EDUCATION
RESEARCH SERVICE

ORIGINAL ARTICLE

Learning and Study Strategies Inventory subtests and factors as predictors of National Board of Chiropractic Examiners Part 1 examination performance

Christine M. Schutz, PhD, Leanne Dalton, BS, and Rodger E. Tepe, PhD

Objective: This study was designed to extend research on the relationship between chiropractic students' learning and study strategies and national board examination performance.
Methods: Sixty-nine first trimester chiropractic students self-administered the Learning and Study Strategies Inventory (LASSI). Linear trends tests (for continuous variables) and Mantel-Haenszel trend tests (for categorical variables) were utilized to determine if the 10 LASSI subtests and 3 factors predicted low, medium and high levels of National Board of Chiropractic Examiners (NBCE) Part 1 scores. Multiple regression was performed to predict overall mean NBCE examination scores using the 3 LASSI factors as predictor variables.
Results: Four LASSI subtests (Anxiety, Concentration, Selecting Main Ideas, Test Strategies) and one factor (Goal Orientation) were significantly associated with NBCE examination levels. One factor (Goal Orientation) was a significant predictor of overall mean NBCE examination performance.
Conclusions: Learning and study strategies are predictive of NBCE Part 1 examination performance in chiropractic students. The current study found LASSI subtests Anxiety, Concentration, Selecting Main Ideas, and Test Strategies, and the Goal-Orientation factor to be significant predictors of NBCE scores. The LASSI may be useful to educators in preparing students for academic success. Further research is warranted to explore the effects of learning and study strategies training on GPA and NBCE performance.

Key Indexing Terms: Chiropractic; Educational Measurement; Test Taking Strategies; Test Taking Skills; Study Skills; Education

J Chiropr Educ 2013;27(1):5–10 DOI 10.7899/JCE-D-12-012

INTRODUCTION

Self-regulated learning is an important concept in higher education research.[1] Self-regulated learners are more effective in learning and have a repertoire of learning and study strategies to match different situations.[2] Learning and study strategies include "thoughts, behaviors, attitudes, motivation and beliefs related to successful learning."[3] Research studies have shown that learning and study strategies are significantly related to academic achievement in higher education[4–6] and can be enhanced through educational interventions.[3]

Few studies have explored learning and study strategies in graduate health-care education, and only two specifically in chiropractic education.[7,8] Understanding the relationship between learning and study strategies and academic performance in chiropractic education is important in curriculum planning, educational intervention design, as well as national board examination preparation and performance.[8] The National Board of Chiropractic Examiners (NBCE) examinations are the primary licensing examinations for the chiropractic profession and are similar in function to the National Board of Medical Examiners examinations.[9] According to Cunningham et al,[10] students spend considerable time and money on short-term preparation and coaching courses for these examinations with no significant improvement in results.

Previous studies have found pre-enrollment grade point average (GPA)[10,11] and in-curriculum GPA[10–12] to be predictors of NBCE examination scores. Research identifying factors associated with NBCE examination performance can be useful to educators for identifying students who might be at risk of poor performance and for designing interventions that improve students' NBCE outcomes.

This paper was selected as a 2012 Association of Chiropractic Colleges - Research Agenda Conference Prize Winning Paper - Award funded by the National Board of Chiropractic Examiners.

Self-regulated learning is measured by the Learning and Study Strategies Inventory (LASSI),[13] a widely utilized instrument in higher education. Psychometric properties of the LASSI have been examined in several studies,[3,14–19] showing good reliability and validity.[4,5] The LASSI subtests have shown generalizability to different samples in higher education, including undergraduates,[4–6] pharmacy students,[20] and medical students.[21,22]

Designers of the LASSI originally proposed that it measure 3 latent factors of self- regulated learning: (1) Skill (Information Processing, Selecting Main Ideas, and Test Strategies); (2) Will (Anxiety, Attitude, and Motivation); and (3) Self-Regulation (Concentration, Self-Testing, Study Aids, and Time Management).[23]

Using factor analysis, other researchers have found different 3-factor subtest combinations that are a better fit for the data.[14,15,17] The 3 latent factors found by Olejnick and Nist[17] are (1) Effort-Related Activities (Motivation, Time Management, and Concentration); (2) Cognitive Activities (Information Processing, Study Aids, and Self-Testing); and (3) Goal Orientation (Anxiety, Selecting Main Ideas, and Test Strategies). Olaussen and Braten[15] and Cano[14] also found a 3-factor latent structure similar to that of Olejnick and Nist[17] with one difference: including the subtest of Attitude in the Effort-Related Activities factor.

Three studies have investigated the relationship between LASSI subtest scores, latent factors, and GPA in college students.[14,15,24] Cano[14] found that 2 of 3 factors, similar to Effort Related Activities and Goal Orientation, were positively related to GPA in undergraduate students. Olaussen and Braten[15] found a similar factor structure also in college students. Loomis[24] found a significant relationship between the LASSI subtest scores and undergraduate online course performance.

Four studies have investigated the relationship between LASSI subtest scores and academic performance in healthcare graduate students.[20–22,25] Sleight and Mavis divided second-year medical students into low, medium, and high cohorts based on Medical College Admission Test (MCAT) scores.[22] The high cohort had the highest scores in Motivation and Concentration and the lowest scores in Study Aids compared with the low and medium cohorts. West and Sadoski[25] found that two LASSI subtests, Time Management and Self-Testing, were stronger predictors of first-semester academic performance in medical students than aptitude as measured by the MCAT. In a study of pharmacy students, Lobb et al[20] demonstrated that subtests Motivation, Anxiety, Concentration, Selecting Main Ideas, and Test Strategies had significant positive correlations with first-year GPA. The LASSI subtests were not significant predictors of first-year academic performance over GPA. Filho and Vieira[21] found that the subtests Anxiety, Motivation, and Selecting Main Ideas predicted progress in basic science courses for anesthesiology residents.

The two studies utilizing chiropractic students have found mixed results. Schutz et al[8] divided a sample of trimester-one chiropractic students into high and low GPA groups and found that the high GPA group scored significantly higher on LASSI subtests Anxiety, Attitude, Concentration, Motivation, Test Strategies, and Selecting Main Ideas, as well as the factors Effort-Related Activities and Goal Orientation. Pringle and Lee[7] compared LASSI subtest scores from sixth-trimester students with scores on the NBCE Part 1 examination and with entering and cumulative GPAs and found moderately high correlations between all of the LASSI subtest scores and NBCE scores and cumulative GPA.

The purpose of the current study was to extend the research on the relationship between LASSI subtest and factor scores and NBCE Part 1 examination performance.

METHODS

Design

This was an observational study designed to investigate the 10 LASSI subtests (Information Processing, Selecting Main Ideas, Test Strategies, Anxiety, Attitude, Motivation, Concentration, Self-Testing, Study Aids, and Time Management) and the 3 LASSI factors (Effort-Related Activities, Goal Orientation, and Cognitive Activities) as predictors of NBCE Part 1 examination scores. The current study utilized the 3-factor latent structure supported by the most current research[14,15,17] (Fig. 1). The study was approved by the Logan Chiropractic College institutional review board.

Subjects

A convenience sample of 102 consenting volunteer students from the spring and summer 2009 trimester-one classes at Logan Chiropractic College completed the LASSI. Inclusion criteria for the current study required the students to complete the LASSI questionnaire in trimester one and take the NBCE Part 1 examination in 2010. Sixty-nine volunteers (Fig. 2) met the inclusion criteria for the study (26 female and 43 male participants, mean age 24 years, SD = 4.70). Tertiles were formed from the distribution of the means of the 6 NBCE Part 1 test scores. As can be seen in Table 1, scores for the low NBCE group (Tertile 1, $n = 22$) ranged from 351.5 to 518.33, the middle NBCE group (Tertile 2, $n = 24$) ranged from 518.33 to 570.67, and the high NBCE group (Tertile 3, $n = 23$) ranged from 570.67 to 684.5.

Instrumentation

The LASSI[23] is a self-administered and self-scored assessment instrument consisting of an 80-item, 10-subtest questionnaire using a 5-point Likert scale. Each of the 10 subtests comprises 8 items. The Likert items refer to the degree to which a statement is perceived as typical of the respondent, with 5 representing the highest ("very much typical of me") to 1 representing the lowest ("not at all typical of me") degree of agreement. Only the Anxiety subtest is reverse scored, meaning that the higher the score, the less anxiety is reported by the subject.

The NBCE Part 1 examination consists of 6 basic science tests including general anatomy, spinal anatomy, physiology, chemistry, pathology, and microbiology/public health.[9] The NBCE Part 1 examination is a standard-

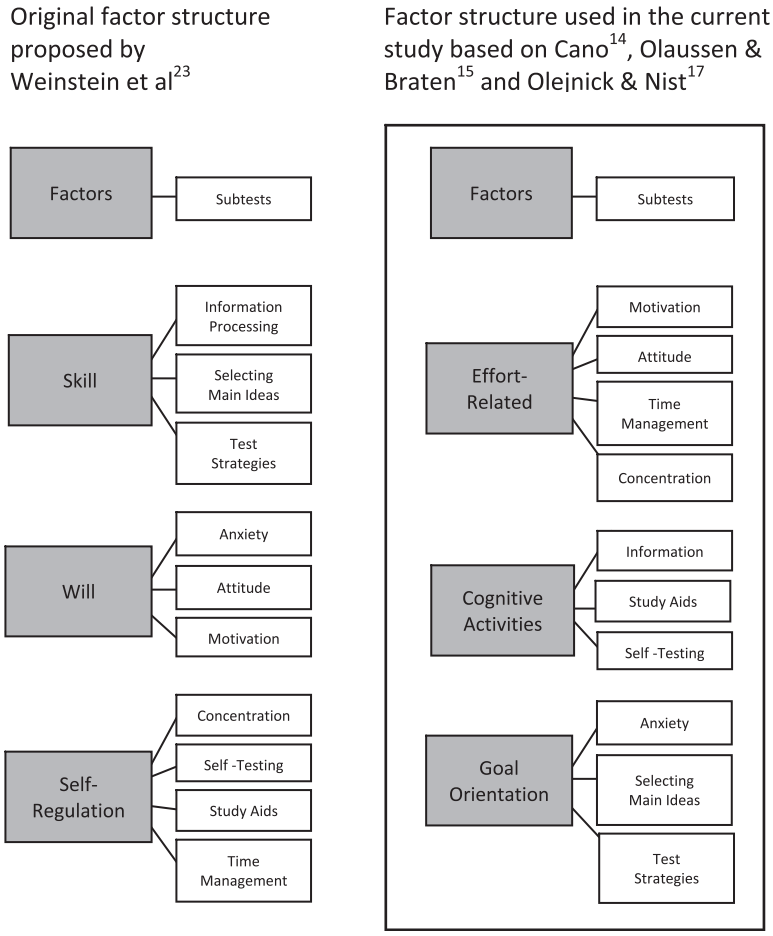

Figure 1 - Learning and study strategies inventory (lassi) original proposed factor structure compared with the factor structure used in the current study.

ized test consisting of 110 multiple-choice questions in each basic science area.

Procedure

Subjects signed consent forms, received instructions, and then completed the LASSI in one class period during the third or fourth week of Trimester 1 in spring and summer of 2009. The standard administration of the LASSI, which includes student access to their respective scores, was utilized. The tests were scored by trained data analysts to ensure consistency and then returned confidentially to students.

The principal investigator (PI) was authorized by the Registrar in the Division of Enrollment Management to obtain NBCE test scores from the transcript record database in a manner consistent with Family Educational Rights and Privacy Act (FERPA) guidelines. Identification numbers were assigned to participants to maintain confidentiality throughout the study. All data collected and compiled were verified by the PI.

Data Analysis

The 6 NBCE Part 1 examinations, the 10 LASSI subtests, and 3 factor scores were analyzed. An overall NBCE examination score was computed for each subject by calculating the mean of the 6 tests. Linear trends tests (for continuous variables) and Mantel-Haenszel trend tests (for categorical variables) were used to determine

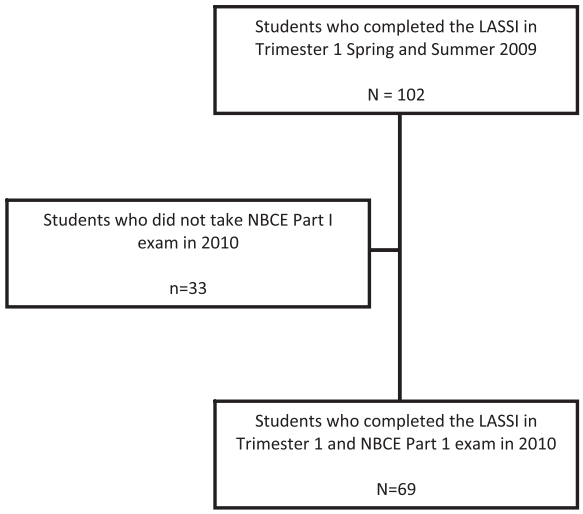

Figure 2 - Flow chart of participants included in the sample.

Table 1 - National Board of Chiropractic Examiners (NBCE) Part 1 Exam Score Means and Standard Deviations for Total Sample and Tertiles

		NBCE Averages		
Basic Science Tests[a]	Total $n = 69$	Low Tertile 1 (351.5 to <518.33) $n = 22$	Medium Tertile 2 (518.33 to <570.67) $n = 24$	High Tertile 3 (570.67 to 684.5) $n = 23$
Chemistry	564.2 ± 88.8	465.3 ± 55.5	577.4 ± 45.4	645.0 ± 49.9
General anatomy	542.0 ± 92.1	447.2 ± 77.3	543.2 ± 37.2	631.5 ± 41.3
Microbiology/public health	519.5 ± 78.1	443.0 ± 68.9	537.7 ± 54.1	573.6 ± 44.5
Pathology	499.3 ± 85.6	404.0 ± 60.7	525.7 ± 46.1	563.0 ± 53.1
Physiology	582.7 ± 77.8	507.2 ± 64.7	579.0 ± 38.1	658.6 ± 38.0
Spinal anatomy	526.4 ± 91.4	428.0 ± 55.2	532.6 ± 48.0	614.0 ± 52.2

[a] Basic science areas tested in the NBCE Part 1 exam

whether the LASSI subtest scores were different between high, medium, and low levels of NBCE Part 1 test scores. A multiple regression model was used to predict the average NBCE Part 1 examination scores using the 3 LASSI factor scores as predictor variables. All analyses were performed with SAS version 9.2 (SAS Inc, Cary, NC), and a 2-tailed p value of .05 was used to determine statistical significance.

RESULTS

Four LASSI subtests were significantly different between the NBCE Part 1 tertiles: Anxiety, Concentration, Selecting Main Ideas, and Test Strategies. In each instance, Tertile 1 LASSI subtest scores were significantly lower than Tertiles 2 and 3, while Tertiles 2 and 3 were no different (Table 2). The LASSI factor score Goal Orientation was significantly different between the NBCE Part 1 tertiles. Tertile-1 Goal Orientation factor scores were significantly lower than Tertiles 2 and 3, while Tertiles 2 and 3 were no different from each other (Table 2). The LASSI factor Goal Orientation was significantly associated with NBCE Part 1 overall examination scores, and all 6 of the NBCE Part 1 basic science tests; however, the other 2 factors Effort-Related Activities and Cognitive Activities did not reach statistical significance (Table 2).

Overall the model R-squares for NBCE Part 1 and the 6 basic science tests were weak to moderate (R^2 range .09–.22) (see Table 3). Specifically, for every 1-point increase in the LASSI factor Goal Orientation, the NBCE Part 1 overall increased by 8 points ($p = .0028$); Chemistry increased by 9.33 points ($p = .0035$); General Anatomy increased by 7.35 points ($p = .03$); Microbiology increased by 7.71 points ($p = .007$); Pathology increased by 7.61 points ($p = .015$); Physiology increased by 7.09 points ($p =$

Table 2 - Trend Tests for National Board of Chiropractic Examiners (NBCE) Tertile Means, Learning and Study Strategies Inventory (LASSI) Subtest Scores, and LASSI Factors

		NBCE Averages			
	Total $n = 69$	Low Tertile 1 (351.5 to <518.33) $n = 22$	Medium Tertile 2 (518.33 to <570.67) $n = 24$	High Tertile 3 (570.67 to 684.5) $n = 23$	p Value
Tri 1 LASSI subtests[a]					
Anxiety	30.2 ± 5.9	27.8 ± 6.0	31.2 ± 6.6	31.6 ± 4.2	.029
Attitude	30.8 ± 5.3	30.3 ± 5.7	31.1 ± 6.0	31.1 ± 4.1	.592
Concentration	25.6 ± 6.0	23.3 ± 6.0	26.2 ± 6.7	27.1 ± 4.6	.035
Information processing	29.5 ± 4.8	29.0 ± 3.6	28.9 ± 6.0	30.7 ± 4.6	.221
Motivation	31.7 ± 5.2	30.8 ± 5.1	31.0 ± 6.0	33.3 ± 4.2	.119
Self-testing	22.4 ± 6.0	21.6 ± 5.9	22.3 ± 6.4	23.1 ± 5.8	.410
Selecting main ideas	30.6 ± 5.1	28.3 ± 5.6	31.7 ± 5.3	31.7 ± 3.8	.022
Study aids	23.7 ± 5.3	23.5 ± 4.7	24.0 ± 6.1	23.7 ± 5.1	.902
Time management	23.2 ± 5.9	23.0 ± 5.1	23.4 ± 6.5	23.3 ± 6.2	.904
Test strategies	31.3 ± 4.5	29.0 ± 3.6	32.3 ± 5.0	32.6 ± 4.0	.007
Tri 1 LASSI factors[b]					
Effort-related activities	27.8 ± 4.5	26.9 ± 4.6	27.9 ± 5.1	28.7 ± 3.6	.178
Goal orientation	30.7 ± 4.2	28.4 ± 3.6	31.7 ± 5.0	32.0 ± 3.0	.003
Cognitive activities	25.2 ± 4.4	24.7 ± 3.8	25.1 ± 5.2	25.8 ± 4.0	.381

[a] Continuous variables compared using linear trend test.
[b] Categorical variables compared using Mantel-Haenszel trend test.

Table 3 - Regression Model for Learning and Study Strategies Inventory (LASSI) Factors and National Board of Chiropractic Examiners (NBCE) Part 1 Exam and Tests

Outcome	Beta Estimate: Goal Orientation	Beta Estimate: Effort-Related Activities	Beta Estimate: Cognitive Activities	Model R^2
Average NBCE	8.0 ($p = .0028$)	−1.97 ($p = .49$)	.69 ($p = .79$)	.164
Chemistry	9.33 ($p = .0035$)	−1.89 ($p = .58$)	−.05 ($p = .99$)	.153
General anatomy	7.35 ($p = .03$)	−4.03 ($p = .27$)	2.31 ($p = .49$)	.09
Microbiology/public health	7.71 ($p = .007$)	−1.61 ($p = .60$)	−1.23 ($p = .66$)	.12
Pathology	7.61 ($p = .015$)	−.87 ($p = .80$)	−.78 ($p = .80$)	.11
Physiology	7.09 ($p = .012$)	−1.8 ($p = .55$)	.36 ($p = .90$)	.11
Spinal anatomy	9.0 ($p = .004$)	−1.6 ($p = .63$)	3.55 ($p = .25$)	.22

.012); and Spinal Anatomy increased by 9.0 points ($p = .004$) (Table 3).

DISCUSSION

Results from this study show that 4 of the 10 LASSI subtests and 1 of the 3 LASSI factors are statistically significant predictors of NBCE Part 1 examination performance. For participants in this study, the LASSI subtests Anxiety, Concentration, Selecting Main Ideas, and Test Strategies, and the Goal Orientation factor predicted differences between low vs middle and high test scores on the NBCE Part 1 examination. The finding that Tertile-1 scores were significantly lower than Tertiles 2 and 3 for 4 subtests and 1 factor may be useful in identifying students at risk for poor NBCE Part 1 examination performance.

Results of the current study have agreements and disagreements with previous research about which LASSI subtests and factors predict standardized test performance. Pringle and Lee[7] found significant correlations between all the LASSI subtest scores and NBCE examination scores for chiropractic students. Sleight and Mavis[22] showed that Motivation, Concentration, and Study Aids differentiated low, medium, and high performance on the MCAT. West and Sadoski[25] demonstrated that Self-Testing and Time Management subtests were predictors of success on the MCAT. Variability in the results of these studies may be due to differences in sampling, instrumentation, and/or experimental procedures. A consensus of studies concludes some of the LASSI subtests and factors are useful in predicting standardized test performance[7,22,25] and GPA in several educational contexts.[8,14,15,20]

Considering that short-term coaching courses have not significantly increased NBCE examination scores,[10] the results of this study suggest that designing interventions based on LASSI subtest performance, such as online tutorials or short courses to improve learning and study strategy skills, may be more beneficial for chiropractic students' NBCE examination preparation. Continuing research is needed to investigate which LASSI tests and factors are the best predictors in various performance categories and to examine the effects of learning and study skills training on NBCE performance.

Limitations of the current study include the inherent biases in self-report instruments and uncertain generalizability owing to the unique characteristics of the sample of trimester-1 chiropractic students. Additionally, our multiple regression models (Table 3) showed weak to moderate R^2 values. While the LASSI factor of Goal Orientation is a significant predictor of the differences between lower and higher performers on NBCE Part 1, a complete model would consider multiple covariates that contribute to predicting NBCE performance. However, the goal of the current study was to study the association between NBCE test scores and LASSI scores, not to build a predictive model for NBCE.

CONCLUSION

The most consistent support from the research, considering the variation in samples and methodologies, is for the LASSI subtests Anxiety and Concentration and the LASSI factor of Goal Orientation in relationship to academic performance, including GPA and national board examination scores. A consensus of research for chiropractic students shows the LASSI subtests of Anxiety, Concentration, Selecting Main Ideas, and Test Strategies, and the LASSI factor Goal Orientation are the best predictors of academic success with regard to GPA and NBCE Part 1 examination and test scores. It may be useful to include aspects of learning and study strategies from the LASSI factors and subtests to aid chiropractic students in preparation for national board examinations as well as to assist educators in designing performance-enhancing interventions.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

About the authors

Christine Schutz is with the Department of Student Services, Leanne Dalton is a senior intern, and Rodger Tepe is the Dean of Research and Development, all at Logan College of Chiropractic. Address correspondence to Christine Schutz, 1851 Schoettler Road, Chesterfield, MO 63006-1065; e-mail: christine.schutz@logan.edu. This article was

received April 18, 2012, revised July 30, 2012, and accepted August 6, 2012.

REFERENCES

1. Muis RM, Winne PH, Jamieson-Noel D. Using a multitrait-multimethod analysis to examine conceptual similarities of three self-regulated learning inventories. *Br J Educ Psychol*. 2007;77:177–195.
2. Winne PH. Self-regulated learning viewed from models of information processing. In: Zimmerman BJ, Schunk DH, eds. Self-*Regulated Learning and Academic Achievement: Theoretical Perspectives*. 2nd ed. Hillsdale, NJ: Erlbaum; 2001:153–189.
3. Weinstein CE, Palmer DR. *LASSI User's Manual: Learning and Study Strategies Inventory*. 2nd ed. Clearwater, FL: H&H Publishing Company, Inc; 2002.
4. Albaili MA. Differences among low-, average- and high-achieving college students on learning and study strategies. *Educ Psychol*. 1997;17(1/2):171–178.
5. Braten I, Olaussen BS. Motivation in college: understanding Norwegian college students' performance on the LASSI motivation subscale and their beliefs about academic motivation. *Learn Individ Differ*. 2000;12(2): 177–187.
6. Swinton J, Moore J. LASSI Project, fall 2000 student outcomes assessment. *LASSI in Action*. July 2003:4–6.
7. Pringle RK, Lee J. The use of the learning and study strategies inventory (LASSI) as a predictor for success or failure on part 1 of the National Board of Chiropractic Examiners test. *J Manipulative Physiol Ther*. 1998;21(3):164–166.
8. Schutz CM, Gallagher ML, Tepe RE. Differences in learning and study strategies inventory scores between chiropractic students with lower and higher grade point averages. *J Chiropr Educ* 2011;25(1):5–10.
9. Sandefur R, Coulter I. Licensure and legal scope of practice. In: Cherkin DC, Mootz RD, eds. *Chiropractic in the United States: Training, Practice, and Research: AHCPR Research Report*. Rockville, MD: US Dept of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research; 1997:36–42.
10. Cunningham KA, Percuoco RE, Marchiori DM, Christensen MG. A preliminary analysis of preparation strategies and other correlates to performance on a basic science qualifying exam in chiropractic. *J Allied Health*. 2006;35(1):e59–e72. http://www.ingentaconnect.com/content/asahp/jah/2006/00000035/00000001/art00013?token=004b18e1b9bcc8895a666f3a7b6c7b40386f5b6b354c7d762549264f65263a3d4f58762f461. Accessed July 12, 2012.
11. Zhang J. The correlation of student's entry-level GPA, academic performance, and the national board examination in all basic science subjects. *J Chiropr Educ*. 1999;13(2):91–99.
12. Wolfenberger V. Correlations between chiropractic national board (part 1) scores. *Coll Univ*. 1999;74(2): 16–20.
13. Weinstein CE. *Overview of the LASSI*. Clearwater, FL: H&H Publishing Company, Inc; 2006.
14. Cano F. An in-depth analysis of the learning and study strategies inventory (LASSI). *Educ Psychol Meas*. 2006;66(6):1023–1038.
15. Olaussen BS, Braten I. Identifying latent variables measured by the learning and study strategies inventory (LASSI) in Norwegian college students. *J Exp Educ*. 1998;67:82–96.
16. Olivarez A, Tallent-Runnels MK. Psychometric properties of the learning and study strategies inventory-high school version. *J Exp Educ* 1994;62:243–257.
17. Olejnick S, Nist SL. Identifying latent variables measured by the learning and study strategies inventory (LASSI). *J Exp Educ*. 1992;60:151–159.
18. Melancon JG. Reliability, structure, and correlations of learning and study strategies inventory scores. *Educ Psychol Meas* 2002;62:1020–1027.
19. Flowers LA, Bridges BK, Moore JL. Concurrent validity of the Learning and Study Strategies Inventory (LASSI): a study of African American precollege students. *J Black Stud*. 2012;43(2):146–160.
20. Lobb WB, Wilkin NE, McCaffrey DJ, Wilson MC, Bentley JP. The predictive utility of nontraditional test scores on first-year pharmacy student academic performance. *Am J Pharm Educ*. 2006;70(6):1–6.
21. Filho GR, Vieira JE. The relationship of learning environment, quality of life and study strategies measures to anesthesiology resident academic performance. *Econ Educ Policy*. 2007;104(6):1467–1472.
22. Sleight DA, Mavis BE. Study skills and academic performance among second-year medical students in problem-based learning. *Med Educ Online*. 2006;11:1–6.
23. Weinstein CE, Palmer DR, Shulte AC. Learning and study strategies inventory. 2nd ed. Clearwater, FL: H&H Publishing Company, Inc.; 2002.
24. Loomis KD. Learning styles and asynchronous learning: comparing the LASSI model to class performance. *J Asynchronous Learn Network* 2000;4(1):23–32.
25. West C, Sadoski M. Do study strategies predict academic performance in medical school? *Med Educ*. 2011;45:696–703.