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Original Article

Education Section

Association of Learning Styles with Academic Achievements in First-year Professional MBBS Students of a Medical College in Eastern India: A Cross-sectional Study

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ABSTRACT

Introduction: Research has shown that learning may be optimised by synchronising the learning environment with the learning style preferences of students. First-year medical students face immense stress as they adapt to a new learning environment and curriculum at the onset of their medical career. The simultaneous use of two supplementary learning styles questionnaires, namely, the Visual-Aural/Auditory-Read/Write-Kinesthetic (VARK) questionnaire and the Vermunt Inventory of Learning Styles (Vermunt ILS), would provide detailed knowledge of their instructional preferences, information processing, and cognitive personality learning styles. Judicious use of such information at this stage may guide them towards improved learning and higher academic achievement.

Aim: To study the association between learning styles and academic achievements in first-year professional MBBS students of a medical college.

Materials and Methods: A cross-sectional study was conducted at Medical College, Kolkata, West Bengal, India over the duration of 10 months from August 2021 to June 2022. Online surveys of 250 first-year MBBS students' learning styles were conducted using the VARK questionnaire and Vermunt ILS, and the marks of three internal assessment examinations were collected. The data was entered into Microsoft Excel. Group as well as individual scores were analysed, and Pearson's Chi-square test was used to determine the association between the students' learning styles and their academic achievement. A p-value of <0.05 was considered statistically significant.

Results: Out of the total of 160 submitted questionnaires, 139 (86.8%) students were visual learners, while the rest were multimodal learners. The factor loading of the ILS scales revealed higher alpha coefficients for learning orientations and mental models of learning, with the 'use of knowledge' being awarded high scores by the highest number of students, 104 (83.56%). A total 134 learners gave lower scores to processing and regulation strategies, but a significant association was found between 126 (94%) of them and their academic scores of ≥50% (p-value=0.024).

Conclusion: Although no positive association was found between learning styles and academic achievement of first-year medical students, the integration of two learning style tests provided educators with comprehensive insight into the learning preferences of their students, enabling them to develop an adaptive curriculum. Students might also utilise knowledge of their learning styles to guide themselves towards self-directed learning, lifelong learning, and higher academic achievement.

Keywords: Curriculum, Learning, Questionnaires, Surveys, Undergraduate medical education, Vermunt inventory of learning styles

INTRODUCTION

The term "learning styles" has been conceptualised in different ways over the years by psychologists, educators, and sociologists. In general, it is referred to as a learner's "personal predisposition towards different learning processes and outcomes" [1] and varies among different learners depending on their previous educational experiences, psychosocial factors, and cultural differences [2]. Numerous prior research investigations have linked students' learning style preferences to academic achievement [3-5]. The first study that clearly demonstrated the influence of learning styles on academic achievement was conducted by Carroll in 1963 (Henson & Borthwick, 1984, cited by Claxton and Murrell, 1987, p.4) [1]. It has now been firmly established that understanding student's learning style preferences is important due to their role in achieving high academic success [1,6]. Research has shown that when the learning environment aligns with learning style preferences, there is a significant increase in learning (meshing hypothesis) [7,8].

According to Curry's onion model, there are three concentric layers of personal learning style traits that can be measured by learning style inventories: the deepest layer is the "cognitive personality" style, followed by the intermediate layer "information processing" style, and the outer layer "instructional preference" style. Author suggested that the outer and intermediate layers are more likely to be influenced by the learning environment compared to the innermost layer, which comprises the "cognitive personality" style. Curry recommended the combined use of different inventories in higher education to measure all layers of learners' learning style characteristics as per the onion model [9].

The VARK questionnaire was developed by Fleming N to measure individual instructional preferences and categorised learners as uni-modal learners (visual, auditory, read-write, kinaesthetic) or multimodal learners (a combination of two or more instructional preferences) [10]. On the other hand, the Vermunt ILS, focused on cognitive processing, metacognitive regulation, mental models of learning, and learning orientation. It aimed to measure learners' 'information processing' and 'cognitive personality' styles, categorising learners as undirected, reproduction-directed, meaning-directed, or application-directed [3]. The combined use of both learning style instruments may provide a measure of all layers of Curry's onion model and offer a broader understanding of learners' learning styles.

Newly admitted first-year medical students may find it challenging to adapt to the medical curriculum due to differences in the volume

and content of the subject matter, as well as the diversity of their age, experience, culture, and learning styles [11]. Revealing their well-formed, 'flexibly stable' [12] learning styles at this stage when they are vulnerable to stress [5] might enable them to align their learning techniques with their learning style preferences to optimise their academic achievement from the beginning of their medical careers. A literature search revealed no previous studies has been done in similar regions and settings that aimed to explore learning styles through the simultaneous use of these two supplementary learning style instruments and to determine their correlation with the academic performance of learners.

Therefore, the aim of the present study was to evaluate the association between learning styles and academic achievements in first year professional MBBS students at Medical College, Kolkata, West Bengal, India.

The primary objective of the present study was to gather detailed information on the learning styles of first year professional MBBS students by concurrently using the VARK questionnaire and the Vermunt ILS as instruments to measure the outer layer, intermediate layer, and deep layers of Curry's onion model. Additionally, the secondary objective of the study was to determine the association between the students' learning style preferences and their academic achievements.

MATERIALS AND METHODS

A cross-sectional study was conducted among the first-year professional MBBS students, batch of 2020-2021, for duration of 10 months from August 2021 to June 2022 at a Medical College in Bengal, Kolkata, with an annual student intake capacity of 250. The study was carried out after obtaining ethical approval (MC/KOL/IEC/NON-SPON/1180/08/2021 dated 25/08/2021) and informed consent from the students.

Inclusion criteria: The inclusion criteria were all consenting first year professional MBBS students, Batch 2020-2021, at the Medical College in Bengal, Kolkata, West Bengal, India.

Exclusion criteria: Defaulters and students who submitted incomplete questionnaires were excluded from the study.

Sample size: The sample size was calculated using the following formula:

$n=Z\alpha^2\times P\times(100-P)/L^2$

n=Minimum sample size

P=Assumed prevalence level of perceived benefits of e-learning/online teaching=50%

Q=complement of P=100-P=50%

$Z\alpha$=1.96 (considering 95% confidence interval, two tailed)

L=absolute error of 10%

Putting the values, $n=\{1.96^2\times50\times50\}/10^2=96$ i.e., approximately 100

So, the minimum sample size will be 100.

N=Finite Population=250

Applying the Finite Population Correction (FPC) (as n/N=0.40, which is >0.05), the sample size will be revised using the following formula for FPC:

$FPC=\sqrt{\{(N-n)/(N-1)\}}=\sqrt{\{(250-100)/(250-1)\}}=0.77$

{N=Finite population size=250}. The revised minimum sample size will be (100×0.77)=77. Assuming a 10% non response rate, the final minimum sample size will be (77+7.7)=85 [13].

An online survey of the learning styles of first year professional MBBS students was conducted using a consolidated questionnaire comprising the VARK questionnaire (version 8.01), the Vermunt ILS, and a prevalidated semistructured questionnaire designed to collect student details (age, sex, roll number, study hours per day). The survey was sent by email to all students who consented to participate in the study. Prior to the questionnaire survey, an online informed consent form was distributed and collected from them.

The VARK questionnaire (version 8.01) consists of 16 multiple-choice questions, each presenting four choices. Each choice corresponds to the four sensory modalities measured by VARK [10,14]. On the other hand, Vermunt's (1994) ILS is a 120-item questionnaire consisting of two parts: Part A- Study Activities, which includes questions on two domains (processing strategies and regulation strategies), and Part B- study motives and views on studying, divided into B1- Study motives addressing learning orientations and B2- Study views addressing mental models of learning. Each of the four components includes five subscales containing from five to nine items, which can be answered on a 5-point scale [Table/Fig-1] [3,15]. This model has four latent factors corresponding to Vermunt's meaning-directed, reproduction-directed, undirected, and application-directed learning styles [Table/Fig-2]. The variable indicators for the four factors were taken from the factor loadings

Vermunt ILS	N
A. ILS A: Study activities	
Processing strategies	
Relating and structuring	6
Critical processing	5
Memorising and rehearsing	6
Analysing	6
Concrete processing	5
Regulation strategies	
Self-regulation of learning process and results	5
Self-regulation of learning content	6
External regulation of learning process	5
External regulation of learning results	5
Lack of regulation	6
ILS B1. Study motives	
Learning orientations	
Personally interested	5
Certificate- oriented	7
Self-test oriented	9
Vocation- oriented	6
Ambivalent	5
ILS B2. Study views	
Mental models of learning	
Construction of knowledge	5
Intake of knowledge	7
Use of knowledge	6
Stimulating education	8
Cooperative learning	7

[Table/Fig-1]: Constructs of Vermunt ILS A and B.
(N=number of items per construct)

	F1	F2	F3	F4
Processing strategies				
Deep processing				
Relating and structuring	0.26			-0.38
Critical processing				
Stepwise processing				
Memorising and rehearsing				
Analysing				
Concrete processing				
Regulation strategies				

Self-regulation				
Learning process and results		0.31		
Learning content				
External regulation				
Learning process		0.29		
Learning results		0.26		0.25
Lack of regulation			-0.28	
Learning orientations				
Personally interested	0.25			
Certificate-oriented				-0.6
Self-test-oriented	0.27			
Vocation-oriented				
Ambivalent			0.62	
Mental models of learning				
Construction of knowledge	0.25			
Intake of knowledge				
Use of knowledge				
Stimulating education	0.27			
Cooperative learning				
Eigenvalue				
Standard deviation	3.143	1.507	1.192	1.079
Proportion of variance	0.494	0.113	0.071	0.058
Cumulative proportion	0.494	0.608	0.679	0.737

[Table/Fig-2]: Factor loading of the ILS Scales in a Four-Factor Equamax Solution (Principal Components Analysis; loadings >-0.25 and <0.25 omitted; n=160).

reported by Vermunt, comprising 20 ILS subscales. According to Vermunt, each of the 20 ILS subscales denoting the four learning styles loaded on at least one factor or more than one factor.

Out of 250 learners, the questionnaires of 160 learners were considered for the present study since the rest of the learners either did not submit the online informed consent form or had submitted incomplete questionnaires. The marks obtained by the study population of students in three subsequent internal assessment examinations of Anatomy were collected and compiled. Based on their marks, students were divided into two groups: those with academic scores <50% (n=62) and those with academic scores ≥50% (n=98). An association between the students' learning styles and their academic achievement was assessed.

STATISTICAL ANALYSIS

The collected data was entered into Microsoft Excel 365. Groups as well as individual scores were factored, and statistical tests (non parametric) were conducted along with Pearson's chi-square test to determine associations. A p-value of <0.05 was considered in determining the level of significance for drawing statistical inferences regarding the relationships among variables.

RESULTS

[Table/Fig-1] showed the constructs comprising processing and regulation strategies (ILS A) and study motives and study views (ILS B). Each of the constructs consisted of five to nine items of Vermunt ILS.

Confirmatory factor analysis was conducted to identify the four learning styles described by Vermunt, revealing the presence of all four learning styles among the present study population of students [Table/Fig-2]. The first factor could be explained as a meaning-directed learning style, with high loadings on relating and structuring, personal interest, and construction of knowledge. However, loadings for critical processing, analysing, concrete processing, and self-regulation were not as clear as anticipated for the components of the meaning-directed learning style. The second factor was characterised by high loadings on self-regulation and external regulation of the learning process and learning results and could be interpreted as an application-directed learning style. However, high loadings for concrete processing, vocation-directed learning orientation and use of knowledge were not noted. The third factor might be representative of an undirected learning style with high loadings on lack of regulation and an ambivalent learning orientation. There were no high loadings for cognitive processing strategies and mental models of knowledge. The fourth factor might be viewed as a reproduction-directed learning style with high loadings on external regulation and certificate-oriented learning orientation. High loadings for cognitive processing strategies and mental models of learning were not found.

Out of the total of 160 submitted questionnaires, male learners comprised 113 (70.6%) and female learners were 47 (29.4%). The mean age of the learners was 19.68±0.78 years, and their mean study hours were 5.86±2.01 [Table/Fig-3].

Number of learners	Mean age (in years)	Mean study hours
Male- 113 (70.6%)	19.68±0.78	5.86±2.01
Female- 47 (29.4%)		

[Table/Fig-3]: Student details.

As illustrated in [Table/Fig-4], the learning style of most learners 139 (86.8%) according to the VARK questionnaire was visual. Only 21 learners were multimodal, exhibiting a combination of auditory, read-write, and kinesthetic learning styles. A total of 128 (92.1%) visual learners and 19 (90.5%) multimodal learners obtained ≥50% marks in their internal assessment exams. It was observed that there was no significant association between the students' learning style as per the VARK questionnaire and their academic scores (p=0.801 by Pearson's χ^2 test).

Type of learning style	Academic scores ≤50%	Academic scores ≥50%
Visual n=139 (86.8%)	n=11 (7.9%)	n=128 (92.1%)
Multimodal (auditory, read-write and kinesthetic) n=21 (13.2%)	n=2 (9.5%)	n=19 (90.5%)

[Table/Fig-4]: Students' Learning Styles (VARK) versus Academic Scores (n=160). *Pearson's χ^2 test showed p =0.801 for visual learners with academic scores ≥50%

[Table/Fig-5] showed that many students gave higher scores to learning orientation and mental models of learning, with the construct 'use of knowledge' being awarded high scores by the highest number of students 104 (83.56%). On the other hand, among students who gave lower scores to processing and regulation strategies, low scores were awarded to the construct 'lack of regulation' by 76 students (56.74%). From this, it could be inferred that students displayed an inclination towards motives, attitudes, and objectives pertaining to their studies rather than the study activities they undertook during their education. Their apparent lack of enthusiasm towards study activities (shown by lower scores given to their ascertainment of its importance) might reflect the Coronavirus Disease-2019 (COVID-19) scenario on medical education because such students were subject to long spells of online platforms for teaching with less scope for the execution of study activities with face-to-face interaction with faculties and peers.

Variables	Preclinical medical students (N=160)	
	I* n (%)	II* n (%)
ILS A	134 (83.75)	26 (16.25)
Processing strategies		
Deep approach (Relating and Structuring + Critical processing)	57 (42.37)	15 (57.63)
Stepwise approach (Memorising and Rehearsing+ Analysing)	62 (46.20)	14 (53.8)
Concrete approach	56 (42.00)	15 (58.00)
Regulation strategies		
Self-regulation	65 (48.33)	13 (51.67)
External regulation	56.7 (42.26)	15 (57.74)
Lack of regulation	76 (56.74)	11 (43.26)

ILS B	35 (21.87)	125 (78.13)
Learning orientations		
Certificate-oriented	10 (29.20)	89 (70.80)
Self-test-oriented	8 (22.30)	97 (77.70)
Personally interested	7 (20.72)	99 (79.28)
Vocation-oriented	8 (22.15)	97 (77.85)
Ambivalent	16 (46.04)	67 (53.96)
Mental model of learning		
Intake of knowledge	8 (22.88)	97 (77.22)
Construction of knowledge	7 (19.00)	101 (81.00)
Use of knowledge	6 (16.44)	104 (83.56)
Stimulating education	7 (20.53)	99 (79.47)
Cooperative learning	8 (24.03)	95 (75.97)

[Table/Fig-5]: Learning style characteristics of preclinical medical students as per Vermunt ILS.
*Frequencies of lower scores (column I=scores 1 or 2) and higher scores (column II=scores 3, 4, or 5) are given in Vermunt ILS

For ILS A, Pearson's χ^2 test showed p=0.024 for learners awarding lower scores to processing and regulation strategies and their academic scores of ≥50%.

For ILS B, Pearson's χ^2 test showed p=0.214 for learners awarding higher scores Learning orientation and mental model of learning and their academic scores of ≥50%.

[Table/Fig-6] revealed an interesting finding regarding ILS A. Although 134 learners gave lower scores to processing and regulation strategies, a significant correlation (p=0.024) was obtained between 126 of these learners and their academic scores (≥50%). Upon deliberation by expert members of the Medical Education Unit of the Institution, it was surmised that the possible explanation might be because the standard of assessments was lowered to keep students motivated and positively focused on their studies amid the COVID scenario, thus assisting them to obtain academic scores of ≥50% with apparently less dedicated effort towards their study activities. From [Table/Fig-6], it was observed regarding ILS B that 125 learners gave higher scores to learning orientation and mental models of learning but there was no significant association (p=0.214) observed between 116 of such learners and their academic scores (≥50%).

Learning style characteristics	Academic scores <50%	Academic scores ≥50%
ILS A- Study activities (Processing and Regulation Strategies) I* (Done never or sometimes) (n=134)	8 (6)	126 (94) (p=0.024)
II* (Done regularly/often) (n=26)	5 (19.2)	21 (80.8)
ILS B- Study motives and Study views (Learning orientation and mental model of learning) I*(Disagreed entirely/mostly) (n=35)	2 (6.55)	33 (93.45)
II*(Agreed mostly/entirely) (n=125)	9 (6.85)	116 (93.15) (p=0.214)

[Table/Fig-6]: Association of students' learning styles characteristics according to Vermunt ILS with their academic scores.
†*Frequencies of lower scores (column I=scores 1 or 2) and higher scores (column II=scores 3,4 or 5) given in Vermunt ILS

DISCUSSION

A literature search revealed diverse findings regarding the learning styles of medical students using the VARK questionnaire. In a study conducted to ascertain the learning styles of 45 ophthalmology students by Hassanzadeh S et al., using the VARK questionnaire, it was found that most of them were auditory learners (34.9%), followed by multimodal learners (30.2%) [16]. Several studies conducted among first-year medical students revealed multimodal being the preferred choice among students [11,17-19]. However, a study undertaken among first-year medical students of Mahavir Institute of Medical Sciences, Telangana, India [20], revealed unimodal as the preferred modality among the majority (80.27%) of students, with kinesthetic learners constituting most of them. Similar to the current study, which revealed the greatest number of first-year medical students as visual learners (n=139, 86.8%), the study conducted by Hernández-Torrano D et al., also found that visual learners constituted the majority (80.8%) of the first-year medical students comprising their study population [17].

According to the study of learning style preferences by Khanal L et al., a greater number of students securing higher marks in Anatomy theory exams were unimodal learners (53.8%) [6]. In the present study, 92.1% of visual learners, compared to 90.5% of multimodal learners, obtained ≥50% marks in their internal assessment exams of Anatomy.

With respect to the Vermunt ILS, similar to the Turkish study of Kalaca S and Gulpinar M, Boyle EA et al., British study, the American study of Kimatian S et al., and the Argentinian study of de Lima AA et al., the present study also revealed four learning styles, namely, meaning-directed, application-directed, reproduction-directed, and undirected learning styles among medical students [3,21-23]. In addition, similar to the present study, the Turkish study by Kalaca S and Gulpinar M noted a greater number of preclinical students awarded higher scores to learning orientations [22]. In contrast to the present study where lower scores were given by most students to the construct of lack of regulation, the Turkish study [22] noted lower scores given by maximum preclinical students to the construct of use of knowledge. Unlike the studies by Boyle EA et al., Kimatian S et al., and Lloyd SH, where a low negative association of undirected learning style with academic performance and a low positive association of meaning-directed with academic performance was observed, the present study revealed no significant correlation between learning styles as per Vermunt ILS and the academic performance of students [3,22,24]. However, an association was found between academic performance and their study activities.

Limitation(s)

The present study was carried out in only one medical college in Eastern India. Conduction of a multicentric study with a larger sample size and a wider representation of students is recommended in the future.

CONCLUSION(S)

Although no association between learning styles and academic achievement was revealed by the present study, the combined use of two instruments of learning styles equipped educators with deep knowledge of the learning styles of their learners. Such information might be utilised by educators to obtain a better understanding of the learning style preferences of students and be instrumental in propelling progress towards an adaptive curriculum where alignment may be sought between students' learning needs and the content, teaching, and learning. Moreover, the present study might provide vital information to first-year medical students by offering insight into the strengths and weaknesses of their learning style preferences at the onset of their medical career. Thus, at the very start of their medical education, their metacognitive abilities might be honed, and they might be guided towards self-regulated learning, lifelong learning, and higher academic achievement.

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