THE EFFECT OF TEACHING GENERAL PSYCHOMOTOR SKILLS BEFORE SPECIFIC ADJUSTMENTS ON STUDENT PERFORMANCE IN A PELVIS AND LUMBAR SPINE CHIROPRACTIC TECHNIQUE COURSE

Paul Wanlass, DC, CSCS, CSPN[1], Amber McCallum[1], DC, Oscar Alvarado[1], DC, Rhiannon Hutton, DC, MAOM[1]

ABSTRACT

Objective: To evaluate if changing the sequence in which students learn the complex psychomotor skill of spinal manipulation of the pelvis and lumbar spine in a chiropractic technique course would help to improve performance on practical exams.

Methods: This is a retrospective study of data collected for practical examinations. In order to assess the results of this change, the midterm and final practical exam scores for the 2 cohorts before the experiment were compared to the scores of the cohorts after the change. The students' gender and cumulative grade point average were examined to determine if they were mediating factors.

Results: The experimental cohort scored lower in their technique exams compared to the control cohort (p = .001), although the difference between the medians was small (184.0 versus 180.0).

Conclusion: The results of this study reveal no improvement in practical exam scores after the sequencing of the pelvis and lumbar spine adjustive technique class instruction was changed from the traditional specific adjustments first and then psychomotor skills vs. teaching the psychomotor skills first followed by teaching specific adjustments. Further research is needed to determine the optimum sequence of teaching chiropractic psychomotor skills to maximize the students' learning experience and clinical performance. *(J Contemporary Chiropr 2022;5: 171-176)*

[1] *Southern California University of Health Sciences*

Key Indexing Terms: Chiropractic; Spinal Manipulation; Healthcare Education: Motor Skills; Sensorimotor Learning; Psychomotor Skills

INTRODUCTION

Spinal manipulation (SM) techniques are one of the important treatment modalities used by chiropractors. SM is a complex bimanual motor skill requiring multiple limb coordination and postural control that students must learn to administer safely and effectively. There is a need for conscious use of educational theory to ground sensorimotor learning for manual therapy. (1) The literature on SM training shows there is significant improvement in performance when motor learning skills are taught using educational strategies. (2-4) Motor skill development is an essential component of clinical education in various health care disciplines. (5) Sufficient practice and implementation of relevant feedback strategies are also very important in successful skill learning practices. Earlier implementation is helpful to motor skills acquisition. (6)

Varying models exist for the acquisition of manual/motor skills. Dunphy and Williamson have described 4 states for manual skills development. These are novice, advanced/beginner, competent/proficient, and expert. (7) Delacruz *et al* identified a 3-stage theory of motor skill acquisition. These are cognitive (i.e., the learner gains basic knowledge about the steps necessary to accomplish a task), associative (practice and repetition) and autonomous (in this stage performance becomes smooth and automatic). (8) Traditionally in chiropractic colleges, theoretical aspects of SM were taught in the beginning. (9) The laboratory component of education consists of instructional demonstrations, observation-based coaching and rehearsals using simulators or student

colleagues as patients. Timely feedback must be provided during this coaching. Newer technology, such as force-plate tables, provide an avenue for instant feedback on the application of techniques involved in SM. Providing feedback to students helps facilitate learning that can be transferred to clinical scenarios. (9) Successful education during this stage plays a major role in student's future interaction with patients.

The sequence of learning SM theory and laboratory exercises plays a major role in the cognitive and associative phases of the motor learning process. Triano described how reversing the traditional sequence of teaching specific SM procedures first and then gross motor skills led to better student performance. (4) Confidence in their SM technique is often a major obstacle for interns beginning their clinical experiences. If students' confidence in their SM performance is improved by changing the sequence of the educational components, this in turn benefits their clinical training. (10)

The purpose of this study was to evaluate if changing the sequence in which students learn the complex psychomotor skill of spinal manipulation of the pelvis and lumbar spine in a chiropractic technique course would help to improve performance on practical exams.

METHODS

Approval for this study was obtained from the Southern California University of Health Sciences Institutional Review Board. Chiropractic Procedures IV is a 2nd-year chiropractic technique course at our university that focuses on SM of the pelvis and lumbar spine. This is the first course where the students perform high-velocity low-amplitude (HVLA) manipulations. There are 70 hours of lab and 15 hours of lecture over a 15-week period. For this study, the sequence of class instruction was changed from the traditional teaching of specific adjustments first and then gross motor skills to the reverse. The students in both cohorts met the prerequisite training for the course. (3) There were 123 students in the control cohort and 128 in the experimental cohort. Because the distribution of technique exam scores and cGPA were not normal, medians and the non-parametric Mann-Whitney test and the Pearson's chi-square test were used for test statistics.

Traditional Teaching Method (Control Cohort)

During the first 3 weeks of the term, students learn the basic side-posture setup, review pelvis and lumbar spine motion palpation, and perform approximately 4-6 specific pelvis procedure set-ups (with no thrusting). All procedures are demonstrated on stage and then again in lab groups. Students were supervised by their lab group instructor and immediate feedback was given. In week 4, students learned how to do the side-posture body drop on a vinyl thrusting dummy. In each lab after that, the students spend the first 15 minutes of class practicing their thrusts on the vinyl dummy with fast-paced music playing in the background designed to help them relax, increase adjusting speed, and improve rhythm. Students focused on choosing the proper height table, practicing with both sides of their body, improving the technique of their body drop including proper biomechanics, depth, and speed of their thrust. These drills are demonstrated on stage and performed by students simultaneously. This training uses visual, auditory, and kinesthetic learning principles. In week 5, the students added thrusts to a specific pelvis and lumbar spine procedures on a student under the supervision of their lab group instructor with immediate feedback given.

Experimental Teaching Method (Experimental Cohort)

Starting on the 1st day, the students learn how to perform the basic side-posture body drop on a vinyl thrusting dummy. In each lab after that, the students spend the first 15 minutes of class practicing their thrusts on the vinyl dummy with fast-paced music playing in the background designed to help them relax, increase adjusting speed, and improve rhythm. Students focused on choosing the proper height table, practicing with both sides of their body, improving the technique of their body drop including proper biomechanics, depth, and speed of their thrust. These drills are demonstrated on stage and performed by students simultaneously. This training uses visual, auditory, and kinesthetic learning principles. Students were supervised by their lab group instructor and immediate feedback was given.

During the rest of the lab time for the first 3 weeks, students learned the basic side-posture set-up and reviewed palpation. In week 4, the students started learning specific pelvis procedure set-ups (with no thrusting). All procedures are demonstrated on stage and then again in lab groups. In week 5, the students added thrusts to specific pelvis and lumbar spine procedures on a student under the supervision of their lab group instructor with immediate feedback given.

This is a retrospective study of data collected from practical examinations. To assess the results of the sequence, changes in the midterm and final practical exam scores for the 2 cohorts (2 trimesters of students) before the experiment were compared to the scores of the 2 cohorts (2 trimesters of students) after the change. The practical exams did not change during this period. Data analysis consisted of comparison of the 2 cohorts as independent samples. The students' gender and cumulative grade point average (cGPA) were examined to determine if they were mediating factors in performance on the examinations.

RESULTS

There were 123 students in the control cohort and 128 in the experimental cohort. Because the distribution of the technique exam scores and cGPA were not normal, medians and the non-parametric Mann-Whitney test, (11) along with Pearson's chi-square test, (12) were used for test statistics.

The experimental cohort scored lower in their technique exams compared to the control cohort (p = .001), although the difference between the medians was small (184.0 versus 180.0).

The cohorts were comparable for gender (control cohort females = 35.0%, experimental cohort females = 37.5%, p= .676). Gender did not affect the relationship between instruction cohort and technique score (Table 1).

Table 1. *Gender and Technique Scores*

	N Female	Median Technique Score Females	N Male	Median Technique Score Males
Control	43	184.0	80	183.0
Experimental	48	180.0	80	180.0
Significance	.007*		.031*	

** Significant at the .05 level*

The cGPA of the experimental cohort was lower than the control cohort (experimental cohort =2.738 cGPA, p= .017, control cohort =2.857 cGPA).

Having a cGPA above the median was a mediating factor for this effect (Table 2).

Table 2. *Cumulative GPA and Technique Scores*

	Median Technique Score	
	Below Median cGPA	Above Median cGPA
Control	182.0	185.0
Experiment	178.0	182.0
Significance	.216	.002*

** Significant at the .05 level*

DISCUSSION

Historically, students learn the theoretical aspects of high-velocity low-amplitude (HVLA) spinal manipulation (SM), followed by a demonstration by an instructor performing a specific spinal manipulation and students imitating the instructed procedure on their classmates. (6) Students may grasp the knowledge of performance skills partially or completely during the various years and levels of their training. (6) In a study analyzing manipulation skills between genders, the precision of adjusting was achieved by both genders by the 5th year of chiropractic education. Female students tend to be more precise adjustors initially, while men have better force application. (13) With this said, it is clear that both precision and force should be concentrated on early in education for inter-gender skillset accumulation.

One best-evidence synthesis of teaching methods concluded that the "evidence presented does not offer a comparison or suggest a clearly superior form of teaching method to be applied as a gold standard for incorporation into the core curriculum of doctor of chiropractic programs." (9) Based upon the findings here, we agree that more research is needed before a gold standard is established. At 1 workshop designed to create a standardized chiropractic education, those involved unanimously agreed that the following should be included: high-velocity low amplitude spinal and extremity manipulation, adjustments assisted by hand-held instruments, drop tables, flexion-distraction tables, and pelvic blocks. However, the order and delivery of teaching was not discussed. (14)

A pilot study by Watson *et al.* evaluated various teaching methods of SM. He observed that the teaching method for SM did not alter the skill acquisition of the students. However, the timeframe in which student feedback was provided impacted their ability to maintain skills when evaluated later. Students who received immediate feedback after making a mistake during testing had improved performance compared to those who had delayed or no feedback. (15)

Feedback from instructors not only has an informational function, but also has motivational properties that have an important influence on learning motor skills. (16) One systematic review of the literature across 4 electronic databases identified articles that examined the effect of feedback on outcomes related to manual therapy skill acquisition and identified 3 key points: 1) Real-time visual feedback in the form of graphical representations of a learner's kinematic parameters, such as force-time profiles, can produce short-term improvements in force-related parameters; 2) Novice learners should be provided regular and frequent feedback in the earlier stages of skill acquisition; and 3) Educators should consider intentionally and progressively removing feedback once learners begin to demonstrate some degree of autonomy in a skill. (17)

Both cohorts in our study received the same lecture and lab training comprised of the Cognitive, Affective, and Psychomotor domains according to Bloom's Taxonomy. (18,19) Of the 7 stages of learning within the Psychomotor

Domain, our students were in the Guided Response stage. (19) This consists of students watching a skilled practitioner perform spinal manipulations, students imitating the manipulations, and practicing that skill set in lab on other students under the supervision of faculty. Both cohorts were exposed to the Conscious Competence Learning Theory. (20,21) This learning model focuses on 2 factors that are important when learning a new skill, in this case spinal manipulation: our awareness (consciousness), and our skill level (competence). There are 4 stages of learning: Unconsciously Incompetent/Unskilled, Consciously Incompetent/Unskilled (the students in this first manipulation course are at this stage), Consciously Competent/Skilled, and Unconsciously Competent/Skilled. Medical students and kinesthetic learners are multimodal learners. (22,23) Therefore, it is important to consider these styles in course design and delivery.

Changing the sequence of teaching specific SM skills after gross motor skills did not improve the practical exam performance of the experimental cohort of students. The decrease in student performance observed, although statistically significant for the students with the lower cGPA, is probably too small to affect their future clinical performance. There are several variables that may have affected the results. Chief among these was the experimental cohort were academically weaker students overall than the control cohort, as shown by their lower cGPA. Another factor was the new way that SM procedures were being taught. It often takes several runs of a course before new class activities run smoothly.

Lower technique exam scores after changing the course sequence in this study was seen in both cohorts but was only statistically significant regarding students with a cGPA below the median. One possible explanation is that these students were more focused on their didactic courses and did not take technique labs as seriously.

Ideas for Future Teaching Strategies

Chiropractic curriculum teaching strategies have yet to be optimized. One survey study conducted in an Australian Chiropractic college showed that the majority of students are multivariate learners, requiring lessons presented in visual, aural/auditory, reading/writing, and kinesthetic teaching, with a greater preference towards kinesthetic learning. (24) The sequential partial task practice (SPTP) strategy in which participants engaged in partial task practice over several repetitions with different partners enhanced student confidence in technique performance. (25) Visual feedback that provides learners with graphical representations of their performance, such as force-time relationships, appear to have the greatest effects in improving force-related parameters. (17) In a qualitative study of Swiss chiropractic students, clarity of communication regarding expectations and a feeling of community were viewed as some of the most important qualities in education. (10) With all of this taken into consideration, future studies should include the use of partner exchanges with icebreakers for community enhancement, rubric explanation for clarity of communication, as well as graph-based visual feedback and repetitive kinesthetic practicum of all adjusting types.

Various devices, based on force-sensing technologies, have been used to provide feedback to students and to assess performances. (15,26) These studies suggest that augmented feedback, defined as "information provided about the action that is supplemental to, or that augments, the inherent feedback" (27) using force-sensing devices during training improves SM skill performance and reduces variability. (28) There is evidence demonstrating the effectiveness of objective feedback, force-sensing chiropractic tables, and mannequins when teaching spinal manipulation (SM) to chiropractic students. (2) In an examination of the effectiveness of an educational intervention combining both Human Analogue Mannequins (HAM) and Force-Sensing Table Technology (FSTT®) for teaching cervical SM, the authors concluded that "Students demonstrated improved peak force control for SM delivered on the mannequin. However, this improvement was not carried over to SM delivered on human subjects. Further research is needed to assess the reason for the lack of change for human thrusts". (29) Future studies may still include the use of force-sensing technology for specificity and motor skill practice. One survey based-study published from a chiropractic teaching convention showed unanimous opinion that teaching high-velocity, low amplitude spinal and extremity manipulation, adjustments assisted by hand-held instruments, drop tables, flexion-distraction tables, and pelvic blocks was important to a chiropractic education. Future studies should be conducted showing student skill level after learning all of these techniques. (10)

Limitations

Limitations to this study may include the fact that students were separated by cohort as a retrospective study which did not take into consideration curricular changes in other courses which may affect student performance.

CONCLUSION

The results of this study reveal no improvement in practical exam scores after the sequence of the pelvis and lumbar spine adjustive technique class instruction was changed from the traditional specific adjustments first and then psychomotor skills versus teaching the psychomotor skills first followed by teaching specific

adjustments. Further research is needed to determine the optimum sequence of teaching chiropractic psychomotor skills to maximize the students' learning experience and clinical performance. We also plan to study the effects of using Human Analogue Mannequins (HAM) and Force-Sensing Table Technology (FSTT®) as a future method of teaching SM to chiropractic students at our university.

ACKNOWLEDGMENTS

The authors recognize and thank the participants in this study, and Kevin Rose, DC, MPH for the statistical analysis of the blinded data.

REFERENCES

1. Downie AS, Vemulpad S, Bull PW. Quantifying the high-velocity, low-amplitude spinal manipulative thrust: a systematic review. J Manipulative Physiol Ther 2010;33(7):542–553

2. Descarreaux M, Dugas C, Lalanne K, Vincelette M, Normand MC. Learning spinal manipulation: the importance of augmented feedback relating to various kinetic parameters. Spine J 2006;6(2):138–145

3. Triano JJ, Bougie J, Rogers C, *et al*. Procedural skills in spinal manipulation: do prerequisites matter? Spine J 2004;4(5):557–563

4. Triano JJ, Descarreaux M, Dugas C. Biomechanics--review of approaches for performance training in spinal manipulation. J Electromyogr Kinesiol 2012;22(5):732–739

5. Elliott D, Grierson LEM, Hayes SJ, Lyons J. Action representations in perception, motor control and learning: implications for medical education. Med Educ 2011;45(2):119–131

6. Harvey MP, Wynd S, Richardson L, Dugas C, Descarreaux M. Learning spinal manipulation: a comparison of two teaching models. J Chiropr Educ 2011;25(2):125–131

7. Dunphy BC, Williamson SL. In pursuit of expertise. Toward an educational model for expertise development. Adv Health Sci Educ Theory Pract 2004;9(2):107–127

8. Delacruz GC, Chung GKWK, Bewley WL. Characterizing trainees in the cognitive phase using the human performance knowledge mapping tool (HPKMT) and microgenetic analysis. (CSE Report 699). Los Angeles: University of California, Los Angeles, National Center for Research on Evaluation, Standards, and Student Testing (CRESST). 2006

9. Stainsby BE, Clarke MCS, Egonia JR. Learning spinal manipulation: A best-evidence synthesis of teaching methods. J Chiropr Educ 2016;30(2):138–151. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5067123/

10. Palmgren PJ, Laksov KB. Exploring chiropractic students' experiences of the educational environment in healthcare professional training: a qualitative study. BMC Med Educ 2015;15:128

11. Kühnast C, Neuhäuser M. A note on the use of the non-parametric Wilcoxon-Mann-Whitney test in the analysis of medical studies. Ger Med Sci 2008;6:Doc02

12. Lydersen S, Fagerland MW, Laake P. Pearson's chi-squared test. Tidsskr Nor Laegeforen. 2019;139(12)

13. Pasquier M, Barbier-Cazorla F, Audo Y, Descarreaux M, Lardon A. Learning spinal manipulation: gender and expertise differences in biomechanical parameters, accuracy, and variability. J Chiropr Educ 2019;33(1):1–7. Available from: https://meridian.allenpress.com/jce/article/33/1/1/12259/Learning-spinal-manipulation-Gender-and-expertise

14. Gleberzon BJ, Cooperstein R, Good C, Roecker C, Blum C. Developing a standardized curriculum for teaching chiropractic technique. J Chiropr Educ 2021;35(2):249–257

15. Watson TA, Radwan H. Comparison of three teaching methods for learning spinal manipulation skill: a pilot study. J Manipulative Physiol Ther 2001;9(1):48–52. Available from: https://doi.org/10.1179/jmt.2001.9.1.48

16. Wulf G, Shea C, Lewthwaite R. Motor skill learning and performance: a review of influential factors: motor skill learning and performance. Med Educ 2010;44(1):75–84. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1365-2923.2009.03421.x

17. Chang I, Rivera MJ, Eberman LE. The effect of feedback on manual therapy skill acquisition: a systematic review. Athl Train Educ J 2020;15(3):224–234. Available from: https://meridian.allenpress.com/atej/article/15/3/224/444340/The-Effect-of-Feedback-on-Manual-Therapy-Skill

18. Adams NE. Bloom's taxonomy of cognitive learning objectives. J Med Libr Assoc 2015;103(3):152–153. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4511057/

19. Clark D. Bloom's taxonomy of learning domains.1999. Available from: http://www.nwlink.com/~donclark/hrd/Bloom/psychomotor_domain.html

20. Cannon HM, Feinstein AH, Friesen DP. Managing complexity: applying the conscious-competence model to experiential learning. In developments in business simulation and experiential learning: proceedings of the annual ABSEL conference. 2010

21. Howell WC, Fleishman EA. Human performance and productivity: Information processing and decision making. Vol. 2. Hillsdale, NJ: Erlbaum; 1982:29–33

22. Busan AM. Learning styles of medical students - implications in education. Curr Hlth Sci J 2014;(2):104–110. Available from: https://doi.org/10.12865/CHSJ.40.02.04

23. Hernandez JE, Vasan N, Huff S, Melovitz-Vasan C. Learning styles/preferences among medical students: kinesthetic learner's multimodal approach to learning anatomy. Med Sci Educ 2020;30(4):1633–1638. Available from: https://link.springer.com/10.1007/s40670-020-01049-1

24. Whillier S, Lystad RP, Abi-Arrage D, *et al*. The learning style preferences of chiropractic students: a cross-sectional study. J Chiropr Educ 2014;28(1):21–27

25. Wise CH, Schenk RJ, Lattanzi JB. A model for teaching and learning spinal thrust manipulation and its effect on participant confidence in technique performance. J Man Manip Ther 2016;24(3):141–150. Available from: http://www.tandfonline.com/doi/full/10.1179/2042618614Y.0000000088

26. Lardon A, Cheron C, Pagé I, Dugas C, Descarreaux M. Systematic augmented feedback and dependency in spinal manipulation learning: a randomized comparative study. J Manipulative Physiol Ther 2016;39(3):185–191. Available from: https://linkinghub.elsevier.com/retrieve/pii/S016147541600049X

27. Schmidt RA, Lee TD. Motor control and learning: a behavioral emphasis. 3rd ed. Champaign, IL: Human Kinetics 1999.

28. Pasquier M, Cheron C, Dugas C, Lardon A, Descarreaux M. The effect of augmented feedback and expertise on spinal manipulation skills: an experimental study. J Manipulative Physiol Ther 2017;40(6):404–410. Available from: https://linkinghub.elsevier.com/retrieve/pii/S016147541730012X

29. Duquette SA, Starmer DJ, Plener JB, BSc DAG. A pilot study to determine the consistency of peak forces during cervical spine manipulation utilizing mannequins. J Chiropr Educ 2021;35(1):8–13. Available from: https://meridian.allenpress.com/jce/article/35/1/8/441478/A-pilot-study-to-determine-the-consistency-of-peak