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Embracing Learning Style Diversity in Surgical Education: Insights from a Medical School

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Submitted to: JMIR Medical Education
on: June 09, 2024

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Abstract

Background: Learning is a complex process that involves the interaction between various factors. In medical education, understanding learning styles is crucial for optimizing the learning process and ensuring that students effectively acquire the necessary knowledge and skills. Previous studies have investigated the relationship between learning styles and academic performance in medical school, aiming to identify if certain learning styles are more favorable to succeed.

Objective: Investigate the relationship between medical students' learning styles and their academic performance, focusing on surgical content, at a university in Brazil.

Methods: A total of 206 students from the clinical cycle and internship participated in this cross-sectional study. Kolb's Learning Style Inventory (LSI) was used to assess learning styles. Data on global and surgical academic performance was obtained from the institution, and results from the Progress Test, a specific assessment taken by Brazilian medical students, were collected

Results: Many of the students were classified as having a diverging learning style (63,6%), followed by accommodating (27,7%), assimilating (6,3%), and converging (2,4%). No significant relationship was found between learning styles and overall academic performance. However, significant differences were observed in the Progress Test results, particularly in the areas of Preventive Medicine, Gynecology and Obstetrics, and Pediatrics.

Conclusions: The findings highlight the importance of considering learning styles in surgical education and the need for inclusive teaching practices that accommodate diverse learning preferences. Further research is necessary to explore the nuances of learning styles across different medical specialties and to develop evidence-based strategies for optimizing the learning experiences of all students.

(JMIR Preprints 09/06/2024:63074)
DOI: https://doi.org/10.2196/preprints.63074

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Keywords: medical education, learning styles, academic performance.

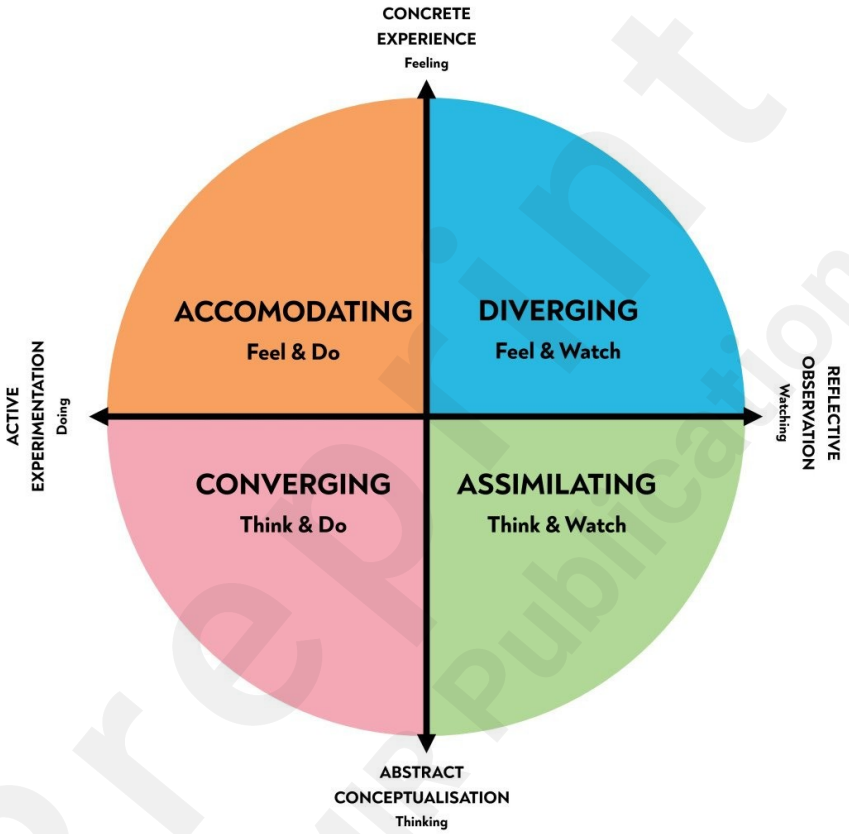
Introduction

Learning is a complex process that involves the interaction between various factors, including the teacher-student relationship. When students learn new content, they go through a cycle that involves recognition, assimilation, experience, and the ability to share the acquired knowledge [1]. In the 1960s, the concept of learning styles emerged, suggesting that individuals have unique ways of acquiring knowledge, skills, and attitudes [2,3]. Learning styles are developed through formal study

or experiences and can be as distinctive as a signature [4].

David Kolb's experiential learning theory and the Learning Style Inventory (LSI) have been widely used to assess learning styles in various educational settings [5]. Kolb's learning cycle consists of four stages: Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) [6]. Each learner has a preferred learning style based on their strengths, classified as accommodating, di-verging, assimilating, or converging [7]. The cycle is shown in Figure 1.

Figure 1. Kolb's learning cycle [8].



In medical education, understanding learning styles is crucial for optimizing the learning process and ensuring that students effectively acquire the necessary knowledge and skills [9]. Previous studies have investigated the relationship between learning styles and academic performance in medical school, aiming to identify if certain learning styles are more favorable to succeed [10-12]. A systematic review found that medical students with con-verging and assimilating learning styles performed better in problem-based learning sessions compared to those with diverging and accommodating styles [10].

Surgical education presents unique challenges, as it requires not only mastering theoretical knowledge but also the development of technical skills, decision-making abilities, and other essential competencies [13,14]. In a study conducted by Sachdeva et al. (2024), surgical residents with a preference for active experimentation and concrete experience learning styles demonstrated better performance in surgical skills assessments [15]. Similarly, Atique et al. (2023) found that medical students with converging and accommodating learning styles had higher self-perceived confidence in performing basic surgical skills [16].

While previous studies have explored the relationship between learning styles and academic performance in medical education, there is limited research specifically focusing on surgical education in the context of a university in the global south. This study aims to investigate the

relationship between medical students' learning styles and their performance in surgical content, both in global assessments and specific tests, at a university in Brazil. By determining students' learning styles using Kolb's LSI, we seek to identify potential associations that can inform curriculum design and teaching strategies to optimize surgical education in this setting.

Methods

This cross-sectional study was conducted in 2022 at the "Faculdade de Medicina de São José do Rio Preto" (FAMERP), a medical school located in the state of São Paulo, Brazil. The participants were medical students from the clinical cycle (third- and fourth year) and internship (fifth- and sixth year) who were above 18 years old and signed consent agreements.

The Learning Style Inventory (LSI) version 3.1, developed by David Kolb, was used to assess the students' learning styles [17]. The LSI is a widely used and validated tool that has demonstrated good reliability, with Cronbach's alpha coefficients ranging from 0.77 to 0.84 for the four learning style scales [18]. The inventory consists of 12 questions, each with four statements that participants rank from 1 to 4 based on their learning preferences. The scores for Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) are calculated based on the rankings. The learning style is then determined by subtracting the scores (AC - CE) and (AE - RO) and plotting the resulting points on a graph, identifying the quadrant in which the intersection of the lines falls.

Data on global academic performance was obtained from the institution, calculated as the average of the students' grades for the year. Surgical performance was determined by the simple average of grades obtained in subjects that compose the surgical curriculum in the corresponding year of 2022.

Additionally, data from the Progress Test, a specific assessment taken by many Brazilian medical students, was collected. The Progress Test is an annual assessment of medical education quality, characterized by its formative, external, and institutional core, indicating the progressive acquisition of skills throughout medical training [19]. Introduced in the 1970s by the Kansas City Medical School of the University of Missouri and the University of Limburg (now Maastricht University) in the Netherlands, the Progress Test has been adopted by several medical schools on an interinstitutional basis [20]. The test consists of 120 multiple-choice questions divided into major medical areas, such as Basic Sciences, Internal Medicine, Pediatrics, General Surgery, Gynecology and Obstetrics, and Preventive Medicine. The total number of correct answers and the scores for each area were used as performance parameters.

The relationship between data was calculated using Fisher's exact test, adjusted by the Bonferroni [21,22]. The effect size was measured using Cramer's V, which indicates the strength of association between variables, with values closer to 1 representing a stronger association [23].

For comparisons involving more than three groups, the Kruskal-Wallis’s test was employed. In cases where the null hypothesis was rejected, a multiple comparisons analysis (pairwise method) was performed, with significance levels adjusted by the Bonferroni method.

When significant differences were found, the effect sizes of pairwise comparisons were calculated using the Mann-Whitney U statistic [24], and the common language effect size was used to estimate the probability that a randomly selected observation from one group is greater than a randomly selected observation from the other group [25].

Results

Participant Characteristics

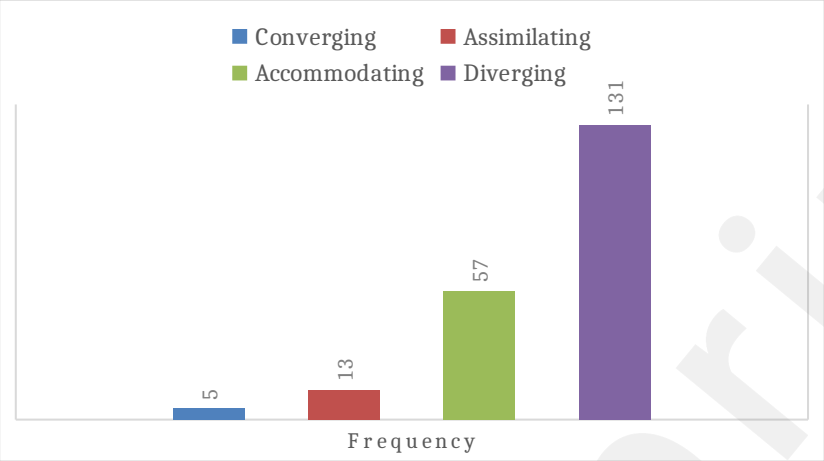
A total of 206 students participated in this study, including 56 third-year, 36 fourth-year, 67 fifth year, and 47 sixth-year students. Among the participants, 50.5% were female, and 92.7% were

between 21 and 30 years old. Most of the students (69.4%, n=143) had finished high school 6-10 years earlier, and 87.4% (n=143) had not completed any other university course before medical school.

Learning Style Distribution

Learning styles' distribution among students is presented in Graphic 1. Most of the students (63,6%) were classified as having a diverging learning style, followed by accommodating (27,7%), assimilating (6,3%), and converging (2,4%).

Graphic 1. Learning styles distribution (absolute numbers).



Factors Associated with Learning Styles

Fisher's exact test revealed no significant relationship between learning styles and gender, age, college year, or income ($p > 0.05$). However, a significant association was found between learning styles and the number of years since high school completion ($p = 0.018$) and having completed another college degree before medical school ($p = 0.048$).

The results indicated a higher proportion of diverging students compared to assimilating and accommodating styles for those who had finished high school "6 to 10 years ago" and "more than 10 years ago." Cramer's V for this analysis was 0.194, indicating a strong effect size and a 19.4% association between the variables.

The comparison between learning styles and having completed "another higher education course" yielded a p-value < 0.05 in Pearson's chi-square test. The Cramer's V effect size was strong (0.196), suggesting a 19.6% association between the variables. However, the multiple comparisons analysis using the Bonferroni method did not identify significant differences in proportions between specific categories, possibly due to the sample size and data concentration in the two categories.

Learning Styles and Academic Performance

Table 1 presents the comparison between academic performance and learning styles. No significant differences were found in either global performance or surgical performance across the learning style groups ($p > 0.05$).

Table 1. Academic performance versus learning style.

Academic performance	Learning style (Mean±SD)				
	Converging	Assimilating	Accommodating	Diverging	p-value
Global performance	8,46 ± 0,13	8,56 ± 0,30	8,63 ± 0,25	8,58 ± 0,27	0,315
Surgical performance	8,40 ± 0,85	8,29 ± 0,35	8,32 ± 0,44	8,31 ± 0,39	0,987

Learning Styles and Progress Test Results

The comparison between learning styles and Progress Test performance is shown in Table 2. No significant differences were observed in Basic Sciences and General Surgery sections ($p > 0.05$).

Although the p-value for the comparison between learning styles and performance in Pediatrics was < 0.05, the effect size was small (2.6%), and the pairwise comparison revealed no significant differences. Similarly, the p-value for the comparison between learning styles and Gynecology and Obstetrics performance was < 0.05, but the effect size was small (3.2%), and the pairwise comparison showed no significant differences.

A significant difference was found between learning styles for Preventive Medicine performance ($p = 0.010$). The Kruskal-Wallis's effect size was small (4.1%), indicating that the independent variables explained up to 4.1% of the variation in the dependent variable. The adjusted significance analysis revealed a significant difference between the "Accommodating" and "Diverging" groups in Preventive Medicine. The "common language" effect size indicated that the probability of a randomly selected person from the "Diverging" group presenting a higher value than a randomly selected person from the "Accommodating" group was 62.9%.

The comparison between learning styles and the percentage of total correct answers in the Progress Test also yielded a significant difference ($p = 0.048$). However, the Kruskal-Walli's effect size was small (2.4%), and the adjusted significance analysis showed no differences between pairs of comparisons.

Table 2. Comparison between Progress Test performance and learning styles.

Progress Test performance	Learning style (Mean±SD)				p-value
	Converging	Assimilating	Accommodating	Diverging	
Basic Sciences	12 ± 3,39	11,31 ± 2,36	12,14 ± 2,99	12,37 ± 2,81	0,568
Internal medicine	9,2 ± 4,66	11,77 ± 3,42	11,4 ± 3,49	12,19 ± 3,28	0,236
Pediatrics	7,0 ± 3,94	8,92 ± 4,42	9,16 ± 3,96	10,44 ± 3,57	0,043*
General Surgery	9,2 ± 4,6	11,62 ± 4,25	10,63 ± 3,61	11,64 ± 3,3	0,210
Gynecology and Obstetrics (GO)	7,6 ± 2,07	9,92 ± 4,55	9,51 ± 3,77	11,79 ± 9,95	0,023*
Preventive medicine	9,6 ± 4,39	10,77 ± 4,51	11,16 ± 3,33	12,59 ± 3,82	0,010*
Total hits	54,60 ± 21,33	64,31 ± 19,46	64,00 ± 16,48	69,88 ± 16,66	0,062
Hits (%)	45,40 ± 17,84	53,69 ± 16,19	53,39 ± 13,75	58,62 ± 13,27	0,048*

Discussion

Principal Results

The present study aimed to investigate the relationship between medical students' learning styles and their academic performance, particularly in surgical content, at a university in Brazil. Understanding the learning preferences of medical students is crucial for optimizing the educational experience and ensuring that students effectively acquire re-quested knowledge and skills [26].

Our findings showed no significant association between learning styles and gender, which is consistent with previous studies conducted in recent years. The social profile of the medical students in this study aligns with the Brazilian profile for this population stratum, characterized by young, unmarried individuals with no children and a balanced proportion of males and females [27,28].

The students' preferred learning styles in this study, predominantly diverging and accommodating, may be influenced by the teaching styles of their instructors. Surgeons' learning preferences and teaching styles contribute to their effectiveness as educators, and they may unconsciously teach in a manner like their own learning style [29]. This could explain the high proportion of students with diverging and accommodating styles, as these styles may be more compatible with the teaching approaches employed by surgical faculty. A recent study by Muniyapillai et al. (2023) found that surgical residents with accommodating and diverging learning styles demonstrated better performance in surgical skills assessments [30].

The shift towards diverging and accommodating learning styles may also be related to the impact of technology and the recent coronavirus pandemic on surgical education. The increased reliance on digital media and the changes brought about by the pandemic have altered the way learners acquire knowledge, with less contact with teachers and colleagues and more interface with screens [31]. This aligns with the preference for practice over observation, which is characteristic to diverging style. A study by Chandrasinghe et al. (2020) highlighted the importance of adapting surgical education to the changing learning preferences of students in the digital era [32].

Regarding academic performance, no robust evidence was found to support a strong relationship between learning styles and surgical or global academic performance. This may suggest that the selection processes and medical curricula are successfully designed to avoid favoring certain students based on their learning styles. Alternatively, students may adapt to the demands of the educational system, becoming more homogeneous in their learning approaches. These findings are consistent with a systematic review by Al-Roomy et al. (2023), which found no conclusive evidence linking learning styles to academic performance in medical education [33].

The significant differences observed in the Progress Test results, particularly in the areas of Preventive Medicine, Gynecology and Obstetrics, and Pediatrics, warrant further investigation. The higher probability of students with a diverging learning style outperforming those with an accommodating style in Preventive Medicine may indicate a potential area for targeted educational interventions. Future studies should explore the specific characteristics of these medical specialties that may favor certain learning styles.

The findings of this study have practical implications for surgical education and medical education in general. Institutions should consider the diversity of learning styles among their students and strive to create an inclusive learning environment that accommodates different preferences. Incorporating a variety of teaching methods and assessment strategies may help ensure that students with less common learning styles are not disadvantaged [34]. Furthermore, fostering self-awareness among students regarding their learning styles can empower them to adapt and optimize their learning experiences [35].

Limitations

This study has some limitations that should be acknowledged. The cross-sectional design does not allow for causal inferences, and the sample was limited to a single institution in Brazil. Future research should employ longitudinal designs and include multiple institutions to provide a more comprehensive understanding of the relationship between learning styles and academic performance in medical education.

Conclusions

This study investigated the relationship between medical students' learning styles and their academic performance, with a focus on surgical content, at a university in Brazil. The findings highlight the importance of considering learning styles in the context of surgical education and medical education.

Although no strong relationship was found between learning styles and overall aca-demic

performance, the study emphasizes the need for inclusive teaching practices that accommodate the diverse learning preferences of students. The predominance of diverging and accommodating learning styles among the participants suggests that surgical educators should adapt their teaching methods to better align with these preferences.

The significant differences observed in the Progress Test results, particularly in the areas of Preventive Medicine, Gynecology and Obstetrics, and Pediatrics, indicate potential areas for targeted educational interventions. Further research is necessary to explore the specific characteristics of these medical specialties that may favor certain learning styles.

The findings of this study have practical implications for medical education. Institutions should strive to create an inclusive learning environment that accommodates different learning styles and promotes self-awareness among students. By incorporating a variety of teaching methods and assessment strategies, educators can ensure that students with less common learning styles are not disadvantaged.

Furthermore, this study highlights the need for future research to explore the nuances of learning styles across different medical specialties and to develop evidence-based strategies for optimizing the learning experiences of all students. Longitudinal studies involving multiple institutions could provide a more comprehensive understanding of the relationship between learning styles and academic performance in medical education.

In conclusion, assessing learning styles provides valuable insights for educational institutions, faculty, and students to make necessary adjustments and identify trends in medical education. By considering the diversity of learning styles and promoting inclusive teaching practices, medical educators can create an optimal learning environment that fosters the development of competent and well-rounded healthcare professionals.

Acknowledgements

Author Contributions: Conceptualization, G.S. and J.A.; methodology, G.S. and J.A.; formal analysis, A.L., V.B. and J.A.; investigation, G.S.; data curation, G.S.; writing—original draft preparation, G.S..; writing—review and editing, C.C and J.A.; visualization, B.G., E.S. and N.C.; supervision, J.A. and A.O.; project administration, G.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest

None declared.

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