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College of Health Sciences

USE OF A NOVEL COLLABORATIVE MEDIA TECHNOLOGY TO PROMOTE
KNOWLEDGE TRANSLATION IN ONLINE CONTINUING EDUCATION FOR
PEDIATRIC PHYSICAL THERAPISTS

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Use of a Novel Collaborative Media Technology to Promote Knowledge Translation in Online

Continuing Education for Pediatric Physical Therapists

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Abstract

Background: Online continuing education is a convenient and cost-effective option for professional development with the potential to speed the translation of evidence to clinical practice. Integrating innovative technology with online course design that reflects best practices in adult education and knowledge translation is one promising approach to meeting this need. Understanding how available technology and course design interact to promote learning in an online environment and what impact these factors have on therapists' intention to implement new skills in clinical practice will better inform online continuing education design.

Purpose: The purpose of this grounded theory study was to understand the processes that pediatric physical therapists use to learn a hands-on clinical assessment in a self-paced asynchronous online continuing education course that utilized an innovative interactive media player.

Method: Data was concurrently collected and analyzed using a constructivist grounded theory approach informed by the Diffusion of Innovations Theory. Nineteen pediatric physical therapists from three organizations who completed an online course on the Segmental Assessment of Trunk Control were recruited using theoretical sampling. Two researchers analyzed transcripts of semi-structured individual interviews and open responses to learning module prompts using constant comparative analysis and a consensus coding process consistent with grounded theory.

Results: The online course design provoked cognitive dissonance for learners when they attempted to assimilate new information on posture control assessment and treatment with their clinical experience. Three approaches to reducing this dissonance emerged: accommodating new concepts without practice change, waiting for others to provide solutions to implementation challenges, and experimenting or adapting information for practice change. The development and resolution of cognitive dissonance was an iterative process embedded within participants' reflective clinical practice. Individual clinicians often demonstrated more than one approach to resolving the dissonance at any given point in time.

Conclusion: Designing online learning experiences that provoke cognitive dissonance using innovative technology may be effective in enhancing clinicians' awareness of gaps in knowledge and practice, confidence in trialing new practice behavior, and motivation to engage in the sustained effort necessary for translating evidence to real-world clinical settings. Instructional designers must also recognize the personal and organizational factors that color the contextual lens through which healthcare professionals consider how and when to use information learned online in clinical practice.

Key words: online education, continuing professional development, knowledge translation, cognitive affective processes.

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Continuing Education for Pediatric Physical Therapists

In the current healthcare marketplace, all health professionals are charged with providing

cost-effective care utilizing the best available evidence.[1] Rehabilitation therapists report that

formal continuing education is the primary strategy they use to keep up with rapidly emerging

evidence and best practice recommendations.[2-5] Online continuing education promises to provide

convenient, flexible, and cost-effective alternatives for busy physical therapists (PTs) that are as

effective as face-to-face conferences.[6-9] However, current models of both traditional and online

continuing education are not effective for changing clinical practice.[10-16]

To achieve higher level learning outcomes needed to change clinical practice, online

courses must incorporate educational strategies that facilitate collaborative social learning as

well as simulated skills practice and guided reflection on complex, real-world clinical cases.[17-21]

Multimedia technology has the potential to facilitate these learning outcomes. However,

multimedia strategies in most courses are utilized primarily to transmit didactic knowledge to

participants, current media players are physically separated from the discussion forums that

learners must use to engage with instructors or each other, and video viewing is a passive

activity.[17,22,23] As a result, the potential for technology to link multimedia content to authentic

skills practice and collaborative discussion has not been realized.

Several authors have studied the impact of current technology on collaborative learning

in online continuing education using asynchronous discussion of video case examples within

platforms including wikis, blogs, moderated discussion boards, or virtual reality

systems.[12,17,21,24-27] Even though this technology links videos to interactive discussion, current

media players are physically separated from the discussion forums that learners must use to

engage with instructors or each other, and video viewing is often a passive activity.[23] The lack of

a direct physical linkage between visual media and discussion platforms limits the effectiveness

of both strategies because it requires busy professionals to shuttle back and forth between

multiple areas of the online environment.[23] Furthermore, learner use of online discussion forums

is often limited which diminishes the effectiveness of this strategy for both collaborative learning

and individual reflection on clinical cases.[12,21,28]

There is a need for integrated media technology in online course design that better

supports the unique learning needs of health professionals for asynchronous online discussion,

collaborative learning, and reflection in continuing education. The Transformative Anchored

Collaboration Environment (TrACE) is a novel spatial-temporal anchored media-player that has

been used to support both synchronous and asynchronous collaborative discussion in

undergraduate science and math education.[23] However, neither TrACE nor any similar anchored

media system has been utilized to teach clinical skills in online continuing education.

Furthermore, no studies were found that investigated the interaction between the available

technology, course design, and collaborative discussion among working health professionals who

are learning a clinical skill online.

Educators need to learn more about how pediatric PTs and other health professionals

engage in learning in multimedia online education environments so that online courses can be

designed to maximize the effectiveness of this active learning strategy. We also need to

understand how the available technology and the course design interact to facilitate the self-

assessment, reflection, and social learning processes that support practice change. Finally, to

design online education that facilitates improved patient outcomes, we need to understand how

health professionals view technology-mediated online collaborative discussion relative to their intention to implement skills learned online in clinical practice.

Purpose

The purpose of this grounded theory study was to understand the processes that pediatric physical therapists use to learn a hands-on clinical assessment in a self-paced asynchronous online continuing education course that utilized TrACE to facilitate individual reflection and collaborative asynchronous discussion of video case examples. Learning a clinical assessment was defined as confidence with identifying tester errors and patient compensations for inadequate trunk postural control when scoring a video example of the Segmental Assessment of Trunk Control (SATCo) within TrACE. Specifically, the following research questions were addressed:

1. How do pediatric physical therapists describe their attitudes about learning a hands-on skill online after completing the pilot Introduction to SATCo course?

2. How do pediatric physical therapists conceptualize the role of the spatial-temporal anchored media system and the course design in learning to identify postural control compensations and tester errors for the Segmental Assessment of Trunk Control (SATCo)?

3. What role does interacting asynchronously with other participants within the spatial-temporal anchored media system play when learning a clinical assessment?

4. How do pediatric physical therapists describe their intention to implement or not to implement the SATCo in clinical practice after using the spatial-temporal anchored media system in an online education course?

Literature Review

Online continuing education is becoming increasingly popular among health professionals and their employers because it allows a convenient and flexible balance between personal and professional responsibilities.[29] However, the quality of these courses varies widely,[8,30] and their ability to facilitate learning that results in practice change and improved patient outcomes is unknown.[8,22,24,27,31,32] This section will review current challenges in online continuing education including the unique needs of health professionals as learners. The interaction of media technology and course design in programs that aim to teach clinical skills to health professionals and to change practice behavior will also be discussed.

The benefits of online education programs for health professional learners and their employers include reduced cost of courses, minimal travel, less time away from work, and flexibility in scheduling.[22] For researchers and educators, online learning allows the dissemination of up-to-date information quickly over a wide geographic area.[17,30] With constantly improving technology available, educators have the potential to design highly interactive courses that are specifically tailored to health professionals' learning needs and practice contexts more easily than in traditional face-to-face workshop settings.[17,22,30,33,34] In addition, online education may facilitate the development of ongoing communities of practice through peer to peer discussion and support.[33,35] However, the potential for online course design to support both continuing clinical competency and the translation of new evidence into practice has not been optimized.[17,22]

Health Professionals as Learners

Adult learners are self-directed and appreciate self-paced learning environments.[10,34] They desire high quality educational programming that incorporates timely, practical knowledge

which is relevant to the complexity of real-world settings.[10,27,34,36] Even though health professionals are adult learners, their needs are unique because learning clinical skills also requires actual or simulated skills practice.[19] In order to address these higher level competencies, the course design must provide opportunities for health professionals to demonstrate procedural and process type knowledge with simulated practice and feedback in an authentic context.[17,19] Research is lacking regarding which elements of course design best support learning clinical skills online.[8,37,38] Finally, integrating knowledge translation principles in course design is important to facilitate practice change. Knowledge translation is the timely and effective integration of current evidence into routine clinical practice by health professionals in order to optimize healthcare outcomes for patients and maximize efficiency within the healthcare system.[39] Several authors have proposed key design principles essential for achieving the higher level learning needed to change clinical practice based on theories of adult education and knowledge translation.[19-21,33,40]

A foundational principle is that the objectives of online continuing education courses for health professionals must extend beyond declarative knowledge.[19,34,41] In addition, activities designed to teach clinical skills must include simulated trial and error practice linked to competency assessment.[17,26] Multimedia and other technology-based strategies must incorporate neuroscience principles that optimize cognitive load and facilitate social construction of knowledge in a non-linear, collaborative environment that reflects the complexity of real-world clinical practice.[17,19,42,43] Active learning strategies, ongoing self-assessment, guided reflection, opportunities for critical thinking about complex cases, and formative feedback from instructors or peers are also important.[17-19,33,34,41,44,45] In particular, opportunities to problem-solve solutions to complex cases with peers have been found to improve physical therapists' confidence for

initiating practice change[46,47] and to help health professionals identify the gap between current and recommended practice.[3,33,47-49] Even though the most effective combination of strategies is currently unknown, research on knowledge translation in rehabilitation suggests that educational programs that incorporate multifaceted knowledge translation and interactive learning strategies are more effective than lecture-based or other passive learning approaches.[3,10,14,50,51]

Current Challenges in Online Continuing Education and Research

Despite expert recommendations to decrease reliance on didactic lectures in continuing education,[11,22,40,41] online course design has not kept pace with best practice recommendations for education. In fact, the same instructor-driven focus found in traditional face-to-face courses prevails online.[8,17,24,43,52] The most common multimedia strategy utilized is the narrated lecture with audio or video slide presentations[8,20,22] with asynchronous discussion of video content emerging as the most utilized active learning strategy.[21,27] Participants in online courses report frustration with the paucity of ideas and conversation in discussion forums for both formal and informal learning environments.[15] Most of the interaction that does occur in these discussion forums is between instructor and participant rather than as a collaborative knowledge creation process among learners.[44] Some participants have reported concerns about confidentiality or how their ideas are received by other participants in online discussion boards.[38,53] This lack of a trusting and supportive collaborative learning community in some online continuing education programs has been proposed as one reason that up to half of all health professional learners fail to complete these courses.[8,20]

Current research on the effectiveness of online continuing education also reflects the didactic focus of most online continuing education. Changes in knowledge, intention to implement new knowledge, confidence in performing clinical skills, and self-reported practice

have been studied primarily using quantitative methods.[15,17,20,24,54] Other quantitative outcomes studied include learner satisfaction with the online environment,[17,20,24] frequency of participant access of online resources,[8,37] and frequency of participation in online discussions.[44] As a result, there is little evidence regarding which online course design factors or combination of factors are effective in facilitating critical thinking and clinical skill competence needed for practice change[32,55] or how the interaction between available multimedia technology and course design influences the learning process or intention to change practice behavior.

The few qualitative studies have focused on barriers to and facilitators of learning in online educational design [38,56] or learner perceptions of online discussion forums.[53] MacNeill et al[53] reported improved understanding of interprofessional roles for 15 multidisciplinary health professionals who participated in a 12-week collaborative online course on either traumatic brain injury or diabetes. These health professionals reported challenges with online group processes but appreciated the flexibility of the online environment, immediate feedback from other learners, and an enriched learning experience. In contrast, other researchers have reported that physicians who were motivated to seek online continuing medical education primarily due to workload and personal constraints demonstrated a superficial approach to learning.[57]

Another commonly reported motivation for engaging in online discussion-based learning programs is networking with other professionals to solve common clinical problems.[38] However, whereas some online learners appreciate the anonymity of e-learning, others report feeling exposed, vulnerable, and unable to risk contributing to online discussions.[28,44,53] Learner frustration with the paucity of knowledge sharing and conversation in online courses limits the effectiveness of this strategy for both professional networking and knowledge construction.[12,28,38] Even though social learning is viewed as paramount for knowledge translation in continuing

education, no studies were found on the nature or role of these discussion activities in effective online collaborative learning. Instead, the few studies available focused on the role of the facilitator in promoting online discussions.[24,44] Research is also lacking regarding the impact of online continuing education on patient outcomes.[8,17,20]

There is some evidence that online continuing education programs can be designed using multifaceted educational and knowledge translation strategies informed by adult learning and behavior change theory to facilitate practice change.[17,24,26,58] Pullen [24] found that incorporating immediate and asynchronous feedback, opportunities to respond to clinical questions, and a point-of-care clinical tool facilitated increased knowledge and self-reported practice change for 300 healthcare professionals who participated in asynchronous online continuing medical education courses in Australia. Pediatric physical therapists in the United States reported improved knowledge and skill in selecting, administering, interpreting, and sharing standardized tests and measures after participating in a hybrid education experience including a two day face-to-face workshop followed by a 16 week discussion-based online program.[58] Renal nurses reported increased confidence in performing button-hole cannulation skills following a self-paced asynchronous online learning module using an interactive ultrasound and cannulation training software application.[26] No studies were found that investigated the use of interactive media or other software applications for continuing education in rehabilitation. In addition, no studies were found that investigated the process by which physical therapists learn clinical skills in an entirely online educational program or the processes they used to determine how new knowledge and skills would be used in practice.

Technology and Online Course Design

Aside from streaming videos, the most common technology used to support online teaching and learning in healthcare is the threaded asynchronous discussion forum.[15,17,38] Several authors have proposed that asynchronous discussion promotes collaborative learning, reflection, self-assessment, and social construction of knowledge.[59,60] In order to achieve the higher level learning needed for health professionals to implement learning in practice, the structure of the discussion environment must support a variety of purposes including knowledge comprehension, critique, construction, synthesis, and sharing.[59] Asynchronous discussion provides increased time for learners to process and reflect on new knowledge before responding as well as to revisit content, questions, and discussion over time.[61-63] However, it is difficult to facilitate focused, interactive, and in-depth asynchronous discussion in traditional threaded forums because participants frequently focus on the most recent posts and subsequently respond with condensed expressions of their own ideas rather than attending to, and reflecting on, the ideas of others in order to apply and synthesize new information across threads.[59] Furthermore, current media players for multimedia course content are physically separated from the discussion forums that learners must use to engage with each other.[23] This lack of a direct physical linkage between visual media and discussion platforms limits the effectiveness of both strategies because it requires busy professionals to shuttle back and forth between multiple areas of the online environment.[64]

Several authors[17,59,65-68] have attempted to integrate course design and media technology to reduce barriers to online discussion and better facilitate collaborative learning in distance education and flipped or hybrid classroom environments for undergraduate and graduate level programs. Strategies have included scaffolding participant discussion using pre-structured

activities as constraints within the forum, using concept maps or tables to visually represent the relationships among key concepts in the discussion, and anchoring the discussion to specific places within text documents to focus the conversation.[59] While each of these strategies has improved some aspects of discussion, none of them fully addresses the need for practicing healthcare professionals to engage in contextually relevant and complex case-based reasoning through both discussion and trial and error practice in order to learn clinical skills online.

In contrast, the Transformative Anchored Collaboration Environment (TrACE) is a novel spatial-temporal anchored media-player that has been used to support both synchronous and asynchronous collaborative discussion in undergraduate education.[23] The TrACE media player is designed to facilitate interaction and asynchronous collaboration around video content by allowing users to place an annotation and an anchored comment thread at any time and physical location in a video. The type and structure of each annotation can be customized to meet specific instructional goals that support knowledge translation including facilitating critical observational and reasoning skills, self-assessment, reflection, synthesis, and co-construction of knowledge through collaborative discussion. Learners can ask anchored questions that can be answered by other participants as well as the instructor, and the annotations may be made anonymously. Instructors may also insert special discussion type questions that automatically pause the video to allow free-text responses. As a result, TrACE is a promising interactive learning environment for health professionals to engage in individual skills practice and both individual and collaborative reflection, problem-solving, and other knowledge creation activities within an online continuing education course. However, no studies were found that utilized TrACE or any other anchored collaborative media environment in online continuing education for healthcare professionals.

Online Training for Outcome Measures

Research regarding online training of physical therapists for clinical skills such as administering and scoring an outcome measure is lacking. Only one study was found that describes a self-paced continuing education course for a pediatric outcome measure. Pediatric physical therapists were able to reliably score the Test of Infant Motor Performance (TIMP) after either attending a four-hour face-to-face workshop or completing a self-paced CD-ROM training program. Participants in the CD-ROM group were able to learn the test more quickly than those in the face-to-face group, and they were less lenient in their scoring. However, 40% of the pediatric PTs in both groups would have required further training to reach the desired reliability standard for scoring the TIMP. No other studies were found describing self-paced training for outcome measures in physical therapy in any format. However, developing online training for outcome measures is important to provide physical therapists with improved access to continuing education on for improved reliability of administration and scoring of these assessments as part of the delivery and reimbursement of quality patient care.

One such outcome measure is the Segmental Assessment of Trunk Control (SATCo). The SATCo is a valid tool that provides a systematic way of assessing specific levels of trunk control for children with neuromotor disorders.[69] Manual support is provided at seven segmental levels while maintaining both the pelvis and spine in neutral vertical alignment. Static, active, and reactive control are systematically assessed at each level. Accurate and reliable scoring depends on the ability of the clinician to identify both errors in testing and compensatory postural control strategies.

Since the SATCo is currently the only measure which allows specific assessment of trunk control for children with moderate to severe motor impairments,[69,70] it is important to provide

training to researchers and pediatric therapists in a wide variety of geographic locations and practice settings as efficiently and effectively as possible. Therefore, an online or hybrid training program for SATCo is appropriate. Scoring for SATCo is specific and complicated which can be challenging for physical therapy students, pediatric PTs, and researchers who are trying to reliably implement this assessment tool even when provided with face to face instruction (Sandra Saavedra, PT, PhD, email communication, March 11, 2018). A hybrid course design integrating self-paced learning using the TrACE media player with face to face skills practice demonstrated improved competence and confidence with SATCo administration and scoring for physical therapist student researchers.[71] Therefore, online course design that integrates cutting-edge media technology such as the TrACE media player may also facilitate the higher level of learning needed for pediatric PTs to implement SATCo in their clinical practice. However, online interactive training for SATCo does not currently exist. Furthermore, there is currently no literature describing how health professionals engage in collaborative learning in online training for outcome assessments, how effective this training is for teaching clinical skills to rehabilitation therapists, or whether therapists intend to implement information learned online in their own clinical practice following online training.

In conclusion, current online course design in continuing education for health professionals does not support the kind of collaborative discussion, reflection, and higher-level learning needed to improve clinical practice and patient outcomes. Integrating novel technology such as the TrACE media player with course design that reflects best practices in adult education and knowledge translation is one promising approach to addressing this gap. Since research is lacking, it is important to learn more about how rehabilitation therapists engage in collaborative discussion in multimedia online education environments, how the available technology and the

course design interact to promote higher level learning, and what impact these factors have on therapists' intention to change their clinical practice. This study will explore how pediatric PTs learn a clinical skill in a collaborative online environment. The development of an initial theory of the processes that pediatric PTs use to decide whether or not to implement a hands-on clinical assessment learned in a self-paced, asynchronous online continuing education course will allow further exploration of the best ways to design and implement online continuing education courses to promote knowledge translation in pediatric physical therapy.

Method

This section will describe the rationale and methods for a qualitative research approach to the study of pediatric physical therapists' intention to use information learned during an online continuing education course utilizing TrACE to facilitate collaborative asynchronous discussion of video case examples and open-ended narrative prompts to facilitate critical reflection on clinical practice change. It will provide a description of the participants and sampling method, the online continuing education intervention, data collection and analysis, and ethical issues for this constructivist grounded theory study which is part of a larger mixed methods study. Trustworthiness and the role of the researcher will also be discussed.

Study Design

Both collaborative online learning and the application of that learning to clinical practice are complex social phenomena.[17,34,72] Therefore, research on how the available technology and the course design interact to facilitate the self-assessment, reflection, and social learning processes that support practice change must move beyond a focus on quantitative measures related to didactic knowledge, frequency of participation, and learner satisfaction. Instead, a process-oriented approach to understanding how health professionals interact with technology

and each other in online continuing education is warranted. Qualitative methods provide an alternative approach to exploring ways that health professionals respond to didactic information and create their understanding of a new clinical assessment when engaged in an online education course using a novel spatial-temporal anchored media player to facilitate a discussion-based collaborative learning community.

A constructivist grounded theory approach places the focus on the phenomenon being studied in a particular time, place, and situation[73] so that data collection and analysis are interrelated concurrent processes.[74] The analysis is grounded in the data through constant comparison of emerging categories until theoretical saturation is achieved. A grounded theory approach is appropriate in areas such as collaborative learning in online continuing education where there is little or no current theory.[74] This approach considers the research situation and the subjectivity of the researcher part of the data and analysis process[73] which is important in a study where the primary researcher is also involved in the online course design and delivery. Finally, studies on the process by which implementation of educational strategies facilitates the movement of research evidence into practice must be informed by knowledge translation theory.[75]

One commonly cited knowledge translation theory is Rogers' Diffusion of Innovations Theory.[76] This theory recognizes the complex nature of clinician behavior across a five-stage continuum from awareness to persuasion, decision, implementation, and finally adoption of innovative practices. A grounded theory approach informed by the Diffusion of Innovations Theory[76,77] allowed a broad exploration of the impact of the anchored spatial-temporal media technology and online course design on discussion-based collaborative learning in a real-world continuing education context.

Informed Consent

Approval for this study was granted by the Human Subjects Committee (HSC) at the University of Hartford and a reliance agreement was established between them and the IRB at the University of Indianapolis in advance of participant recruitment. A packet with information on the study including the purpose, duration, inclusion and exclusion criteria, and consent form was provided to participants during the first week of each online course as part of the course design. Participants who agreed to participate in the study submitted the informed consent form online. The lead researcher also obtained verbal consent at the start of each semi-structured interview following the completion of the online course. The consent process for this study and for a concurrent mixed methods study related to the same online continuing education course were separate, and learners were able choose to participate or decline for each study.

Sampling

Recruitment and Enrollment. Participants for this study were recruited from two online course cohorts. The first cohort included 34 PTs who were employed by a large public school district in the northeast and who were enrolled in the pilot Introduction to SATCo online continuing education course between February and May 2017. The second online course cohort included 16 pediatric outpatient PTs employed by four children's hospitals who were enrolled in a second pilot Introduction to SATCo online course between April and July 2017. Two of the hospitals were in northeastern states and two in Midwestern states. Due to the ongoing development of the online course, the pilot courses were offered to all the therapists free of charge. For the school therapists, the online course was a pre-requisite to a one-day in-person training (hybrid course) that was sponsored by their employer in May 2017. The hospital pediatric therapists participated only in the online course.

The physical therapy supervisor for the school district assisted with providing staff a brochure that included information about the hybrid course and the possibility of participating in the two related research studies. This brochure detailed the course objectives, timeframe for course completion, information about the instructors, and the overall purpose of the study. Pediatric therapists in the online only course were recruited to participate in the second pilot online course through personal contacts of the primary researcher with leaders in each children's hospital. They were provided with the same brochure as the school therapists. The primary researcher was one of the course designers and a course instructor for both the hybrid and online only courses.

The sample for this study was a sub-sample of the convenience sample for a related mixed methods study on the use of the TrACE media player for online continuing education of health professionals. Participants in the sub-sample were selected from all pediatric practice settings in which course participants worked in order to maximize transferability of the research findings. These settings included early intervention, preschool, and K-12 school based physical therapy as well hospital based outpatient clinics in two of the four children's hospitals. Purposive sampling is appropriate for grounded theory studies before theoretical sampling is possible.[78] All learners in the online courses completed a brief informational questionnaire including demographic information and five questions about SATCo based on the five categories of Rogers Diffusion of Innovations theory: knowledge, persuasion, decision, implementation, and confirmation.[76] Since the hybrid cohort completed the online course earlier than the hospital based PTs, information from this questionnaire was used to establish an initial maximum variation purposive sample[78] of four PTs from the hybrid course. At least one PT was recruited from early intervention, pre-school, and school based practice settings. Theoretical sampling[70]

of subsequent health professionals from both the hybrid and online only courses was used to identify participants who could best provide information related to emergent questions and categories developed from the initial interview codes and themes. Each PT was interviewed once, and theoretical saturation was established after 19 interviews. Open responses from the Blackboard modules were also analyzed for the 29 online learners who consented to participate in this study and data were triangulated with interview data to promote credibility. (See Figure 1 for online course and interview sampling flow.)

Inclusion and Exclusion Criteria. Licensed physical therapists employed by the school district or one of the three children's hospitals working with infants or children of any age who had not received prior hands-on training for SATCo and who completed the entire pilot online Introduction to SATCo course were included in the study. All three PTs from one organization in the online only cohort did not complete the full Introduction to SATCo course and were excluded from the study. In addition, all PTs from the hospital that had received prior hands-on training for SATCo were excluded because they were concurrently utilizing this outcome measure in clinical research.

Procedures

　　Intervention. The pilot online course consisted of ten self-paced modules that were completed asynchronously within a defined 12-week time-period. Interactive learning activities were designed to introduce pediatric PTs to the administration and scoring of the SATCo. Journal article readings, narrated video slide presentations, and video case examples were utilized in each module. Narrated video lectures and case examples were presented in the learning management system. In addition, PTs completed knowledge checks in the learning management system and TrACE media player for the modules. Open ended questions at the end

of the modules on open and closed chains, SATCo administration and scoring, common tester errors, and compensatory strategies were utilized to prompt critical reflection on PTs current practice and attitudes toward using information learned in the online course. (See Table 1 for end of module open response prompts.) Activities in the TrACE media player were also designed to facilitate critical reflection and asynchronous discussion of key concepts throughout the course.

The TrACE media player activities were designed to facilitate critical reflection along with interaction and asynchronous collaboration around video content by allowing users to overlay comments at any specific time and physical location in a video.[23] To link a comment to a specific location in a video, PTs would click or tap at the desired location in the video to place an annotation and anchor their comment thread. In addition, the type and structure of each annotation prompt was customized to meet specific instructional goals. For example, multiple choice questions allowed for self-assessment of critical observational skills, whereas open-ended prompts were designed to promote critical reflection and clinical reasoning skills. Learners were also able to post a question about a specific time and place in the video that could be answered by other participants or the instructors. Finally, TrACE activities included options for anonymous posting to comment threads to facilitate increased participation in collaborative discussions by learners who feared sharing their questions or opinions publicly.

Online course design. The online course was designed to incorporate multiple evidence-based strategies including the ability for participants to progress at their own rate,[10,12,20,79] to navigate within current and earlier modules from the course in a non-linear manner,[17,21,24,79] to participate in knowledge checks,[17,43] to practice simulated skills,[17,35,43] to reflect on clinical practice,[18,53,80] to identify potential barriers and supports for implementing SATCo in practice,[81,82] and to provide asynchronous two-way communication[44,53] with peers and the

instructors within the TrACE media player. Course participants also engaged in scoring the

SATCo on video case examples of a typically developing infant and a child with cerebral palsy

at both the beginning and end of the course.

During the first course module, all participants completed a brief learner information

questionnaire and the research study consent process, introduced themselves asynchronously to

other participants, viewed a video demonstration on how to use the TrACE media player, and

practiced making annotations within TrACE. They then read the published journal article on the

administration and scoring of SATCo, reviewed the provided SATCo score form, and completed

a pre-test by independently scoring two case videos in TrACE via private responses to the

instructors. Reflective prompts designed to elicit clinical reasoning during scoring were

incorporated in the pre-test. Participants were not able to progress in the online course until

these elements had been completed. Each module unfolded sequentially when the requirements

of the previous module had been completed. Participants could freely navigate through any

module they were currently working on or had already completed, but could not skip ahead in

the course.

Modules two and three presented foundational concepts in the assessment of trunk

control in children with neuromotor disability. Modules three through nine included video case

examples in TrACE with asynchronous discussion prompts, multiple choice knowledge checks,

and open-ended reflective prompts designed to develop therapists' ability to identify common

tester errors and compensatory strategies for inadequate trunk control during SATCo

administration and scoring. Modules four, seven, and eight also included open response

questions completed within the learning management system that prompted critical reflection on

use of concepts from each module in clinical practice.(See Table 2.) Participants completed a

post-test in module ten by scoring the same case example for SATCo that they scored in the first module pre-test. Therapists were provided with individual feedback regarding their performance on the post-test by an instructor. Therapists were also required to complete a post-course evaluation to receive continuing education credit for the pilot online course.

Data Collection. Data collection occurred concurrently with mixed methods data collection for a related study on using the TrACE media player in online continuing education course design. Participation in both studies was voluntary and did not affect learners' ability to complete the hybrid or online only educational activities or to receive continuing education credit. Data from the pre-test and post-test during the online course along with analysis of other quantitative and qualitative data available in TrACE will be analyzed as part of the concurrent mixed-methods study following the completion of this grounded theory study to improve trustworthiness.

Data was collected and analyzed concurrently using constant comparative analysis consistent with a grounded theory approach.[74] Each participant was interviewed by telephone once within the three months following completion of their Introduction to SATCo course at a mutually convenient time. Semi-structured individual interviews[73] lasting 30-60 minutes focused on the participant's experience in the online education course and intention to use the SATCo in clinical practice were conducted by the primary researcher using an interview guide. The initial interview guide (see Appendix A) was developed based on results of graduate student experiences with TrACE in flipped classroom models at the University of Hartford,[71] a review of the literature on online continuing education in healthcare, and the Diffusion of Innovations Theory.[76] The interview guide was adapted twice during data analysis based on concurrent conceptual and theoretical analysis. Interviews were recorded using freeconferencecall.com with

a back-up recording on a mini digital recorder. Typed verbatim transcriptions were completed within two weeks of each interview by a transcription service and reviewed by the primary researcher for accuracy within two weeks.

Data Analysis. The researchers employed multiple strategies throughout data collection and analysis to promote credibility, confirmability, and transferability in order to enhance the trustworthiness of the study. Audiotapes were reviewed within 48 hours of recording by the primary researcher and written memos on initial impressions and main concepts were created.[74] The typed verbatim transcript of each interview was reviewed for accuracy within 14 days by the primary researcher and uploaded to the QSR NVivo 11 (QSR International Pty Ltd., Victoria, Australia) software package. Transcripts were read a second time as a whole to obtain an overall sense of the themes from each interview.[74,83] On the third reading, line by line codes and analytical memos [74] were recorded by the primary researcher for each transcript in NVivo 11, and initial codes were developed using a constant comparative analysis process.[73] Narrative data from the open response questions on tester errors and compensatory strategies were also analyzed for all study participants and these data were triangulated with the interview data to promote credibility.

Next, a second researcher with experience in instructional design and qualitative analysis who was not affiliated with the online continuing education courses independently coded the initial data to enhance credibility of the findings.[84] The primary and second researchers used a consensus decision-making process to determine the initial codes and subsequent focused codes. The researchers met several times during the course of analysis to refine emerging themes and categories in order to enhance credibility and confirmability through analyst triangulation[85] and to facilitate reflexivity through inclusion of researchers from multiple disciplines.[73,86]

Conceptual and theoretical memo writing was utilized throughout the data analysis process to explore relationships among categories, develop the emerging theory, and support ongoing theoretical sampling.[73,83] Theoretical sampling continued with concurrent data analysis until saturation of the categories was reached and a central code was established.[87]

Both researchers maintained an audit trail including detailed descriptions of the initial and focused coding as well as the iterative theoretical sampling process to promote confirmability.[83,84] Member checking of the analysis was conducted with participants by email after the theoretical codes had been developed in order to ensure that the findings were credible and reflected a reasonable account of participants' experiences.[84,87] The inclusion of PTs with varying levels of clinical and online learning experience who were working in different pediatric practice settings through the theoretical sampling process promotes transferability of the theory.[83] Since the primary researcher was also involved with the development and delivery of the online education course, reflexive journaling was used throughout data collection and analysis to identify and address potential bias for improved confirmability of the analysis and trustworthiness of the emerging theory.[87,88]

Results

Participants

All of the hospital therapists and 20 of the 34 school-based therapists who were eligible consented to participate in this study. Nineteen pediatric physical therapists were identified through theoretical sampling as described above. Years of pediatric experience ranged from 1 to 42 with a mean of 17 years for study participants and 18 years overall. Seventy-four percent of the online participants and the study participant group had completed online education activities prior to the Introduction to SATCo course. Therapists' self-rated confidence in online learning

prior to the SATCo course ranged from 5 to 10 on a 10-point ordinal scale for study participants

and 4 to 10 overall with a mean confidence rating of 8 for both groups. Study participants were

evenly distributed among pediatric practice settings. (See Table 2 for participant characteristics)

Learning a clinical skill online with TrACE

The online course design was instrumental in provoking cognitive dissonance for learners

in both the hybrid and online only courses. The SATCo course content encouraged participants

to reexamine their assumptions regarding how posture control develops and can be trained in

children with neuromotor impairment. As a result, some PTs were required to think about

posture control assessment and treatment in a new way.   They were required to reorganize and

re-conceptualize prior understanding of trunk control and to consider implementing this new

approach in practice. The clinical reasoning questions and open-ended prompts in the TrACE

video cases, and the reflective prompts at the end of the Blackboard modules, provoked health

professionals' cognitive dissonance about using the SATCo and related treatment concepts in

practice. As a result, therapists accessed, identified, reflected on, and compared prior knowledge

and practice to new concepts within the context of personal and organizational factors during and

after the online course.

Our grounded theory analysis uncovered three approaches that participants used to reduce

cognitive dissonance: accommodating new concepts without practice change, waiting for others

to provide solutions to implementation challenges, and experimenting or adapting information

for practice change. The development and resolution of cognitive dissonance was an iterative

process embedded within participants' reflective clinical practice. Individual clinicians often

demonstrated more than one approach to resolving the dissonance at any given point in time.

(See Figure 2)

Cognitive Dissonance

According to Festinger's theory of cognitive dissonance,[89] individuals experience psychological tension or discomfort when their beliefs or attitudes are inconsistent with their actions. This discrepancy must be resolved to restore consistency among the individual's cognitions and behavior. Participants experienced cognitive dissonance in the online course when they attempted to reason through video case examples and critical reflection activities while considering two conflicting beliefs about the assessment and treatment of postural control in children. New information was assimilated with prior knowledge grounded in clinical experience. Most participants were motivated to contemplate incorporating the segmental approach in their practice because their clinical experiences with the current assessment and treatment approach was not optimal.

All therapists had experienced difficulty with assessing and treating children with moderate to severe deficits in head and trunk control prior to participating in the online course. After learning about the SATCo, they believed that the segmental approach had the potential to help solve this persistent problem. When reflecting on their current practice during the course, PTs shared their surprise in finding examples from their current caseload where children demonstrated a new concept that they had not recognized before such as the use of closed chain compensatory strategies for inadequate trunk control.

> So, I think particularly interesting for me in the course was some of the compensatory strategies that maybe I don't think about. So, stuff like where their arms are positioned, and whether or not they're positioned, like, touching another body part or if they're free. And even just the toy to mouth with their hands. Those kinds of things I don't think I was thinking of quite as in depth before the course. And so, I think that I will—I'm thinking a little bit differently when I'm watching kids, and I'm trying to support them about what they're maybe doing to maintain that posture that maybe I didn't think of as a compensatory strategy before the course. (P12)

Therapists were also surprised by children they were assessing or treating who did not have as much trunk control as they had previously given them credit for. Some PTs were surprised by the difference in function that was achieved when they tried providing increased segmental support to a child. These experiences contrasted starkly with therapists' prior expectations of how trunk control could be improved through treatment, and this discrepancy heightened PTs feeling of cognitive dissonance.

> And previously, when I've been working with [this child], we had still been working on sitting. And before, mom would be happy when we'd be able to get him to sit independently for a couple of seconds statically, but this—I've noticed he really doesn't have control from his axilla all the way down. So even though I wasn't providing him with support and it looked like he was sitting independently, he truly still doesn't have the control in those areas. (P18)

Participants wrestled with giving up their prior strategy of fading or removing support when working on upright posture rather than supporting a child up to the segmental level where they were learning trunk control. Prior to the online course, diminishing the amount of support was viewed as a way of demonstrating gains in function and posture control by PTs in all practice settings. In contrast, the segmental approach focuses on optimizing alignment and providing adequate support for learning trunk control at the segmental level where a child loses static, active, or reactive control. Some PTs experienced dissonance when trying to fit this new approach into a current treatment philosophy focused on the child demonstrating progress in functional skills by minimizing supports and using compensatory strategies to maximize function.

> So if I set a kid up that the staff is going to do a gait training with them, I might have it set to be a little bit higher because that way I know that they won't worry about that child, you know, losing it. And they can go to adaptive P.E. class so they can do the work in the class. But then when I work with them, I might actually lower the prompt or take away a prompt because I'm trying to get it where they have to work at it. But I want them

to be able to do what they need to do with their supports. But then if I want them to get better [posture control], then during therapy I might change it up. (P03)

And I think it just brings me back to, like I said, not overriding my concern for those compensations. I sometimes will. I'm aware of them. I will document them. But I'll say, 'You know what? The kid's got to be able to participate in circle time." And that's valuable at that point in time in his life… So, they participate that day, but maybe the next day, a more difficult task, they won't be able to participate with. So, you just have to really be able to predict the outcome of ignoring those compensations. (P01)

Early in the online course, some PTs assimilated information learned online by merging new information about segmental assessment with prevailing conceptual models of treatment for postural control deficits such as strengthening trunk muscles or working on shoulder and pelvic stability in prone and quadruped**.** Others debated the relevance of segmental concepts compared to current approaches to treatment for their children on their caseload.

Now that I'm learning how to assess trunk stability at different levels I can see where specifically a child is demonstrating weakness and work on those levels in order to decrease their compensatory strategies… I will start to focus primarily on strengthening areas of weakness and much less on the child developing compensatory strategies.(P04)

I guess it would be advantageous for them to be working on gaining some trunk control with some support in the lower thoracic area. But I also think this is a kid who really needs a lot of time on strengthening abdominals in general, and then working on hands and knees and rocking to get pelvic and shoulder girdle stability. (P08)

Gaining trunk control from therapeutic work in prone and quadruped has been a mainstream treatment philosophy in pediatric physical therapy for decades, and working on segmental control in upright postures was a novel idea for most participants. In addition, even though trunk strengthening and stabilization are important therapeutic goals for children with motor disability, they are not part of the segmental approach to gaining trunk control. PTs had difficulty reconciling this prevailing approach with the information they were learning online.

Engaging in multiple case-based and reflective activities in the online course helped many PTs to move beyond these initial conceptions and to refine their understanding of how segmental assessment can inform trunk control interventions. Together with characteristics of the SATCo, the course design promoted cognitive dissonance in learners by continually engaging them in reflection regarding their current practice and the potential for practice change.

Cognitive dissonance provoked by online course design. Active learning through video case examples in TrACE and the open-ended reflection questions at the end of each module encouraged PTs to make meaningful connections between the information they were learning online and their own clinical practice. This resulted in varying degrees of cognitive dissonance for most participants. An overview of the link between segmental assessment and treatment was provided in the online modules and TrACE activities, but the focus of the course was on administering, scoring, and interpreting SATCo. The reflective questions at the end of each module also allowed brief asynchronous exchanges between each participant and the instructors. Instructors were able to pose additional questions to participants in order to facilitate deeper reflection and critical thinking and promote clearer identification of differences between participants' current understanding or clinical practice and the course content.

PTs were encouraged to reflect on how they might approach implementing SATCo and segmental concepts in their own practice and to consider what barriers to implementation they might encounter. Instructors provided feedback on learners' questions about the course content, acknowledged challenges and successes with PTs attempts to trial information in their practice, and gently prompted further reflection to stimulate awareness of the gap between a participant's prior mental models for posture control and segmental concepts when appropriate. Learners

found these activities valuable in facilitating reflection and making their clinical reasoning more explicit as they moved through the online course modules.

> And that part of the open-ended questions where I was put on the spot to say what I thought. And I had to write it out. And so, there's that point of reflection where you have to articulate what your reasoning is. (P01)

The TrACE activities provided learners with multiple opportunities to practice SATCo skills in video case examples and to reflect further on their clinical reasoning. Some questions required learners to submit scores for video SATCo tests on a typically developing infant or a child with cerebral palsy. Scoring was done through private replies to the instructors to allow each participant to practice scoring the test independently. Learners were also asked to identify and publicly comment on open and closed chain strategies, tester errors, and compensatory strategies that they observed in TrACE video cases during those course modules.

Although these open-ended prompts were designed to facilitate discussion and peer feedback among course participants, this did not occur in either cohort during the online course due to the self-paced and asynchronous nature of the modules. However, these activities did promote cognitive dissonance in participants by forcing them to engage deeply with course material, requiring them to commit to their observations for the video cases, and encouraging them to explain their clinical reasoning. In addition to promoting cognitive dissonance, these activities helped learners synthesize information across modules in the course and gain confidence in their ability to complete specific skills related to SATCo administration and scoring.

> My favorite thing was the actual TrACE where you could actually see a real patient and actually be able to do some clinical thinking, which is the first time I've had to do that on an online course because it's usually just a presentation and then you took a small test. This time you actually got to use your clinical thinking and look at the patient and be able to answer what you believed was going on. (P18)

> Well, that activity, you had to take everything that you had learned before and actually apply it. Rather than just learning individual pieces and making comments, that particular activity [open ended prompt on TrACE] you had to have some knowledge and be able to kind of synthesize everything and use it in a practical way. Not just learning information, but putting it together. (P11)

Cognitive load, interaction, and attitudes toward online learning. Some learners in the school based cohort experienced significant technical difficulty when using TrACE. These challenges with usability increased the extraneous cognitive load for these learners and added to the cognitive tension provoked by cognitive dissonance during the online course. Hospital based therapists described an initial learning period after which they found TrACE easy to use, and they related this ability to overcome technical challenges to their regular use of technology for clinical documentation. Overall, most PTs learned to use TrACE effectively during the first three weeks of the course with support from the instructors. For all participants, TrACE activities required greater active participation, time, and engagement with the course material than a traditional online or face-to-face continuing education course. This was significantly different than many participants' prior experiences with continuing education in either format, and most PTs had to adjust their expectations and their approach to completing the course material.

Even though not all learners enjoyed using TrACE, most participants found the online course valuable and stated that they would consider additional online learning courses in the future. They appreciated the opportunity to practice critical elements of SATCo administration and scoring on real video cases. Like the open-ended prompts on Blackboard, TrACE activities provided the opportunity for learners to assess their understanding of key concepts and to make their clinical reasoning explicit. These activities also created a desirable difficulty that forced

clinicians to slow down and reflect on their observations and clinical decisions in the online

course.

> I've been a clinician for several years; I'm used to real-time and not really doing the videos. So, kind of using the video and trying to figure out when can I do slow motion to kind of help me figure out where I need to be. And a lot of kind of, 'Okay, start again. Where did this happen that I saw it?' …So, I think it's just trying to figure out when I should replay it to get a better look, when I should slow it down, and figuring out the exact points where I saw what I saw. (P19)

> Those are good too when you're just learning about specific—like you had to make a comment, 'Okay, what compensatory strategies is the child using?' Or, 'Look at the examiner in this one. What do you think? Is there something the examiner could do better?' There were things like that where you could look at specific pieces and sort of develop your competencies for the child's compensatory strategies, examiner error. (P11)

Since the courses were self-paced, instructors attempted to promote peer discussion and

problem solving by limiting their engagement with participants in TrACE during the online

modules. Most individual feedback was provided to learners at the end of each course. Only

one learner took advantage of the ability to add their own question within TrACE. Most PTs

described the need to balance work, family, and online learning responsibilities by focusing on

completing all the course requirements within the allotted time frame as a reason for not

engaging in discussion with peers across modules over time.

Because discussion among participants did not occur, learners received delayed feedback

on performance of TrACE activities. The lack of discussion also limited the ability of learners to

utilize social relationships and supports to confidently construct new models and conceptions for

the assessment and treatment of trunk control during the online course. Participants also talked

about missing hands on practice and immediate feedback from instructors on their performance

compared to prior experiences with in-person continuing education experiences.

So. there were certainly times when I was kind of trying to figure out, in the midst of - "Hmm, I think this one has control and I think this one doesn't," just from watching videos and trying to figure it out for myself. And I kind of wish the response could have been more immediate, so I could get it stuck into my brain in that moment… I mean, I guess it's not hard because I can put the dot, but *still*, do you mean *this*, or do you mean *this*? It's a little bit harder. (P07)

Watching the videos, I mean, I've never heard of this test before. Everything was helpful. The videos as part of the learning, where you can watch, you can flip through a PowerPoint, were helpful. The TrACE videos were helpful in actually seeing it performed. But I still feel like I need that clinical hands-on time to really be able to go and implement it into practice. (P02)

Overall, participants in both courses demonstrated positive attitudes towards the course design but desired opportunities for synchronous conversation, hands on practice, and more immediate feedback from the instructors. Despite these challenges, being forced to commit to decisions within the TrACE activities and to reflect on the implications of the new knowledge for current practice created a desirable difficulty that stimulated cognitive dissonance for practice change in learners. Most participants expressed confidence in their ability to identify tester errors and compensatory strategies in the video cases by the end of the online course. They understood how to administer and score the SATCo, but they were unsure of their ability to physically carry out the assessment within their individual practice settings due to characteristics of the SATCo and a lack of confidence in their hands-on skills.

Dissonance provoked by characteristics of the SATCo. Even in the organization where all staff were required to complete the online course, most participants were motivated to learn the SATCo and related segmental treatment concepts. Therapists were excited to have a more specific approach to treating impaired head and trunk control for children with moderate to severe motor disability. They believed that the SATCo could provide valuable information to inform treatment planning and potentially improve outcomes for children on their caseloads.

Therapists recognized the emerging level of evidence for the SATCo but expressed a pressing

need for implementing segmental concepts in their clinical practice even though the approach

was relatively new.

> I think what it gets down to for me is this is really useful-- this is a really great tool because we've never had anything close to-- any kind of tool to objectively look at trunk control. That's always something that's been missing. (P11)

> I think this environment, it's so key for kids to be able to look and use their eyes. And so we have a lot of kids that, in some of our more intensive programs, that have real issues with maintaining their heads in a position where they can benefit from even looking at things, or visually engaging with a switch or a scanner or something. So, it gives us a way to approach it maybe differently. (P09)

However, this interest in immediately applying segmental assessment concepts learned

online to treatment activities provoked additional cognitive dissonance. The online course

provided an overview of the implications of segmental concepts for treatment of these children,

but it lacked specific actionable strategies for therapists to utilize the results of segmental

assessment for treatment. The tension between PTs excitement about segmental concepts and

their uncertainty about how to use information from SATCo to develop a segmental intervention

program for children on their caseloads resulted in some therapists dismissing the immediate

usefulness of performing a formal SATCo in their practice.

> If I knew I had the resources to treat them effectively, I probably would be more inclined to try and do more assessing other than my little, more informal assessing, but more specific assessing. (P16)

Thinking about mastering the complexity of performing a formal SATCo in their practice

setting was also challenging for many participants. Acquiring specialized equipment, including a

bench with specialized strapping and a video recorder, was a potential barrier for therapists in all

practice settings but particularly for those providing home-based services. All participants

expressed difficulty with arranging for two or more testers to perform a single assessment.

SATCo was also perceived as a demanding assessment, requiring the testers to watch for errors

and compensatory strategies in real time while simultaneously maintaining a neutral vertical

trunk alignment throughout the testing. PTs viewed these aspects of the SATCo as barriers to

implementation. Therefore, the therapists' desire to access specific information about a child's

segmental trunk control to facilitate more specific intervention planning was at odds with the

perceived difficulty of carrying out the assessment in a real-world clinical setting.

> We practice in the school or home environments which can be challenging to get two or three PTs together for one student. (P20)

> I think the SATCo, in general, is challenging for a lot of our patients, not having the bench, and trying to keep the patient in the best alignment. So that can be hard for some kids and especially if I have a parent who's not engaged and it's just me. (P17)

Finally, therapists experienced dissonance when comparing rigorous administration of

SATCo to less formal use of segmental assessment concepts in real-world practice settings.

They wondered whether adapting information they had learned online to fit their routine practice

was valid and acceptable. Some PTs viewed rigorous, competent performance of a formal

SATCo as the only possibility. These therapists felt cautious about adapting or experimenting

with SATCo in their clinical practice because they did not believe they had the skill and

resources to perform it with fidelity.

> Well, I think the big difference is that this is an assessment, versus a treatment approach. So sometimes the treatment approach is, of course—there's a lot more trial and error, depending on the individual. But if this is an assessment, I guess there's a little bit more pressure on my end if it feels like I'm not getting it right. (P02)

I think my challenge would be doing the test 100% correctly. I feel like I could do the test and get more of a general result, because I don't know if I'll be able to take a look at everything and make sure everything is done correctly, like my hand placement, and the child's position, and their hands, and notice that the child's touching my arm and—So, I know how it's supposed to be done, I'm just not sure it could be done 100% correctly in the home. (P04)

PTs expressed the need to balance their interest in the more specific information about segmental trunk control that could be gained from formal SATCo administration with contextual factors that constrained their ability to fully implement it immediately.

Overall, PTs experienced cognitive dissonance in their clinical reasoning and practice for children with moderate to severe motor disability related to both characteristics of the SATCo and the course design. Engaging in reflective practice both within the online course and within their routine clinical practice during and following the course provided therapists with a heightened awareness of the gap between their current practice and a segmental approach to assessment and treatment for trunk control. PTs viewed this dissonance through a contextual lens that included both personal and organizational factors as they worked to reduce or resolve the psychological tension.

Viewing Dissonance Through a Contextual Lens

All therapists identified organizational factors as barriers or supports to implementing segmental assessment in their own practice setting. For many participants, the process of resolving cognitive dissonance also required further reflection on personal factors including their beliefs and self-concept related to evidence-based practice and their confidence in performing a formal SATCo.

Organizational context. Therapists described multiple barriers to implementing the SATCo in their routine clinical practice across all settings. These barriers included lack of time,

scheduling and other workflow challenges, caseload demands, documentation requirements, multiple sites within a single organization, varying levels of parent or staff engagement during treatment sessions, and the lack of specialized equipment. For therapists treating infants and toddlers in natural environments such as home or daycare, another barrier was the frequent presence of siblings and the need to work within family routines during sessions.

Therapists had also developed strong mental models representing a treatment philosophy specific to their practice setting. As a result, PTs sometimes perceived the segmental approach as inconsistent with their practice setting philosophy, and this perception influenced their opinion regarding whether or not SATCo might be useful. This tension was most prevalent among PTs working in early intervention or school based practice where the program philosophy is well established for each context.

Early intervention PTs felt uncomfortable bringing specialized equipment and a video camera to a family's home or other natural environments to perform a formal SATCo. They described good coherence between coaching families to use segmental concepts and their current intervention approach, but they perceived the formal testing protocol and equipment as "medical" and inconsistent with their usual practice. For school therapists, the tension was related to integrating a more specific focus on segmental alignment and postural control with their primary focus on promoting the functional skills necessary to participate in the educational program.

> The school system is restrictive in ways that the medical health system- you know when you're in a purely medical model it doesn't restrict. But there's more issues that you have to deal with. So, you combine that with trying to absorb an approach that's looking at an impairment level… trying to apply those concepts within the parameters of a school-based therapy model, you just found yourself weaving through concepts and saying, 'Well that's a great concept. How would that fit in my environment?" (P01)

The positive impact of supportive leadership was also evident for interview participants in two of the three organizations. Leaders in both organizations encouraged and supported staff to facilitate integration of SATCo into routine practice across multiple sites. Supports provided included dedicated meeting time, acquisition of necessary equipment, and staff development events to promote improved confidence with hands-on skills and to collectively agree on when and how SATCo could be implemented in each setting.

> We have four people that went through the course and so, we picked two for each site so that we could have a partner at each site, and that we can collaborate to kind of make it happen here, so it's nice to get some peer feedback on it. And we have a meeting coming up next week that we're going to meet and try to pull it together for all that. (P12)

> There was a leadership meeting all day on Thursday. And I'm no longer on the leadership team. But a couple of the people were telling me that they've already recommended that we do structured time for us to get into small groups and administer the SATCo in different settings. (P05)

The presence of strong leadership support helped to facilitate optimism regarding the potential to overcome contextual barriers. Both organizations had well-established processes in place to encourage the translation of new evidence to routine practice prior to the online course. This structure provided an organizational evidence-based practice culture for staff which contributed to a general expectation that problems with implementation would be solved and that SATCo would be used across all sites and settings over time. In contrast, the culture of evidence-based practice at the third organization was focused on the individual clinician. All participants from this organization perceived the barriers related to implementing formal segmental assessments as prohibitive of routine use. Even though they recognized the value of the approach, they did not see a way forward that would allow them to integrate it into their practice.

I feel like just logistically it would be hard to use it in our setting, just trying to get a second person and videoing, I feel like just because of time constraints and getting a second staff member, it would be hard to actually carry out the exact test. I think I'll definitely take components of it and in kind of an evaluation way, not the standardized test, take what I've learned from learning the test. But I think, to do the test in the way it was intended, I think it's hard logistically in our setting. (P19)

Personal confidence. Participants intertwined their contemplation of practice change with considerations about both the complex organizational system within which they worked and their personal mental models related to the perceived difficulty and benefits associated with practice change. In addition, most therapists lacked adequate confidence in their hands-on skills to implement the assessment without additional support. They weighed their individual confidence against the organizational barriers and supports to determine if they would be able to incorporate segmental concepts into routine practice. Participants who were leaning toward implementing segmental concepts longed for live instruction of SATCo administration skills and feedback on their performance. This instruction was lacking in the online course.

I would like a hands-on piece. Because I think I can watch the videos, and I see how to do it. So- I haven't tried it yet, so I guess that's the- I will have to try it and see if I felt that I was given enough information in order to do it on my own or that- but I do. I think it would be more beneficial yet to have the in-person component. But, I see what they're doing through the videos so I think I could do it. I would just want someone evaluating to see that I'm doing it correctly. (P04)

And I think that'll help people, to be able to do it [SATCo] in teams, and know that everybody's trained. And we can all give each other feedback and stuff. I think that'll really help raise, I mean, for me, and I'm sure everybody else, confidence level in being able to do it. (P05)

These participant quotes also demonstrate the variation in attitudes about responsibility for closing the gap related to contextual barriers and inadequate confidence when PTs were considering adoption of segmental assessment in practice. Some PTs expressed a desire for

instructors or future courses to provide the practice and feedback they required, while other therapists took the initiative to plan for practice and feedback with peers to improve their confidence following the online course. Individual attitudes toward responsibility for solving organizational and personal contextual challenges also contributed to the varied ways that therapists resolved their cognitive dissonance.

Resolving the Dissonance

All participants who experienced cognitive dissonance were compelled to find a way to resolve this tension. Although the dissonance was mediated by organizational and personal contextual factors, these factors alone did not dictate the process of resolving the tension. Therapists used three different strategies to reduce or resolve cognitive dissonance when considering individual practice change following the online course: accommodating new information in current practice, waiting for solutions to overcome barriers to use, and experimenting with adapting information for practice change. This was an iterative process in which a therapist often demonstrated behavior and attitudes characteristic of more than one strategy simultaneously or over time.

Accommodating new information without practice change. For some therapists, the perceived benefit of incorporating the SATCo in their practice did not outweigh the perceived mismatch with their practice philosophy, workflow challenges, or SATCo requirements. Organizational or opinion leader support for practice change was not always adequate to overcome these challenges with implementation. Instead, therapists elected to accommodate the new information with prior conceptions and clinical reasoning. Therapists in all three organizations demonstrated this strategy for dissonance resolution. These PTs valued what they

learned online, and they worked to find a way to integrate this new information with their current

concepts without changing their approach to clinical reasoning or practice behavior.

> You know when you do something for a really long time and you don't necessarily label it anymore, you just know it's there. That's kind of where it was. Like, 'Oh yeah, yeah that's what they're using.' You know it's there, but you don't necessarily label that. (P03)

> I mean, I can still do all those things that I was doing, as far as trying to build better control of the trunk, in terms of extension, flexion, rotation, and all those things. I can still do those without the SATCo. And in my mind, the SATCo gives you more information, but it makes it harder to specifically target [treatment]. (P16)

Accommodating new concepts within their current practice allowed therapists to

reconcile their belief in the value of a segmental approach as part of evidence-based practice

with their desire to maintain their current clinical reasoning and practice behavior. Therapists

resolved the dissonance provoked by acquiring new knowledge about segmental concepts

without changing their prior conception of how to approach posture control assessment and

treatment for children.

Waiting for solutions to overcome barriers to practice change. A second strategy for

reducing cognitive dissonance emerged **w**hen therapists believed that the benefit was greater than

the cost of change but did not believe that they could personally overcome these barriers in their

practice setting.   Therapists in all three organizations utilized this strategy. These PTs elected to

wait for others, either organizational leaders or course instructors, to adapt the information or

solve other challenges that made it difficult to use the SATCo and related treatment concepts in

their routine practice.

> I feel like I have the assessment now. I can handle that, but give me some ideas of how, more specifically, I can use this in my daily work. And certainly, there are people out there who will come up with ways to use it that will be valuable to a lot of people. (P16)

> You know, maybe have another module for practical application of this [assessment] protocol or something like that, and maybe do a little segment on showing people how it can be modified to their practice setting. (P10)

Therapists who used this strategy for dissonance resolution often described applying concepts from the online course in their clinical reasoning, goal setting, and documentation of the quality of trunk control for children with moderate to severe motor impairment. The PTs working in one of the two organizations with formal leadership support for SATCo implementation also talked about their expectation that the leadership team would address implementation challenges. These therapists expected that the segmental approach would be part of routine practice within their organization over time. Therapists in the third organization were resigned to using parts of the new information learned online without any expectation of full implementation of the segmental approach in practice. Overall, PTs who were waiting for others to find solutions changed their conceptions of posture control but only implemented information that was easy to incorporate in their routine practice.

Experimenting and adapting information for practice change. The most common strategy that PTs in both online cohorts used to resolve inconsistencies between prior and new conceptions of pediatric posture control was to trial small amounts of information in their own clinical practice. This experimentation involved what therapists described as "informal assessment" that was applied during treatment sessions in the form of caregiver education, manual handling, or adjustment of positional supports without specialized equipment.

> And I kind of tried the other day with one of my patients. I don't have the straps but I just kind of used my legs to secure over their lap and just kind of played with the handling at different levels. (P12)

I feel like I was doing it a little bit more informally going through because I didn't have a bench and things at the time. So, I'm just more looking at hand placements along the different levels, like different parts of the rib cage, or things like that, and just trying to communicate to the families or caregivers to look at   smaller segments, and challenge them a little bit more. Or say, "Oh, look they're really falling over. You need to move your hands up a little bit higher." More in a treatment perspective I guess, than formal assessment. (P06)

Therapists utilized reflection during and following clinical practice experiences to process the results of trialing segmental concepts with infants and children on their caseload. At times, PTs were surprised to notice segmental principles of trunk control influencing their actions even when they were not yet fully convinced that the approach would work in their setting. They talked about finding themselves using segmental manual support during treatment or adjusting a child's adaptive equipment to provide support closer to the level of informally assessed trunk control.

I don't know why I didn't make this connection- I guess because it was before the [live] class where you guys really showed the positioning and stuff. Now that I think about it, this same kid, the last time I went in to see her, and they had her in the prone stander, and I actually – it's funny, I just realized this-- I actually did just that. I raised up the straps, and I raised up a couple of different things, and I changed some of the supports, and she looked better. (P03)

So, when I was working with the student, it was really interesting to me, because when I would give her, just say, axillary support, she had head control. But as soon as I moved down to upper thoracic, or mid-thoracic, or whatever it was, she lost it completely…And it was really interesting to assess control segmentally like that. And I thought, "Okay. There's something to this." (P05)

These experiences led to further experimentation and reflection in clinical practice which built their confidence with adapting information and willingness to use a segmental approach more consistently in practice. Some therapists integrated segmental language into caregiver education for children with moderate to severe trunk control impairments. Other PTs considered

ways to use existing positioning equipment to provide more segmental support in the classroom

or during standardized assessments.

> So, he [a toddler] is going down the chain, and I've had quite a bit of discussion   with his parents about where his control is at right now. And even though I haven't taken him through the test, we can kind of see where his level of control is. And his parents really started understanding. They were like, "Why isn't he doing this? Why isn't he doing that?" And when we break it down, and I showed them where along the chain he's starting to get control, that seemed to help them quite a bit in understanding what they had to do for him. (P02)

> I could immediately try some of the things, you know, try different segments. I was immediately telling parents or staff members, "Well, try moving your hands down a little bit. They seem pretty sturdy there. Let's see, their head—they're not only able to keep it in static for five seconds, they can also look around and reach—so let's challenge them a little bit more and move your hands down a little bit lower." (P06)

The iterative process of trialing new practices, observing the results, reflecting on these

observations, and adapting new information in clinical practice rekindled PTs desire for

additional problem-solving and practice with peers. They anticipated that peer practice would

further increase their confidence in manual skills as well as confirm that their individual results

were valid. Therapists in two of the three organizations worked with leaders to plan both formal

and informal collaborative learning activities with peers to further problem solve how to adapt

information and to spread the use of segmental concepts in their practice setting.

> If we worked in groups, or you know small groups, or things like that to be able to record some videos once we got parent permission, and then show them and talk about them—discuss them at one of our PT meetings about who would be performing the SATCo, to be able to review it and see how we felt, see how other people feel. Get a little bit more knowledge about it, and then try and have people be, you know, participating and using it a little bit more. (P05)

> I think we need to get together and maybe practice it on a mutual patient or on each other and just kind of review it. And then we'll probably have to talk about presenting it to our other co-workers once we feel confident, and then we'll just figure out how to order the equipment. (P14)

Participants who engaged in ongoing critical reflection, peer discussion, and experimentation within a supportive organizational context following the online course described increasing consistency of using segmental concepts in treatment and strong intentions to fully implement the SATCo over time. This decision represented an important change in therapists' conceptions of postural control development, assessment, and treatment for children with moderate to severe motor impairments. Changes in conceptions appeared to correlate with the individual therapist's creativity, depth of critical reflection, attitudes toward responsibility for overcoming barriers to change, and tolerance of uncertainty or failure when experimenting with the new approach in practice. Compared to the PTs who were waiting for solutions, therapists who were reducing dissonance through experimenting and adapting information also expressed greater self-efficacy and more interest in collaborating with peers to overcome barriers to implementation.

Each therapist's effort to use clinical reasoning and critical reflection to navigate the dissonance was interrelated with personal and organizational contextual factors. Few therapists utilized a single strategy to reduce the tension between prior and new conceptions of trunk control assessment and treatment. Moreover, strategy selection was mediated by the therapist's available social network, how they weighted their confidence in trialing new behaviors, and the presence or lack of peer support for practice change. For some participants, resolution of cognitive dissonance signified the end of attempts to integrate new information in practice. However, other therapists viewed the process of implementation as iterative and ongoing. The degree of responsibility that each therapist accepted for continuing the implementation process

varied, and this factor appeared to relate to their primary strategy for resolving the cognitive dissonance.

Discussion

Overall, the results of this study provide information to help bridge the gap in knowledge about the interaction between course design and the psychological processes therapists use to navigate the tension created by simultaneously holding prior and new conceptions when learning a new clinical skill online. This section will compare current literature about course design and clinician attitudes about learning clinical skills online, collaborative social learning, contextual factors influencing practice behavior following continuing education, and the role of reflective clinical practice in knowledge translation with the findings of this study. Therapists' conceptualization of the role of TrACE in online learning will be explored. Literature related to the theme of cognitive dissonance and other cognitive affective processes which emerged during the grounded theory analysis and therapists' intention to change or not change clinical practice will also be discussed. Finally, limitations of the study will be outlined, and directions for future research will be suggested.

Research Question 1: Attitudes toward online learning for clinical skills

Reported learner satisfaction with the pilot Introduction to SATCo course was consistent with findings of other studies where online courses were based on adult learning principles.[20,24,27,37,90] Even though many participants experienced significant usability challenges associated with the TrACE media player which increased the extraneous cognitive load[91] of the course, most PTs described an enriched learning experience and positive attitudes toward learning online. Elements of evidence-based course design[10,17,18,20,34,36,43,81] that were supportive of learning the SATCo online included scaffolding information through sequential unfolding of

course modules, opportunities for ongoing practice and self-assessment, and guided reflection activities. The course design was effective in generating both excitement and cognitive dissonance about the segmental approach to trunk control, and many therapists expressed interest in exploring how these concepts could be implemented in their practice setting.

Research Question 2: The role of TrACE in learning a clinical skill online.

Like other studies of online learning for clinical skills,[26,47,92,93] the requirement to respond to clinical questions about realistic video case examples and the multiple opportunities for simulated practice in TrACE contributed to increased confidence in specific skills following the online course. In particular, PTs were confident in their ability to identify compensatory posture control strategies or test administration errors after practicing these skills within the TrACE media player. However, administration of the SATCo was more complicated than the clinical skills taught in other studies, and confidence gained online was not adequate to overcome therapists' desire for additional in-person training prior to implementing the formal assessment in practice. PTs in the online only course did not receive any hands-on skills training, but clinicians in the hybrid course benefitted from hands-on practice and immediate feedback on performance from instructors during a one-day in-person workshop. All participants agreed that even though the online modules and practice provided a good understanding of how to perform the SATCo, hands-on training with feedback would be essential to master this assessment. This finding from our study brings into question the assertion by Butler et al[69] that the SATCo can be reliably administered and scored by diligently following the protocol without extensive training or practice.

Research Question 3: **The role of asynchronous interaction in TrACE**

The self-paced asynchronous design of the online course was appealing to PTs, but this element of the course design also limited collaborative learning and discussion. Although some therapists did read comments posted by peers during the TrACE activities, no meaningful discussion between participants occurred during the course. Social interaction is considered paramount for translating knowledge from continuing education into clinical practice,[13,94-96] however our findings agree with other authors who describe online discussion occurring primarily between learners and the instructors rather than among peers in asynchronous learning online.

The lack of common deadlines within the 12-week timeframe for completing the modules contributed to missed opportunities for discussion with other participants. It is also possible that usability challenges with TrACE discouraged participants from returning to prior modules once completed. Another factor which may have influenced online discussion was the ease of more immediate communication among participants within the same organization. The participants in these online continuing education courses differed from a more typical online cohort in which learners are distributed over a wide geographic area. Multiple clinicians from each organization completed the course within the same time period. This provided a unique opportunity for in-person collaborative learning within two of the three organizations that had an organizational evidence-based practice culture with supportive leadership. As a result, several therapists reported discussing course concepts or problem-solving technological challenges with peers during the online course, and some PTs were planning collaborative learning to improve confidence with hands-on skills in their practice setting following completion of the course.

Using the TrACE media player within this self-paced asynchronous course design effectively provided increased time for clinicians to process information and facilitated knowledge comprehension, critique, critical reflection, and synthesis through case-based reasoning and practice. The cognitive dissonance provoked by these activities encouraged PTs to consider practice change. However, the self-paced course design did not allow collaborative knowledge creation or problem-solving online during the course. In a mixed methods study of learner preferences for interaction in self-paced online courses, Rhode[97] also reported challenges for learner to learner interactions with self-paced design. However, these learners valued interactions with instructors and course content more than interactions with other learners in self-paced courses whereas participants in this study highly valued collaborative learning with colleagues during the course. More research is needed to explore pediatric PTs preferences for various learning interactions in online continuing education and the role of collaborative social learning and personal learning styles in online course design.

Research Question4: Intention to implement SATCo

One interesting finding regarding collaborative social learning was that several participants reported planning or completing collaborative learning experiences with peers in their organization and the development of a formal implementation process for SATCo following completion of the online course. Opportunities to problem-solve complex cases with peers have been associated with improved confidence to initiate practice change,[47,93] and discussing information with colleagues is one process for resolving cognitive dissonance.[45,89] Informal peer-to-peer learning following the online course was reported by therapists in the two organizations with formal processes and leadership support for spreading the use of SATCo within their workplace. For these therapists, the supportive organizational culture facilitated ongoing social

learning in-person rather than online, and this unique support appears to have improved therapist's confidence in their ability to implement SATCo in their practice over time.

The contextual lens and practice change

The impact of organizational culture on the ability of health professionals to access supports and navigate barriers when implementing new clinical practices is well-established.[2,13,96,98-102] In addition, the fact that nearly all early intervention and school based PTs attended the hybrid Introduction to SATCo course in their organization may have provided a "critical mass"[103] and momentum that augmented some therapists' sense of self-efficacy to initiate practice change. These therapists became internal facilitators of ongoing social learning[95,98,103] to implement the SATCo more widely in their organization. Furthermore, therapists from the hospital which had a formal process for spreading new clinical practices had been selected strategically for the online course so that they would be able to develop other staff and facilitate the spread of the segmental approach. In contrast, the organizational culture of the third organization contributed to limited practice change for individual therapists. These findings are consistent with prior research on the impact of organizational context on adoption of new clinical practices.[104-107]

Even though factors at the systems level influenced how PTs viewed their ability to implement SATCo in their practice setting, organizational context alone did not explain the variation in the dissonance resolution process and intention to change or not to change clinical practice. A supportive organizational culture is helpful in facilitating practice change, but several authors propose that implementation of new practices also depends on cognitive and psychological processes for each clinician.[45,103,108,109] Personal factors including prior experiences, readiness, and tolerance of change,[98] confidence,[3,102,103] attitudes about

responsibility for overcoming challenges,[96,103,110] cognitive dissonance[45,103] and self-efficacy[81,103] also colored the contextual lens.

Prior research on organizational culture has focused predominantly on identifying systemic factors in the local context that function as facilitators or barriers to practice change.[102,107] In addition, knowledge translation has historically been viewed as a linear process in which evidence is moved in a rational and systematic way from researcher to clinicians and other users.[98,100,111] Recently, several authors[95,103,112,113] have proposed that translation of new knowledge to practice is a messy and complex process in which the nature of the evidence is negotiated, adapted, and contested in healthcare decision making. Decisions made in clinical practice are based on information from a variety of sources beyond research evidence including clinical expertise, contextual and cultural knowledge, personal knowledge, patient characteristics, and practical or ethical knowledge.[55] Our results support the idea that both personal and organizational context are important in the complex process through which new knowledge and behaviors are debated, trialed, and adapted within clinical practice. Due to the supportive organizational context within which most participants in this study worked, personal factors had a stronger influence than organizational culture on the way individual clinicians chose to reduce or resolve the cognitive dissonance that was provoked by learning about the SATCO and related segmental concepts online.

Cognitive-affective processes in knowledge translation.

A foundational strategy when designing educational or other interventions to promote translation of new knowledge to practice is to help practitioners identify the gap between current and recommended practice.[34,72,81,100] However, awareness of the knowledge to practice gap is not enough to change practice.[114] In addition to experiencing adequate tension for change,

clinician's must be motivated to change within a supportive context.[98,107,112] Brehaut et al[45] suggest that using constructs from cognitive and educational psychology to tailor knowledge translation interventions may better explain the impact of these knowledge translation interventions on behavior change than adhering solely to theories focused on macro level factors such as contextual barriers and facilitators. Our results provide initial support for the role of cognitive-affective processes such as cognitive dissonance, desirable difficulties, self-efficacy, and critical reflection in augmenting sustained motivation for physical therapists to experiment with implementing a challenging new practice like the SATCo once they have identified a gap in practice.[103] To our knowledge, this is the first study to utilize innovative technology such as TrACE to facilitate these processes as part of the online course design.

According to cognitive dissonance theory, individuals can reduce dissonance in several different ways. These strategies include making the inconsistent behavior less relevant by altering their commitment to changing, discounting the information, attributing their failure to change behavior to external factors, or changing their practice. [89,115] These methods of reducing dissonance can occur subconsciously even when clinicians state their overall support for practice change. Therapists in our study who accommodated new concepts without changing their current practice appear to have subconsciously made changing their behavior less relevant to their self-concept as evidence-based practitioners. In effect, they altered their commitment to the goal of implementing the SATCo in their practice setting. Alternatively, PTs who were waiting for others to offer solutions to implementation challenges attributed their inability to change practice to external factors including multiple contextual barriers.

Dissonance resolution and intention to change practice

On the continuum of innovation adoption described in the Diffusion of Innovations Theory,[76] therapists who were accommodating information or waiting for solutions were aware of the segmental approach, and some of them were persuaded that it should be implemented in pediatric practice. Some of these PTs described a change in clinical reasoning or in the language used to describe what they were already doing in practice. However, if these therapists did not also engage in experimenting with segmental concepts routinely in reflective clinical practice they did not change their approach to trunk control assessment and treatment.

In order to change clinical practice, clinicians must believe that the current approach is not adequate and that implementing the new evidence based practice will improve the effectiveness of care.[115] They must also be motivated and committed to the goal of implementing the new practice and believe in their ability to achieve this goal.[98,103] Therapists who experimented with segmental assessment and treatment activities or trialed administering the SATCo on a small number of children in their practice were initially drawn to this approach by their strong belief that outcomes for children on their caseload would improve. They persisted in working to overcome challenges to using segmental concepts in practice by continually reflecting on the outcomes of their experimentation, adapting and trialing different ways of using concepts in practice, and sharing information with colleagues. This iterative decision process is similar to the clinical reasoning process therapists utilize when developing expertise through clinical practice experiences.[116]

Overall, therapists who were experimenting and adapting information described greater self-efficacy, critical reflection, and focus on social learning within their organizations than therapists who did not experiment or adapt information for their practice setting. In particular,

reflective clinical practice helped therapists critically appraise their skills, attitudes, and concept of posture control. This process facilitated critical review, evaluation, and revision of their clinical reasoning over time. Because therapists were interviewed soon after completing the online course, no PTs had progressed to sustained use of the SATCo or segmental concepts in their routine practice. However, several therapists in two of the three organizations had developed formal plans to spread the innovation across multiple sites suggesting a commitment to sustained use at the time of their interviews.

One important difference between Rogers stages of innovation-decision[76] and our findings is that the process of reducing cognitive dissonance and moving along the continuum of practice change was not linear. Rogers describes a step-wise movement in which the tasks of one stage must be completed before moving on to the next stage. Our findings suggest that both cognitive-affective processes like cognitive dissonance and the larger process of clinical practice change are non-linear and complex. (See Figure 3.) Few PTs utilized a single strategy to reduce cognitive dissonance, and therapists frequently described attitudes, cognitions, and behavior characteristic of multiple strategies and stages simultaneously when asked to reflect on their clinical practice. These findings are consistent with other research suggesting that translation of evidence to practice is a complex, emergent, social process dependent on organizational context in which knowledge and practice cannot be separated.[103,107]

In conclusion, it is important to consider micro-level processes such as cognitive dissonance, desirable difficulties, self-efficacy, and critical reflection when designing online learning to promote clinician behavior change because PTs consider multiple forms of evidence at the point of care delivery.[103,117] For the PTs in this study, the process of considering adoption of a segmental approach to trunk control assessment and treatment involved ongoing iterative

cycles of learning in the context of reflective clinical practice. This learning in practice included weighting and negotiating tacit knowledge grounded in their clinical experience against research based evidence and their confidence with skills learned online. Furthermore, the process of implementing new information in clinical practice is as iterative and complex at the individual level. To our knowledge, this is the first study to describe a non-linear process of innovation-decision utilized by physical therapists in the context of reflective clinical practice when considering whether or not to implement practice change following online continuing education.

Implications for future research. Social learning with colleagues was an important component of practice change for therapists in our study. This kind of collaborative learning does not appear to be feasible in a course that is entirely self-paced. Research to address the usability challenges identified for TrACE in this study will be reported in a separate manuscript. Future research on how collaborative technology such as TrACE could contribute to asynchronous collaborative learning of clinical skills when integrated with strategies such as intermediate deadlines, opportunities for limited synchronous interaction with other learners, or a post-course community of practice[81] would inform course design for knowledge translation in online continuing education. Exploration of the influence of learning styles on therapist's preferred interaction and instructional strategies in online continuing education is also warranted.

In addition, it will be important to determine which characteristics make clinical skills conducive to online or hybrid course designs in order to maximize the efficiency and effectiveness of continuing professional development activities for physical therapists. It would also be interesting to explore how cognitive-affective and contextual factors interact over time for therapists in the two organizations that were working on spreading implementation of SATCo at the time of this study. Finally, the role of cognitive dissonance and other cognitive-affective

processes related to knowledge translation strategies such as audit and feedback, knowledge brokering, and peer review should be explored.

Limitations

The inclusion of physical therapists with varying levels of clinical experience who were working in a wide variety of pediatric practice settings in the theoretical sampling process promotes transferability of our findings. However, the strong influence of a supportive organizational culture and leadership in two of the three organizations is atypical, and the impact of personal context and cognitive affective processes on clinicians' efforts to use the SATCo in practice may be greater in our study than in other organizational contexts.

Conclusion

Based on our findings, designing learning experiences which provoke cognitive dissonance may be effective in enhancing clinicians' awareness of gaps in knowledge and practice, confidence in trialing new practice behavior, and motivation to engage in the sustained effort necessary for translating evidence to real-world clinical settings. In conjunction with other best practices in online education, innovative technology such as TrACE may be utilized to provoke cognitive dissonance through a combination of desirable difficulties, simulated skills practice, and critical reflection that stimulates intuitive and analytic reasoning in realistic clinical cases. Translation of innovative instructional technology to online continuing education in healthcare may pose implementation challenges unrelated to the educational content. Even with emerging evidence demonstrating the value of such innovations, research to identify and address contextual barriers such as perceived increase in design, instructor, or technological support may be required before these innovations are adopted more widely.   Instructional designers must also recognize the personal and organizational factors that color the contextual lens through which

healthcare professionals consider how and when to use information learned online in practice. Even in the most supportive organizational culture, both personal and organizational factors influenced the strategies clinicians used to navigate cognitive dissonance in this study. Finally, professional development occurred as an iterative, non-linear cycle through which dissonance was provoked and resolved within reflective clinical practice. Pediatric physical therapists who are wish to promote knowledge translation through continuing education may benefit from designing activities that recognize the apparent inseparable nature of knowledge gained from clinical practice and research.

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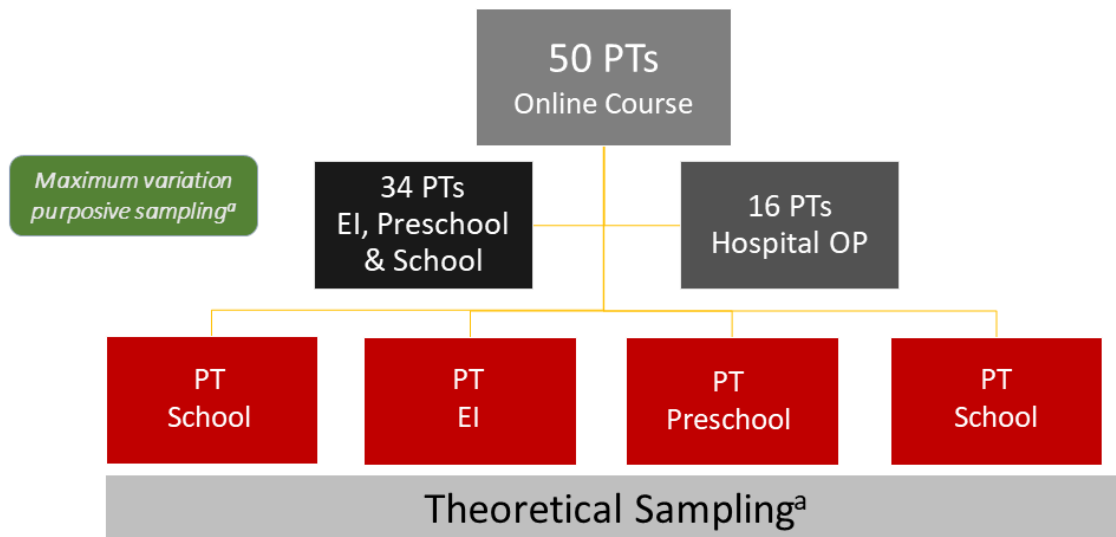
Table 1. End of Module Reflection Prompts

Module Topic	Question
Module 4: Open and Closed Chains	Reflect on your own pediatric therapy practice and describe how you would apply the concept of open and closed kinetic chains to one assessment or treatment activity. For example, you could reflect on how having the child hold the tape measure in the Pediatric Functional Reach Test may or may not affect your assessment based on the concepts of open and closed kinetic chains. Please provide a specific example from your own current or anticipated clinical practice.
Module 6: SATCo Administration	Reflect on your own pediatric therapy practice and what you would need to do to try a SATCo assessment. What barriers or supports are present for you in your setting? Provide a specific example of the setting, how you would need to secure the equipment, who could assist you, and any other factors you would need to consider.
Module 7: Common Tester Errors	Reflect on your own pediatric therapy practice. How will you approach identifying and correcting tester errors when administering the SATCo in your setting?
Module 8: Compensatory Strategies	Reflect on your current approach to your work with infants and children. After completing this learning module about compensatory strategies that children use when postural control is inadequate: What (if anything) will you STOP doing in your clinical practice? What (if anything) will you START doing? What (if anything) will you CONTINUE doing?
Module 9: SATCo Scoring	How do you anticipate balancing rigorous administration and scoring of the SATCo with the demands of a real-world clinical setting and the need for clinically relevant scoring?

Table 2. Participant Characteristics

	Online Course (n=50)	Interview Participants (n=19)
Hybrid online course	34	13
Online only course	16	6
Professional degree		
Bachelors	20	9
Masters	11	6
DPT	19	5
Additional Degrees		
Advanced Masters	3	0
tDPT	14	9
PhD or equivalent	1	0
Years of Pediatric Experience (Mean, SD, Range)	16.8, 12.3, 1-42	20.5, 13.5,1-42
Primary Pediatric Practice Setting		
Hospital outpatient	16	6
School (age 3-21 years)	14	6
Early Intervention	18	6
Administration	2	1
Online learning confidence (Mean, SD, Range)	8.33, 1.56, 5-10	8.05, 1.5, 5-10
Prior online learning		
Yes	37	14
No	13	5

Figure 1. Recruitment and Sampling Flow

a Breckenridge J, Jones D. Demystifying theoretical sampling in grounded theory research. *Grounded theory review: an international journal* 2009;8(2).

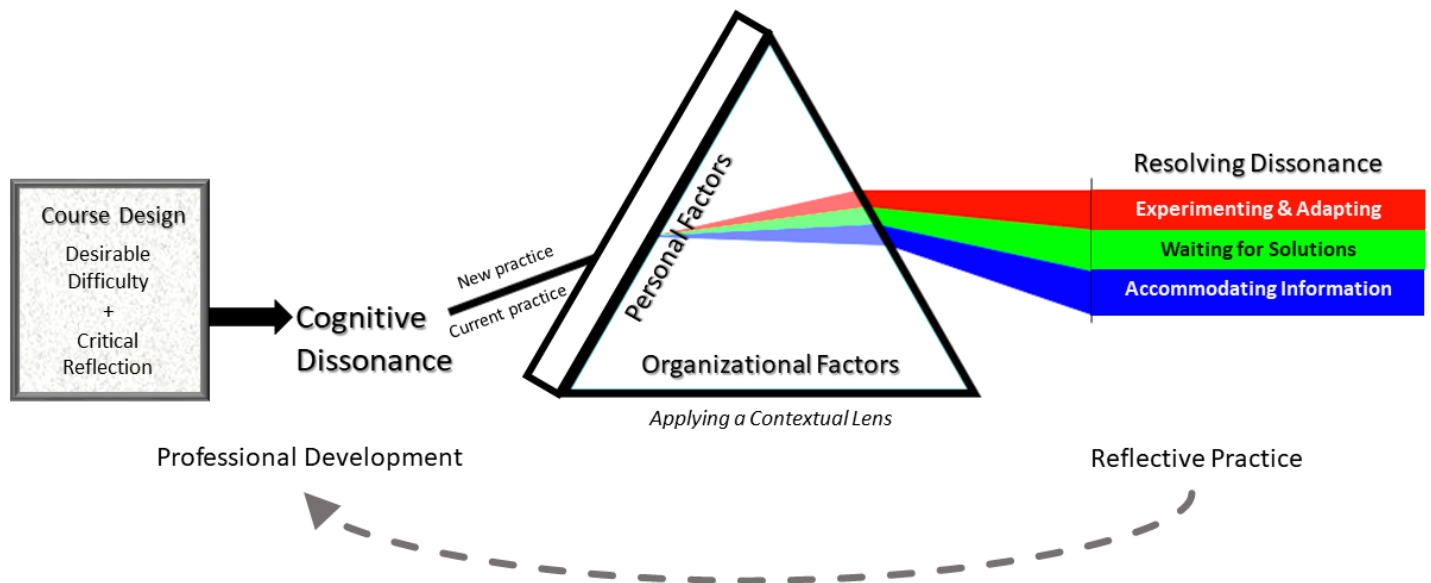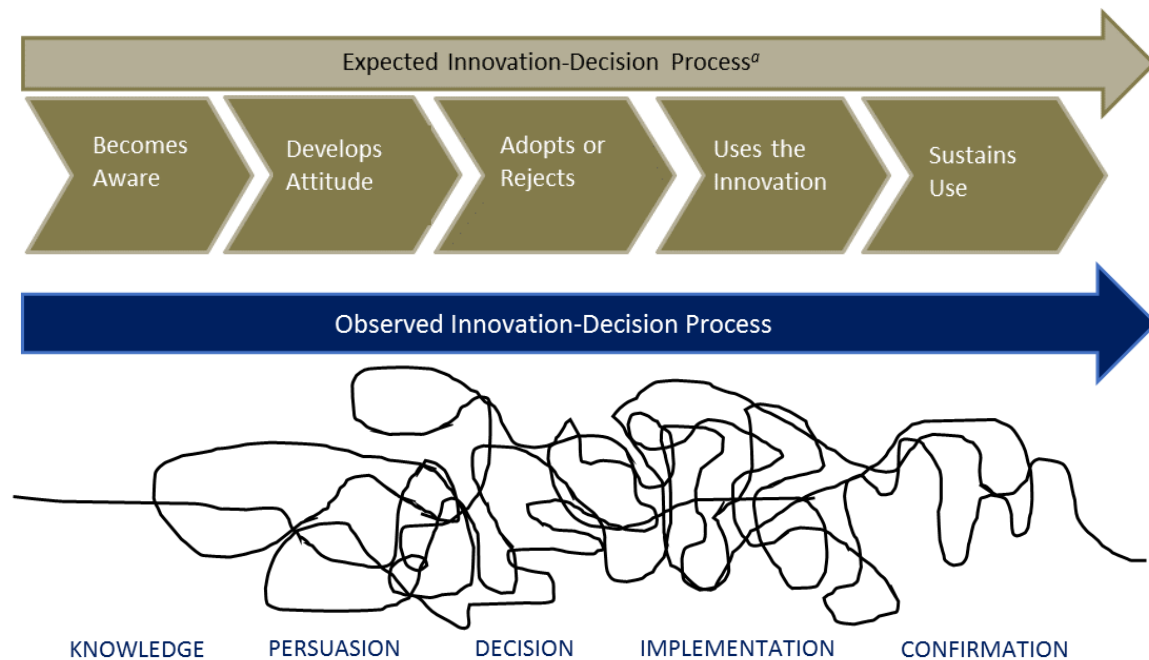Figure 2. **Navigating Cognitive Dissonance for Practice Change**

Figure 3. **The non-linear process of clinical practice change**

a Rogers EM. *Diffusion of Innovations.* 5th Edition ed. New York, New York: Simon and Schuster; 2003.

Appendix A

Description of the Study: I am in learning how physical therapists learn clinical skills in online courses. Since you participated in the pilot online training for the Segmental Assessment of Trunk Control (SATCo), I would like to ask you some qualitative questions about your experience with the online course and with the TrACE media player system. Would that be ok?

*Semi-Structured Interview Guide***:**

1.   Please tell me about your work as a physical therapist

      a.   Where/How long have you worked there? How many hours a week do you work?

      b.   How long have you been a physical therapist? How long a pediatric PT?

      c.   What is your typical caseload like? Ages? Diagnoses? Level of severity of motor impairments?

      d.   When is the last time you attended a formal continuing education course in any format prior to this course? (live workshop, online course, lecture, etc.)

      e.   What experiences have you had with online learning prior to this course?

2.   Reflect for a moment on your experiences with learning the SATCo in the online course. Tell me about what it is like to learn a clinical skill online.

      a.   Could you share a specific example?

      b.   How does your experience in learning SATCo online compare to other ways you have learned about and tried to implement clinical assessment measures?

      c.   Probe for attitudes toward online learning for clinical skills

      d.   Probe for role of asynchronous discussion and/or TrACE in learning online

3.   Tell me about your experience using the TrACE media player in the online course.

      a.   What was helpful or not helpful about TrACE?

b.   Probe for role of asynchronous discussion in TrACE

c.   Probe for confidence in identifying tester errors and/or patient postural control

compensations

d.   Probe for intention to use the SATCo in school-based practice following online

training.

Thank you for taking the time to talk with me about your experiences. Your responses will be

kept confidential and you will receive a summary of the findings once our study is completed.