The Journal of Education in Perioperative Medicine

ORIGINAL RESEARCH

Undirected learning styles and academic risk: Analysis of the impact of stress, strain and coping

STEPHEN KIMATIAN, MD
SARA LLOYD, PHD
JEFFREY BERGER, MD
LORRAINE STEINER, PHD
ROBERT MCKAY, MD
DEBORAH SCHWENGEL, MD

Abstract

Background Learning style inventories used in conjunction with a measure of academic achievement consistently show an association of meaning directed learning patterns with academic success, but have failed to show a clear association of undirected learning styles with academic failure. Using survey methods with anesthesia residents, this study questioned whether additional assessment of factors related to stress, strain, and coping help to better define the association between undirected learning styles and academic risk.

Methods

Pearson chi squared tests. 296 subjects were enrolled from eight institutions with 142 (48%) completing the study. American Board of Anesthesiologists In Training Examinations (ITE) percentiles (ITE%) were used as a measure of academic achievement. The Vermunt Inventory of Learning Styles (ILS) was used to identify four learning patterns and 20 strategies, and the Osipow Stress Inventory-Revised (OSI-R) was used as a measure of six scales of occupational stress, four of personal strain, and four coping resources.

Results Two learning patterns had significant relationship with ITE scores. As seen in previous studies, Meaning Directed Learning was beneficial for academic achievement while Undirected Learning was the least beneficial. Higher scores on Meaning Directed Learning correlated positively with higher ITE scores while higher Undirected and lower Meaning Directed patterns related negatively to ITE%. OSI-R measures of stress, strain and coping indicated that residents with Undirected learning patterns had higher scores on three scales related to stress, and 4 related to strain, while displaying lower scores on two scales related to coping. Residents with higher Meaning Directed patterns scored lower on two scales of stress and two scales of strain, with higher scores on two scales for coping resources.

Conclusions Low Meaning Directed and high Undirected learning patterns correlated with lower ITE percentiles, higher scores for stress and strain, and lower coping resources. This association suggests that successful remediation of at-risk residents must address stress, strain and coping if long term academic improvement is expected. Further research to identify the value of stress, strain, and coping screening and education is warranted.

The Journal of Education in Perioperative Medicine

Stephen Kimatian is Vice Chair for Education and Chair of Pediatric Anesthesiology at the Anesthesiology Institute, Cleveland Clinic, Cleveland, OH; **Sara Lloyd** is President of Human Resources Advantage, Professional Coach for residents at the University of Kansas School of Medicine, Wichita, KS; **Jeffrey Berger** is Associate Professor of Anesthesiology at the George Washington University School of Medicine and Health Sciences, Washington, D.C.; **Lorraine Steiner** is Associate Professor in the Department of Mathematics, Director of Institutional Research at Newman University, Wichita, KS; **Robert McKay** is Professor and Chair, Department of Anesthesiology at the University of Kansas School of Medicine, Wichita, KS; **Deborah Schwengel** is Assistant Professor of Anesthesiology, Critical Care and Pediatrics, Program Director at Johns Hopkins University School of Medicine, Baltimore, MD.

Corresponding author: Stephen J. Kimatian, MD, FAAP, Department of Pediatric Anesthesiology, Anesthesiology Institute, 9500 Euclid Ave/P21, Cleveland, OH 44195, Telephone: (216) 444-5996

Email address: Stephen Kimatian: kimatis@ccf.org

No financial support received from foundations, institutions, pharmaceutical or other private companies.

Introduction

All programs deal with residents with educational deficiencies and struggle to find ways to identify and remediate deficits.[1-7] The most common resident deficit cited is insufficient medical knowledge with 7-12% of residents identified as being at "academic risk".[7-10]

In this study, the American Board of Anesthesiology In Service Training Exam (ITE) was the certifying body. The American Board of Anesthesiology is a member of the American Board of Medical Subspecialties and the national accrediting body for Anesthesiology. At the time of this study the ITE was given annually to all anesthesiology residents training in programs accredited by the Accreditation Council for Graduate Medical Education. The ITE is a nationally standardized and validated tool for assessment of resident knowledge. [11]

Early identification of residents with learning deficiencies[12,13] is central to providing sufficient time for targeted assistance to correct deficiencies. Intervention with residents during the first year is more likely to succeed due to lighter patient loads and expectations for more feedback and guidance.[14] Responses to enhance resident performance range from informal learning plans, such as advice to "study more and attend journal club," to specific, written remediation programs with measurable goals and objectives.[9,12,13] While these may address the observed symptoms of poor academic performance, the key goal of primary prevention should be to expand learning patterns, guide teaching, and set a basis for long term success in future learning environments. The added benefit of successful, long term, remediation is decreased department resource utilization and faculty time demands.[14] If learning problems are not identified and addressed, learning strategies do not change. Suboptimal learning results from ineffective study patterns leads to increasing resident frustration, affecting both clinical and academic outcomes.[15]

Given the process of gaining admission to medical school, residents are considered "high achievers;" making the identification of academic risk something that is not consistent with their self-image. Successful remediation requires helping with resident denial, identifying specific areas of challenge, targeting unique issues, and establishing goals for mentoring or remediation plans.[13] The challenge is finding the optimal blend of cognitive/metacognitive skills that facilitate meaning directed learning patterns and develop a deep approach to learning.[16-18]

Diagnostic assessments tied to established relationships measuring academic achievement are an essential, but currently elusive, component of successful remediation.[1-19] The Vermunt Inventory of Learning Styles (ILS) measures four different categories of strategies: cognitive processing (thinking activities to process learning contents), metacognitive regulation activities (regulating the cognitive activities), mental models of learning (integration of learning conceptions including the role of self, teachers and others), and learning orientations (personal goals, motives, doubts and concerns).[20] Four Learning Styles emerged from these strategies: the Meaning Directed Learning Style (MDLS), the Reproduction Learning Style, (RDLS), the Application Directed Styles (ADLS) and the Undirected Learning Style (UDLS) . The Meaning Directed Learning Style includes student patterns of self-regulation of learning and processing that integrate applications of learning and develop of independent thinking. The Reproduction Directed Learning Style identifies students who look to teachers to tell them what to learn with a focus on memorizing and rehearsing information. The Application Directed Style identifies students focused on learning focused on meeting the requirements for certification of accreditation. Lastly,

students with Undirected Learning Styles often display difficulty in determining between primary and secondary points, struggling with the amount of materials to study, and concerns about ability to process materials. The ILS is validated in students seeking advanced professional degrees in law, medicine and psychology and may play a diagnostic role in the earlier detection of learners potentially at risk academically. [19-21]

In order to make optimal use of limited resources, clarity in identifying deficits helps to focus remediation plans on specific areas of deficiency and set clear goals aimed at measurable improvements .[6,9,22] Lacking structured processes, struggling residents tend to spend more time using unsuccessful learning strategies when simply urged to increase study. Without specialized intervention on how to improve efficiency, they become increasingly frustrated and are more likely to experience negative outcomes.[1,13,22]

In a previous pilot study, the authors explored anesthesiology residents' learning patterns using the Vermunt Inventory of Learning Styles (ILS). The pilot study confirmed the finding of previous studies of learning pattern inventories that showed a positive relationship between Meaning Directed Learning Patterns and higher ITE% and a negative relationship between ITE% and Undirected patterns. However, the relationship between UDLS and performance was bimodal with some student performing well on the ITE despite having an UDLS. This confounding finding was also noted by Vermunt, who's later work focused on patterns rather than styles to more clearly indicate periods of change, growth, and acclimation.[20,21,24] Based on coaching with residents struggling to increase their ITE%, the role of stress and strain as factors in examinations measuring academic knowledge emerged. It was hypothesized that measuring occupational stress, personal strain, and coping resources, as assessed using the Osipow Stress Inventory-Revised,[25] might reveal relationships between non-academic factors and measures of medical knowledge and help explain how students with UDLS might, with a robust support system, succeed despite an inefficient method of study.

The general questions of this study were: (1) Do relationships exist between measures of Medical Knowledge, as assessed by the American Board of Anesthesiology In-Training Examination and learning patterns and strategies as identified by the Vermunt Inventory of Learning Styles? (2) What relationships exist between non-academic factors of stress, strain and coping, as measured by the Osipow Stress Inventory-Revised, and significant learning patterns? (3) Do learning strategies and factors of stress strain and coping correlate with academic performance?

Methods

Context of the study

The authors conducted survey research offered to all residents enrolled in eight ACGME accredited anesthesiology residency programs: George Washington University, Johns Hopkins University, University of Kansas Medical Center—Kansas City, University of Kansas Medical Center—Wichita, Ochsner Medical Center, Penn State Milton S. Hershey Medical Center, University of Rochester, and University of Washington.

Institutional Review Board Approval was received from each institution, and residents were recruited to volunteer to participate in the study. To avoid any perception of coercion, to protect resident identity, and to ensure that the results of the study would not be used in resident evaluations, program directors designated a study coordinator to recruit the residents and administer the survey instruments. Program directors did not know the identity of residents who participated and received only aggregate data for their department. Residents who wanted access to individual results could request direct communication from the Principal Investigator and an individualized coaching session at no cost.

The study was completed during the first four months of 2009 such that all surveys were completed before the residents took that year's American Board of Anesthesiology In-Training Examination (ITE). After study

coordinators obtained approved consent from each participant, the resident received a numbered study packet with the Vermunt Inventory of Learning Styles (ILS), Osipow Occupational Stress Inventory-Revised (OSI-R), and an Educational Demographic Survey to determine age, gender, postgraduate year (PGY), family status, ethnicity, and relationship to faculty mentor and fellow residents. Following survey completion, the packets were sent to the principal investigator for scoring. The program coordinator maintained a spreadsheet of resident participants and packet identification numbers. After receiving ITE results, the program coordinators added the ITE scores and post graduate year to the spreadsheet and forwarded the results to the primary investigator. Personalized results were sent to their programs in sealed envelopes by identification numbers, assuring confidentiality of results.

Data Analysis: Vermunt's Inventory of Learning Styles is a diagnostic assessment focused on tertiary learning. The 120 question self-report survey utilizes a 1-5 Likert Scale. The 20 learning strategies comprised four domains: Processing Strategies, Regulation Strategies (metacognition), Mental Models of Learning, and Learning Orientations. A factor analysis identified four learning styles, later referred to as learning patterns: Meaning Directed, Reproduction Directed, Undirected, and Application Directed. Definitions of each learning pattern and scale can be found in the glossary.

The Osipow Stress Inventory-Revised is a 140 question self-report diagnostic assessment with a Likert scale ranging from 1-5. The three domains measured are: Occupational Stress, Personal Strain, and Coping Resources. Occupational Stress is measured by six scales: Role Overload, Role Insufficiency, Role Ambiguity, Role Boundary, Responsibility and Physical Environment. Personal Strain has four scales: Vocational Strain, Psychological Strain, Interpersonal Strain, and Physical Strain. Coping Resources measure Recreation, Self-care, Social Support, and Rational Cognitive Coping.

Descriptive statistics of measures of ITE% are reported in Table 1. The descriptive statistics for the four learning patterns and twenty strategies, and six scales of occupational stress, four scales of personal strain and four coping resources were also calculated, including means and standard deviations. Correlations were analyzed to determine a relationship of learning patterns and strategies with ITE%, Table 2. A dependent *t*-test was conducted to determine if there was a significant difference in mean learning patterns, specifically between Meaning Directed and Undirected learning patterns, between those who scored lower on ITE% (less than or equal to the 35%tile) compared to those who scored higher (above the 35%tile). The Meaning Directed and Undirected learning pattern scores were divided between low and high based on the means for the respective variables. Factorial ANOVA was then used to determine the individual effects and interaction effect of Meaning Directed and Undirected learning patterns on ITE%. A correlation analysis of occupational stress, personal strain, and coping resources variables with Meaning Directed and Undirected Learning patterns was also conducted. A p-value less than 0.05 was considered significant.

Results

Of the 296 enrolled students in the eight ACGME accredited anesthesiology post graduate education programs, 160 (54%) responded, of which 142 (48%) had complete data, see Figure 1. The ITE% mean for all programs is 50.7 with a standard deviation of 28.89.

A dependent *t*-test revealed that on average the mean of the Meaning Directed learning patterns was lower for those scoring at the 35th percentile or below (M=3.0, SE=.05) than to those scoring above the 35th percentile (M=3.4, SE=.08, $t(140)=3.879$, $p<.01$, $r=.31$). There was not a significant difference in the means of the Undirected learning pattern scores between low scorers and high scorers.

Interaction Effect of Meaning Directed and Undirected Learning Patterns on ITE%

Both the Meaning Directed and Undirected learning pattern scores were approximately bell-shaped with means of 3.25 and 2.79, respectively. A participant was considered to have

a low Meaning Directed learning pattern if their score was below 3.25 and high if it was greater than or equal to 3.25. Similarly, a participant was considered to have a low Undirected learning pattern if the score was less than 2.79 and high if it was greater than or equal to 2.79. Analysis using factorial ANOVA further defined any individual and interaction effects of Meaning Directed and Undirected learning patterns on ITE%. Meaning Directed learning pattern had a significant main effect on ITE% ($F(1,138)=10.741$, $p<.01$). When Meaning Directed was ignored, Undirected did not have an effect on ITE%. However, the interaction effect was significant ($F(1,138)=4.430$, $p<.05$). The effect of Meaning Directed learning pattern on ITE% is different for participants with low Undirected learning pattern compared to participants with high Undirected learning pattern. Specifically, for those participants with low Meaning Directed learning pattern, ITE% was significantly lower for those with high Undirected learning pattern (M=36.0, SD=28.1) compared to those with low Undirected learning pattern (M=50.5, SD=30.1). For those participants with high Meaning Directed learning pattern, the ITE% was similar between low (M=56.0, SD=25.7) and high (M=61.0, SD=26.2) Undirected learning patterns. See Figure 2.

Differentiated Performance of ILS Orientation and Strategies for those Participants with High Undirected Learning Patterns

A correlation analysis showed that those participants with higher scores of Undirected learning patterns tend to have higher scores on Ambivalent ($r=.674$, $p<.01$) and Lack of Regulation ($r=.660$, $p<.01$). There was also a correlation between Undirected learning patterns and low scores on Self-regulation of Learning Content ($r=-.189$, $p<.05$) as well as with Construction of Knowledge ($r=.181$, $p<.05$), however, the effect sizes are low. There is no indication that those with higher scores of Undirected learning pattern have lower scores on Self-regulation of Learning Process and Results, Critical Processing, or Analyzing. Participants with higher scores of Meaning Directed learning pattern tend to have lower scores on Ambivalent ($r=-.236$, $p<.01$) and Lack of Regulation ($r=-.205$, $p<.01$), but again the effect sizes are low. They have higher scores on Self-regulation of Learning Process and Result ($r=.774$, $p<.01$), Self-regulation of Learning Content ($r=.777$, $p<.01$), Critical Processing ($r=.808$, $p<.01$), Analyzing ($r=.496$, $p<.01$), and Construction of Knowledge ($r=.496$, $p<.01$). For the most part, these are strong correlations with medium to high effect sizes.

Discussion

Positive and negative relationships exist between measures of medical knowledge and learning patterns. Confirming previous studies, as Meaning Directed scores increased, ITE percentiles tended to increase. Similarly, those with higher Undirected and lower Meaning patterns tended to have lower ITE percentiles. The pattern of low Meaning Directed and High Undirected identified those most at risk academically and the targeted group for remediation. The question remained, however, of why these residents, having had a very successful academic career up to this point, now found themselves at academic risk. The authors hypothesized that the transition to the work based "apprenticeship" of residency requires higher levels of metacognitive management, personal organization, and coping skills to facilitate the transition.

In this study, the addition of the OSI-R allowed for assessment of nonacademic factors such as stress, strain, and coping, to further understanding of the relationship between academic performance and learning styles. Residents with high Undirected scores show more stress and strain and report fewer coping resources while those with high Meaning Patterns demonstrated less strain and stress and more effective coping resources.

The combination of these two diagnostic assessments, ILS and OSI-R, provides focused academic and non-academic strategies to improve the educational experience for struggling residents. Anecdotal information from coaching using both of these tools suggest that the additional focus on nonacademic factors can play a significant role, not only in remediation from the acute signs of academic risk, but in

long term academic success and higher levels of personal satisfaction and personal accomplishment. This raises the need for further studies to determine if proactive assessment and identification of learning style coupled with stress, strain, and coping mechanisms, and personal coaching and mentorship can modify the risk of academic failure. Earlier identification of at-risk residents leads to specialized interventions for earlier adaptation of more effective learning and coping strategies, increasing learning opportunities. Specific strategies gleaned from diagnostic assessments provide clarity, specificity and structure for remediation plans and for goal development. Potential benefits include earlier identification of struggling residents, enhanced educational growth from formal or informal remediation plans, decreased faculty time determining concerns, and measured outcomes.

This study had several limitations. The ITE, while a standardized tool for measurement of medical knowledge, does not asses other areas of academic competency. As standardized tools for evaluation of other competencies become available, further research in these relationships would be merited. The study was limited to a single specialty and it is unknown if these relationships would extend to residents in other medical specialties, although the authors could not readily identify any reason why they would not apply more broadly in graduate medical education. Additional studies are needed to explore learning patterns and ITE results in other medical specialties to explore earlier identification of residents potentially at risk for academic and non-academic factors. While the authors were able to statistically identify the association between leaning styles and stress strain and coping, causation is only implied. Causation would be better supported if subsequent work determines that interventions designed to address the associated issues of stress, strain and coping results in a shift toward Meaning Directed learning and improved academic performance.

References

1 Guerrasio, J. *Remediation of the Struggling Medical Learner*. LaVergne, TN: Association for Hospital Medical Education 2013.

2 Guerrasio J, Garrity MJ, Aagaard EM. Learner deficits and academic outcomes of medical students, residents, fellows, and attending physicians referred to a remediation program. *Acad Medicine* 2014;**89**:352-8.

3 Hauer KE, Ciccone A, Henzel TR, Katsufrakis P, Miller SH, Norcross WA, Papadakis MA, Irby DM. Remediation of the deficiencies of physicians across the continuum from medical school to practice: a thematic review of the literature. *Acad Med* 2009; **84:**1822-32.

4 Leung FH, Rathnapalan S. A framework to teach self-reflection for the remedial resident. *Med Teach* 2011;**33**(Web paper):e154-7.

5 Smith CS, Stevens NG, Servis M. A general framework for approaching residents in difficulty. *Res Edu* 2007;**39**:331-6.

6 Torbeck L, Canal DF. Remediation practices for surgery residents. *Am J Surg* 2009;**197**:397-402.

7 Reamy BV, Harman JH. Residents in trouble: an in-depth assessment of the 25-year experience of a single family medicine residency. *Res Edu* 2006; **38**:252-7.

8 Ratan RB, Pica AG, Berkowitz, RL. A model for instituting a comprehensive program of remediation for at-risk residents. *Ob Gyn* 2008;**112**:1155-9.

9 Torbeck L, Wrightson A. A method for defining competency-based promotion criteria for family medicine residents. *Acad Med* 2005;80:832-9.

10 Yao DC, Wright SM. The challenge of problem residents. JGIM;**16**:486-92.

11 Available from: http://www.theaba.org.

12 Bergen PC, Littlefield JH, O'Keege GE, Rege RV, Anthony TA, Lim LT, Turnage, RH. Identification of high-risk residents. *J Surg Res* 2000;**92**:239-244.

13 Katz ED, Dahms R, Sadosty AT, Stahmer SA, Goyal D. Guiding principles for resident remediation: recommendations of the CORD Remediation Task Force. *Acad Emerg Med* 2010;**17**S95-103.

14 Shapiro J, Prislin MD, Larsen, KM, Lenahan, PM. Working with the resident in difficulty. *Fam Med* 1987;**19**:368-75.

15 Sayer M, De Saintonge MC, Evans D, Wood D. Support for students with academic difficulties. *Med Edu* 2002;**36**:643-50.

16 Mattick K, Knight L. High-quality learning: harder to achieve than we think? *Med Ed* 2007;**41**:638-44.

17 Mattick K, Dennis I, Bligh J. Approaches to learning and studying in medical students: validation of a revised inventory and its relation to student characteristics and performance. *Med Ed* 2004;**38**:535-43.

18 McManus IC, Richards P, Winder BC, Sproston KA. Clinical experience, performance in final examinations, and learning style in medical students: prospective study. *BMJ* 1998;**316**:345-50.

19 Boyle A, Duffy T, Dunleavy K. Learning styles and academic outcome: the validity and utility of Vermunt's Inventory of Learning Styles in a British higher education setting. *Brit J of Ed Psych* 2003;**73**:267-90.

20 Vermunt JD. Metacognitive, cognitive and affective aspects of learning styles and strategies: A phenoneurographic analysis. *High Ed* 1996;**31**:25-50.

21 Vermunt JD, Vermetten YJ. 2004. Patterns in student learning: relationships between learning strategies, conceptions of learning, and learning orientations, *Ed Psych Rev* 2004;**16**:359-84.

22 Kedian T, Gussad L, Savageau JA, Cohrssen A, Abramson I, Everard K, Dobbie A. An ounce of prevention: how are we managing the early assessment of residents' clinical skills? *Fam Med* 2012;**44**:723-6.

23 Dupras DM, Edson RS, Halvorsen AJ, Hopkins RH, McDonald FS. "Problem Residents": Prevalence, problems and remediation in the era of core competencies. *Am J Med* 2012;**125**:421-5.

24 Lloyd SH. Dissertation: An exploratory study of the relationship between In-Training Examination percentiles of anesthesiology residents and the Vermunt Inventory of Learning Styles 2007.

25 Osipow S. *Occupational Stress Inventory-Revised Edition (OSI-R), Professional Manual* 1998. Lutz, FL: Psych Assess Resources.

26 Busato VV, Prins FJ, Elshout JJ, Hamaker C. Learning styles: a cross-sectional and longitudinal study in higher education. *Brit J of Ed Psych* 1998;**68**,427-41.

27 French JRP. *Job demands and worker health.* Paper presented at the American Psychological Association symposium, Washington, DC. 1976.

TABLES AND FIGURES

Figure 1 Survey Information and Dropouts

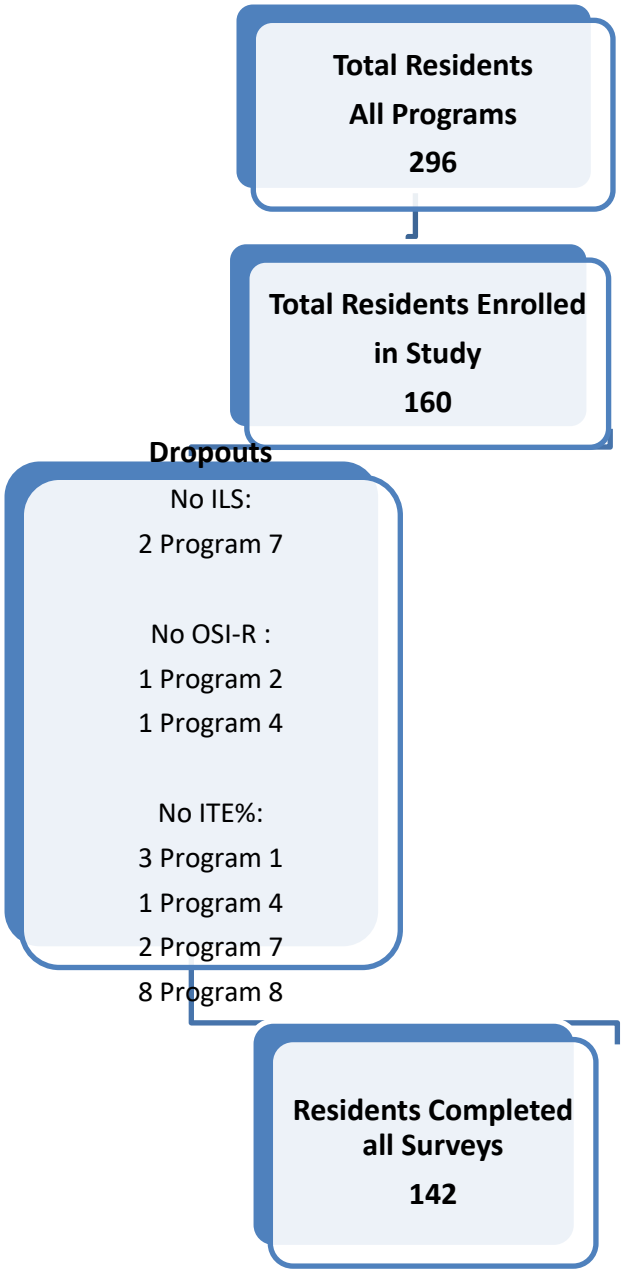

Figure 2 The Effects of Meaning Directed and Undirected Learning Patterns in ITE Percentiles

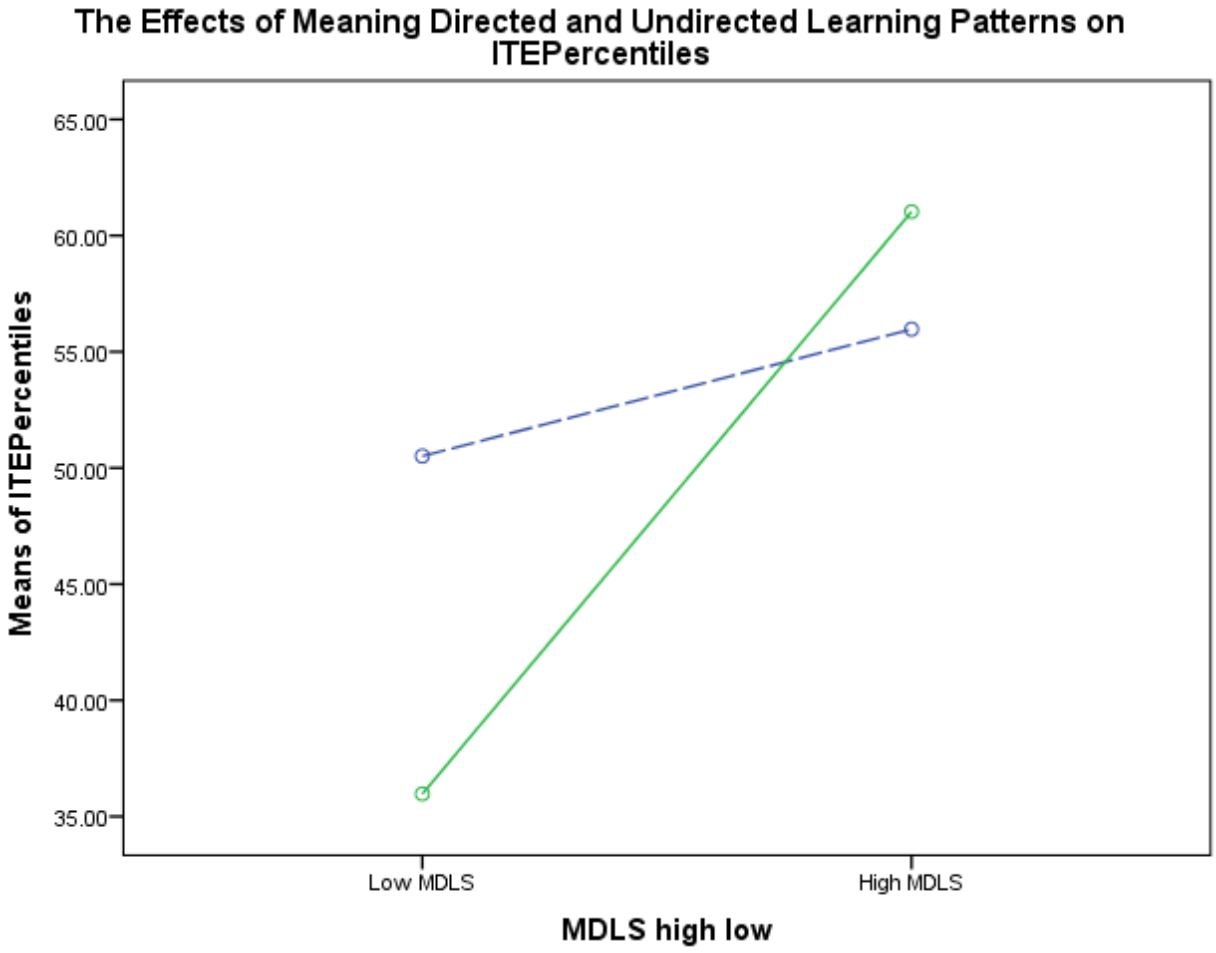

Table 1 Descriptive Statistics of Measures of ITE Percentile by Program

Program	1	2	3	4	5	6	7	8
N	14	18	11	45	22	4	19	9
ITE% Mean	49.7	62.2	41.9	53.3	46.8	50.3	42.3	55.6
ITE% SD	27.75	30.86	24.55	27.28	31.33	33.76	31.09	26.34

Table 2 Correlation of OSI-R with MDLS and ULDS

	Occupational Stress			Personal Strain				Coping Resources	
	RO	RI	RA	VS	PSY	IS	PHY	RE	RC
MD	.06	-.20*	-.21*	-.22*	-.18*	-.14	-.14	.20*	.37**
UD	.19*	.17*	.26**	.27**	.34**	.42**	.31**	-.18*	-.24**

Note. *p < .05. **p < .01.

OSI-R = Occupational Stress Inventory-Revised; MDLS = Meaning Directed Learning Style; UDLS = Undirected Learning Style; RO = Role Overload; RI = Role Insufficiency; RA = Role Ambiguity; VS = Vocational Strain; PSY = Psychological Strain; IS = Interpersonal Strain; PHS = Physical Strain; RE = Recreation; RC = Rational Cognitive Coping.

Low MD
High UD