The Evolution of Learning Styles in Surgery: A Cross-Sectional Study Comparing Residents and Teachers.

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Gabriela Gouvea Silva[1] MD, MSc; Carlos Dario da Silva Costa[1] MD, MSc; Bruno Cardoso Gonçalves[1] MD, MSc; Luiz Vianney Saldanha Cidrão Nunes[1] MD, MSc, PhD; Emerson Santos[1] MSc; Natalia Almeida de Arnaldo Rodriguez Castro[1] MD, MSc; Alba Regina Abreu de Lima[1] MSc, PhD; Vânia Maria Sabadoto Brienze[1] MSc, PhD; Antônio Hélio Oliani[1] MD, MSc, PhD; Júlio César André[1] MD, MSc, PhD

[1]Faculdade de Medicina de São José do Rio Preto (FAMERP) São José do Rio Preto BR

Corresponding Author:
Gabriela Gouvea Silva MD, MSc
Faculdade de Medicina de São José do Rio Preto (FAMERP)
Avenida Brigadeiro Faria Lima
5416
São José do Rio Preto
BR

Abstract

Background: Studies confirm a relationship between learning style and medical career choice in the learning style patterns observed in distinct types of residency programs. Such patterns can also be applied to general surgery, from medical school to the latest stages of training. Aligning teaching strategies with the predominant learning styles in surgical residency programs has the potential to make training more effective.

Objective: This study aimed to determine the learning styles of general surgery residents and professors in a Brazilian teaching hospital and compare the results with the existing literature.

Methods: Cross-sectional study conducted in a teaching hospital of a public university in Brazil. Thirty-four general surgery residents of any year of training and 30 professors participated in the study. Participants completed a sociodemographic survey and David Kolb's Learning Style Inventory. It classifies participants into one of four distinct types of learners: accommodating, diverging, assimilating, and converging. Relationship between sociodemographic data and learning styles was analyzed using Fisher's test, adjusted by the Bonferroni method, and the effect size was measured using Cramer's V test.

Results: The learning style distribution was similar in both groups, with 43,75% diverging, 42,18% accommodating, 10.93% assimilating, and 3.12% converging styles. A significant relationship was found between sex and learning style (p=0.049) and between age and learning style for professors (p=0.029). The effect sizes were strong (0.46) and very strong (0.506), respectively.

Conclusions: The prevalence of learning styles among general surgery residents and professors at this Brazilian hospital differs from that of previous studies, with a higher proportion of diverging and accommodating learners and a lower proportion of converging learners, pointing to a change in learning styles. Understanding learning styles is important for developing effective and inclusive surgical training programs. Further research with larger and more diverse populations is needed to confirm these results and explore the factors contributing to the observed differences in learning styles.

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“The Evolution of Learning Styles in Surgery: A Cross-Sectional Study Comparing Residents and Teachers”

Gabriela Gouvea Silva[1], Carlos Dario da Silva Costa[1], Bruno Cardoso Gonçalves[1], Luiz Vianney Saldanha Cidrão Nunes[1], Emerson Roberto dos Santos[1], Natália Almeida de Arnaldo Rodriguez Castro[1], Alba Regina de Abreu Lima[1], Vânia Maria Sabadoto Brienze[1], Antônio Hélio Oliani[1], Júlio César André[1].

[1] Center for Studies and Development of Health Education – CEDES, Faculdade de Medicina de São José do Rio Preto (FAMERP), São José do Rio Preto, Brazil.

Corresponding Author: Gabriela Gouvea Silva
Av. Brigadeiro Faria Lima, 5416- Vila Santa Cândido
São José- São Pedro, São Paulo, Brazil.
Postal Code: 15090-000.
Tel: +55 17 98202-2252
Email: gouvea.g@hotmail.com

Abstract

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Keywords: Learning; General Surgery; Medical Education; Medical residency; Surgeons; Brazil.

Introduction

The concept of learning styles was first developed at the beginning of 1960 as the result of the interest in individual differences while learning [1]. According to Dunn, everyone has a unique learning style, like a signature. In this prospect, adjusting the teaching to the different learning styles may help learners and improve educational outcomes. In the current literature, there are various models to determine the learning styles. There is a long and active discussion about whether learning styles are fixed or flexible, and to what extent the context can determine it [2]. Some studies have shown that adapting learning styles can enhance student engagement, motivation, and academic performance [3].

Knowledge is the main domain of medical education, but outcomes strongly depend on other domains such as attitude, lifelong learning, and empathy; in surgery, some domains are central: resilience, craftsmanship, decision-making, etc [4]. Therefore, the clinical and surgical environments are challenging for both training surgeons and their professors. Surgical training requires the development of complex skills and behaviors, and understanding how surgical residents learn is crucial to optimizing this process [5].

Educating surgeons is an ancient tradition that has existed since the development of surgery [6]. The apprenticeship model has been one of the essential components of surgical training and generally involves “see one, do one, teach one” [7]. However, it is currently necessary to carry out more complex procedures with greater regularity and safety, claiming even better-prepared professionals [8].

Studies confirm a relationship between learning style and medical career choice in the learning style patterns observed in distinct types of residency programs. Such patterns can also be applied to general surgery, from medical school to the latest stages of training [9]. Aligning teaching strategies with the predominant learning styles in surgical residency programs has the potential to make training more effective [10].

It is also important to note that current surgical trainees come from diverse educational, cultural, ethnic, and gender backgrounds, and personal factors also influence their learning characteristics [11].

Little is known about the teaching and learning preferences among surgeons and how they influence the effectiveness of training [12]. Despite its relevance, studies investigating learning styles in the context of general surgery residency are scarce, especially in countries outside North America and Europe.

This study aimed to determine the learning styles of general surgery residents and in a Brazilian teaching hospital, compare our results with the existing literature, and discuss their implications for surgical training. By providing data from a different geographical and cultural setting, we hope to contribute to a better understanding of learning styles in surgical training and stimulate further research on this important topic.

Methods

This cross-sectional study was conducted in 2022 at the Hospital de Base de São José do Rio Preto, a teaching hospital affiliated with *Faculdade de Medicina de São José do Rio Preto* (a public university in São Paulo, Brazil). The study population consisted of general surgery residents in any year of training and hospital professors. All participants were over 18 years old and signed the free and informed consent form.

Data collection involved two instruments: a sociodemographic survey and David Kolb's Learning Style Inventory (LSI). The sociodemographic survey collected information on participants' age and sex, and years of residency (for residents) or teaching experience (for professors). The LSI is a

validated tool that consists of 12 questions, each with four statements that the participants ranked from 1 to 4 according to their learning preferences. The LSI tool classifies the participants into one of four types of learners based on Kolb's learning cycle: 1) accommodating (learn primarily by experience), 2) diverging (learn by reflective observation), 3) assimilating (learn by exploring associations and interrelationships), and 4) converging (learn by doing or trying things with practical results) [14].

The LSI test was administered in a controlled environment, with a researcher present to provide instructions and clarify any doubts. Participants had 30 minutes to complete it. The sociodemographic survey was completed immediately after completing the LSI test.

The relationship between data was calculated using Fisher's test, adjusted by the Bonferroni method [15]. Fisher's exact test was chosen due to the small sample size and the presence of categories with expected frequencies lower than 5 [16]. The size effect was measured using Cramer's V test, which indicates the grade of association between variables: the result is stronger as it approaches the value of 1 [17].

Data analysis was performed using the Statistical Package for the Social Sciences and a p-value <0.05 was considered statistically significant. The study was approved by the Research Ethics Committee of *Faculdade de Medicina de São José do Rio Preto* (approval number: 12345/2022).

Recruitment

All general surgery residents were invited to answer printed free and informed consent form and the LSI's test, in person. The same was done with the faculty members. The questionaries were then collected and transformed into digital archives, processed in digital tables after codification.

Statistical Analysis

Power

The sample size was calculated using the formula for finite populations, considering a confidence level of 95%, a margin of error of 5%, and an expected prevalence of 50% for each learning style. The minimum sample size was 67 participants, and the total number of residents and professors was 80 [13].

Data Exclusion

Questionaries responded incorrectly according to Kolb's rules were discarded.

Results

A total of 64 participants (34 residents and 30 professors) were included in this study. The sociodemographic characteristics of the participants are presented in Table 1. Among residents, 18 (52.9%) were male and 16 (47.1%) were female. Most residents (91.2%) were under 30 years of age. Among professors, 24 (80,0%) were male, and 6 (16,0%) were female, and most of them (56.7%) were between 40 and 70 years of age. All professors graduated from universities when traditional teaching methods were used whereas 47% of the residents graduated from universities that used active or mixed teaching methods.

Table 1. Sociodemographic characteristics of participants.

Characteristics		**Residents (n=34) n (%)**	**Professors (n=50) n (%)**
Age (years)	<30	31 (91.2)	2 (6.7)

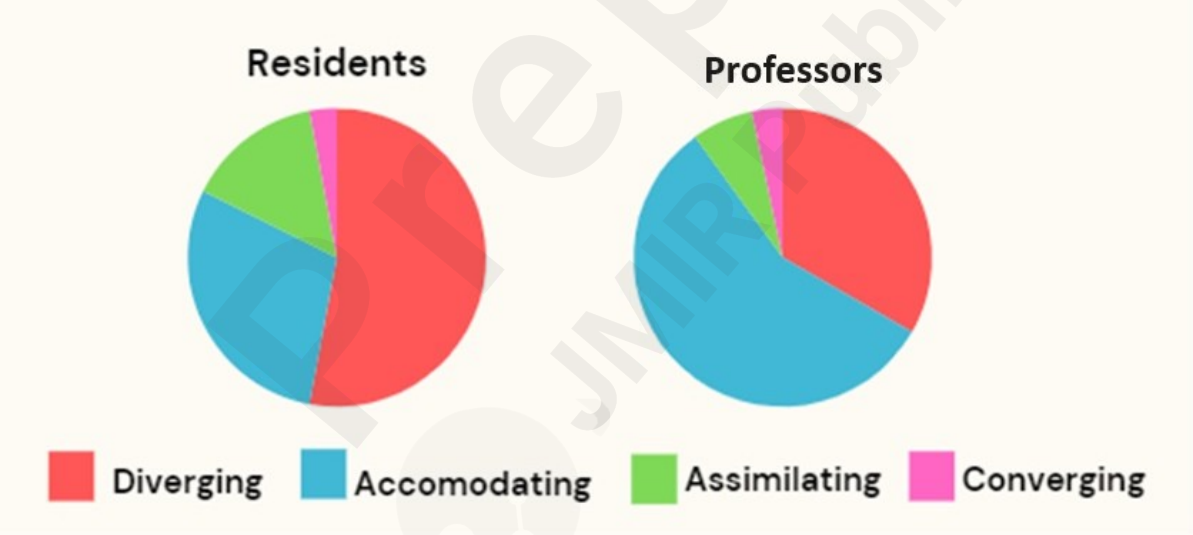
	30-39	3 (8.8)	11 (36.7)
	40-70	0 (0)	17 (56.7)
Sex	Male	18 (52.9)	24 (80)
	Female	16 (47.1)	6 (16)
Teaching method used at the University of origin	Traditional	18 (52.9)	30 (100)
	Active/mixed	16 (47.1)	0 (0)

The distribution of Kolb's learning styles is presented in Table 2 and Chart 1. The most prevalent learning styles were diverging (52,9%) in the residents' group and accommodating (56,7%) in the professors' group.

Table 2. Learning styles among surgery groups.

Learning styles	**Residents (n=34) n (%)**	**Professors (n=30) n (%)**	**Total (n=64) n (%)**
Converging	1 (2.94)	1 (3.33)	2 (3,12)
Assimilating	5 (14.7)	2 (6.7)	7 (10.93)
Accommodating	10 (29.4)	17 (56.7)	27 (42.18)
Diverging	18 (52.9)	10 (33.3)	28 (43.75)

Chart 1: Learning styles prevalent in surgery groups.



The relationship between sociodemographic data and learning styles was analyzed using Fisher's exact test (Table 3). A significant association was found between sex and learning style (p=0.049; Cramer's V=0.46), indicating a strong effect size. However, determining which specific categories were significantly different using the Bonferroni post-hoc test was not possible. Among professors, a significant relationship was observed between age and learning style (p=0.029; Cramer's V=0.506), suggesting a very strong effect size. However, specific age groups that differed significantly could not be identified with the Bonferroni post-hoc test, possibly due to the small sample size.

Table 3. Relationship between sociodemographic data and learning styles.

Variables	**p-values (Fisher's exact**	**Effect sizes**

	test)	(Cramer's V)
Sex	0.049*	0.46 (strong)
Age (residents)	0.999	0.12 (weak)
Age (professors)	0.029*	0.506 (very strong)
Teaching method used at the university of origin (residents)	0.999	0.08 (weak)

*Statistically significant at $p<0.05$

Discussion

Table 1 and Chart 1 show that the learning style distribution is similar in both groups. This convergence can facilitate both teaching and learning [18], as the two activities involved can find correspondence with each other. However, similarity does not facilitate the process for converging and assimilating styles, as they are few and may be isolated. Therefore, avoiding leaving them behind is important when a comprehensive residency program is considered. This underscores the importance of mapping learning styles when programming, as it provides a basis for guiding the learning needs.

Limitations

The population portraited is a small sample of a larger Brazilian surgical group. More data can be further collected to compare the country with other nations, in America, Europe or even Asia. The medical reality in Brazil is diverse and worth a broader approach.

Comparison with Prior Work

Few studies on learning styles in surgery were found in the literature, but we can state that our results are different from previous results.

In the 1980s, Baker III et al. reported a prevalence of converging (46%), followed by accommodating (26%) and assimilating (20%) styles among surgeons [19]. In the 2000s, this pattern was confirmed by Contessa et al [20]. They argued that surgical practice requires quick decision-making and problem-resolution, justifying the converging style and its more pragmatic view. In 2007, Mammen et al published similar results obtained in the US population [21].

After Quillin reduced his working hours in general surgery residency, he showed the results collected from 1999-2012. At that time, the proportion of accommodating learners was higher, especially after 2003, when the workload was reduced [22].

In 2017, for the first time, diverging learners became the majority in a study with 47 surgeons in the United Kingdom [23]. In 2018, also in the UK, a study with residents in various surgical areas found that converging, followed by accommodating styles were predominant [24]. In 2020, similar results were published in Scotland by Hopkins et al [11]. The most recent publication on the topic reported a predominance of assimilating followed by converging styles in Spain [25]. Table 4 and Figure 1 show a resumed view on the existing literature.

Figure 1: Timeline of surgical learning styles according to the existent literature.

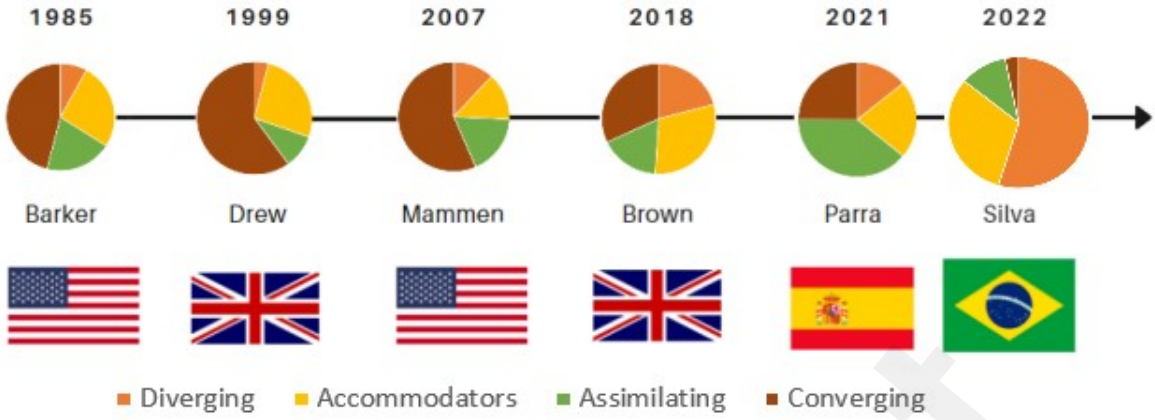


Table 4. Data of learning styles in surgery through time around the world.

Author	Publication year	Country	Population (n)	Diverging	Accomodator	Assimilating	Converging
Baker III	1985	USA	Surgeons (39)	8%	26%	20%	46%
Drew	1999	UK	Basic surgical trainees (52)	3,9%	27%	9,6%	59,5%
Mammen	2007	USA	General surgery residents (91)	10,6%	14,6%	17,2%	57,8%
Brown	2018	UK	Medical students (60)	20,8%	30,2%	17%	32%
Parra	2021	Spain	Surgical residents and staff (64)	14,1%	21,9%	39,1%	25%

The results of the present study were diverging (43,8%), accommodating (42,2%), assimilating (11,0%), and converging (3,12%) styles. These results amplify the existing literature, showing an increase in diverging and a decrease in converging styles over the years. These findings indicate a shift in the learning preferences of surgical residents and professors, which may have been influenced by various factors, such as changes in surgical education, technological advancements, and sociocultural aspects.

The geographical location may be a possible explanation for our results, as previous studies were conducted in North America and Europe. Cultural differences and variations in surgical training programs across countries may have contributed to the observed differences in learning styles. Another hypothesis may be the course of time: the last two decades have seen huge technological changes, when social media, smartphones, and laptops became widely available, greatly impacting the teaching-learning process [26]. Furthermore, with the occurrence of the pandemic, the increased distances imposed by contact restrictions have further deepened these changes [27].

From this data, it is also possible to notice that the number of females among residents and professors is remarkable. In general, the surgical environment is still very masculine, explaining the discrepancy between women's styles at the beginning (residents) and the end of their careers (professors) [10]. However, the proportion of women in surgery has increased in the past few decades [13].

The findings of our study have important implications for surgical education. Understanding the predominant learning styles of residents and professors can help adapt teaching strategies and curriculum design to better meet their needs. For example, incorporating more reflective observation and practical experiences can benefit diverging and accommodating learners while also providing opportunities for abstract conceptualization and active experimentation to support assimilating and converging learners. Furthermore, recognizing the diversity of learning styles in a residency program can promote the development of a more inclusive and effective learning environment [14].

Conclusions

This study investigated the prevalence of learning styles among general surgery residents and professors in a Brazilian university hospital. Our findings differ from those of previous studies conducted in North America and Europe, where converging and assimilating styles generally prevail. The significant decrease in the prevalence of converging style compared to that of earlier studies is notable. This change in the learning style distribution may be attributed to factors such as changes in surgical education, technological advancements, and cultural differences across countries. Further research is needed to better understand these factors and their impact on learning styles in surgical training.

Our results have important implications for surgical education. Understanding the prevalent learning styles of residents and professors can guide the development of more effective teaching strategies. Incorporating various learning activities that cater to different learning styles can create a more inclusive and engaging learning environment. Surgical residency programs should consider assessing learning styles as part of their curriculum design and evaluation processes.

We also found a significant relationship between professors' learning styles and gender and age variables. However, due to the small sample size, further research with larger and more diverse populations is needed to better understand these associations.

Our findings suggest recognizing and addressing diverse learning styles in surgical training. Adapting teaching methods and creating more inclusive learning environments in surgical residency programs can increase educational efficiency and better prepare future surgeons for professional challenges.

Conflicts of Interest

None declared.

Abbreviations

LSI: learning style inventory.
USA: United States of America.
UK: United Kingdom.

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Supplementary Files

Figures

Chart 1.

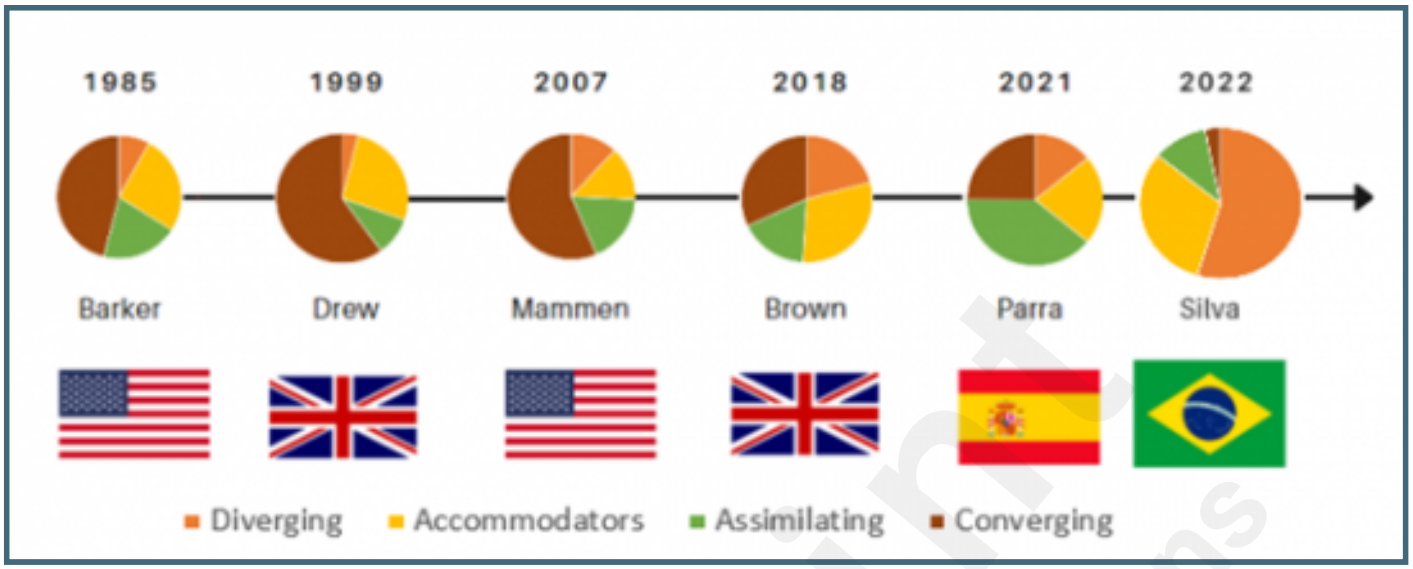

Image 1.