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BRIEF REPORT

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Learning style preferences of internal medicine residents and in-training examination scores: is there a correlation?

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ABSTRACT

The internal medicine in-training examination (IM-ITE) has been traditionally used as a measuring tool to evaluate the base of knowledge of the residents in internal medicine residency programs across the US. Multiple interventions has been applied and studied to increase the first-time passing rate of ABIM, as it is an indicator of each residency program's performance and ranking. Additionally, studies have demonstrated that different learning styles and preferences are a predictor of exam results; however, it is not well known whether certain preferred learning styles are correlated with certain IM-ITE results. Primary objective of our study was to find a correlation between residents' preferred learning style, based on Kolb learning style inventory, and their PGY1 and PGY2 IM-ITE performance score difference. Secondary objective was to find the correlation between PGY2s' IM-ITE score and their preferred learning styles based on the Kolb learning style inventory. Mean scores of PGY1 and PGY2 IM-ITE were compared in each learning style group. Additionally, the mean difference between the PGY1 and PGY2 IM-ITE scores for each learning group was compared as well. The analysis of the mean IM-ITE score from PGY1 to PGY2 between groups revealed a statistically significant improvement in IM-ITE score from PGY1 to PGY2 in all groups, however, with a larger difference in one of the groups.

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1. Background

The internal medicine in-training examination (IM-ITE) has been traditionally used as a measuring tool to evaluate the base of knowledge of the residents in internal medicine residency programs across the US [1]. Multiple research studies have revealed a correlation between the IM-ITE results and the results of the American Board of Internal Medicine (ABIM); therefore, IM-ITE has also been used as a tool for residency programs to identify residents at risk of failing the ABIM [1–3]. Multiple interventions has been applied and studied to increase the first-time passing rate of ABIM, as it is an indicator of each residency program's performance and ranking [2]. Additionally, studies have demonstrated that different learning styles and preferences are a predictor of exam results [4,5,6]; however, it is not well known whether certain preferred learning styles are correlated with certain IM-ITE results.

2. Objective and methods

Primary objective of this study was to find a correlation between residents' preferred learning style, based on Kolb learning style inventory, and their PGY1 and PGY2 IM-ITE performance score difference. Secondary objective was to find the correlation between PGY2s' IM-ITE score and their preferred learning styles based on the Kolb learning style inventory. We performed a cross-sectional study of IM-ITE performance and learning style among 68 internal medicine PGY2 (33) and PGY3 (35) residents at a residency program in Baltimore, MD, in 2017–2018 academic year. Their IM-ITE performance data at PGY 1 and 2 levels were obtained and recorded. Thirty-three residents also completed the questionnaire for Kolb's learning style inventory and were categorized based on their learning styles as accommodating (ACM), diverging (DVG), assimilating (ASM) and converging (CNV). IM-ITE scores at PGY1, PGY2 and their pair-wise difference were described using means, standard deviation, median and inter-quartile range for the entire sample and by four learning styles. Analysis of variance (ANOVA) test was used to see if the pair-wise differences were statistically meaningful for any of the four learning styles. To further understand difference between various learning styles, multiple comparison analysis were conducted using Tukey's method. Kruskal–Wallis test were used to identify if the pair-wise differences were skewed. If necessary, variables were

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transformed to reduce skew in the data. Subjects with missing learning style information were compared to subjects with known learning style in order to test possibility of bias in the results due to missing data.

Due to limited number of subjects who completed the Kolb learning style, we further analyzed the data by collapsing ASM, DVG and ACM into non-CNV (13 individuals) and compared them as one group to the CNV (19 individuals) group. One outlier was removed for better interpretation of the results. First, we determined whether CNV and non-CNV differed by comparing mean PGY1 IMI-ITE scores. We then compared the two groups mean IM-ITE scores at PGY1 and PGY2 using repeated measures ANOVA with post hoc comparisons.

3. Results

Mean IM-ITE score for 68 PGY1 and PGY2 residents was 58.17 and 65.97, respectively, with a mean difference of 8.29 ($p < 0.0001$), which indicates meaningful improvement of the score from PGY1 to PGY2 in all groups. Mean scores of PGY1 and PGY2 IM-ITE were also compared in each learning style group. All learning style groups showed meaningful improvement of ITE score from PGY1 to PGY2 level with the largest improvement in the DVG group (mean difference of 18.2) and strongest statistical significance in the ASM group ($p < 0.0001$) (Table 1).

Additionally, the mean difference between the PGY1 and PGY2 IM-ITE scores for each learning group were compared using one-way ANOVA method, which revealed statistically significant difference between means of different learning groups taken together ($p = 0.0079$) (Table 2). However, no significant difference was observed when the mean IM-ITE scores were compared in at PGY2 level only. To further analyze the four different learning groups, comparison of difference of means was performed using Tukey method, while comparing each group to another, making for six different combinations (Table 3). Except for the convergent–divergent group ($p = 0.0041$), no statistically significant difference in mean IM-ITE differences was observed in pair-wise learning styles. The same pair-wise comparison of the PGY2 IM-ITE scores was performed which revealed no meaningful difference (Table 4).

By comparing CNV to non-CNV individuals, we found no significant differences between the two groups (59.4 vs 57.3 for CNV and non-CNV respectively). Then using repeated measures ANOVA with post hoc comparisons, we found that the mean IM-ITE score, from PGY1 to PGY2, the CNV group improved significantly ($p < 0.01$) as did non-CNV group ($p < 0.01$). Additionally, it was noted that while both CNV and non-CNV groups' mean IM-ITE score improved from PGY1 to PGY2, the non-CNV group improved more (9.9 versus 5) (Table 5).

4. Discussion

The primary results of this study revealed that the difference between the PGY1 and PGY2 level IM-ITE score was statistically meaningful for all learning styles, indicating that a meaningful increase in the mean PGY1 to PGY2 IM-ITE score existed regardless of the learning style. However, when looking at the one-way ANOVA on differences of the means between four different learning styles (Table 2), there is a statistically significant difference between the four learning styles, raising the question whether any of the learning styles is superior to the others.

We therefore examined such theory by comparing all four learning styles to each other, making for six separate comparisons. The only statistically meaningful result was that between converging and diverging learning styles, showing a p-value of 0.0041 (Table 3). We speculate that a statistically significant difference between the converging and diverging styles can be explained by either significant baseline difference in their first year IM-ITE results or by curricula catered to the needs to learners with a particular learning style preferences.

In the light of small study population specifically in learning style categories of ACM, ASM and DVG, and to better analyze and evaluate for a meaningful difference between these learning styles, we categorized the learning style groups as CNV and non-CNV. The analysis of the mean IM-ITE score from PGY1 to PGY2 between these groups revealed a statistically significant improvement in IM-ITE score from PGY1 to PGY2 in both groups, however with a larger difference on the non-CNV group. While these results are affected by the small sample size and other factors not counted for such as residents' rotation at time of exam, preparation before the exam and proximity of the exam to year of graduation, these results show possible correlation between learning styles and IM-ITE scores.

Historically, trying to recognize one's preferred learning style was used as a tool to help with a career choices. Fifty-seven percent of the residents whose data were analyzed identified the converging style as their preferred learning style. This potentially reflects the fact that most of the cohort participants were in their final stages of career differentiation. Our study is limited due to several factors, including but not limited to the facts that it is a single institution retrospective study and number of participants is likely too small to reliably generalize our findings to larger groups of residents in internal medicine and other medical specialties across the US and possibly other countries. Further, the concept of

Table 1. Paired T Test or Wilcoxon signed-rank sum test of mean between in-service PGY1 and PGY2.

		Comparison of mean of IM-ITE between In-service PGY1 and PGY2			*p*-Value
Outcome	Statistics	In-service PGY1	In-service PGY2	Mean difference	
Overall IM-ITE	Mean	58.17	65.97	8.29	<0.0001
	SD	8.60	9.78	7.03	
	Median	58.00	67.00	8.00	
	Q1	50.00	60.00	3.00	
	Q3	64.00	72.00	12.00	
IM-ITE in ACM	Mean	55.50	65.00	9.50	0.0466
	SD	8.70	10.86	5.80	
	Median	55.00	68.50	10.00	
	Q1	48.00	57.00	5.50	
	Q3	63.00	73.00	13.50	
IM-ITE in ASM	Mean	58.50	67.00	8.50	<0.0001
	SD	5.82	6.66	1.39	
	Median	59.50	68.00	8.00	
	Q1	54.00	61.00	8.00	
	Q3	63.00	73.00	9.00	
IM-ITE in CNV	Mean	59.42	63.95	5.00	0.0005
	SD	8.48	9.53	5.39	
	Median	60.00	66.00	5.00	
	Q1	52.00	56.00	1.00	
	Q3	66.00	72.00	9.00	
IM-ITE in DVG	Mean	54.00	72.20	18.20	0.0486
	SD	12.04	6.61	14.52	
	Median	57.00	71.00	15.00	
	Q1	53.00	70.00	10.00	
	Q3	61.00	77.00	17.00	

Table 2. One-way ANOVA or Kruskal–Wallis test of mean between learning style groups.

	Learning style				*p*-Value
Outcome	ACM	ASM	CNV	DVG	
Difference of IM-ITE between in-service PGY2 and in-service PGY1	9.50 (5.80)	8.50 (1.38)	5.00 (5.40)	18.20 (14.52)	0.0079
IM-ITE at In-service PGY2	65.00 (10.86)	67.00 (6.66)	63.95 (9.53)	72.20 (6.61)	0.3311

Table 3. Pair-wise comparisons of mean difference between learning style using Tukey's method.

Pair-wise comparison	Difference between means	Simultaneous 95% confidence limits		*p*-Value
ACM–DVG	−8.700	−21.500	4.100	0.2716
ACM–ASM	1.000	−11.317	13.317	0.9961
ACM–CNV	4.500	−5.997	14.997	0.6526
ASM–DVG	−9.700	−21.254	1.854	0.1248
ASM–CNV	3.500	−5.435	12.435	0.7130
CNV–DVG	−13.200	−22.791	−3.609	0.0041

Table 4. Pair-wise comparisons of IM-ITE at in-service PGY2 between learning style using Tukey's method.

Pair-wise comparison	Difference between means	Simultaneous 95% confidence limits		*p*-Value
ACM–DVG	−7.200	−23.477	9.077	0.6311
ACM–ASM	−2.000	−17.663	13.663	0.9854
ACM–CNV	1.050	−12.240	14.340	0.9964
ASM–DVG	−5.200	−19.893	9.493	0.7725
ASM–CNV	3.050	−8.244	14.344	0.8831
CNV–DVG	−8.250	−20.382	3.882	0.2720

Table 5. Comparison of CNV and non-CNV mean IM-ITE scores at PGY1 and PGY2.

	Mean PGY1 IM-ITE score	Mean PGY2 IM-ITE score
CNV	59.4	64.4
Non-CNV	57.3	67.2

differentiating learning styles has drawn criticism as it could be viewed as a potential stereotyping instrument, and that learning styles and skills change over time. It also should be taken into account that medical learning and education has evolved to a lot extent recently with further influence and takeover of the social media and nonconventional education and teaching. Therefore, there could potentially be mixed and fluid learning styles not fitting the four learning styles used in our study.

In conclusion, in the era of ever-expanding knowledge and rapidly changing culture in medical education fields, educators should continue to remain open minded and willing to experiment and adjust their methods of delivering curricula in order to maintain optimal cognitive load and promote knowledge retention.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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