A model for teaching and learning spinal thrust manipulation and its effect on participant confidence in technique performance

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Background: Despite emerging evidence to support the use of high velocity thrust manipulation in the management of lumbar spinal conditions, utilization of thrust manipulation among clinicians remains relatively low. One reason for the underutilization of these procedures may be related to disparity in training in the performance of these techniques at the professional and post professional levels.

Purpose: To assess the effect of using a new model of active learning on participant confidence in the performance of spinal thrust manipulation and the implications for its use in the professional and post-professional training of physical therapists.

Methods: A cohort of 15 DPT students in their final semester of entry-level professional training participated in an active training session emphasizing a sequential partial task practice (SPTP) strategy in which participants engaged in partial task practice over several repetitions with different partners. Participants' level of confidence in the performance of these techniques was determined through comparison of pre- and post-training session surveys and a post-session open-ended interview.

Results: The increase in scores across all items of the individual pre- and post-session surveys suggests that this model was effective in changing overall participant perception regarding the effectiveness and safety of these techniques and in increasing student confidence in their performance. Interviews revealed that participants greatly preferred the SPTP strategy, which enhanced their confidence in technique performance.

Conclusion: Results indicate that this new model of psychomotor training may be effective at improving confidence in the performance of spinal thrust manipulation and, subsequently, may be useful for encouraging the future use of these techniques in the care of individuals with impairments of the spine. Inasmuch, this method of instruction may be useful for training of physical therapists at both the professional and post-professional levels.

Keywords: Thrust manipulation, Active learning, Psychomotor training

Introduction

Approximately 50–80% of the population will experience low back pain (LBP) at some point in their lives.¹ Although most cases of LBP resolve without intervention, 90% of cases recur over time.^{2,3} Common interventions utilized for patients with LBP have had mixed results.^{4,5} The evidence supporting the use of thrust manipulation in the management of persons with acute non-specific LBP has increased in recent years and has led to a paradigm shift in what is now considered the best practice for this population.⁶

The Guide to Physical Therapist Practice⁷ defines mobilization and manipulation as, 'a manual therapy technique comprised of a continuum of skilled passive movements to joints and/or related soft tissues that are applied at varying speeds and amplitudes, including a small amplitude/high velocity therapeutic movement'. According to Maitland *et al.*,⁸ non-thrust manipulation involves passive movement to a joint that occurs within Grades I–IV and can be prohibited by the patient if desired. Grieve distinguishes the term, manipulation, from mobilization by defining manipulation as, 'an accurately localized, single, quick, and decisive movement of small amplitude following careful positioning of the patient'.⁹ For the purposes of this manuscript, the

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term, thrust joint manipulation (TJM), will be used to refer to Grade V techniques that are performed with high velocity and low amplitude at or near the end range of available joint motion.

The Normative Model for Physical Therapist Education¹⁰ and the Commission on Accreditation in Physical Therapy Education Evaluative Criteria¹¹ mandate instruction in TJM at the first professional level; however, it does not prescribe the manner and extent to which these techniques are to be taught. Boissonnault *et al.*¹² surveyed 116 physical therapy programs in the United States and found that 75% of programs currently include, or plan to include, spinal TJM in their curriculum. A survey of 329 clinical instructors (CIs) and 21 academic coordinators of clinical education revealed that, for those who did not teach thrust, 53% attributed this to the fact that no one was qualified to teach the techniques.¹³ Sharma and Sabus¹⁴ found that physical therapist students on clinical internships performed spinal TJM minimally and did not perform peripheral TJM at all. Barriers to performance of these techniques included CI comfort level with the techniques and concern regarding whether the techniques were patient-appropriate.

When studying clinical decision-making and intervention application in Australia and the United Kingdom, Turner and Whitfield¹⁵ found that training in both the core curriculum of a program, as well as practice in the clinical environment, influenced clinical decisions. Despite an increase in student exposure to TJM during first professional physical therapist education, instruction in the use of these techniques during clinical internships has not increased proportionately. It has been suggested that additional CI training in the use of TJM may increase the likelihood of students practicing these techniques in the clinic.¹⁶

The absence of effective teaching strategies during the professional training of physical therapist students in the performance of TJM may inhibit confidence development and the future use of these procedures during clinical practice. The purpose of this manuscript is to describe a new model of active learning and investigate the effects of using this new teaching strategy in the development of participant confidence in the performance of spinal TJM. More specifically, the impact of an innovative new teaching strategy that may be used to enhance student confidence in the performance of TJM of the spine will be described. This model is designed to increase skill and confidence in the performance of these procedures for participants at the first professional, post-professional residency and fellowship, or continuing education levels. This teaching strategy, called 'Sequential Partial Task Practice (SPTP)',

was designed to improve upon current methods used to teach TJM by facilitating task variability and random practice.

Teaching and Learning Psychomotor Skills

Orthopaedic manual physical therapy (OMPT) practice requires assessment and feedback on motor performance. The obvious goal when teaching manipulative procedures is for the learner to develop the capability to perform these techniques at a later point in time, with variable populations, in variable settings, and with the ability to modify the technique in order to meet the unique demands of each patient. Principles of motor learning may help to inform best practices in teaching psychomotor skills, such as spinal TJM, for acquisition and retention.

The typical process for most OMPT lab experiences involves some form of instructor demonstration in technique performance. Recent literature questions whether the demonstration should be done by an expert clinician or a student who is learning.¹⁷ While the expert clinician provides the most accurate depiction of the skill, research is showing that students gain knowledge by watching a novice attempt the technique and learn from the feedback they receive.¹⁷ In 115 primary school children who were tested in his/her ability to learn 15 new verbs using object manipulation, de Nooijer *et al.*¹⁸ found that the imitation that took place during retrieval of the verb was more effective than observation only in the process of learning. These results reinforce the importance of repetition and tactile manipulation to the process of learning a new skill and challenge typical methods of TJM instruction.

Feedback

Aside from the quantity of practice time, feedback is considered to be the most important variable influencing skill acquisition.¹⁹ Teaching methods for instruction in manual interventions typically involve classroom or video demonstration followed by student practice with either concurrent or delayed qualitative instructor feedback. Quantitative feedback of performance is often delayed.²⁰ In this context, qualitative feedback refers to less-structured, subjective comments from the instructor as opposed to quantitative, in which more definitive, specific feedback is used. Evidence supports the concept that performance of a motor task degrades if the knowledge of results is not precise. Some have identified that delayed feedback is preferable to immediate concurrent feedback in facilitating retention of motor tasks. Continuous visual feedback that is provided concurrent with task performance may actually interfere with retention of a discrete motor skill.²⁰ Watson and Radwan²¹ attempted to determine the difference in the acquisition and retention of a spinal

manipulation skill in 23 physical therapy students given three different types of feedback including delayed verbal feedback at the conclusion of the task, immediate concurrent feedback during performance, and absence of feedback. Although there was no difference in the students' ability to acquire the skill initially, the group that received concurrent feedback appeared to have greater retention of the motor task. These findings have implications for faculty to student ratios, however, the results do not support the requirement for instructor feedback only.

Ammons²² found that long delays between the task and feedback could negatively impact learning. However, reduced and less precise feedback may require the student to attend to their own internal cues regarding performance and may lead to better performance during skill acquisition but, perhaps, less skill during retention. Intrinsic feedback is provided by sensory systems during performance of a task while extrinsic feedback is provided by the instructor and is supplementary, not inherent, to the task. Extrinsic feedback is most effective when the instructor withholds the feedback intermittently. Frequent, immediate extrinsic feedback may actually discourage participants from attending to their own sensory cues and limit the process of independent solution retrieval which leads to learning.²³ When extrinsic feedback is faded, the instructor provides less and less guidance and direction as the student acquires the skill.²³

Quantity of practice

The literature consistently reflects that the quantity of practice time is a necessary component in the development of a new task.²³ Oermann et al.²⁴ identified the effects of deliberate practice, defined as a brief episode one time per month for 12 months, on the retention of cardiopulmonary resuscitation among nursing students compared to a control group who received initial training only. The group who engaged in routine practice, albeit brief, performed better over time.²⁴ Extending the amount of supervised practice, as well as providing teaching aids, such as videos or printed resources, for unsupervised practice is critical for instructors of OMPT. The creation of learning experiences where there are fewer techniques to learn may allow more time for students to practice sufficiently and improve task performance.

Ericsson et al.²⁵ demonstrated that deliberate practice that includes motivation, effort, and preexisting knowledge and experience is necessary to improve the performance of professional musicians. Adams and Wood²⁶ compared final year chiropractic students with practicing clinicians and noted that those with more experience performed the techniques with greater skill. The degree of student exposure that can

be enhanced through deliberate practice may be helpful for improving technique performance.

Blocked vs random practice

Providing adequate practice time is critical to the development of a motor task, however, the question of how to structure the practice schedule to achieve optimal results depends upon whether skill acquisition or skill retention is the primary objective. The motor learning literature provides some guidance in this area. Schmidt et al.²⁷ suggested an advantage to the use of variable practice, where different variations of a task are practiced, as opposed to constant practice, where the task is practiced without variation. Zipp and Gentile²⁸ found that blocked practice was more effective than random practice for retention and transfer tests. Blocked practice describes a sequence of instruction that allows for repetitive practice of a particular skill or component of the skill until the student achieves mastery.²³ Random practice involves practice of different tasks on consecutive trials.²³ Blocked variable practice, where one motor task is practiced several times in the same fashion before moving on to the next task, with concurrent feedback, has been found to be effective in producing lower error scores in the acquisition of a motor task. However, random variable practice, where specific tasks are randomly varied, was found to be more effective at facilitating retention of the motor task. The concept of contextual interference, in which a task is practiced in combination with others, may increase the time required to acquire the skill, but improve skill retention. Random variable practice increases contextual interference, which requires greater cognitive demand, as compared to blocked practice, which occurs more habitually at subcortical levels. Therefore, random practice facilitates skill retention more effectively while blocked practice enhances skill acquisition through repeated and deliberate practice that diminishes the interference brought on by cognitive thought. Enebo and Sherwood²⁹ attempted to evaluate the effects of various parameters, including practice schedule and type of feedback, on the acquisition and retention of a thoracic TJM in 33 chiropractic students. They determined accuracy using a force simulator apparatus to measure force production. They concluded that use of a blocked variable practice schedule resulted in greater accuracy; however, retention of the skill was enhanced through random variable practice.²⁹

Most learned motor tasks are developed through a process of cognitive engagement and habitual subcortical performance. A teenager learning to parallel park a vehicle, for example, may acquire the skill through blocked practice, however, to ensure retention of this task for passage of the driver's test,

cognitive processing of the critical aspects of the task must be attended to. Blocked practice may be best for acquisition of a new task, such as learning the intricacies of spinal TJM, whereas random practice has traditionally been considered better for retention and transfer of task performance. Task variability in the parameters of the technique such as speed, amplitude, grade, and partner, will enhance learning and allow the new skill to be more easily generalized to other situations. Increasing the speed of performance may result in a reduction in accuracy. Since the speed of application is a critical component in the proper performance of manipulation, the instructor should emphasize both accuracy and speed of performance early in the learning process.²³ Some authors suggest that novice learners require blocked practice to develop a ‘movement topology’ for complicated tasks and that random practice may complicate mastery of the skill.²³

Partial task vs complete task practice

Partial task practice, versus complete task practice, must also be considered when planning a learning experience.²³ For tasks that require coordination and timing of events within the task, practicing the task in its entirety is recommended. However, if information processing is required within the task, then each portion of the task may be practiced individually and brought together as a whole later in the process.²³ The impact on student confidence of a teaching approach that combines blocked and random practice strategies, with concurrent verbal feedback, that is organized in a sequential fashion, where each partial task is added to the previous task, has not been reported in the literature.

Confidence development

The probability of a student performing a particular manipulative task in future clinical practice may be related to his or her level of confidence in the performance of these skills during his or her professional training. Some authors have explored the application of instrumental learning, sometimes referred to as operant conditioning, on teaching strategies. Adopted from the work of B. F. Skinner, reinforcement of a particular behavior may influence the likelihood of an individual repeating the behavior. Ideomotor learning theory suggests that individuals may engage in psychomotor activities that are consistent with their expectations and influenced by subtle cues provided either before or during a task.³⁰ Ruge and Wolfensteller³¹ studied how the brain translates symbolic instruction into behavior. Using fMRI's, they concluded that coupling between the left prefrontal cortex and anterior striatum occurs to promote the transition from symbols to pragmatic action and the anterior caudate is impacted by the

expected outcome of a behavior. Behaviors appear to, therefore, be the result of both instrumental and ideomotor learning mechanisms while other areas of the brain display more habitual behaviors. This suggests that individuals learn through a process of linking behavior with the expected outcome of that behavior and that such behaviors may be influenced through subtle cues while other aspects of behavior are based upon habitual patterns.³¹ This evidence suggests that confidence in the performance of a motor task, such as TJM, may be facilitated through the use of teaching strategies that include subtle cueing before, during, and after the task, that provide the learner with clear expectations regarding the outcome of the task. Methods that create habitual patterns of activity through repetition and allow the learner to experience successful task performance may also assist with confidence development.

A Model for Teaching and Learning Spinal Manipulation

This newly proposed model for teaching and learning spinal manipulation (Fig. 1) is designed to maximize performance and enhance student confidence in the performance of these procedures. Within this model, there are three distinct phases of learning: (1) the ‘preparation for learning phase’, which is designed to optimize in-class lab instruction by preparing students for the active learning experience; (2) the ‘active learning phase’, which features a novel method for developing student confidence in motor skill performance; and (3) the ‘evaluation of learning phase’, which ensures that psychomotor learning has occurred. Each phase targets a variety of learning domains and phases of the learning cycle.^{32,33} Table 1 identifies the dominant learning domain and phase of the learning cycle represented by each phase of the model. The objective of the Active Learning Phase is to maximize the amount of time spent in the psychomotor domain of learning with the aim of developing student confidence in performance of a psychomotor task. The key teaching strategy within this phase and the strategy evaluated within this study is called the ‘Sequential Partial Task Practice (SPTP) strategy’. Within this teaching strategy, both task variability and random practice are achieved by repeatedly and consecutively practicing steps as the participant moves from partner to partner. The tasks may be performed slowly or in real time. During SPTP, a lab assistant and partner provide intermittent feedback during the initial phase and gradually withdraw feedback to encourage reliance on intrinsic feedback as repeated tasks occur. The last phase of the SPTP requires the participant to engage in blocked practice of the entire technique which is recorded on video for later peer- and self-reflection.

Figure 1 Phases and instructional techniques of model used to teach spinal thrust manipulation.

The SPTP is designed to improve upon common methods of instruction where participants observe performance of the entire technique and then practice each technique in its entirety on the same partner. The SPTP method allows students to maximize the benefits of partial task and repetitive practice as previously described.

Methods

Prior to implementation, this study was deemed by the university Internal Review Board of the primary

investigator to be exempt from review by virtue of the fact that this study did not represent a unique condition that differed from the typical teaching and learning experiences that were planned for this class. A cohort of 15 Doctor of Physical Therapy students in their final semester of entry-level professional education participated in this study. The 15 students consisted of six females and nine males who had voluntarily enrolled in an elective course in OMPT. All of the students had been exposed to these

techniques in their prior semester and some had also utilized these techniques in a previous clinical affiliation. After a presentation on safety and efficacy and a brief review of the current literature, the instructor implemented SPTP for instruction in six specific thoraco-lumbo-pelvic thrust manipulation techniques that are commonly used during a single 3-hour lab session. These techniques, which are described elsewhere, included: (1) Upper- and Mid-Thoracic Traction, (2) Thoracic Postero-Anterior with Rotation (Screw), (3) Thoracic Segmental Rotation (Pistol), (4) Upper Thoracic Facet-Opposition Lock, (5) Lumbo-Sacral Regional, and (6) Lumbar Ligamentous Tension Locking Neutral Gapping.³⁴ Figure 2 provides a sample of the lumbar neutral gapping technique used during this instructional session. The principal investigator, who provided the instruction, has more than 20 years of experience and is a fellow of the American Academy of Orthopaedic Manual Physical Therapy. A lab assistant, who is also an experienced Fellow, was used during the instructional session in accordance with the Manipulation Educational Manual,⁶ which recommends a student/faculty ratio of 10:1 for the teaching of psychomotor skills. The lab assistant provided students with concurrent feedback throughout the session.

Upon entering the classroom, students were paired and randomly assigned to either the 'patient' group or the 'therapist' group. The SPTP strategy consisted of the instructor demonstrating each spinal TJM technique as a complete task in real-time using a student volunteer. The instructor then divided the complete task into three individual partial tasks consisting of the: (1) patient set-up SPTP, consisting of moving the patient into the position to be

manipulated, (2) hand placement SPTP, consisting of the therapist placing his or her hands in the position to provide the manipulative force, and (3) force application SPTP, consisting of delivery of the manipulative force through the hand contacts. The instructor performed each partial task as each student simultaneously performed the same task on his or her partner. The student then moved immediately to the next adjacent partner who was in position on the plinth and performed the same partial task again. This process was repeated until 3–5 repetitions of the same task were consecutively performed on 3–5 different partners. After each student completed the patient set-up, hand placement, and force application partial-tasks, the instructor and students simultaneously performed the complete technique in real-time. The student then moved to the next partner and so on until 3–5 repetitions of the complete technique were consecutively performed on 3–5 different partners. Partners then switched roles and the process was repeated. For the lumbar neutral gapping technique shown in Fig. 2, the SPTP process proceeded as follows: (1) patient set-up SPTP: Patient assumes position of right side-lying facing therapist who is standing as left hip is flexed and fixed by placing the foot behind the right knee as the therapist palpates interspinous space. The therapist grasps the right arm and pulls upward creating left rotation, (2) hand placement SPTP: The cephalad hand contacts the upper side of superior vertebra as the caudal hand contacts the underside of the inferior vertebra while creating a skin lock, (3) force application SPTP: slack is taken up through both hand contacts until end range is achieved. During slow exhalation, a high velocity thrust is delivered through all hand contacts.

Table 1 Matching spinal thrust manipulation instructional phases of learning and learning experiences with Bloom's³² learning domains and Kolb's³³ phases of learning

Model phase of learning	Learning experiences	Dominant learning domain ³²	Dominant phases of learning cycle ³³
Preparation for learning phase	Reading assignment Preparatory questions Literature review Clinician interview Practice act project Video demonstration	Cognitive, Affective	Abstract conceptualization
Active learning phase	Instructor demonstration Set-up SPTP Hand-placement SPTP Force-application SPTP Whole-technique SPTP Peer, self-assessment Clinical application cases Video self-reflection	Cognitive, Psychomotor	Active experimentation Concrete experience Reflective observation
Evaluation of learning phase	Written examination Oral examination Practical examination Follow-up examination	Cognitive, Affective, Psychomotor	Abstract conceptualization Active experimentation

Figure 2 Lumbar ligamentous tension locking neutral gapping/closing technique (From: [Wise CH, Gulick DT: *Mobilization Notes: A Rehabilitation Specialist's Pocket Guide*. Philadelphia, PA: F.A. Davis Company, 2009], with permission).

Measures were taken to assess student opinion regarding the implementation of this specific teaching method and the impact of this teaching method on student confidence in his or her ability to perform spinal TJM. Immediately prior to commencing the SPTP session, each student completed a pre-session survey (Appendix) consisting of seven questions using a five point-Likert-scale that ranged from strongly disagree to strongly agree. Immediately following the active learning session, students completed a post-session survey, which was identical to the pre-session survey, except for statement reordering, which was done to reduce answer patterning bias.

In addition to the pre- and post-session surveys, a researcher not involved in the teaching phase conducted individual interviews with each student within 4 days of the SPTP session. The researcher used an interview guide with open-ended questions meant to solicit student opinion and confidence levels. The interviews were audiotaped and transcribed verbatim. They were reviewed by both the PI and the researcher conducting the interviews. The students were assured of anonymity and their responses in no way influenced their grade for the course. The interview consisted of three main questions with follow-up probes as needed. They were: (1) 'In the context of other methods used to teach hands-on skills throughout the curriculum, what did you like the most about the manner in which these techniques were taught?', (2) 'In the context of other methods used to teach hands-on skills throughout the curriculum, what did you like the least about the manner in which these techniques were taught?', (3) 'After this learning experience, how confident do you feel in your ability to use these techniques with patients?'

Outcomes

Survey results

On the pre-session survey, students answered strongly agree or agree on four of the seven items (57%)

suggesting that this cohort had some level of comfort with these procedures prior to the learning session. On the post-session survey, students marked 6.4 of the 7 items (91%) as strongly agree or agree, which revealed an improvement of 20% in students' level of confidence in performance of these techniques following this single teaching session. Even among a cohort of students who had prior exposure to spinal TJM, the new teaching method appeared to be effective in influencing opinion. The survey item that students rated lowest on both the pre- and post-session survey was, '*I am able to confidently teach spinal thrust mobilization/manipulation to a colleague*'. One hundred per cent of the students scored this item as strongly disagree, disagree, or neutral on the pre-session survey, but only 35% of the students submitted this response on the post-session survey. This finding suggests that the majority of students reached a level of confidence that allowed them to feel comfortable teaching someone else these techniques.

A primary stated objective of the learning session was to encourage student use of these techniques with patients during clinical internships and post-graduation. It is, therefore, important to note that the survey item, '*I am fully capable and competent in the performance of lumbo-pelvic thrust mobilization/manipulation on an actual patient*', was rated as strongly agree or agree by 88% of the students at the conclusion of the session. This is compared with only 18% of the students who indicated this response prior to the instructional session. This item subsumes other important aspects, such as opinion about safety and effectiveness, and the value of considering thrust as an intervention option.

Overall, the findings of the pre- and post-session surveys suggest that students were less confident about the effectiveness of spinal TJM and their ability to use these techniques prior to the SPTP session than they were immediately following the teaching experience.

Interview results

Table 2 provides a sampling of specific responses offered by students in each of the three main categories of the open-ended interview. Analysis revealed several trends among the student responses. All students (15/15) preferred the SPTP strategy over other previous lab experiences where the instructor demonstrated the whole-task followed by independent practice of the whole task. The students thought that the SPTP provided more thorough instruction, keeping them on task and allowing them to attend to the many details of these complex maneuvers. The most often cited comments included an appreciation for the repetitive nature of this teaching method (15/15) and the ability to practice on individuals of various sizes and degrees of mobility (9/15). The

students believed that having the opportunity to practice each component of the task individually over multiple repetitions enhanced their psychomotor performance. They commented on how this method forced them to perform these techniques on people of different sizes, thus better preparing them for clinical practice. Students also remarked that this method provided more detailed information than other methods about the specific aspects of the technique (i.e. hand position, body position, force application, etc.). They indicated that this method allowed more time for lab assistant feedback which allowed them to correct performance errors (6/15).

On the negative side, many students commented on the increased time required to implement this teaching strategy (11/15). The overall learning experience took longer, thus reducing the total number of techniques that could be taught in a single lab session. However, all but one of the students who provided this comment followed up by saying that it was time well spent. Several students commented on how the repetitive nature of the method produced slight post-manipulative soreness when playing the patient role (6/15). As for implementing these techniques with actual patients, several students (5/15) indicated that they felt very confident as a result of this method; however, most (10/15) thought that it was a nice first step but that additional practice was needed.

Discussion

Although long considered to be within the purview of physical therapist practice, the use of TJM for spinal conditions has only recently been the focus of attention among physical therapists within the United States.⁶ Recent evidence indicates that despite an increase in the entry-level academic training of physical therapists, students have limited opportunities to practice spinal TJM during their clinical internship experiences. Barriers to student performance

of these procedures include lack of CI training and comfort with the practice of spinal TJM.¹² Clinical instructor reluctance is related to perceived risk and may be attributed to a lack of formal training during their professional education. The decision to incorporate spinal TJM should be based on comparable treatment effectiveness rather than an exaggerated concern regarding the risks associated with such procedures. The educational community is continually challenged to explore new and effective teaching strategies designed to enhance performance and develop student confidence. Professional education that includes strategies designed to enhance student confidence in the performance of psychomotor skills may result in an increase in their use during internships and clinical practice. In the present study, an innovative approach to teaching spinal TJM, known as SPTP was investigated. The increase in student responses in all items between pre- and post-session surveys suggests that this learning experience was effective in changing overall student perception and confidence in the performance of spinal TJM. Open-ended interviews provided additional insight into student opinion of this instructional model. Students greatly preferred instruction that included blocked practice of sequential partial tasks that culminated in the performance of a complete task over other methods of instruction. Students indicated that the breakdown of complex motor skills into partial tasks and the repetitive practice on individuals of varying size and mobility greatly enhanced his or her confidence in technique performance. Throughout this experience, student confidence improved in response to the sequential practice of distinct motor tasks in a blocked fashion, as measured through survey and interview. Blocked practice is known to enhance acquisition of a new motor skill, although blocked practice alone may not aid in skill retention.^{23,28} Task randomization was facilitated by altering specific task performance as students moved

Table 2 A sampling of specific responses offered by students in each of the three main categories of questions during post-session interviews

1. 'In the context of other methods used to teach hands-on skills throughout the curriculum, what did you like the most about the manner in which these techniques were taught?'
• 'You get to work with different people that you don't usually practice with.'
• 'Breaking it up into steps so you formulate a diagram in your mind. It helped me to visualize each step and then come back and put it all together in to a whole.'
• 'Breaking it into pieces is really helpful for someone like me who can only take little bits of information at a time.'
• 'By the time you get to the end, you know how to do this and exactly where to put your hands.'
• 'If you messed up in the beginning, it was no big deal cause you practiced again and again and it became more fluid and easy to do'
2. 'In the context of other methods used to teach hands-on skills throughout the curriculum, what did you like the least about the manner in which these techniques were taught.'
• 'I'm definitely more sore today from having the positions done over and over again.'
• 'I'm a little bit slower so people around me would already be on step 2 or we would be switching partners and I was still processing everything.'
• 'With some of the basic parts of the technique we could have stopped a little earlier.'
• 'It definitely took longer...but it was worth it.'
3. 'After this learning experience, how confident do you feel in your ability to use these techniques with patients?'
• 'I feel really comfortable with all those, I could perform any of those right now.'
• 'I'm mildly confident, but I still need more practice.'
• 'I feel very confident with doing this technique, not just with the other students in the class, but actually using it in the clinic.'

from partner to partner. Random variable practice has been found to be more effective at facilitating retention of motor tasks.²⁹

While students may become more confident in their skill application, resistance from clinical instructors may still pose a barrier to intervention implementation during student clinical experiences. Flynn *et al.*³⁵ acknowledged this barrier and explicitly discussed strategies that physical therapist students may use to advocate for the practice of these procedures during their clinical internship experiences. Acknowledging that CI's may not have the level of training in spinal TJM and may be resistant to students performing these procedures is an important step in beginning the dialogue between CIs and students. Their model encourages students to track interventions and outcomes for clients with LBP as the basis for incorporating spinal TJM into the plan of care during their clinical internship experiences.³⁵

The current best evidence supports the use of high velocity thrust manipulation in the management of LBP.⁶ However, due to factors such as perceived risk, concerns over liability, and lack of appropriate training, these procedures are grossly underutilized in the routine physical therapy care of this population.¹² The physical therapist must constantly be challenged to utilize the current best evidence in clinical practice. When considering the use of spinal TJM clinically or when making decisions regarding the integration of this content into the professional educational curricula of physical therapists, one must consider the risk-benefit ratio of adopting such interventions. The decision to forego the use of spinal TJM should be based on comparable treatment effectiveness rather than an exaggerated concern regarding associated risks.

Limitations

There were several limitations to this method/model presentation and evaluation. This method was utilized only once and within a very specific area of curricular content. Although this method has promise for the training of psychomotor skills across multiple areas of content and skill level, its application to these other environments has not yet been tested. As students taking a course for credit, the participants may have felt pressure to respond in the expected fashion thus introducing bias. In addition, the students in this cohort already had exposure to several of these procedures and, in fact, had chosen to take this elective course thus demonstrating their favorable opinion of these procedures prior to this evaluation. The use of unvalidated survey tools and open interviews were unable to perfectly correlate student responses with the implementation of our model. Although student confidence and opinion was

changed as a result of this model, no attempt to measure improvement in the performance of each psychomotor skill was attempted. It was, therefore, not possible to identify the impact of this model on technique performance. Although student confidence in the performance of these techniques was observed, the impact of student confidence on the frequency of using these techniques during internships and clinical practice was not tested and should be considered in future studies.

Future research initiatives should focus on determining the learning outcomes achieved through the use of this model and should focus on isolating which of these parameters appears to have the greatest impact on student confidence. Investigating the impact of this teaching strategy on skill acquisition of a motor task and applying this strategy to a variety of other motor tasks may yield valuable information on how to best pursue skill mastery. Ultimately, linking patient outcomes with the method used for skill acquisition of motor tasks will be important for directing future teaching and learning initiatives.

Conclusion

In this method/model presentation, we have attempted to describe a new approach to teaching spinal TJM that is in accordance with current concepts related to skill acquisition and retention of new motor tasks. One aspect of this model, the SPTP teaching strategy, was utilized in a lab environment within the context of an OMPT elective course using a cohort of 15 DPT students in their final semester of professional training. The results revealed support for this method of instruction as evidenced by changes in such parameters as increased student confidence in performing these techniques on patients and in teaching others these techniques. Students unanimously preferred this method over other strategies that are commonly used to teach spinal TJM.

Appendix: High velocity thrust survey

Instructions: Circle the word that most closely reflects your opinion and attitude toward the following statements.

1. Spinal thrust mobilization/manipulation is safe.
Strongly Disagree (0,0)* Disagree (0,0) Neutral (1,0) Agree (12,3) Strongly Agree (2,12)
2. Spinal thrust mobilization/manipulation is effective.
Strongly Disagree (0,0) Disagree (0,0) Neutral (3,0) Agree (11,6) Strongly Agree (1,9)
3. Spinal thrust mobilization/manipulation should be routinely considered in the PT care of individuals with back pain.
Strongly Disagree (0,0) Disagree (1,0) Neutral (5,0) Agree (9,6) Strongly Agree (0,9)
4. Spinal thrust mobilization/manipulation should be taught to PT's during their entry-level education.

Strongly Disagree (0,0) Disagree (0,0) Neutral (1,0) Agree (7,7) Strongly Agree (6,8)

5. I am fully capable and competent in performing spinal thrust mobilization/manipulation on an actual patient.
Strongly Disagree (2,0) Disagree (2,1) Neutral (8,4) Agree (3,8) Strongly Agree (0,2)

6. I am able to confidently teach spinal thrust mobilization/manipulation techniques to a colleague.
Strongly Disagree (3,0) Disagree (5,0) Neutral (7,1) Agree (0,14) Strongly Agree (0,0)

7. I will use spinal thrust mobilization/manipulation techniques with my patients.
Strongly Disagree (0,0) Disagree (0,0) Neutral (6,0) Agree (7,9) Strongly Agree (2,6)

*Numbers in parentheses represents frequency of responses on pre- and post-session survey, respectively.

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