

Assessment of Learning Preferences of Undergraduate Medical Students using the Vark Questionnaire and its Association with Academic Performance

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Abstract: Background: Current medical education, operating within the Competency-Based Medical Education (CBME) framework, has gradually shifted toward a learning outcome-oriented, student-centered teaching model. All teaching arrangements under this framework must be designed around the learning objectives that students are required to achieve, rather than solely following the pace of instructors' lectures. The focus of teaching has shifted from how teachers teach to how students learn. This requires us to quickly identify the methods each student is most accustomed to using to receive and process information. The Visual, Auditory, Read/write, and Kinesthetic (VARK) model can precisely help us identify these different sensory learning preferences it categorizes learning preferences into four types based on the senses used to receive information: visual learners who receive information through sight, auditory learners who receive information through hearing, read/write learners who receive information through reading and writing, and kinesthetic learners who receive information through hands-on, physical participation. This model has been validated, is reliable and easy to use, and is simple to implement. **Research Objectives:** To identify the learning modalities preferred among undergraduate medical students at Government Medical College, Kadapa, and to analyze the correlation between these preferences and academic performance. **Methods:** An institution-based cross-sectional study was conducted between 1st January 2026 and 5th March 2026 among 459 medical undergraduates using a self-administered, validated VARK questionnaire (version 7.1) circulated through a Google Form, alongside a socio-demographic proforma. Data were analysed in SPSS version 26 using frequencies, percentages, mean $\pm$ standard deviation, one-way ANOVA, and the chi-square test, with $p < 0.05$ considered statistically significant. **Results:** Of 459 participants (mean age 20.5 ± 1.46 years; 55.3% female), unimodal learners predominated (63%), followed by bimodal (27%), quadmodal (6%), and trimodal (4%) learners. Kinesthetic learning recorded the highest mean score (7.92 ± 3.56), followed by auditory (7.4 ± 3.44), visual (5.63 ± 3.4), and read/write (4.61 ± 3.35) styles. Kinesthetic preference showed a statistically significant association with academic performance ($F=7.51$, $p=0.001$), and overall modality type was significantly associated with performance band ($\chi^2=18.1$, $p=0.01$). **Conclusion:** The conclusions drawn from this study are that among the participating undergraduate medical students, the majority rely on a single dominant sensory learning modality, with the largest number of students preferring kinesthetic and auditory learning. The study also found that kinesthetic learning preferences, as well as the overall distribution of all students' learning modalities, have a significant correlation with their academic performance. This conclusion supports a specific direction: more hands-on practical content, demonstration-driven teaching methods, and interactive teaching strategies that promote student participation should be incorporated into the curriculum for undergraduate medical students.

Keywords: VARK questionnaire; learning styles; medical students; academic performance; kinesthetic learning; multimodal learning; Competency-Based Medical Education.

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INTRODUCTION

All medical colleges in India are implementing Competency-Based Medical Education, or CBME. This new educational model has fundamentally changed the roles that students and teachers are required to play, and

the requirements they must meet. The old teaching model that preceded it centered on forcing students to rote-memorize content and keep pace with fixed course schedules, regardless of whether students had truly mastered the material. The new model has completely

shifted this focus: all teaching is structured around whether students can achieve preset competency goals, with the learner placed at the center of all efforts [1,2]. To successfully implement this shift, teachers can no longer apply a single teaching method to all students. They must recognize that there are extreme differences in how different people receive, process, and retain knowledge.

To support the curriculum reform required for this new model, a number of new arrangements have already been introduced: for example, students are exposed to real clinical settings in hospitals shortly after enrollment, foundational introductory courses have been launched to build students' core knowledge, and learning modules specifically designed to practice practical skills have been rolled out. But whether these new attempts can truly deliver their intended effects ultimately depends on whether teachers' actual instructional approaches can align with the diverse sensory and cognitive habits of all students. If they cannot align, no matter how modern the curriculum is designed, students will not be able to learn effectively.

Each student has a unique combination of sensory preferences. Once formed, this set of preferences rarely changes in the short term, and it directly determines which learning method will yield the highest efficiency for acquiring new knowledge. Existing research has confirmed that these preferences have a tangible correlation with students' academic performance [3]. Later, to organize these learning preferences, the academic community proposed a variety of theoretical frameworks. Among these, the visual, auditory, read-write, kinesthetic model first introduced by Fleming and Mills in 1992, known as the VARK model, remains one of the most widely used frameworks to this day. It is simple, concise, and most importantly, students can complete the corresponding assessment on their own without additional support [3,4]. The VARK tool categorizes learners into four types: visual learners, who absorb knowledge most effectively through charts and schematic diagrams; auditory learners, who learn best through discussions and oral explanations; read-write learners, who retain information optimally when studying written materials; and kinesthetic learners, who can only master knowledge through hands-on operation and personal experience. Beyond these four preference types, it also divides learners into two categories: unimodal learners, who rely primarily on a single learning mode, and multimodal learners, who utilize two or more modes simultaneously.

Over the years, both international researchers and local Indian scholars have accumulated a substantial body of related research, and the number of such studies continues to grow. All of these studies have centered on one core task: distributing VARK questionnaires to groups of medical students to investigate their learning preferences. All these studies have reached a consistent

conclusion: even among students from different institutions, different countries, or different grades within the same institution, there are significant differences in the dominant learning styles among the populations [5–9]. Specifically, some studies found that the largest group of students at their respective institutions were auditory or kinesthetic learners, while other studies reached completely opposite conclusions, reporting that read-write or visual preferences were more prevalent. This divergence in research findings actually points to a key fact: the distribution of learning styles among students at an institution is not fixed, and is likely influenced by local curriculum design, the teaching methods teachers use on a daily basis, the language of instruction used in classes, and even the cultural environment of the entire region [10–12].

Another core issue that the academic community has yet to reach a unified consensus on is whether there is a link between learning styles and students' academic performance, with different studies holding conflicting views that have yet to be resolved. Many studies have proposed that there is no statistically significant correlation between the two, meaning that learning styles do not impact academic performance. However, other studies reject this conclusion, particularly those that focused on specific learning preferences such as kinesthetic and read-write; these studies did measure quantifiable, concrete links between learning styles and final academic outcomes [6,9,13]. It is precisely this contradiction between research conclusions that reminds all education practitioners that they cannot arbitrarily apply research findings from other educational contexts directly to their own institutions. Every region needs to collect local data tailored to its specific context to draw conclusions that fit its own circumstances.

Government Medical College, Kadapa, like the many other Indian medical colleges currently undergoing the CBME transition, had never previously conducted an analysis of the overall distribution of learning styles among all its undergraduate medical students. No one could clearly state what learning preferences the school's students actually favored. If the most common sensory learning modes among the school's students could be identified, and if it could be clarified whether these learning preferences correlate with students' academic performance, these findings would provide practical, actionable reference for several core tasks of the school: for example, how to plan curricula more reasonably in the future, how to diversify teachers' teaching methods to meet the needs of different students, and even how to provide targeted support for students at risk of falling behind or achieving poor grades to help them keep up with the overall learning pace. It is for this reason that the present study was conducted. The study focused on two primary objectives: first, to use the VARK questionnaire to comprehensively catalog the different learning methods used by undergraduate medical students at Government Medical College, Kadapa;



second, to conduct an in-depth exploration of the extent of the correlation between these students' learning preferences and their academic performance.

OBJECTIVES

The first task of this study is to use the VARK questionnaire to identify the preferred learning styles of undergraduate medical students at Government Medical College in Kadapa. In addition to sorting out all participants' learning preferences, this study will also calculate the distribution of the two categories of learning modes unimodal and multimodal among all students participating in the study, that is, how many people are only accustomed to learning in one way, and how many people use several ways to learn at the same time.

The second task to be completed next is to assess the correlation between two sets of factors and students' academic performance: the first set is each student's corresponding scores on all dimensions of the VARK learning styles, and the second set is students' overall learning modes, which are divided into four categories: unimodal, bimodal, trimodal, and quadrimodal. Through these assessments, this study will sort out which learning preferences require teachers to adopt targeted teaching plans.

METHODOLOGY

This is a cross-sectional study conducted at a fixed institution. The entire study was implemented at the Department of Community Medicine, Government Medical College Kadapa, and lasted approximately two months, starting from January 1, 2026 and continuing until March 5, 2026.

The subjects of this study are all current undergraduate medical students at this college, covering four academic years, that is, the (2022, 2023, 2024, and 2025 batches) of students admitted in sequence. We adopted a universal sampling method to recruit participants. On the scheduled day of data collection, we sent invitations to participate one by one to all eligible students who were present on campus that day. In the end, a total of 459 valid questionnaires that could be used for statistical analysis were collected and sorted out. The reasons for choosing this universal sampling method were, first, to reduce the selection bias that might occur during sampling, and second, to comprehensively collect the learning preferences of all undergraduate students, obtain complete data that could represent the overall situation, and avoid limiting this survey to a single grade, which would lead to one-sided results.

Not all students could join this study. Those who could be included had to meet several criteria simultaneously: they had to be undergraduate medical students of these four academic years at Government Medical College Kadapa, and they had to be willing to sign the informed

consent form and participate voluntarily throughout the process, with no coercion whatsoever.

There were also certain circumstances that prevented students who met the basic criteria from joining the study, that is, the pre-established exclusion criteria: students who were not present on campus on the scheduled day of data collection could not participate. This included students who had been approved for leave in advance and were absent, students who had never attended theoretical classes during the study period, and students who directly refused to sign the informed consent form and were unwilling to participate. Apart from these pre-stated exclusion conditions, we did not add any other additional restrictions, which fully met the requirements of universal sampling, ensuring that all eligible students present on campus that day could participate smoothly.

The core tool used in the study to collect information was the validated VARK questionnaire version 7.1. This questionnaire is available for free public use, with a total of 16 items, all filled out by the participants themselves. After completion, respondents could be categorized into four types according to their learning preferences: visual, auditory, read-write, and kinesthetic [4]. In addition to this core questionnaire, we also used a uniformly formatted information collection form to collect basic personal information related to demographics, such as age, gender, academic year, and academic performance. As for the students' socioeconomic status, we used the updated 2025 modified B.G. Prasad classification scale to categorize them [14,15].

Before officially starting data collection, we first explained the core purpose of this study to all students who were willing to participate, and repeatedly clarified that participation was entirely voluntary with no mandatory requirements. After that, we integrated the personal information collection form and the VARK questionnaire into a complete self-administered questionnaire, created it as a Google Form, and distributed it to all participants via electronic channels for them to fill out.

To reduce the recall bias that might occur when students recalled past situations, and to maintain a consistent and representative test environment for all batches, the questionnaires for each batch of students were distributed and collected immediately after they finished the scheduled theoretical classes. All submitted and completed questionnaires were first checked for the completeness of their content. After confirming that all required items were filled in without omissions, they were entered into the final dataset used for analysis.

Statistical Data Analysis

Data were entered into Microsoft Excel and subsequently analysed using IBM SPSS Statistics, version 26. Categorical variables, including gender, academic year, and modality category, were summarised



as frequencies and percentages, while continuous variables, including age and VARK component scores, were expressed as mean $\pm$ standard deviation. Inferential statistics were applied to test associations between learning style and academic performance: one-way analysis of variance (ANOVA) was used to compare mean VARK component scores across the three academic performance bands (50–65%, 65–75%, and >75%), and the chi-square test was used to assess the association between overall modality pattern (unimodal, bimodal, trimodal, quadmodal) and academic performance category. A two-tailed p-value of less than 0.05 was considered statistically significant throughout the analysis.

RESULTS

A total of 459 medical undergraduates participated in the study, with a mean age of 20.5 ± 1.46 years; the majority (67.8%) were aged 20–22 years, while smaller proportions fell within the 17–19 year (24.6%) and 23–25 year (7.6%) age bands. Females constituted a slight majority of the study population (55.3%, $n=254$) compared with males (44.7%, $n=205$). Representation across academic years was relatively even, with the 2023 batch contributing the largest share (34.0%), followed by the 2025 batch (33.1%), the 2024 batch (22.7%), and the 2022 batch (10.2%). With regard to academic performance, nearly half of the students (47.3%) scored above 75%, while 30.7% scored between 65% and 75%, and 22.0% scored between 50% and 65%. Notably, 78% of participants belonged to the upper socio-economic class according to the modified B.G. Prasad classification, 2025 (Table 1).

Table 1: Socio-demographic profile of undergraduate medical students (n = 459)

S.No.	Characteristics	Category	Frequency (n=459)	Percentage (%)
1	Age group (years)	17–19	113	24.6
		20–22	311	67.8
		23–25	35	7.6
2	Gender	Female	254	55.3
		Male	205	44.7
3	Academic year (batch)	2022	47	10.2
		2023	156	34.0
		2024	104	22.7
		2025	152	33.1
4	Academic performance (%)	50–65	101	22.0
		65–75	141	30.7
		>75	217	47.3

On assessment of individual VARK components, the kinesthetic modality recorded the highest overall mean score (7.92 ± 3.56), followed by the auditory (7.4 ± 3.44), visual (5.63 ± 3.4), and read/write (4.61 ± 3.35) modalities (Figure 1). When examined across academic performance bands, mean kinesthetic scores differed significantly between the 50–65%, 65–75%, and >75%

groups ($F=7.51$, $p=0.001$), with the highest kinesthetic scores observed among students in the intermediate (65–75%) performance band. In contrast, visual ($F=2.26$, $p=0.11$), auditory ($F=1.88$, $p=0.15$), and read/write ($F=2.03$, $p=0.13$) component scores did not differ significantly across performance bands (Table 2).

Table 2: Association between individual VARK components and academic performance

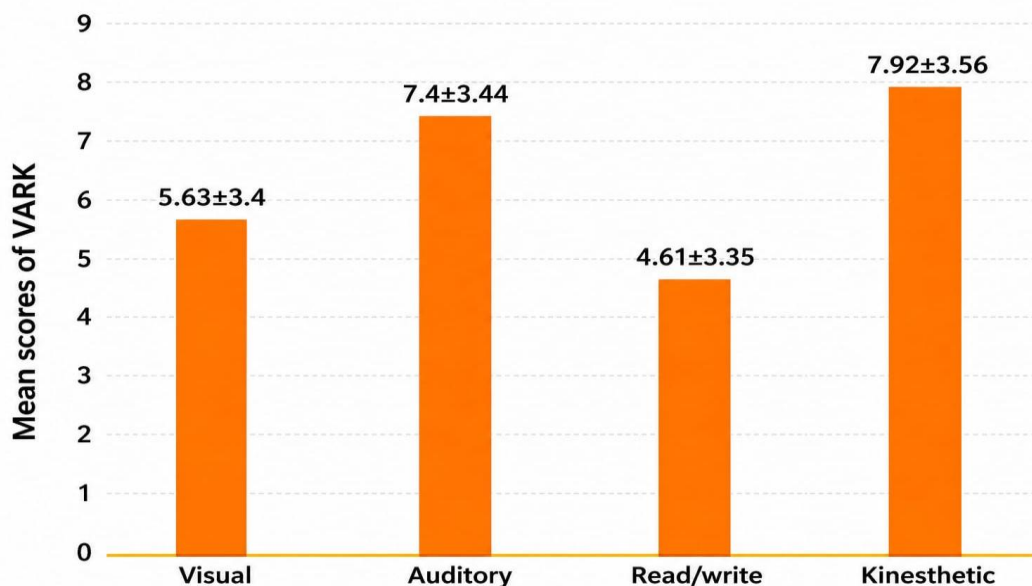
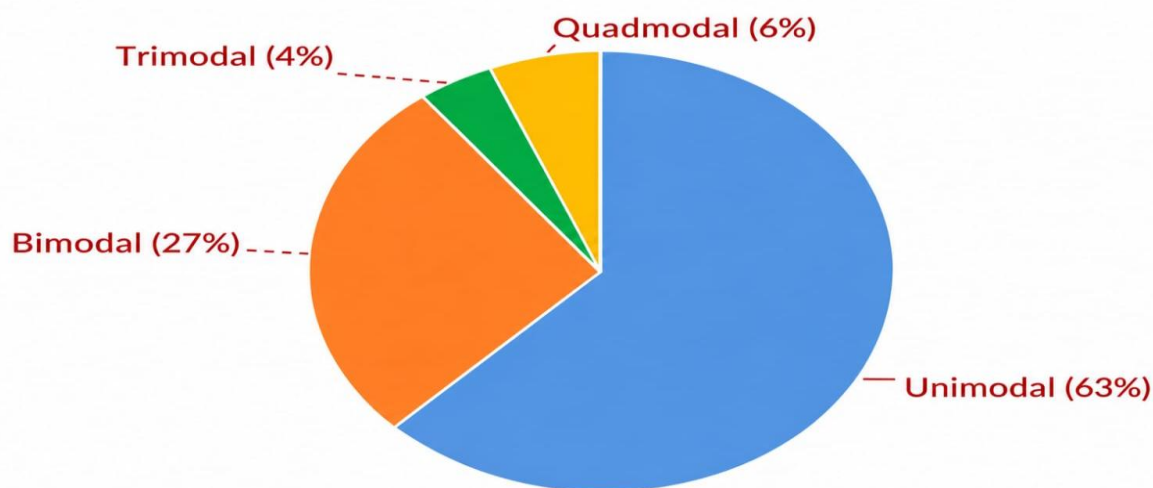
Academic Performance (%)	Visual	Auditory	Read/Write	Kinesthetic
50–65	5.65 ± 3.04	7.13 ± 3.39	4.37 ± 2.62	7.98 ± 3.34
65–75	6.09 ± 3.65	7.87 ± 3.61	5.08 ± 3.60	8.79 ± 3.51
>75	5.31 ± 3.37	7.23 ± 3.35	4.41 ± 3.48	7.32 ± 3.60
F value	2.26	1.88	2.03	7.51
P value	0.11(NS)	0.15(NS)	0.13(NS)	0.001(S)

With respect to overall modality distribution, the majority of students (63%) were classified as unimodal learners, relying predominantly on a single sensory preference, while 27% were bimodal, 6% quadmodal, and 4% trimodal (Figure 2). The association between overall modality pattern and academic performance band was statistically significant ($\chi^2=18.1$, $p=0.01$). Among

unimodal learners, just over half (51.9%) scored above 75%, whereas this proportion was lower among bimodal (40.5%), trimodal (27.8%), and quadmodal (42.3%) learners; quadmodal learners showed the highest concentration in the 65–75% performance band (53.8%) (Table 3).

Table 3: Association between preferred modality and academic performance

Academic Performance (%)	Unimodal, n (%)	Bimodal, n (%)	Trimodal, n (%)	Quadmodal, n (%)
50–65	61(21.1)	35(27.8)	4(22.2)	1(3.8)
65–75	78(27.0)	40(31.7)	9(50.0)	14(53.8)
>75	150 (51.9)	51(40.5)	5(27.8)	11(42.3)
Total,n (%)	289(100)	126(100)	18(100)	26(100)

**Figure 1: Mean scores of individual VARK components****Figure 2: Distribution of study participants based on preferred learning modality**

DISCUSSION

The present study found that kinesthetic and auditory learning preferences predominated among undergraduate medical students at Government Medical College, Kadapa, with the majority of students (63%) demonstrating a unimodal learning preference. This pattern aligns broadly with previous Indian and international VARK-based studies, although the relative ranking of specific modalities varies considerably

between settings. Urval *et al.* [6], in their study of undergraduate medical students at Kasturba Medical College, reported auditory preference as the most dominant (7.11 ± 2.72), closely followed by kinesthetic (6.94 ± 4.15), with a lower proportion of unimodal learners (46.7%) and a correspondingly higher proportion of bimodal learners (36.7%) compared with the present study (Table 4). Ojeh *et al.* [7], studying medical students in Barbados, found read/write (33.8%)

and kinesthetic (32.5%) preferences predominant, with unimodal learners constituting 40.1% and quadmodal learners an unusually high 36.3%, a markedly different distribution from both the present study and the Urval cohort. These cross-study differences likely reflect

variation in curricular emphasis, teaching delivery methods, language of instruction, and prior educational exposure across institutions and countries, reinforcing the value of institution-specific learning style assessment rather than extrapolation from external data.

Table 4: Comparison of learning style distribution with previous studies

Sl. No.	Study	Predominant Learning Style (Mean± SD)	Mode of Learning (Unimodal/Multimodal)
1	Present study	Kinesthetic (7.92±3.56), Auditory (7.4±3.44), Visual (5.63±3.4), Read/write (4.61±3.35)	Unimodal (63%), Bimodal (27%), Quadmodal (6%), Trimodal (4%)
2	Urval et al. [6] (2014)	Auditory (7.11±2.72), Kinesthetic (6.94±4.15), Read/write (5.59±3.18), Visual (4.64±2.48)	Unimodal (46.7%), Bimodal (36.7%), Trimodal (11%), Quadmodal (5.6%)
3	Ojeh et al. [7] (2017)	Read/write (33.8%), Kinesthetic (32.5%), Auditory (20.4%), Visual (13.4%)	Unimodal (40.1%), Quadmodal (36.3%), Bimodal (14%), Trimodal (9.6%)

The finding that kinesthetic learning preference was significantly associated with academic performance ($F=7.51$, $p=0.001$), while visual, auditory, and read/write preferences were not, is consistent with several reports in the literature suggesting that hands-on, demonstration-based and practically oriented teaching methods resonate strongly with medical undergraduates, given the inherently applied and procedural nature of clinical medicine [9,12]. The peak in kinesthetic scores among students in the intermediate (65–75%) performance band, rather than a simple linear relationship with performance, suggests that the relationship between learning style and academic outcome may be non-linear and modulated by other factors such as study habits, motivation, and the extent to which actual teaching delivery matches a student's preferred modality. This observation is echoed by Akturan et al. [10], who found that intrinsic motivation, rather than learning style preference alone, was the stronger predictor of academic engagement and achievement among medical students, suggesting that VARK preference may interact with, rather than independently determine, academic success.

The significant association observed between overall modality pattern and academic performance ($\chi^2=18.1$, $p=0.01$) merits particular attention, as it diverges from several studies, including those by Almigbal [9] and Samarakoon et al. [11], which reported no significant relationship between learning style preference (whether unimodal or multimodal) and academic achievement. One plausible explanation for the discordant finding in the present study is that unimodal learners, by virtue of relying on a single, well-defined channel of information processing, may be better positioned to direct focused study effort, particularly when at least some component of institutional teaching aligns with that preferred channel. The CBME framework's increasing emphasis on early clinical exposure, skills modules, and casebased learning may inadvertently favour kinesthetic and unimodal learners over students whose preferences are more diffusely multimodal [1,2]. Taken together, these

findings support the broader pedagogical recommendation, echoed across the VARK literature [8,16], that faculty should consciously diversify instructional delivery, combining visual aids, structured discussion, written material, and hands-on demonstration within a single teaching session, so that the full spectrum of student learning preferences is accommodated rather than catered to selectively.

LIMITATIONS OF THE STUDY

This study has several limitations that should be considered when interpreting the findings. First, being a cross-sectional study conducted at a single institution over a relatively short two-month period, the results may not be generalisable to medical student populations in other colleges, regions, or curricular contexts, and the cross-sectional design precludes any inference of causality between learning style and academic performance. Second, the VARK questionnaire is a self-reported instrument and is therefore susceptible to social desirability and response bias, as students may select responses they perceive as favourable rather than those that most accurately reflect their genuine learning behaviour. Third, academic performance was assessed using aggregate percentage scores without disaggregation by subject or examination type, which may obscure modality-specific effects that differ between theoretical and practical assessments. Finally, potential confounding variables known to influence academic performance, including study habits, prior academic record, attendance, and psychological factors such as motivation and examination anxiety, were not controlled for in the present analysis and may partly explain the observed associations.

CONCLUSION

This cross-sectional study of 459 undergraduate medical students at Government Medical College, Kadapa, demonstrates that the majority of students (63%) preferred a unimodal learning style, relying predominantly on a single sensory modality, while a



smaller proportion adopted bimodal (27%), quadmodal (6%), or trimodal (4%) approaches. Among the individual VARK components, kinesthetic learning emerged as the most preferred modality (mean score 7.92 ± 3.56), followed closely by auditory learning (7.4 ± 3.44), with read/write preference being the least common (4.61 ± 3.35). This distribution suggests that today's medical undergraduates gravitate strongly toward hands-on, practical, and interactive modes of learning, including demonstrations, clinical skill sessions, and verbal discussion, over purely text-based study methods, a pattern consistent with the experiential ethos that the CBME curriculum seeks to promote.

Importantly, both the kinesthetic component score and the overall modality pattern showed statistically significant associations with academic performance, indicating that learning style is not merely a matter of student preference but may be meaningfully related to academic outcomes within the current teaching environment. These findings carry direct implications for curriculum planning and faculty development at Government Medical College, Kadapa, and potentially at similar institutions: teaching strategies that deliberately incorporate kinesthetic and interactive elements, alongside traditional auditory and visual methods, may enhance learning effectiveness for the broadest possible crosssection of students. Identifying individual and cohort-level learning preferences through instruments such as VARK allows educators to move toward a more student-centred approach, ultimately strengthening both engagement and academic achievement among the next generation of medical graduates.

Ethics Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC), Government Medical College, Kadapa, Andhra Pradesh, India, prior to the commencement of the study (IEC Approval No: 48/GMC/KDP/2025; Date: 27/11/2025). Formal approval for this study was granted by IEC after comprehensive review of the statistical analysis. The study was conducted in accordance with the applicable national ethical guidelines for biomedical and health research involving human participants.

Informed Consent

Written informed consent was obtained electronically from all participants before enrollment in the study. Participation was entirely voluntary, and students were informed about the purpose of the study, the confidentiality of their responses, and their right to decline participation or withdraw from the study at any stage without any academic consequences. No personally identifiable information was collected, and all data were anonymized prior to analysis.

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