. In retrospect, an ANOVA or

unpaired *t*-test could have been used for the initial data analysis to better compare the mean scores between groups or the data could have undergone further post-hoc analysis. However, the biostatistician consulted by the research group did not recommend further analysis as no significant difference was identified. However, some practical knowledge was gained in terms of integrating similar technology into the classroom. The timing and duration of app-based technology must be considered to align with the attention span and daily routines of the students. Additionally, perhaps more variety of app-based technology would be beneficial to avoid inevitable disengagement for children of this age and attention span. Furthermore, a month seemed insufficient to appreciate potential changes in visual-motor integration as changes for both the control and experimental group were minimal.

The findings also raise broader questions regarding the integration of app-based technology within the classroom. In 2012, Apple reported over 20,000 various educational apps had been developed with more than 1.5 million iPads at use in schools, not to mention other brands of similar technology (Rao, 2012). However, there is a paucity of research regarding comparative benefit or general impact of these technologies on education and development of visual-motor skills. Empirical evidence is needed prior to universal implementation of technology in the classroom. The findings related to the impact of technology integration, though limited in scope, suggest app-based technology targeting visual-motor integration may be practically implemented in an elementary classroom setting, however, further comparison is needed with traditional instructional methods.

In retrospect, preliminary studies incorporating observational or qualitative methods might have better informed an experimental study. For example, focus groups or interviews involving teachers working with the target population may have provided a richer perspective on the integration and timing of the study. Analysis of student and

teacher perceptions of the technology, its integration within the general curriculum, or logistical barriers may have improved parameters of the study from the outset.

More broadly, implementation of tablet technology may also impact the way children develop prehensile patterns of the hand, emphasizing touch as opposed to the pinch patterns required by writing utensils (Crescenzi, Jewitt, & Price, 2014). While the current generation of students will enter a technologically ubiquitous society and workforce, it is also pertinent to understand how this trend may impact other areas of function. This is particularly important to the practice of occupational therapy, with the stated aim of promoting occupational performance among various populations. While the first two studies examined the impact of a specific technology on distinct patient populations, the perception of clinicians regarding technology use is also an important component to a multi-faceted understanding within the profession. Thus, the subsequent study shifted towards an examination of the perspective of practitioners regarding integration of technology in clinical settings.

4.3 Exploring the needs of certified hand therapists regarding electronic applications (Short, LaRowe, Treherne, Francis, Garau, Schutt & Wei, 2017b)

Applied, experimental research is required to examine the efficacy of technology-based interventions in practice. Additionally, the perspective of practitioners is essential to understand the perceived benefits and integration of technology into clinical settings. Electronic sources are often the preferred method to access information and the majority of health care providers, including physicians, own a mobile device with some degree of use in clinical practice (Schoville, *et al.*, 2014; Chan *et al.*, 2015). Electronic health resources have demonstrated benefits including organization of specific health information, management of service delivery, as well as improved patient and provider

communication (Free *et al.*, 2013). As each health science discipline has a unique scope of practice, knowledge base, and approach to patient care, discipline-specific technologies are warranted. This study (Short *et al.*, 2017b) therefore involved a survey of specialist clinicians, practicing in the U.S., to ascertain practitioner perspectives on the development and use of an app specific to the specialty of hand therapy.

A cross-sectional survey design was chosen to specifically target clinicians with the certified hand therapist specialty credential in partnership with the American Society of Hand Therapists (ASHT) Research Division. The survey was developed based on the literature and expert review to outline the scope of the potential electronic resource as well as recommended content to be included. It was comprised of three distinct areas – participant demographics, preferred app components, and frequency of various diagnoses encountered in the participant's clinical setting. A sample of 341 respondents, representing a 15% response rate, provided aggregate data from which the findings and discussion were developed.

Demographic findings aligned with similar practice analysis studies (Keller *et al.*, 2016) with the majority of the sample in the 51-60 years of age category (41.6%) as well as predominantly white (90.6%) and female (88.8%). This demographic context may limit generalizability of findings regarding technology to some degree, however, it is representative of professional demographics among certified hand therapists; predominantly female with an average age of 48 (Keller *et al.*, 2016).

Responses for the app were overall positive with home program illustrations, evidence-based practice (EBP) resources, postoperative protocols, and functional outcome measures as the most prioritized components. Not surprisingly, these components mainly represent tools to facilitate patient care as opposed to basic clinical reference for which the specialist practitioners would likely be familiar. For example, home

program illustrations are ubiquitous in clinical settings, however, there is wide variation in format and quality, for which the app might provide standardized, consistent exercise demonstration. Additionally, electronic clinical resources, some of which become outdated as practice trends evolve, have the potential to be updated in "real time" in an app format.

Interestingly, when asked how likely they would be to use the app technology with recommended components, sentiment was mixed with 64% reporting "definitely" or "highly likely" and 36% reporting "somewhat likely" or "never". Though these divergent perspectives were in relation this specific app, they may also be representative of broader attitudes of clinicians working within the hand specialty. However, this is speculation and outside the scope of the study but may provide an avenue for future research.

Further examining the theme of technology integration in practice and daily life, the results of this study were cited by Ouegnin & Valdes (2019) for an analysis of patient preferences regarding written or video-based home exercise program instructions. Patients in the sample overwhelmingly preferred a video taken on their mobile device as opposed to a traditional written handout. The video was perceived as a more effective and detailed method of communicating specifics of home exercises by the patient sample. In synergy with the identified challenge of addressing technology integration, the authors found the "…results of this study (Short *et al.*, 2017b) further support the need for evolving evidence-based health care strategies that efficiently use technological innovation to remain relevant to current societal trends" (Ouegnin & Valdes, 2019, p. 3.).

The results of this study were also used by two occupational therapy doctoral students, in their final year of study, to develop content for an app guided by recommended

specifications as part of a doctoral capstone project. However, due to time and financial constraints, the app has yet to materialize. Findings remain available as published in the *Journal of Hand Therapy* to guide development of app and other technologies specific to specialty hand practice (Short *et al.*, 2017b). As the findings highlight clinician' priorities and clinical needs, they may be applicable to future research or development of clinical resources outside the scope of technology as well. For example, results regarding frequency of specific diagnoses encountered clinically might inform development of additional educational resources.

In a broader sense, this study provides insight into technology integration and development from the perspective of specialist occupational therapists. Namely, the clinicians surveyed were open to and found technology beneficial that is "user-driven", with content inclusion guided by clinical experts, for effective implementation. It seems many app-based healthcare technologies have limited pre-development research, operating on an assumption of efficacy and use by practitioners. Even with therapists' recommendations guiding content development and inclusion, only a portion of respondents reported they would be likely to use the app as a clinical resource. Lower rates of implementation could be assumed without user-guided developmental strategies. The expressed desires of the clinicians surveyed align with the need for evidence-based technology interventions with practical benefit to practice.

Reflecting on the methodologies, a quantitative, survey-based study seemed to answer the research question regarding specific content for inclusion and use of app-based technology among a group of specialist practitioners. However, analysis could have been more nuanced, describing stratified results (e.g. incorporating comparative clinical experience, age demographics) to examine generational differences. Moreover, qualitative methods, in the form of open-ended questions or focus groups, might have

provided a deeper, complementary qualitative perspective. For example, a focus group might have highlighted areas that the survey did not address regarding content inclusion or an in-depth understanding of challenges with integrating this type of technology in a clinical setting. Having examined a specific technology and perceptions regarding clinical integration, the line of inquiry broadened, shifting towards an examination of the impact of mobile technology use on the human body.

4.4 Defining mobile tech posture: prevalence and position among Millennials (Short, Cool, DeLay, Lannom, O'Donnell & Stuber (2020a)

As technology continues to revolutionize societal communication, access to information, and routines of daily life, it may also significantly impact the functional positioning and posture of the human body. The profile view of an individual engaged in a text message conversation or engrossed in the latest viral video reveals colloquial "tech neck" or "tech posture"; the head and neck flexed downward toward the device, cradled in the hands, with the elbows flexed and wrist angled to bring the screen into the visual field. The thumbs are positioned in front of the screen for rapid-fire communication or "swiping". This position violates several essential principles of ergonomics and prevention of cumulative trauma disorders (CTDs), including non-neutral joint angles, repetitive motion, as well as significant head and neck flexion (Pendleton & Schulz-Krohn, 2018). Perhaps most concerning is the duration and frequency for which this posture is assumed on a daily basis; more than three hours per day for adults in the domestic U.S. according to a recent study (The Nielsen Company, 2018), further magnifying the risk of musculoskeletal imbalance and injury.

Informal descriptions notwithstanding, the literature is lacking a formal biomechanical definition of *mobile tech posture,* specifying joint angles and the posture assumed when using *specifically* mobile technology as opposed to a laptop or computer

workstation. Mobile tech posture is unique in that the human body must adapt to a small, handheld device unsupported in space, requiring more deviation from ideal posture than other technologies (e.g. computer workstations). This study sought to provide an operational biomechanical definition of mobile tech posture regarding the neck and upper extremity through goniometric measurement and describe daily time spent in this position among a healthy sample of graduate students.

College students spend more time using technology, including mobile technology, compared to other adult demographics in the U.S. (Pew Research Center, 2011). There is also evidence of musculoskeletal impact associated with this trend, with 52% of college laptop users reporting musculoskeletal symptoms according to one study (Dockrell, Bennett, & Culleton-Quinn, 2015). The sample of graduate students (n=46) used for this study (Short *et al.*, 2020a) was one of convenience and coincidentally, representative of a demographic with the highest use rates of mobile technology.

As a reliable measure of usage, Screen Time app data, which automatically tracks iPhone usage, was collected from participants to quantify daily time spent using mobile technology. The results aligned with the Nielsen's (2018) study with participants spending an average of 143 minutes (2 hours, 23 minutes) per day on their smartphone. This represented a significant portion of waking hours interacting with technology in a static posture.

Consideration of time spent using mobile technology (approximately 2.5 hours) in proportion to other occupations encourages analysis of how technology use fits into the broader framework of occupation. Instrumental activities of daily living (IADLs), according to the Occupational Therapy Practice Framework (OTPF), are "…activities to support daily life within the home and community that often require more complex interactions than those used in ADLs" (American Occupational Therapy Association

[AOTA], 2015b, p. S19). IADLs are delineated categorically and include communication management, financial management, health management and maintenance, as well as shopping. Currently, smartphone and tablet use are included under "communication management", however, app technology has evolved beyond communication into many other categories of IADLs. Consider health management and maintenance as an example – apps now track activity levels with biofeedback to encourage movement, support diet and exercise routines, as well as monitor vital signs. Furthermore, the finding suggesting 2.5 hours per day of mobile device use (excluding other technologies) represents nearly 16% of the typical 16 "waking" hours. Purposeful activity of this prevalence warrants further critical analysis of its place within the scope and practice of occupation.

An activity that is becoming such a predominant part of daily life also encourages examination of its physical impact on the human body. The study also yielded mean joint angles of the neck and upper extremity while interacting with mobile technology. Some degree of inherent subjectivity in joint angle measurement (goniometry) exists, regardless of technique or experience level of the evaluator. Clinically-accepted techniques, as described by Clarkson (2012) were used systematically by the researcher, a licensed occupational therapist and certified hand therapist with ten years of experience, for increased reliability and validity of measurement.

While clinically-accepted goniometric techniques are described for most joints of the upper extremity, a unique challenge to this study was quantifying scapular protraction, typically present with "slouched" posture when using technology. As the research team felt this was an important component of the study, a collaborative approach was taken with input from an anatomist to work towards an assessment method. Analysis of scapular motion around a vertical axis (protraction and retraction) suggested two bony landmarks, namely the superior angle and acromion, observed superiorly, as reference

points for goniometer alignment. Repeated measures, while not empirically tested, yielded consistent measurements, and the method was published as a proposed technique (Short *et al.,* 2019b) and used for the current study (Short *et al,* 2020a). The novel technique is currently being tested in an additional study for inter-rater reliability.

Descriptive statistics were used to find the mean angles of the neck and joints of the upper extremity while interacting with mobile technology. Positional trends of anatomical concern included cervical spine and head flexion, elbow flexion, wrist ulnar deviation, as well as thumb abduction with repetitive flexion. Prior research has indicated musculoskeletal imbalance as well as specific pathologies associated with these positions including cubital tunnel syndrome and De Quervain's tenosynovitis (Gelberman *et al.*, 1998; Harvey, Harvey, & Horsley, 1990). These identified positions of clinical concern were used to guide development of a follow-up study (Short *et al.*, 2019a) regarding cumulative trauma injuries among graduate students related to technology use.

Though the study sample represented a demographic associated with high levels of technology use, generalizability of the results was limited by its narrow age range and predominant female gender. Furthermore, the study focused on small, hand-held mobile technology use in a seated position, discounting the use of various technologies in other position (e.g. using a laptop computer on a countertop or texting while supine in bed). However, as an initial effort, the results suggest the positioning required to use hand-held mobile technologies as well as a starting point for further inquiry.

As with any global advance in technology, widespread benefits often overshadow potential negative impact which may only be evident in hindsight. Mobile technology allows for unparalleled communication, access to information, and real-time

dissemination of media. However, these benefits change the way humans posture and interact with one another; a widespread societal trend warranting critical examination. Findings of this study represent a broader contribution to the theme regarding the impact of technology, providing an operational definition for a pervasive posture associated with mobile technology and its prevalence among a prime demographic for technology integration. Based on the joint angles of concern identified with mobile tech posture, a subsequent study was developed to examine the incidence of related cumulative trauma disorders among the same sample.

4.5 Mobile technology and cumulative trauma symptomology among Millennials (Short, Blair, Crowell, Loewenstein, Lynch, & Warner, 2019a)

As discussed previously, a thorough understanding of the impact of integration of technology on occupation requires analysis from multiple perspectives. Building on the findings of the initial study (Short *et al.*, 2020a) regarding prevalence and biomechanical definition of mobile tech posture, this study (Short *et al.,* 2019a) implemented a cross-sectional, observational design to describe symptoms of cumulative trauma disorders (CTDs) of the upper extremity in a healthy sample of Millennials, born between 1981 and 1996 (Dimock, 2019). Healthy Millennials in the same graduate program were chosen for several reasons including a) relative homogeneity of age and lifestyle (graduate students in the same program), b) ubiquity of technology in daily life from a young age, c) similar patterns of current technology use for academic coursework, and d) convenience.

The methodologies of this study were guided by the findings of the prior study which identified a mean 143 minutes (2 hours, 23 minutes) per day using hand-held mobile technology for the sample and its associated postural risk factors for CTDs (Short, *et al.*,

2019(a)). Researchers posited that individuals spending this amount of time per day in a sub-optimal posture would manifest discernable levels of musculoskeletal symptoms. Analyzing mobile tech posture and associated musculoskeletal imbalance, several specific musculoskeletal pathologies were selected for assessment including thoracic outlet syndrome, medial and lateral epicondylitis, cubital tunnel syndrome, carpal tunnel syndrome, De Quervain's tenosynovitis, and thumb carpometacarpal (CMC) osteoarthritis. Orthopedic special tests associated with each pathology, specifically noted within the study, were implemented based on the primary author's clinical experience as well as identified specificity and sensitivity described in the literature. Recognizing the subjectivity of special tests, authors described symptomology, as opposed to a definitive diagnosis which would require further medical evaluation.

Student researchers completed a competency check-off with a licensed occupational therapist who was also a certified hand therapist to ensure competent administration of the orthopedic special tests. During data collection and test administration, the researchers were supervised by a different professional with the same licensure and specialty for reliability and consistency.

The study found 54% of the sample (*n*=42) demonstrated at least one positive orthopedic special test. This finding aligns with prior research by Dockrell, Bennett, & Culleton-Quinn (2015) who found 52% of college laptop users self-reported musculoskeletal symptoms. Additionally, the study provided more specific symptomology with evidence for De Quervain's tenosynovitis (*n*=19; 36%), thoracic outlet syndrome (*n*=13; 25%), and cubital tunnel syndrome (*n*=10; 18.9%) representing the most common symptomatic patterns identified by orthopedic special tests. While not a formal diagnosis and with varying degrees of specificity and sensitivity, the pattern does appear consistent with potential risk factors identified through analysis of mobile tech posture.

Of note, participants in the study were all young adults with a mean age of 24, not a demographic group commonly associated with CTDs. Research findings are variable regarding the incidence and prevalence of upper extremity CTDs, however, several studies provide evidence that incidence increases with age (Osei *et al.*, 2016; Wolf, Sturdivant, & Owens, 2009; Wolf *et al.*, 2010). A large-scale retrospective using a U.S. military database of over 12 million individuals found rates of De Quervain's tenosynovitis more than doubled in the over-40 demographic with two out of every 1,000 individuals diagnosed compared to the under-20 demographic (.06/1000) (Wolf, Sturdivant, & Owens, 2009). A similar study found both medial and lateral epicondylitis were more common in the over-40 age group as well (Wolf *et al.*, 2010). The findings of the current study, though limited by the small sample size and variable reliability of special tests, suggest the potential for higher incidence of these conditions among an otherwise healthy sample of young adult graduate students. Further research may include more definitive diagnostic methods, larger samples, and between-groups comparison to further discern prevalence and the potential contribution of increased use of mobile technology.

Interestingly, the findings of both studies regarding hand-held mobile technology use and musculoskeletal symptoms supported findings of prior large-scale studies (The Nielsen Company, 2018; Dockrell, Bennett, & Culleton-Quinn, 2015). Additional research may serve public health interests by affirming a connection between increased mobile technology use and CTDs and may also provide suggestions for the threshold of "safe" frequency and duration of use to limit the risk of musculoskeletal symptoms. While empirical research is limited regarding a "safe" threshold of mobile technology use, the researchers speculate that limiting continuous use to one hour with frequent rest breaks, similar to ergonomic recommendations for computer

workstations (Pendleton & Schultz-Krohn, 2018), may be a starting point to reduce the risk of CTDs.

Prior research (The Nielsen Company, 2018) identified an increase in mobile technology use across all U.S. demographics, suggesting this posture and its potential implications may impact other age demographics. Moreover, as technology is now integrated from a young age for many individuals, potential musculoskeletal issues may emerge earlier in the lifespan as compared to previous generations.

As the name implies, *cumulative* trauma disorders are related to summative forces in the musculoskeletal system over time (Saunders *et al.*, 2016), and therefore prevention is key. Occupational therapists, with an understanding of underlying anatomy, activity analysis, and a holistic view of meaningful activity, are uniquely qualified to address the impact of this trend. However, a biomechanical definition of mobile tech posture may also have relevance to other disciplines including ergonomics, engineering, and anthropometrics, all of which address human interaction with the external environment. As it relates to the impact of technology integration, this study and its precursor (Short *et al.*, 2020a) encourage further examination of the physical impact of increasing mobile technology use.

4.6 Barriers and solutions to fieldwork education in hand therapy (Short, Sample, Murphy, Austin & Glass, 2017c)

The motivation for this study began with practical barriers encountered with placement of students in clinical settings within the specialty area of hand therapy practice. As an additional board certification, the certified hand therapist credential requires an additional 4,000 hours of direct patient care as well as a comprehensive board exam (Hand Therapy Certification Commission, 2016). As a result, many certified

hand clinicians are hesitant to take on entry-level students for clinical rotations as their education is geared more towards generalist practice. However, many students develop an affinity for a particular area of practice during their didactic education and want to pursue specialty clinical rotations. The purpose of this study was to gain the perception of practicing certified hand therapists regarding perceived barriers to accepting students, as well as provide insight for prospective students to prepare themselves for successful clinical rotations in this specialty area of practice. To that end, a mixed-methods, cross-sectional survey design was chosen to examine trends among therapists, including qualitative feedback on perceptions and proposed solutions to facilitate knowledge translation between clinicians and students.

To access the target population of active specialty clinicians, discussions were held with the Hand Therapy Certification Commission (HTCC), whose overall mission aligned with the intent of the study. Prior practice analysis had demonstrated certified hand therapists to be an experienced, but older group of clinicians, with nearly 25% of clinicians phasing into retirement in the next decade (Keller *et al.*, 2016). The commission had already been examining macro trends within the specialty and welcomed the partnership to inform policy. There was no financial support from the commission, however, expertise was provided to guide the study and the commission provided an email listing of members to disseminate the survey.

The survey was informed by prior research addressing primary clinical skills needed to work in the specialty of hand therapy (Kasch, Greenburg, & Muenzen, 2003). Based on the review and critique of two occupational therapy faculty members and three members of the HTCC, the survey was refined to enhance its clarity and scope. The survey categories were divided into subgroups of knowledge, skillset, and experience with various components in each category (i.e. knowledge of anatomy and physiology,

ability to fabricate custom orthotics, etc.). This peer-review process yielded the expansion of categories to include all available options identified by the reviewers.

The survey yielded more than 2,000 respondents, representing a 37% response rate. A gift card drawing was used as an additional incentive, however, participants seemed interested in the topic with many contributing optional qualitative feedback. The modest response rate generated a large sample which enhanced validity and generalizability of the results, providing valuable insight into clinician perspectives on the topic. Additionally, the open-ended qualitative feedback underwent content analysis, coding, and triangulation among individual researchers to validate themes. The quantitative and qualitative results were analyzed and presented separately in the study, representing a mixed-method design in the literal sense, however, with minimal integration of findings.

The topic of this particular study may not seem to readily align with the broader themes of cultural competence and technology integration. However, some of the findings of the study were unanticipated and support the need for client-centered practice, encompassing cultural and technological relevance. The researchers anticipated that clinicians would predominantly recommend student development of particular skillsets and areas of knowledge. However, the principle recommendations of the participants were not clinical skill development or even specific to the hand specialty, but rather development of therapeutic communication and professionalism. These findings among such a large sample may have broader implications for occupational therapy practice and education. In effect, the respondents felt that clinical skills could be developed over time, but the ability to connect at a therapeutic level and demonstrate professional behaviors were of greater importance for students during clinical education. As therapeutic communication and professionalism involve building rapport and developing a therapeutic clinician-patient interaction, this

naturally entails providing culturally and technologically relevant communication and interventions (Maloney, Margaret, & Griffith, 2013). The researchers assumed that the results of the survey would prioritize clinical skill development (e.g. specific interventions, knowledge base), particularly among a sample of specialty clinicians where clinical skills are arguably more complex than that of generalists. The quantitative findings and recurring comments among participants reinforced the idea of interpersonal skills as foundational to clinical success.

Within the broader profession of occupational therapy, the concept of therapeutic communication and rapport are described as *therapeutic use of self.* This idea refers to a practitioners' "…planned use of his or her personality, insights, perceptions, and judgements as part of the therapeutic process" (Punwar & Peloquin, 2000). Pendleton and Schultz-Krohn (2018, p. 100) describes therapeutic use of self as imbedded in the Mindfulness Model which includes "…celebration of individuality and diversity" (p.101). Thus, to effectively practice *therapeutic use of self*, occupational therapists must have sensitivity to and understanding of the impact of their own cultural perspective and that of the patient. These findings provide a segue to the next series of studies which feature an examination of international service learning (ISL) as pedagogy to promote client-centered, culturally-competent care.

4.7 Exploring the impact of service learning in Haiti on the cultural competence of OTD students (Short & St. Peters, 2017)

Accepting cultural competence as a priority to address changing patient demographics, particularly in the U.S., this study was designed to assess the impact of international service-learning (ISL) as a pedagogical method to promote cultural competence in occupational therapy doctoral (OTD) students. Long advocated as a method to increase the generalizability and practical application of knowledge, service learning finds its

roots in the ideas of Dewey, who first put forth experiential learning as a combination of knowledge and experience (Dewey, 1938). Experiential learning provides real-world application of knowledge, ideally in a scenario that involves real-world consequences as opposed to the relative safety and limitations of the classroom. Within higher education, experiential learning has evolved, often including experiences imbedded in the curriculum, outcome assessments, as well as student and faculty development (Kolb & Kolb, 2005). Reflective journaling has also been advocated as a method to process and increase the impact of service learning initiatives (Sedlak *et al.*, 2003). Prior studies were identified in the occupational therapy literature examining service learning and its unique benefits. Gitlow and Flecky (2005) and Greene (1997) focused mainly on the benefit of the experience on student' perceptions of professional concepts including disability and core values of the profession. The apparent benefits of service learning outlined in these studies encouraged further examination.

The candidate's affiliated university provided the infrastructure for the development and integration of an OT-specific, international service-learning endeavor into the curriculum. This enabled a rich line of inquiry for the critical appraisal of ISL as a pedagogy. The course, entitled OTD706: Missions and Outreach, was developed based on a constructivist educational model, providing opportunities for the application of knowledge through interaction with other individuals and the surrounding environment (Driscoll, 2005, p. 388 as cited in Christiansen 2008). Additionally, occupational therapy-based clinical services (e.g. seating and mobility) were integrated into the experience, along with reflective journaling, as advocated by the literature. The course was intentionally positioned after the OTD students first semester of study, allowing for the application of foundational knowledge gained in their initial coursework.

First-year, second-semester doctoral of occupational therapy students were offered a voluntary international service learning (ISL) opportunity to serve in Haiti, providing seating and mobility services under the supervision of occupational and physical therapists. This arrangement dictated the study design to some degree, with a quantitative single-group, pretest-posttest approach as the most feasible strategy. The candidate was also a chaperone and lead therapist on the trip, increasing the possibility of influencing participant behavior. Several parameters were established to limit this potential effect on the study. Quantitative data collection took place before and after (not during) the trip, the purpose of the study was not revealed to participants, and anonymity was maintained and emphasized to participants before beginning the study.

The Cultural Intelligence Scale (CQS), developed by Ang *et al.* (2007), was chosen to measure cultural intelligence as a construct of cultural competence as it addressed multiple facets of cultural intelligence, had been used previously in similar studies, and demonstrated validity and reliability. Additionally, sub-scales included attitudinal, motivational, cognitive, and metacognitive assessment for a more nuanced examination of the various aspects of cultural intelligence.

Administered seven weeks prior to and the week after returning, CQS results were statistically significant for overall score and for each sub-scale. Although the sample size was small (n = 12) the effect size for each sub-scale was large ($\eta > .8$), increasing the validity of results for use of *t*-test analysis on a small sample according to de Winter (2013). Consistent with the researcher's initial hypothesis, the international service experience appears to have impacted multiple levels of cultural intelligence. Cognitive and metacognitive impact seem to have translated into attitudinal and behavioral outcomes; knowledge translated inner change and action.

Though qualitative data was not formally collected here, students participated in reflective journaling throughout their experience in Haiti. Following the model outlined by Odawara (2005), journal prompts were provided, encouraging reflection on any "critical incidents", or impactful moments, experienced throughout the week. Journal prompts specifically encouraged reflection on the relationship between culture and practice. With informed consent, the journal responses were reviewed by the researchers informally after the study, providing valuable insight into the participant' perspective. Many students contrasted their own Western predisposition towards individualism with the much more familial approach to occupation encountered in Haiti. For example, when establishing an individuals' functional status, many patients replied that they did not need or want to do a particular daily activity (e.g. dressing) as they had relatives at home who did it for them. This dichotomy between ingrained individualism and familial collectivism challenged the foundational understanding of occupation, often with an underlying assumption of *individual* function. The cross-cultural service also afforded the participants, the majority of whom were white, reflecting domestic U.S. ethnic trends among occupational therapy students (American Occupational Therapy Association [AOTA], 2018), the invaluable experience of being the minority in a different culture.

Prior research using the CQS to examine the impact of cross-cultural study tours demonstrated significant improvement on metacognitive, cognitive, and motivational cultural intelligence (CQ) but did *not* find impact on behavioral cultural intelligence (Wood & St. Peters, 2014). In contrast to service learning, the study tours involved more passive learning without goal-directed cooperation between students and the local target population. The authors postulate that behavioral cultural intelligence increased for student participants as they were not only immersed in the culture, but worked together with local Haitians to provide clinical services, requiring complex, goal-directed interaction. For example, students completed collaborative assessments

which included obtaining a thorough patient medical and social history; performed physical assessments which required close personal contact, and provided education and training in the use of mobility equipment. Additionally, these complex clinical interactions required the use of a translator as well as interpretation and adjustment to the nuances of cross-cultural non-verbal communication to build trust with the individual. As opposed to classroom learning or simulation, students' actions and instructions had real-world impact. Each individual's unique medical history, precautions, and mobility needs had to be thoroughly considered to provide a safe and beneficial solution. Insufficient padding may lead to skin breakdown or lack of education may contribute to improper use of equipment and injury. These "higher stakes" may have also contributed to an increased level of cognitive and attitudinal commitment, manifesting in behavioral change.

The findings of this study (Short & St. Peters, 2017) contribute to prior research generally supporting service learning as a pedagogy for occupational therapy students (Gitlow & Flecky, 2005; Greene, 1997; Lau, 2016) with specific support for its impact on cultural intelligence as a construct of cultural-competence. While encouraging for use of cross-cultural service learning as pedagogy to increase cultural competence, it must be noted that the self-reported results may reflect a short-term impact likely influenced by the emotional "high" of returning from an intensive clinical experience in a foreign country. Immediate results may or may not have been indicative of permanence or long-term impact for occupational therapy doctoral (OTD) students with the end-goal of translating increased cultural competence into future practice. Furthermore, without formal analysis of journaling or additional qualitative data, the underlying perception of participants was not examined to identify aspects of the experience that were particularly meaningful. Building on this short-term inquiry, a follow-up mixed-methods study (Short *et al.*, 2020a) was developed to examine the long-term impact and integration of journal response analysis (section 4.9).

4.8 Cross-cultural service learning as pedagogy for character development of OTD students (St. Peters & Short, 2018)

As a follow-up endeavor to the previous cross-cultural study (Short & St. Peters, 2017), the research question for this study shifted towards impact of similar experiences on the character development of occupational therapy students. As a rehabilitative professional, knowledge and clinical expertise are vital, however, the occupational therapy clinician must also be motivated by underlying character traits to *apply* clinical knowledge for the benefit of the patient. Additionally, cultural competence (a body of knowledge *and* skillset) is only beneficial with empathetic, therapeutic application, or to reiterate the occupational therapy term, *therapeutic use of self* (American Occupational Therapy Association [AOTA], 2015b*)*.

With *altruism,* "…demonstrating concern for the welfare of others" (American Occupational Therapy Association [AOTA], 2015a, p.2), as a guiding principle of the profession, researchers sought to examine the impact of cross-cultural service on specific related character traits. Moreover, the researchers sought to understand not only *if* character development was influenced experientially, but *what* specific aspects of the experience were most meaningful to the participants. Therefore, a mixed-methods design was chosen to examine quantitative impact coupled with journaling and focus groups to yield complimentary qualitative responses. Also of note, the partner organization and service provision were similar to the previous study (Short & St. Peters, 2017), however, the participants served in Guatemala as opposed to Haiti.

The Comprehensive Inventory of Virtuous Instantiations of Character (CIVIC) (Ng, Tay, & Kuykendall, 2017) instrument was used a standardized measure of a broad spectrum of character traits. Additionally, study participants completed the aforementioned Cultural Intelligence Survey (CQS) to examine cross-cultural impact as well. Qualitative

questions were developed to examine *specific* components of the trip, as perceived by participants, which may have had the most impact on character and cultural competence (i.e. “Did your motivation (to participate) shift during or after the experience? If so, how?"; “Do you feel this trip will impact your desire to serve others for the long-term? In what specific ways?”; “Describe specific interactions with individuals in Guatemala that impacted your perspective on culture and service?”).

As one researcher was again imbedded with the team during the experience, several precautions were taken to limit bias. The focus group was implemented after the experience and facilitated by the non-participating researcher and journal responses were blinded to researchers with a third party transcribing data prior to analysis. Identifying information was removed from journal entries which were aggregated into a single document for analysis.

Although not included in this formal publication, the participants were also administered the CQS assessment before and after the trip for a separate longitudinal study. All participants demonstrated statistically significant improvement on all sub-scales of the CQS, strengthening the findings of the initial study regarding cultural intelligence (Short & St. Peters, 2017). Formal findings were presented in the publication regarding statistically significant change for specific character traits as well as qualitative statements from journaling and a focus group to examine student perceptions of underlying impact.

Pre and post-trip scores on the CIVIC were analyzed using inferential statistics to identify statistically significant change. Additionally, qualitative responses were analyzed through an a) individual reading of the qualitative data in its entirety, b) individual hand coding with labeling for possible themes, c) grouping of labels into

themes, and d) collectively interrelating themes with quantitative findings with an analysis of convergence or divergence of the data sets (Creswell & Creswell, 2018).

Specific traits with supporting qualitative statements from participants are presented in the published manuscript (Volume II). Participant reflections demonstrated a trend of initial curiosity prior to the experience that grew as the week progressed, increasing awareness of social cues, as well as increased motivation to learn more about the culture (e.g. family dynamics, language, customs, beliefs) to improve interaction and service delivery.

Impacted traits also seemed to overlap with implementation of cultural competence for the benefit of the patient including *openness to evidence, propriety, self-control,* and *social perceptiveness.* Related qualitative responses reflected a general appreciation of the impact of culture in the intervention process, adjusting behavior to cultural norms, as well as increased self-awareness. Several comments reflected the "relational" versus "task oriented" nature of the Guatemalan culture and the need to develop a trusting therapeutic rapport with the individual before moving on to assessment and intervention. This is consistent with the metacognitive subscale of the CQS with resultant behavioral change, essentially the applied definition of cultural competence. This also reflects the emphasis on therapeutic communication expressed by the specialist clinicians regarding preferred skillsets for students working in specialty settings (Short *et al.*, 2017c).

The findings of the study affirm the theory and empirical evidence for the benefits of experiential learning (Dewey, 1938; Kolb, 1984; Lovat & Clement, 2016) as well as research that supports its specific impact on moral development (Kohlberg, 1971; Kohlberg, 1973; Boss, 1994). To demonstrate profession-specific impact, improved CIVIC traits were further analyzed by occupational therapy academics to determine

their relationship to Principles and Standards of Conduct outlined by the American Occupational Therapy Association [AOTA] (2015a). Robust connections were identified, increasing the face validity of the findings as related to preferred ethical attributes of the profession. (see appendix in Volume II for this study). For example, the CIVIC virtue of "fairness" was identified as related to all AOTA Principles and Standards of Conduct including beneficence, nonmaleficence, autonomy, justice, veracity, and fidelity. As the AOTA Principles and Standards of Conduct present broader professional values, the CIVIC virtues appear to be more specific contributing components (see appendix X).

This particular study contributed to the body of evidence supporting experiential learning for moral development (Kohlberg, 1971; Boss, 1994), additional research suggests virtual learning environments with experiential components may have similar impact. Klimenko *et al.* (2018) cited the results of this study in support of experiential learning for moral development, however, examined the impact of two different online courses on the moral development of college students as measured by the Moral Competence Test (MCT) (Lind, 2014). Improvements in post-course MCT scores were found for students who took either developmental psychology or research methods lab sections, however, results were statistically significant for students who took the research methods lab. Further analysis revealed that online discussion groups (virtual peer interaction) were the most beneficial assignment contributing to moral reasoning, hypothesized to have encouraged critical analysis of participants' own views on morality.

Discipline-specific, cross-cultural service learning appears to have a positive impact on both cultural competence and character development with the additional benefit of clinical skill development. However, other pedagogical approaches and formats demonstrate similar impact (Klimenko *et al.*, 2018) and comparative research may

highlight best-practices for specific beneficial assignments or experiences, regardless of domestic, international, or virtual format.

It is important to note that the identified impact of the international service learning (ISL) studies presented thus far (Short & St. Peters, 2017; St. Peters & Short, 2018) in the commentary, as well as the majority of related research, identified only short-term impact, with post-tests typically administered directly after the experiential learning. This is a significant limitation as it does not necessarily mean changes were permanent or had any long-term implications for future professional behavior or clinical practice. This limitation guided development of the study outlined in the next section which features a longitudinal analysis of various student cohorts who participated in ISL at long-term intervals after their experience.

4.9 Long-term impact of international service learning: cultural competence revisited (Short, St. Peters, Almonroeder, Bolomope, Daller, Deaton, Kreill, 2020b)

The previous studies regarding the impact of international service learning (ISL) presented with two key weaknesses. Firstly, the sample size was relatively small for each study. Secondly, the studies focused on the immediate short-term impact of ISL which may or may not translate into culturally competent future practice. In an attempt to strengthen initial findings with a larger sample and examine longer-term impact, this study included a second administration of the CQS, with the same participants, at 6-month, 1-year, 2-year, and 3-year intervals from the original experience. Study participants were in their 2nd year of study, 3rd year of study, or in clinical practice when the follow-up CQS was administered, having had additional experience and time to practice skills developed during the original experience.

Additionally, this study gained qualitative feedback from participants regarding any cross-cultural interaction since their initial experience, current perspective on cultural competence, as well as perceived impact the initial experience had on their current practice of occupational therapy. These responses were categorized by participant group, allowing for quantitative analysis based on their academic or clinical progression at the time of data collection. For example, the initial Haiti group (2016) was in clinical practice while the Romania group (2018) were in their second year of didactic coursework.

Increasing the overall sample size to 40 participants allowed similar quantitative data analysis of the short-term impact, with comparison of means (*t*-test) demonstrating statistically significant results for all four factors of the CQS - metacognitive, cognitive, motivational, and behavioral CQ. This was anticipated as researchers (Short & St. Peters, 2017) had previously identified impact with individual groups, however, the initial findings were supported with consolidation of participants from multiple groups.

Building upon this short-term trend, additional analysis compared CQS scores between student groups and at long-term follow-up intervals (6-months, 1-year, 2-years, and 3-years) after the initial pre-trip administration. Descriptive statistics found a sustained increase in mean score for all four factors of CQS at each long-term follow-up interval from initial baseline score. However, statistical significance using non-parametric analysis (Wilcoxin signed-rank test) was found only for metacognitive cultural intelligence (CQ) for the 3-year (*p*-value = .01) and 1-year (*p*-value = .04) follow-up groups.

Comparative CQS scores at intervals beyond the initial experience provide a longitudinal perspective on the impact of the initial experience regarding cultural competence. Collective short-term data demonstrated a consistent statistically

significant improvement on all four factors of the CQS, representing a construct of cultural competence. However, decay of the initial improvement is apparent with long-term follow-up, though mean scores remained above baseline pre-trip CQS, each factor also demonstrated a decrease from immediate short-term assessment. The immediate short-term gains are consistent with qualitative data collected from student participants for the initial studies with a trend of excitement and passion to serve after a novel experience with tangible impact to individuals served while in-country. Perhaps the initial passion and excitement gave way to the more typical pattern of coursework and return to "normal" life. However, metacognitive CQS remained statistically significant for two different groups, and this should not be overlooked, as there may have been a more lasting impact on cultural self-awareness and perception. Perhaps the experience contributed to a more permanent change in awareness (metacognitive) while the attitudinal and behavioral factors require additional experiential reinforcement.

Following an explanatory mixed-method design, qualitative data were analyzed to identify participants' perception regarding the long-term impact of the initial experience. Themes, corroborated through researcher coding and triangulation, highlighted individual participants' self-perception of long-term impact of their experience regarding cultural competence as well as an influence on their approach to the practice of occupational therapy. A general trend of increased self-awareness and intentionality, consistent with metacognitive impact, was pervasive throughout the qualitative data. Participants reported recognition of an acute impact after the trip with increased cultural sensitivity and practical modification of approach to client-centered care. The following individual reflection from a student who was in clinical practice at the time of follow-up CQS administration is representative of this general trend:

> ‘I’ve always loved cultures but since the experience I have consistently challenged myself to hold a larger world view. I’ve prioritized living with less and consistently challenge my American way of life. As far as how my cross cultural experience has affected me as an OT, I have chosen to practice OT in an [underserved] area to continue to feed that need to do more for the benefit of others, even if that means a sacrifice of my own living situation’ (Short *et al.,* 2019b, p. 14).

The research series regarding international service learning evolved from a desire to critically examine the impact of cross-cultural service learning. This follow-up study confirmed initial findings on short-term impact and while less conclusive, provided some additional support for longer-term impact specific to metacognition. As a pedagogy to contribute to culturally sensitive and appropriate practice, cross-cultural service learning appears to be a beneficial endeavor for occupational therapy education, however, as with any learning, further experience will solidify changes in cognition, attitude, and behavior.

5 Role of the candidate in the research process

Status as a tenure-track faculty member at Huntington University has afforded me diverse opportunities for scholarship. Faculty and staff are encouraged in their intellectual pursuits and release time is provided to that end. Additionally, as research activity is integrated into the curriculum, doctoral students are motivated to participate in faculty-led initiatives, providing a mutually beneficial arrangement for research project development and implementation.

With the exception of the manuscripts co-authored by St. Peters, the studies described herein represent candidate-driven efforts with support from student researchers. For each, the candidate developed the original idea for the study as well as the foundational methodologies, also serving as the Principle Investigator for Institutional Review Board (IRB) purposes and formal submission to various journals. Doctoral occupational therapy (OTD) students self-selected to participate in various research projects based on areas of interest and provided valuable contributions to literature review and data collection with faculty guidance. However, the original idea, methodologies, and ultimate oversight for each study were the responsibility of the candidate as first author. Additionally, revisions were handled in large part by the candidate. Appendix A provides a description of candidate and co-author contributions for each individual study.

Manuscripts co-authored by St. Peters were collaborative, interdisciplinary endeavors, coupling occupational therapy and organizational leadership expertise to critically analyze the value of cross-cultural service learning. Shared interests led to the collaborative efforts with each author heavily invested and involved throughout the various phases of research. Appendix B provides a formal statement from St. Peters regarding the approach and candidate involvement.

Lastly, and perhaps the most unique role, was that of imbedded researcher for the cross-cultural service learning series. Developing and leading the service learning initiatives permitted a unique depth of insight into the participant's perspective. Serving as the lead faculty for student recruitment, pre-trip orientation and training, as well as a lead therapist working alongside students in-country allowed for informal observation of transformation with empirical evidence to support the impact. For example, one student in particular had never flown on a plane before and had only traveled outside of the Midwestern U.S. a few times. Initially hesitant to even participate, by the end of the week this particular student was leading seating evaluations in Haiti through a translator. Along with providing a unique format for research, the opportunity to share in the lived experience was most rewarding to see the impact on students' personal and professional development. Additionally, this unique researcher immersion allowed for insight into the qualitative data analysis, with the researcher able to relate to the described impact of the experience. Having served as a lead therapist with the partner organization on a similar outreach prior to bringing students allowed for intentional design of the studies. The ability to anticipate and empathize with the participants as they navigated the clinical and emotional complexity of the situation provided insight into the use of the standardized assessments and journal prompts for data collection. While some potential for bias may have existed with the researcher serving on the team with the students' knowledge of the study, data collection was anonymous and not collected during the experience, limiting the impact of the researcher's presence. Quantitative assessments (e.g. CQS, CIVIC) were administered confidentially before and after the experience during trip orientation meetings. Post-trip focus groups were led by the non-participating author (St. Peters), and both researchers were blinded to the anonymous qualitative data during analysis. There may have been some desire on the part of the

student participants to see positive results of the study, however, participants knew the general focus of the study but not the specific hypothesis of the researchers.

6 Impact of published works

The impact of the research included in this commentary is presented in this section, specifically regarding contributions to the occupational therapy literature, formal education within the profession, and clinical practice. Though the studies included in the commentary are relatively recent, early citations of the findings in other works demonstrates broad use, within and external to, the profession of occupational therapy. Relevant citations and the use of study findings, where available, are presented as a dimension of their overall impact. The body of work as a whole also provides some general conclusions as well as suggestions for future efforts.

The integration of technology and implications for the practice of occupational therapy is an evolving topic which warrants "real-time" examination as it has significant implications for the profession and patient care. Short *et al.* (2017a) demonstrated the potential for specific app technology to impact fine motor skills in a healthy population. Expanding Dexteria™ use into a classroom of typically-developing elementary aged students, Short *et al.* (2018) highlighted the logistical ability for technology integration into an established curriculum, albeit with inconclusive results regarding efficacy. Though each study had its strengths and weaknesses, the design and progression provides insight regarding suggested pathways for occupation-based researchers to examine technology; specifically, demonstrating potential efficacy with a healthy population before moving into a specific population or diagnostic group.

As mentioned previously, findings of the initial Dexteria™ study are currently being cited by the app developer in support of product efficacy, lending credibility to OT-based research in the rehabilitation marketplace. International, cross-disciplinary citations of the study include *Frontiers in Psychology* by authors from the University of Nottingham (U.K.) and the Revista de la Sociedad Andaluza de Traumatologia y

Ortopedia (Journal of the Andalusian Society of Trauma and Orthopedics), as part of a presentation on similar app technology for hand rehabilitation (Delgado *et al.*, 2018).

Shifting the approach from efficacy to clinician preference and usage, Short *et al.* (2017b) highlighted trends among specialist clinicians regarding the use of app technology specific to the practice of hand therapy. As hoped by the researchers, the results of the study are being used to promote practical and effective implementation of technology in clinical settings (Ouegnin & Valdes, 2019). With over 6,500 certified hand therapists practicing worldwide, results may inform development of app technology or other clinical resources for patient care. The study methodologies also provide a potential template for research in the pre-development phase of technology, serving as an empirical guide for the development of effective practice-specific tools.

Examination of integration and the perception of technology within the practice of occupational therapy is merited due to the direct impact on practice and patient care. Equally important is a broader analysis of the impact of technology on occupation and its place within the professional scope of practice. As an example, consider the overall purpose of the Dexteria™ app and similar technology – to improve fine motor control and as a result, occupational performance. The underlying assumption is that use of the tablet technology is transferable to the 3-dimensional world of activities of daily living (ADLs) and instrumental activities of daily living (IADLs) as a *facilitator* of occupation. However, the findings of Short *et al.* (2020a) aligned with prior research (Nielsen, 2018), indicating humans are spending increasing amounts of time interacting with technology, which for some, may be a primary meaningful activity. This warrants further examination into the proper place of technology within the scope of occupational therapy practice – is technology solely a facilitator of occupation or does it stand alone as an entirely separate life activity? This theoretical question and its implications would seem to necessitate a large scale, mixed-methods study with

representation from all stakeholders – patients, policy makers, academics, and clinicians.

Additionally, Short *et al.* (2020a) provided an operational, biomechanical definition of *mobile tech posture* for further empirical examination. At the time of publication, no formal biomechanical definition existed in the literature, the results of this study representing a unique contribution which hopefully will be used across disciplines for further study. The findings also aligned with prior research suggesting hand-held mobile technology is becoming a predominant part of societal daily routine, prioritizing analysis and impact on occupation (Nielsen, 2018). As a secondary contribution, the study precipitated development of a novel technique for goniometric measurement of scapular protraction as a component of mobile tech posture (Short *et al,* 2019b). Additional research to examine the reliability and validity of the proposed technique is currently in process.

The subsequent study regarding CTD symptomology (Short *et al.*, 2019a) affirmed similar research suggesting increased integration of technology may contribute to musculoskeletal symptoms (Dockrell, Bennett, & Culleton-Quinn, 2015), potentially earlier in the lifespan. Rates of symptomology among the sample of healthy young adults encourage further examination of the contribution of technology use on musculoskeletal disorders typically associated with individuals over 40 years of age.

Incidentally, the initial cultural competence study (Short & St. Peters, 2017) was the first manuscript reviewed and published by the then nascent *Journal of Occupational Therapy Education.* The journal was established with a specific focus on the scholarship of teaching and learning (SOTL) specific to occupational therapy (Howell, Causey-Upton, & Hayden, 2017). The study provided a unique pedagogical approach for the inaugural edition of the journal along with other related studies in the field.

The series of studies on cross-cultural service learning have also been cited by various related publications which further support unique experiential learning as pedagogy. Early and Lasker (2018) cited the original study in their study examining benefits and challenges of using service-learning in a hybrid online global health course. The findings demonstrate similar themes of impact on student participants, including increased awareness and motivation to address social issues. In some ways, this captures the essence of the intent of the cross-cultural theme, as the results contributed to the literature to support experiential opportunities for learning as well as societal impact. It is my sincere aspiration that the measured initial impact will grow exponentially as student participants continue to intentionally serve underserved populations throughout their personal and professional lives.

Practically, the cross-cultural research has also been used by the partner organization to promote partnerships with like-minded occupational and physical therapy programs, providing additional opportunities for student participants. As the first cooperative partnership including occupational therapy students as opposed to solely licensed clinicians, the initial collaboration has served as a model for additional partnerships with mutual benefit for both organizations, individuals served, and student participants. Additionally, in a time when many institutions of higher education are making difficult financial decisions, the results support continued efforts for international service learning (ISL) as pedagogy for student academic and personal development, encouraging resource allocation for these types of endeavors.

7 Reflections on development as a researcher

The process of analyzing each individual study and the broader research agenda in retrospect has enabled me to reflect upon my development as a researcher. Reflective clinical practice is encouraged within the profession of occupational therapy (Kinsella & Whiteford, 2009) and this process has provided a similar reflexive opportunity as a scholar.

The nascent effort with the initial Dexteria™ pilot study began with a practical question of clinical efficacy regarding a mobile app and the rudimentary study design provided a starting point. The successful publication of the initial pilot study increased my confidence and provided a foundation to develop increasingly complex studies with more sophisticated data collection and analysis. The follow-up study involved an organizational partnership to provide the necessary participant access and employed an experimental, comparative design. The completion of successive quantitative studies highlighted the strengths and weaknesses of solely quantitative research in addressing my research questions. The quantitative findings highlighted superficial patterns and trends without examination of the underlying perception of the participants. Subsequent efforts evolved into a mixed-methods approach, providing enhanced depth of understanding of the observed phenomena.

The initial cross-cultural study (Short & St. Peters, 2017) included a novel design within the occupational therapy literature and required thoughtful development of methodologies. With the role complexity of serving as a leader on the service team as well as an imbedded researcher, a more straightforward, quantitative design was employed. The findings regarding improved cultural intelligence (CQS) were encouraging, but did little to highlight the underlying perception of the participants regarding the impact of the experience. The researchers felt there was evidence that

change had occurred, but wanted to understand why the experience was meaningful and what specifically had the most profound impact. The follow-up study employed an explanatory, mixed-methods design with quantitative data collection and analysis preceding that of qualitative. This provided a much richer perspective and highlighted commonality of perception among participants regarding the experiential impact. A new appreciation was gained with the shift to mixed-methods design with qualitative data providing a deeper understanding of the participant experience, giving more meaning to identified quantitative trends. Practically, the qualitative data served as a program evaluation in a sense, allowing for some modifications to the service-learning endeavors to facilitate the student experience. For example, the duration of the in-country experience was increased, pre-trip orientation was expanded to include basic medical Spanish, and student roles on the seating team were enhanced to allow for some autonomy under the supervision of the lead therapist.

Synthesis and reflection on my prior published work, guided by my PhD advisors' feedback, has also greatly improved my understanding and perspective regarding research theory and methodologies. As discussed earlier, in retrospect, a pragmatic, positivist tendency (Golafshani, 2003) is evident in this body of work. This is to some degree attributable to my background and training as an occupational therapist within a specialty area of practice. The need to rely on empirical, evidence-based practice was ingrained throughout my formal education and the specialty of upper extremity rehabilitation, with a large orthopedic and neurologic component, further emphasizes the need for translation of evidence into clinical practice. As a certified hand therapist, much of the approach and intervention is guided by protocols which are developed and refined based on evidence and research. The underlying assumptions of evidence-based practice include the ability to translate empirical findings into patient care for improved outcomes, aligning with core principles of positivism (Thyer, 2008). Additional reading and reflection has allowed a much broader, deeper theoretical

perspective which will guide my further research endeavors. As with most learning, repetition and familiarity builds confidence and willingness to take on greater challenges. This has proven true in my development as a researcher as well; as my confidence in methodologies and data analysis have increased, there has been a greater degree of willingness to explore more complex avenues of inquiry.

Transparently, my motivation has changed from my initial efforts as well, from a more obligatory approach to genuine curiosity. As a tenure-track faculty member, scholarship and publications are mandated as part of the promotion and tenure process. Analyzing and integrating research findings were a common part of clinical practice, however, contributing to the literature was an adjustment coming from a clinical setting with a focus on patient care. The reflective analysis and synthesis of included publications has allowed an opportunity for reflexivity; increasing self-awareness and understanding of how prior experience may have impacted the approach and interpretation of results (Finlay, 2002). For example, while coming from the perspective of an orthopedics-based practitioner has encouraged the integration of empirical evidence in practice, the biomechanical emphasis in this specialty area may have contributed to a tendency to deemphasize the qualitative aspect of phenomena. Reflecting on the methodologies of included studies reveals a clear preference and accentuation of quantitative results. Acknowledging this tendency may allow for conscious suspension of these presuppositions, particularly with future qualitative endeavors (Finlay, 2008).

Trial and error as well as peer-review have afforded significant improvement in my professional writing as well. The initial peer-review of the first publication was emotionally difficult after having invested so much into the manuscript and having it scrutinized at that level. However, in hindsight, this professional feedback greatly strengthened the initial manuscript and future writing as well. The sheer length of

some of my initial submissions highlights a lack of specificity, redundancy, and needless expansion. Later efforts are more apparently focused, succinct, and readable as the impact of critique yielded benefit in expression.

With the rise of interdisciplinary healthcare, it is important for occupational therapy researchers to be able to reach various target audiences and speak in familiar language to advocate for and express the distinct value of the profession. Additionally, many rounds of peer-review and submission to journals of varying format and target audience has provided a more dynamic style and greater flexibility in writing. Most occupational therapy journals require APA formatting with a more social science approach and style. However, submissions to journals in the hand and upper extremity specialty (e.g. *Journal of Hand Therapy, Hand Therapy)* are more medical in tone and require AMA (American Medical Association) formatting. The reviewers for the various journals also provide differing feedback based on their respective area of practice or instruction which allows some degree of anticipation of what will be expected prior to submission.

Recognizing my areas of weakness as a researcher has encouraged a more interdisciplinary, collaborative approach (Klein, 2008) in my later work. Accepting a faculty posting as a clinician, my research skills were primarily focused on interpreting study findings and working to integrate them into clinical practice. As a faculty member and researcher, my role shifted toward research development, design, and implementation. My prior clinical work in several different areas of practice provided catalysts for many different research ideas and questions based on practical challenges encountered as a clinician. However, the logistics of study implementation, particularly data analysis and interpretation, were not areas of strength. In my later efforts (Short *et al*., 2020a; Short *et al*., 2020b) collaboration with a colleague with a rehabilitation and statistics background significantly enhanced the analysis and interpretation of

study findings. Additionally, informal collaboration among faculty at the university, within my department and externally, has broadened my perspective and approach. Critical analysis of the collective works included in this thesis has also provided insight into how methods and data analysis might have been improved and better planned for future studies.

The body of work presented represents collaboration among occupational therapists of differing specialties, physical therapists, organizational leadership faculty, as well as students with various undergraduate backgrounds. Leading and working with various teams over the years has provided beneficial experience in leading teams as well as managing group dynamics to draw on individual strengths. The complexity of the research process is by nature a more natural fit with a team-based approach as the skillsets necessary to complete a study and publish are numerous. Establishing organizational partnerships, writing literature reviews, designing methodologies, and data analysis require diverse areas of expertise and ability. Research teams benefit from diversity of individual qualities including curiosity, charisma, and teamwork as well as less overt qualities like strong writing and attention to detail for manuscript revision. Personal reflection leads to the conclusion that the strongest research teams with high quality end-products are a result, at least in part, of valuing various qualities among the team to maximize individual contributions with the sum being greater than the individual parts.

Reflecting on my early research endeavors, a more authoritarian leadership style was employed, perhaps related to insecurity as an inexperienced researcher. As my own confidence has grown, a more collaborative approach has emerged with increased trust in co-authors and student researchers. As research experience is gained, becoming entrenched in methods and approach may be a risk. Allowing for equality in voice among team members, has in the experience of the candidate, often provided a

fresh perspective and led to different types of inquiry and design. Student co-authors have made invaluable contributions to specific studies, for example, suggesting the Dexteria™ app be tested on the participant's non-dominant hand to allow for more improvement in dexterity, developing and refining literature reviews, and a general familiarity with technology to streamline the logistics of data collection and study implementation.

In conclusion, working as a lead researcher on the various studies included in this commentary provided me with invaluable experiential learning. Retrospective analysis through the pursuit of this PhD has further deepened my understanding of the research process and methods which will undoubtedly strengthen my future scholarly pursuits.

8 Conclusions

To reiterate what was stated at the beginning of this thesis, the aim of this commentary was to critically analyze the included published works in retrospect, providing a synthesis of the findings within the themes of technology integration and cultural diversity. The collective results provide multi-faceted, empirical perspectives on these topics as well as practical examination of the efficacy of specific technologies and pedagogy. The studies were published in five different journals, have been used to market the efficacy of specific technologies, have been cited by related cross-disciplinary studies, provided multiple avenues for further inquiry, and informed organizational policy. The findings represent a broad and unique contribution to the literature and as with any critical inquiry, there is much left to be explored. Related scholarly pursuits in progress include a comparison of the impact of local and international service-learning, the use of sonographic imaging to examine the musculoskeletal impact of "tech posture", as well as reliability studies regarding the proposed novel technique for scapular goniometry. An additional mixed-method endeavor focuses on the perceptions of and impact on individuals who received seating and mobility services provided during the ISL experiences previously described. As technology use may be included as a component of occupational performance, this study represents the potential for the confluence of the major themes identified in this thesis.

9 References

American Occupational Therapy Association. (2015a). 'Occupational therapy code of ethics (2015)'. *American Journal of Occupational Therapy*, 69 (Suppl. 3), pp. 1-8. doi: 10.5014/ajot.2015.696S03.

American Occupational Therapy Association. (2015b). 'Occupational therapy practice framework: Domain and process (3rd ed.)'. *American Journal of Occupational Therapy*, 68 (Suppl. 1), S1-S48. doi:10.5014/ajot.2014.682006.

American Occupational Therapy Association. (2018). Academic programs annual data report: Academic year 2017-2018. Available at: https://www.aota.org/~/media/Corporate/Files/EducationCareers/Educators/2017-2018-Annual-Data-Report.pdf (Accessed 15 June 2019).

Anderson, C., Henner, T., & Burkey, J. (2013). 'Tablet computers in support of rural and frontier clinical practice'. *International Journal of Medical Informatics*, 82 (11), pp. 1046-1058. doi: 10.1016/j.ijmedinf.2013.08.006.

Ang, S., Van Dyne, L., Koh, C., Ng, K-Y., Templer, K. J., Tay, C., & Chandrasekar, N. A. (2007). 'Cultural intelligence: Its measurement and effects on cultural judgment and decision making, cultural adaptation, and task performance'. *Management and Organization Review*, 3, pp. 335-371. doi: 10.1111/j.1740-8784.2007.00082.

Beery, K.E., & Beery, N. A. (2010*). The Beery-Buktenica Developmental Test of Visual-Motor Integration: VMI with supplemental developmental tests of visual perception and motor coordination: Administration, scoring, and teaching manual.* Parsippany, NJ: Modern Curriculum Press.

Boss, J. A. (1994). 'The effect of community service work on the moral development of college ethics students'. *Journal of Moral Education*, 23 (2), pp. 183-198. doi: 10.1080/0305724940230206.

Boyt Schell, B. A., Gillen, G., & Scaffa, M. (2013). *Willard and Spackman's occupational therapy* (12th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Brown, T., Chinner, A., & Stagnitti, K. (2011). 'Convergent validity of two visual motor integration tests'. *British Journal of Occupational Therapy*. 74 (6), pp. 295-303. doi: 10.4276/030802211X13074383957986.

Capell, J., Dean, E., & Veenstra, G. (2008). 'The relationship between cultural competence and ethnocentrism of health care professionals'. *Journal of Transcultural Nursing*, 19 (2), pp. 121-125. doi: 10.1177/1043659607312970.

Chan, L.K., Bridges, S.M., Doherty, I., Ng, M.L., Jin, J., Sharma, N., Chan, N.K. & Lai, H.Y.Y. (2015). 'A qualitative study on how health professional students and their PBL facilitators perceive the use of mobile devices during PBL'. *Interdisciplinary Journal of Problem-Based Learning,* 9 (1), p.12. doi: 10.7771/1541-5015.1510.

Christiansen, T. K. (2008). 'The role of theory in instructional design: Some views of an ID practitioner.' *Performance Improvement*, 47 (4), pp. 25-32. doi: 10.1002/pfi.199

Clarkson, H. M. (2012). *Musculoskeletal assessment: joint range of motion and manual muscle strength* (3rd ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Coallier, M., Rouleau, N., Bara, F., & Morin, M. F. (2014). 'Visual-motor skills performance on the Beery-VMI: A study of Canadian kindergarten children'. *Open Journal of Occupational Therapy*, 2 (2). doi: 10.15453/2168-6408.1074.

Confalonieri, M., Tomasi, P., Depaul, M., Guandalini, G., Baldessari, M., Oss, D., Prada, F., Mazzalai, A., Da Lio, M.D., & De Cecco., M. (2013). 'Neuro-physical rehabilitation by means of novel touch technologies'. *Studies in Health Technology and Informatics,* 189*,* pp. 158-63. doi: 10.3233/978-1-61499-268-4-158.

Crescenzi, L., Jewitt, C., & Price, S. (2014). 'The role of touch in preschool children's learning using iPad versus paper interaction'. *Australian Journal of Language & Literacy*, 37 (2), pp. 86-95.

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). Los Angeles, CA: Sage Publications, Inc.

Cross, T., Bazron, B., Dennis, K., & Isaacs, M. R. (1989). Towards a culturally competent system of care: A monograph on effective services for minority children who are severely emotionally disturbed. (CASSP Technical Assistance Center Monograph Report). Available at: http://www.mhsoac.ca.gov/meetings/docs/Meetings/2010/June/CLCC_Tab_4_Towards_Culturally_Competent_System.pdf. (Accessed 2 July 2019).

Cui, Y., Zhu, Y., Laukkanen, H., & Rabin, J. (2012). 'Evaluation of visual-motor and integration skills in preschool and elementary school-aged Chinese children'. *Journal of Behavioral Optometry*, 23 (5-6), pp. 123-128.

Dein, S. (2006). 'Race, culture and ethnicity in minority research: a critical discussion'. *Journal of Cultural Diversity*, 13 (2), p. 68.

Delgado, B.T., Alvarez, J.J., Pineda, A., Villar, P., Sanchez-Laulhe, P., Romero, L. (2018). 'Innovation and new technologies in hand surgery, presentation of the App Rehand'. *Journal of the Andalusian Society of Trauma and Orthopedics,* 35 (3-4), pp. 9-15.

Dewey, J. (1938). *Experience and education*. New York, NY: The Macmillan Company.

de Winter, J. C. F. (2013). 'Using the student's t-test with extremely small sample sizes'. *Practical Assessment, Research, & Evaluation,* 8 (10), pp. 1-12.

Dimock, M. (2019). Defining generations: Where Millennials end and Generation Z begins. Pew Research Center. Available at: https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins. (Accessed 15 June 2019).

Dockrell, S., Bennett, K., & Culleton-Quinn, E. (2015). 'Computer use and musculoskeletal symptoms among undergraduate university students'. *Computers & Education*, 85, pp. 102-109. doi: 10.1016/j.compedu.2015.02.001.

Early, J., & Lasker, G. A. (2018). 'Strengthening communities of inquiry online and offline: Exploring the benefits and challenges of including service- learning in a fully online women's global health course'. *Pedagogy in Health Promotion*, 4 (3), pp. 218 – 226. doi: 10.1177/2373379917730843.

Finlay, L. (2002). 'Outing" the researcher: The provenance, process, and practice of reflexivity'. *Qualitative Health Research*, 12 (4), pp. 531-545. doi: 10.1177/104973202129120052.

Finlay, L. (2008). 'A dance between the reduction and reflexivity: Explicating the" phenomenological psychological attitude"'. *Journal of Phenomenological Psychology*, 39 (1), pp. 1-32. doi: 10.1163/156916208X311601.

Fisher-Borne, M., Cain, J. M., & Martin, S. L. (2015). 'From mastery to accountability: Cultural humility as an alternative to cultural competence'. *Social Work Education*, 34 (2), pp. 165-181. doi: 10.1080/02615479.2014.977244.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *How to design and evaluate research in education.* New York, NY: McGraw-Hill.

Frank, G., & Polkinghorne, D. (2010). 'Qualitative research in occupational therapy: From the first to the second generation'. *OTJR: Occupation, Participation, and Health*, 30 (2), pp. 51-57. doi: 10.3928/15394492-20100325-02.

Free, C., Phillips, G., Watson, L., Galli, L., Felix, L., Edwards, P., Patel, V., & Haines, A. (2013). 'The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis'. *PLoS Medicine*, 10 (1), e1001363. doi: 10.1371/journal.pmed.1001363.

Frey, W. (2014). The U.S. will become 'minority white' in 2045, Census projects. Available at: https://www.brookings.edu/blog/the- avenue/2018/03/14/the-us-will-become-minority-white-in-2045-census-projects/. (Accessed 25 June 2019).

Gelberman, R. H., Yamaguchi, K., Hollstien, S. B., Winn, S. S., Heidenreich Jr, F. P., Bindra, R. R., Hsieh, P., & Silva, M. J. (1998). 'Changes in interstitial pressure and cross-sectional area of the cubital tunnel and of the ulnar nerve with flexion of the elbow. An experimental study in human cadavera'. *Journal of Bone & Joint Surgery*, 80 (4), pp. 492-501. doi: 10.2106/00004623-199804000-00005.

Gitlow, L., & Flecky, K. (2005). 'Integrating disability studies concepts into occupational therapy education using service learning'. *American Journal of Occupational Therapy,* 59, pp. 546-553. doi: 10.5014/ajot.59.5.546.

Golafshani, N. (2003). 'Understanding reliability and validity in qualitative research'. *The Qualitative Report*, 8 (4), pp. 597-606.

Greene, D. (1997). 'The use of service learning in client environments to enhance ethical reasoning in students'. *American Journal of Occupational Therapy*, 51 (10), pp, 844-852. doi: 10.5014/ajot.51.10.844.

Hand Therapy Certification Commission. (2016). Who is a certified hand therapist (CHT)?. Available at: https://www.htcc.org/consumer-information/the-cht-credential/who-is-a-cht. (Accessed 22 June 2019).

Harvey, F. J., Harvey, P. M., & Horsley, M. W. (1990). 'De Quervain's disease: surgical or nonsurgical treatment'. *Journal of Hand Surgery*, 15 (1), pp. 83-87. doi: 10.1016/s0363-5023(09)91110-8.

Hanson, W. E., Creswell, J. W., Clark, V. L. P., Petska, K. S., & Creswell, J. D. (2005). 'Mixed methods research designs in counseling psychology'. *Journal of Counseling Psychology*, 52 (2), pp. 224-235.doi: 10.1037/0022-0167.52.2.224.

Hesse-Biber, S. N. (2010). *Mixed methods research: Merging theory with practice*. New York, NY: Guilford Press.

Hinojosa, J., & Kramer, P. (1997). 'Statement--fundamental concepts of occupational therapy: occupation, purposeful activity, and function'. *American Journal of Occupational Therapy*, 51 (10), pp. 864-866. doi: 10.5014/ajot.51.10.864.

Holloway, I., & Galvin, K. (2016). *Qualitative research in nursing and healthcare*. Hoboken, NJ: John Wiley & Sons.

Howell, D., Causey-Upton, R., & Hayden, C. L. (2017). 'Launching the Journal of Occupational Therapy Education'. *Journal of Occupational Therapy Education,* 1 (1), pp. 1-5. doi: 10.26681/jote.2017.010101.

Kasch, M., Greenburg, S., Muenzen, P. (2003). 'Competencies in hand therapy'. *Journal of Hand Therapy,* 16*,* pp. 49-58. doi: 10.1016/s0894-1130(03)80024-8.

Keller, J.L., Caro, C.M., Dimick, M.P., Landrieu, K., Fullenwider, L, & Walsh, J.M. (2016). 'Thirty years of hand therapy: The 2014 practice analysis'. *Journal of Hand Therapy,* 29, pp. 222-234. doi: 10.1016/j.jht.2016.02.011.

Kinsella, E. A., & Whiteford, G. E. (2009). 'Knowledge generation and utilisation in occupational therapy: Towards epistemic reflexivity'. *Australian*

Occupational Therapy Journal, 56 (4), pp. 249-258.
doi: 10.1111/j.1440-1630.2007.00726.x.

Klimenko, M. A., Surdel, N., Muir, K., & Sofia, F. (2018). 'Can online college education make students smarter and more moral? A preliminary study of the effects of two online college course assignments on students' moral competence'. *Ethics in Progress*, 9 (2), pp. 44-55. doi: 10.14746/eip.2018.2.4.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Upper Saddle River, NJ: Prentice Hall, Inc.

Kolb, A. Y., & Kolb, D. A. (2005). 'Learning styles and learning spaces: Enhancing experiential learning in higher education'. *Academy of Management Learning & Education*, 4 (2), pp. 193-212. doi: 10.5465/amle.2005.17268566

Kohlberg, L. (1971). *The philosophy of moral education*. New York, NY: Harper & Row.

Kohlberg, L. (1973). 'Stages and aging in moral development—Some speculations'. *Gerontologist,* 13 (4), pp. 497-502. doi: 10.1093/geront/13.4.497

Klein, J. T. (2008). 'Evaluation of interdisciplinary and transdisciplinary research: a literature review'. *American Journal of Preventive Medicine*, 35 (2), pp. S116-S123. doi: 10.1016/j.amepre.2008.05.010.

Krefting, L. (1991). 'Rigor in qualitative research: The assessment of trustworthiness'. *American Journal of Occupational Therapy,* 45 (3), pp. 214-222.
doi: 10.5014/ajot.45.3.214.

Lau, C. (2016). 'Impact of a child-based health promotion service-learning project on the growth of occupational therapy students'. *American Journal of Occupational Therapy*, 70 (5), pp. 7005180030p1- 7005180030p10. doi: 10.5014/ajot.2016.021527.

Lind G. (2014, March 24). Moral Competence Test (MCT). Available at: http://www.uni-konstanz.de/ag-moral/mut/mjt-engl.htm. (Accessed 1 July 2019).

Lovat, T., & Clement, N. (2016). 'Service learning as holistic values pedagogy'. *Journal of Experiential Education*, 39 (2), pp. 115-129. doi: 10.1177/1053825916628548.

Maloney, S. M., & Griffith, K. (2013). 'Occupational therapy students' development of therapeutic communication skills during a service-learning experience'. *Occupational Therapy in Mental Health*, 29 (1), pp. 10-26. doi: 10.1080/0164212X.2013.760288.

Mao, H. F., Li, W., & Lo, J. L. (1999). 'Construct validity of Beery's Developmental Test of Visual-Motor Integration for Taiwanese children'. *Occupational Therapy Journal of Research*, 19 (4), pp. 241-257. doi: 10.1177/153944929901900402.

Mathiowetz, V., Weber, K., Kashman, N., & Volland, G. (1985). 'Adult norms for the nine hole peg test of finger dexterity'. *Occupational Therapy Journal of Research*, 5 (1), pp. 24-38. doi: 10.1177/153944928500500102.

Miyawaki, C. E. (2016). 'Caregiving practice patterns of Asian, Hispanic, and non-Hispanic White American family caregivers of older adults across generations'. *Journal of Cross-cultural Gerontology,* 31 (1), pp. 35-55. doi: 10.1007/s10823-016-9281-5.

Mortenson, W. B., & Oliffe, J. L. (2009). 'Mixed methods research in occupational therapy: A survey and critique'. *OTJR: Occupation, Participation and Health,* 29 (1), pp. 14-23. doi: 10.1177/153944920902900103.

Murden, R., Norman, A., Ross, J., Sturdivant, E., Kedia, M., & Shah, S. (2008). 'Occupational therapy students' perceptions of their cultural awareness and competency'. *Occupational Therapy International*, 15 (3), pp. 191-203. doi: 10.1002/oti.253.

Naumann, L. P., Vazire, S., Rentfrow, P. J., & Gosling, S. D. (2009). 'Personality judgments based on physical appearance'. *Personality and Social Psychology Bulletin*, 35 (12), pp. 1661-1671. doi: 10.1177/0146167209346309.

The Nielsen Company. (2018). Time flies: U.S. adults now spend nearly half a day interacting with media. Available at: https://www.nielsen.com/us/en/insights/news/2018/time-flies-us-adults-now-spend-nearly-half-a-day-interacting-with-media.html. (Accessed 22 June 2019).

Ng, V., Tay, L., & Kuykendall, L. (2017). 'The development and validation of a measure of character: The CIVIC'. *Journal of Positive Psychology*, 13 (4), pp. 346-372. doi: 10.1080/17439760.2017.1291850.

Odawara, E. (2005). 'Cultural competency in occupational therapy: Beyond a crosscultural view of practice'. *American Journal of Occupational Therapy*, 59, pp. 325-334. doi: 10.5014/ajot.59.3.325.

Onwuegbuzie, A. J., & Leech, N. L. (2005). 'On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies'. *International Journal of Social Research Methodology*, 8 (5), pp. 375-387. doi: 10.1080/13645570500402447.

Osei, D. A., Groves, A. P., Bommarito, K., & Ray, W. Z. (2016). 'Cubital tunnel syndrome: incidence and demographics in a national administrative database'. *Neurosurgery*, 80 (3), pp. 417-420. doi: 10.1093/neuros/nyw061.

Ouegnin, A., & Valdes, K. (2019). 'Client preferences and perceptions regarding a written home exercise program or video self-modeling: A cross-sectional study'. To be published in *Journal of Hand Therapy* [Preprint]. Available at: https://www.jhandtherapy.org/article/S0894-1130(18)30153-4/fulltext. (Accessed 10 June 2019).

Oxford Grice, K., Vogel, K.A., Le, V., Mitchell, A., Muniz, S., & Vollmer, M.A. (2003). 'Brief Report -Adult norms for a commercially available nine hole peg test for finger dexterity'. *American Journal of Occupational Therapy,* 57*,* pp. 570-573. doi: 10.5014/ajot.57.5.570.

Page, P. (2014). 'Beyond statistical significance: clinical interpretation of rehabilitation research literature'. *International Journal of Sports Physical Therapy,* 9 (5), pp. 726-736.

Pendleton, H. M., Schultz-Krohn, W. (2018). *Pedretti's occupational therapy: Practice skills for physical dysfunction.* St. Louis, MO: Elsevier.

Pew Research Center. (2011). College students and technology. Available at:https://www.pewinternet.org/2011/07/19/college-students-and- technology/. (Accessed 23 July 2019).

Pitchford, N. & Outhwaite, L. (2016). 'Can touch screen tablets be used to assess cognitive and motor skills in early years primary school children? A cross-cultural study'. *Frontiers in Psychology,* 7, p. 1666. doi: 10.3389/fpsyg.2016.01666.

Proffitt, R., & Lange, B. (2015). 'Considerations in the efficacy and effectiveness of virtual reality interventions for stroke rehabilitation: Moving the field forward'. *Physical Therapy,* 95 (3), pp. 441-448. doi: 10.2522/ptj.20130571.

Proffitt, R., Schwartz, J. K., Foreman, M., & Smith, R. O. (2019). 'Role of occupational therapy practitioners in mass market technology research and development'. *American Journal of Occupational Therapy*, 73 (1), pp. 7301347010p1-7301347010p6. doi: 10.5014/ajot.2019.028167.

Punwar, A. J., & Peloquin, S. M. (2000). *Occupational therapy: Principles and practice*. Philadelphia, PA: Lippincott Williams & Wilkins.

Rao, L. (2012). Apple: 20,000 education iPad apps developed; 1.5 million devices in use at schools. TechCrunch. Available at: http://techcrunch.com/2012/01/19/apple-20000-education-ipadapps-developed-1-5-million-devices-in-use-at-schools/. (Accessed 22 August 2019).

Royeen, M., & Crabtree, J. (2006). *Culture in rehabilitation: From competency to proficiency.* Upper Saddle River, NJ: Pearson.

Saponsnik, G., Chow, C.M., Gladstone, D., Cheung, D., Brawer, E., Thorpe, K.E., Saldanha, A., Dang, A., Bayley, M., & Schweizer, T.A. (2014). 'iPad technology for home rehabilitation after stroke (iHOME): A proof-of-concept randomized trial'. *International Journal of Stroke*, 9 (7), pp. 956-962. doi: 10.1111/ijs.12328.

Saunders, R., Astifidis, R., Burke, S., Higgins, J., & McClinton, M. (2015). *Hand and upper extremity rehabilitation: a practical guide (4th ed.).* St. Louis, MO: Elsevier.

Schoville, R. R., Shever, L. L., Calarco, M. M., & Tschannen, D. (2014). 'A cost-benefit analysis: electronic clinical procedural resource supporting evidence-based practice'. *Nursing Economics*, 32 (5), p. 241-247.

Sedlak, C. A., Doheny, M. O., Panthofer, N., & Anaya, E. (2003). 'Critical thinking in students' service-learning experiences'. *College Teaching*, 51 (3), 99-104. doi: 10.1080/87567550309596420.

Short, N., Best, S., Bhowmick, A., Brenner, D., Cundall, C., Farmer, M., Patel, M. & Ross, M. (2018). 'Impact of the Dexteria™ application use on visual–motor integration in elementary-age children'. *Journal of Occupational Therapy, Schools, & Early Intervention*, 11 (4), pp. 364-373. doi: 10.1080/19411243.2018.1445061.

Short, N., Blair, M., Crowell, C., Loewenstein, A., Lynch, A., & Warner, A. (2019a). 'Mobile technology and cumulative trauma symptomology among millennials'. To be published in *Hand Therapy* [Preprint]. Available at https://journals.sagepub.com/doi/abs/10.1177. (Accessed 15 December 2019).

Short, N., Harmsen, R., Kjellgren, G., O'Neill, C., Pinney, H., Rivera, A., & Warnaar, V. (2017a). 'Use of Dexteria application to improve fine motor coordination in the nondominant hand'. *Journal of Hand Therapy,* 30*,* pp. 106-108. doi: 10.1016/j.jht.2016.03.014.

Short, N., LaRowe, J., Treherne, T., Francis, F., Garau, C., Schutt, M., & Wei, C. (2017b). 'Exploring the needs of certified hand therapists regarding electronic applications'. *Journal of Hand Therapy*, 31 (1), pp. 52–58. doi: 10.1016/j.jht.2016.11.010.

Short, N., Mays, S., Cool, A., Delay, A., Lannom, A., O'Donnell, L., & Stuber, R. (2020a). 'Defining mobile tech posture: prevalence and position among Millennials'. *Open Journal of Occupational Therapy*, 8 (1), pp. 1-10. doi: 10.15453/2168-6408.1640.

Short, N., Mays, M., Ford, R., & Fahrney, E. (2019b). 'Proposed method for goniometric measurement of scapular protraction and retraction'. To be published in *Journal of Hand Therapy* [Preprint]. Available at https://www.jhandtherapy.org/article/S0894-1130(19)30061-4/fulltext. (Accessed 15 December 2019).

Short, N., Sample, S., Murphy, M., Austin, B., & Glass, J. (2017c). 'Barriers and solutions to fieldwork education in hand therapy'. *Journal of Hand Therapy*, 31 (3), pp. 308-314. doi: 10.1016/j.jht.2017.05.013.

Short, N. & St. Peters, H. Y. (2017). 'Exploring the impact of service learning in Haiti on the cultural competence of OTD students'. *Journal of Occupational Therapy Education*, 1 (1), pp.1-15. doi: 10.26681/jote.2017.010106.

Short, N., St. Peters, H., Almonroeder, T., Bolomope, G., Daller, K., Deaton, K. & Kreill, M. (2020b). 'Long-term impact of cross-cultural service learning: Cultural

competence revisited'. *Journal of Occupational Therapy Education,* 4 (1), pp. 1-14. doi: 10.26681/jote.2020.040109.

Smith, R. O. (2017). 'Technology and occupation: Past, present, and the next 100 years of theory and practice'. *American Journal of Occupational Therapy*, 71 (6), pp. 7106150010p1-7106150010p15. doi: 10.5014/ajot.2017.716003.

Sortor, J. M., & Kulp, M. T. (2003). 'Are the results of the Beery-Buktenica Developmental Test of Visual-Motor Integration and its subtests related to achievement test scores?'. *Optometry and Vision Science,* 80 (11), pp. 758-763. doi: 10.1097/00006324-200311000-00013.

St. Peters, H. Y. & Short, N. (2018). 'Cross-cultural service learning as pedagogy for character development in OTD students'. *Open Journal of Occupational Therapy*, 6 (4), pp. 8-16. doi: 10.15453/2168-6408.1493.

Suarez-Balcazar, Y., Rodawoski, J., Balcazar, F., Taylor-Ritzler, T., Portillo, N., Barwacz, D., & Willis, C. (2009). 'Perceived levels of cultural competence among occupational therapists'. *American Journal of Occupational Therapy,* 63 (4), pp. 498-505. doi: 10.5014/ajot.63.4.498.

Sue, D. W. (2004). 'Whiteness and ethnocentric monoculturalism: making the" invisible" visible'. *American Psychologist*, 59 (8), pp. 761-769. doi: 10.1037/0003-066X.59.8.761.

Tashakkori, A., & Teddlie, C. (2003). *Handbook of Mixed Methods in Social and Behavioral Research*. Thousand Oaks, CA: Sage.

Thyer, B. A. (2008). 'The quest for evidence-based practice?: We are all positivists!'. *Research on Social Work Practice*, 18 (4), pp. 339-345. doi: 10.1177/1049731507313998.

Tomori, K, UEzu, S., Kinjo, S., Ogahara, K., Nagatani, R., & Higashi, T. (2011). 'Utilization of the iPad application: aid for decision-making in occupation choice'. *Occupational Therapy International,* 19*,* pp. 88-97. doi: 10.1002/oti.325.

West, D. (2012). How mobile devices are transforming healthcare. Available at: https://www.brookings.edu/research/how-mobile-devices-are-transforming-healthcare/. (Accessed 22 July 2019).

Wittman, P., & Velde, B. P. (2002). 'Attaining cultural competence, critical thinking, and intellectual development: a challenge for occupational therapists'. *American Journal of Occupational Therapy,* 56 (4), pp. 454-456. doi: 10.5014/ajot.56.4.454.

Wolf, J. M., Mountcastle, S., Burks, R., Sturdivant, R. X., & Owens, B. D. (2010). 'Epidemiology of lateral and medial epicondylitis in a military population'. *Military Medicine,* 175 (5), pp. 336-339. doi: 10.7205/milmed-d-09-00086.

Wolf, J. M., Sturdivant, R. X., & Owens, B. D. (2009). 'Incidence of de Quervain's tenosynovitis in a young, active population'. *Journal of Hand Surgery*, 34 (1), pp. 112-115. doi: 10.1016/j.jhsa.2008.08.020.

Wood, E.D. & St. Peters, H.Y. (2014). 'Short-term cross-cultural study tours: Impact on cultural intelligence'. *International Journal of Human Resource Management,* 25 (4), pp. 558-570. doi: 10.1080/09585192.2013.796315.

Appendix A: Author & co-author contributions for individual studies

Publication	Description of candidate & co-author contributions	Candidate Estimated Contribution (%)
Short, Harmsen, Kjellgren, O'Neill, Pinney, Rivera & Warnaar (2017a)	Candidate led study design, discussions with app developer, and methodologies while student researchers contributed to data collection and manuscript preparation.	70%
Short, Best, Bhowmick, Brenner, Cundall, Farmer, Patel & Ross (2018)	Candidate wrote contract agreement with participating elementary school including arrangements with participating teachers to integrate app technology into curriculum. Candidate also arranged support from app developer for Dexteria^{TM} app downloads at no cost for use in study. Best, a pediatric occupational therapist, provided consultation for use of developmental assessment and manuscript preparation. Student researchers assisted with literature review, data collection, analysis, and manuscript preparation. Candidate managed most revisions leading to final publication.	70%
Short, LaRowe, Treherne, Francis, Garau, Schutt & Wei (2017b)	Candidate led development of study, including submission of proposal to the American Society of Hand Therapists Research Division for dissemination of survey to members. Student assistants contributed to literature review, data collection, and manuscript preparation.	70%
Short, Cool, DeLay, Lannom, O'Donnell & Stuber (2020a)	As a more nuanced, clinical study, the candidate developed the original idea for the study as part of a larger endeavor addressing mobile technology use. The candidate oversaw all data collection and personally took goniometry measurements of	80%

	participants for reliability and consistency. Additionally, the candidate completed the majority of data analysis and manuscript preparation. Student researchers assisted with literature review, data collection, and manuscript preparation.	
Short, Blair, Crowell, Loewenstein, Lynch, & Warner (2019a)	Candidate led development of original idea and methods as well as selection and preparation of clinical assessment involved with data collection. Student researchers assisted with data collection, analysis, and manuscript preparation.	70%
Short, Sample, Murphy, Austin & Glass (2017c)	Candidate led development of this study through collaboration with the Hand Therapy Certification Commission (HTCC) to address facilitation of student clinical rotations in hand therapy settings. Agreements led to use of the HTCC membership as study sample. Student participants provided assistance with literature review and manuscript preparation.	85%
Short & St. Peters (2017)	Candidate and co-author collaborated on original idea, research question, methodologies, and manuscript preparation. Candidate provided majority of physical data collection and served as an imbedded researcher with the study participants while in Haiti.	65%
St. Peters & Short (2018)	Candidate and co-author collaborated on original idea, research question, methodologies, and manuscript preparation. Candidate provided majority of physical data collection and served as an imbedded researcher with the study participants while in Guatemala. St. Peters provided essential guidance to data analysis with collaborative manuscript preparation.	65%

Short, St. Peters, Almonroeder, Bolomope, Daller, Deaton & Kreill (2020b)	Candidate and St. Peters collaborated on original idea, research question, methodologies, and manuscript preparation. Candidate served as imbedded researcher with student participants. Almonroeder served as a consultant for data analysis. Student researchers provided assistance with literature review, qualitative data analysis, and manuscript preparation.	65%

Appendix B: Co-Author statement regarding candidate contribution

19 December 2018

To Whom It May Concern:

As a co-author with Dr. Nathan Short on the publications listed below, I attest to the collaborative nature of the studies with both authors playing primary roles throughout the research process. Each author contributed to the development of the research questions, designs, methodologies, data collection and analysis, and manuscript preparation.

Additionally, Short served as an embedded researcher during study implementation, providing clinical orientation and mentorship of students during the service learning experiences in Haiti, Guatemala, and Romania. This provided increased depth of insight into the lived experience of study participants, enhancing the depth of insight into findings and implications.

St. Peters, H. Y. & Short, N. (2018). Cross-cultural service learning as pedagogy for character development in OTD students. *Open Journal of Occupational Therapy, 6*(4), 8-16.

Short, N. & St. Peters, H. Y. (2017). Exploring the impact of service learning in Haiti on the cultural competence of OTD students. *Journal of Occupational Therapy Education. 1*(1).

An additional study examining the long-term impact of service learning on cultural competence is currently in process with a similar contribution from the authors.

Sincerely,

Heather Y. Z. St. Peters, Ph.D.
Associate Professor of Organizational Leadership
Director, Master of Arts in Organizational Leadership
2303 College Avenue
Huntington, IN 46750 USA

Email: hstpeters@huntington.edu
Phone +1 001 260.359.4138
FAX: +1 001 260.359.4329