Original Article

Relationship between Hemispheric Preference Score and Academic Performance among Preclinical Medical Students Studying Medicine and Dentistry

Laxman Khanal, Sandip Shah, Sarun Koirala, Jyotsna Rimal[1], Baikuntha Raj Adhikari[2], Dharanidhar Baral[3]

Departments of Human Anatomy, [1]Health Professional Education, [2]Psychiatry and [3]Public Health and Community Medicine, B. P. Koirala Institute of Health Sciences, Dharan, Nepal

Abstract

Background: Understanding the style of learning and thinking (SOLAT) of the students is necessary to keep students actively involved in learning, which could influence the academic performance of the students. **Aim:** The objective of this study was to compare the right and left hemisphere preferences for processing information with academic performance of medical students in both theory and practical exams. **Materials and Methods:** The hemispheric preference score for learning and thinking style among first year MBBS (95) and BDS (42) students was determined by SOLAT tool prepared by Dr. V. Venkataraman (1994). A comparison of the hemispheric score between high achievers and low achievers in theory and practical exams was performed by using the unpaired Student's *t*-test and Mann–Whitney *U*-test. **Results:** The mean hemispheric scores for the right hemisphere, left hemisphere, and whole brain were 26.51, 14.5, and 6.76, respectively. High achievers in theory exam and practical exam received a higher left-hemispheric score and whole-brain score than low achievers; the difference in the mean value of hemispheric score was statistically not significant. **Conclusion:** There was no statistically significant relationship between academic achievement and hemispheric preference scores.

Keywords: *Academic performance, hemispheric preference, learning style, Style of Learning and Thinking*

Introduction

Hemispheric preference or lateralization refers to the preferred mode of cognitive processing that is linked with the predominant activity of one of the cerebral hemispheres, right or left. The right and left cerebral hemispheres are specialized for different functions. The initial idea of hemispheric preference was based upon the important work done by Dr. Roger Sperry in late 1960s, which he named "split-brain model." He discovered that the human brain has two different ways of thinking. It is the propensity for one side of the brain to be used more than the other.[1] The exact timing of the evolution of brain lateralization is still a source of debate. According to Lenneberg, lateralization begins during language acquisition and is completed only after puberty.[2,3]

Functionally, the brain hemispheres are equally important, but they are not symmetric for specific cognitive function.[4] The left hemisphere is primarily responsible for logical and sequential data processing. On the other hand, the right hemisphere is in charge of processing information in a holistic and nonlinear manner.[5,6] The left hemisphere is thought to be more realistic, analytical, linear, logical, memory-based, and judgmental than the right hemisphere. While, the right hemisphere is recognized for having holistic functioning characteristics based on visual-spatial skills.[7] Kane and Kane had explained in detail comparisons of right and left hemispheric functions in their published work.[8]

Academic performance refers to the outcome of the activities of a learner that reflect the extent to which a person has accomplished the specific goals of the academic activities of the school, college, and university. The outcome of the performance of a learner in an academic environment is being assessed by various methods.[9,10] Even though there is no evidence for the best method, grading the students based on their performance in

How to cite this article: Khanal L, Shah S, Koirala S, Rimal J, Adhikari BR, Baral D. Relationship between hemispheric preference score and academic performance among preclinical medical students studying medicine and dentistry. Int J App Basic Med Res 2023;13:16-22.

Submitted:31-Jul-2022
Revised: 27-Dec-2022
Accepted: 17-Jan-2023
Published: 27-Mar-2023

Address for correspondence:
Dr. Laxman Khanal, Department of Human Anatomy, B. P. Koirala Institute of Health Sciences, Dharan, Nepal. E-mail: laxman.khanal@bpkihs.edu

Access this article online

Website: www.ijabmr.org

DOI: 10.4103/ijabmr.ijabmr_440_22

Quick Response Code:

practical and theory exams is common method for the assessment of academic performance.

Various factors affect the academic performance of students, including study habits, attitude, motivation, race/ethnicity, and genetics.[11-13] Hemispheric preference is also believed to play a role in academic performance. Medical students need to develop a wide range of skills, some of which are domains of the left hemisphere and others of the right hemisphere. Logical thinking, fine motor skills, problem-solving, and organizing concepts are the domains of the left hemisphere. Analysis and memorization of visual information and spatial anatomical relationships, communication, and recognition of different shapes come under the right hemisphere domain.[14]

In recent times, the incorporation of skill-based learning into the curriculum has been strongly recommended for the production of efficient medical graduates. Being informed about the relationship between hemispheric brain preference and academic scores among medical students may help in implementing various teaching and learning methods.[15,16] It might also be useful for students and educators to apply effective teaching-learning methods to improve their performance. Hence, the rationale of this study is based on this concept of teaching and learning perspective. The objective of present study is to compare the hemispheric preference score with the academic performance of preclinical medical students.

Materials and Methods

The present study is a quantitative cross-sectional descriptive study in which the relationship between exposure and outcome is assessed at the same time in a specific population.[17]All the research procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, amended in 2013.Ethical clearance was taken from the Institutional Review Committee (IRC) before proceeding for data collection (IRC/1500/019) on April 15, 2019.

Sample and sampling method

The study population consisted of students studying MBBS (100) and BDS (40) in their 1st year at BP Koirala Institute of Health Sciences (BPKIHS). A convenience method of sampling was used, which is a systematic method of collecting and recording each unit of the population.[18]

The Open Epi toolkit, a free and open-source software for epidemiologic statistics, was used to calculate the minimum sample size.[19] The mean and standard deviation (SD) were derived from a study conducted among higher secondary level science students in India.[20]To calculate the sample size, the assumptions made were-confidence interval (2 sided): 95%; power: 80%; mean score of right hemispheric score: 22.64; SD of right hemispheric score = 4.83; mean score of right hemispheric score: 18.21; SD of right hemispheric score = 4.21; nonresponse = 10%.

Despite the fact that the minimum sample size was 40, the current study included all 1st-year medical students studying MBBS and BDS. Inclusion criteria were 1st-year medical students (MBBS and BDS) who completed the questionnaire. Exclusion criteria were students who did not complete the questionnaire or were absent.

Measurement instruments

The data collection tool used was the Style of Learning and Thinking (SOLAT) questionnaire for determining the hemispheric preference for learning and thinking. The SOLAT tool was developed and standardized by Dr. Venkataraman (1994), an Indian expert.[21,22] This is a more advanced version of the Torrance SOLAT test[5] that consists of 50 items. It is simple, easy to understand, and best suited for learning environments.[22] Each item consists of two statements (a) and (b). The statement "a" represents the right hemispheric preference (R score), statement "b" represents the left hemispheric preference (L score), and checking both statements represents the integrated or whole hemisphere (W score).[6,22] The authors of the SOLAT tool used the test-retest method to assess the tool's reliability. The reliability coefficient of correlation for the right hemisphere function was 0.89, the coefficient of correlation for the left hemisphere function was 0.65, and the coefficient of correlation for the integrated function was 0.71. These coefficients indicate that the SOLAT tool has a high level of reliability.[6,22,23] Due to copyright issue, the SOLAT tool and manual were purchased from its publisher, and permission was obtained via E-mail for use in this research project.

A semi structured self-designed proforma was also used for the collection of demographic and other characteristics of students that might affect students' academic performance. For the sake of feasibility, the study was conducted in the lecture theater and practical room.

Data collection

After taking ethical approval from the IRC of the university, researchers collected the list of students studying MBBS and BDS from the class representatives of the respective courses. Students were informed about the objective of the study in the lecture theater and practical classroom followed by completing the informed consent form for participation in the research. After providing instruction and answering the doubts, printed copies of the SOLAT questionnaire were distributed to all the students who consented to participate in the research. All completed questionnaires were collected from the students. Other information such as gender, age, nationality, method of study, approximate study hours per day (excluding classroom study), and study habits were also recorded.

Data management and statistical analysis

Data were entered into Microsoft Excel (Redmond, WA: Microsoft Corporation, 2007) and then analyzed by the Statistical Package for Social Sciences (SPSS) version 20 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY, USA: IBM Corp.).

For the descriptive statistics, the results were presented as percentages, mean scores, and SDs. To generate the inferential statistics, the students were divided into three equal groups based on their academic performances in the theory and practical exams. Students who scored the highest were labeled as high achievers, those who scored average marks were labeled average achievers, and those who scored the lowest marks were labeled low achievers.

Quantitative variables were checked for normality using the Kolmogorov − Smirnov and Shapiro–Wilk tests before conducting inferential statistical tests. The score (percentage) in the theory exam and total right hemispheric scores were normally distributed ($P > 0.05$); all other variables were not. Student's *t*-test (or Mann–Whitney *U*-test for nonparametric data) was used to compare hemispheric preference scores between two groups of students on the basis of academic performance, i.e., high achievers and low achievers. The Pearson correlation coefficient test (or Spearman correlation coefficient test for nonparametric data) was used to calculate the correlation coefficient between the hemispheric preference score and exam score (percent). $P < 0.05$ was considered statistically significant.

Results

The current study included 137 students from the 1st year of MBBS ($n = 95$) and BDS ($n = 42$). The subjects' ages ranged from 18 to 25 years. The male-female ratio was 1.36. The Nepalese to Indian nationality ratio was 2.51. The majority of the subjects ($n = 129$) were right-handed. The mean study hours per day were 3.53. Other variables related to study habits are depicted in Table 1.

The mean values of the total right score, total left score, and total whole score were 26.51 (SD = 5.95), 14.5 (SD = 4.61), and 6.76 (SD = 5.64), respectively. The mean values of academic score obtained on the practical and theory exam were 57.37 (SD = 14.99) and 56.42 (SD = 11.38), respectively [Table 2].

Table 3 and Figure 1 show the comparison of the right, left, and whole hemispheric scores between the low achievers and high achievers in theory exam. Students with a higher R score (27.53 ± 6.91) performed poorly compared to the students with lower R scores (26.00 ± 4.53), but the students with higher L scores (14.61 ± 4.73) were high achievers and those with lower L scores (14.58 ± 4.30) were low achievers. Similarly, the case of integrated brain score (W score) being higher in high achievers was observed.

Table 1: Sample distribution according to various qualitative variables

Variables	Groups	Frequency (%)
Course of study	MBBS	95 (69.3)
	BDS	42 (30.7)
Gender	Male	79 (57.7)
	Female	58 (42.3)
Nationality	Nepalese	98 (71.5)
	Indian	39 (28.5)
Handedness	Right	129 (94.2)
	Left	8 (5.8)
Study methods	Group	6 (4.4)
	Partner	7 (5.1)
	Individual	119 (86.9)
	More than one method	3 (2.2)
	All three methods	2 (1.5)
Missed classes	Often	23 (16.8)
	Rarely	114 (83.2)

Table 2: Descriptive statistics of mean hemispheric preference scores and academic performance

Variables	Mean±SD	Minimum	Maximum
Score in theory (%)	56.42±11.38	25.69	82.08
Score in practical (%)	57.38±15.0	10.63	83.10
Total R score	26.51±5.95	6	43
Total L score	14.50±4.61	5	33
Total W score	6.76±5.64	0	29

SD: Standard deviation

Table 3: Comparison of hemispheric scores with academic achievement in theory exam

	Achiever in theory exam	*n*	Mean±SD	Mean rank	*P*
Total R score	Low achiever	45	27.53±6.91	NA	0.215*
	High achiever	46	26.00±4.53	NA	
Total L score	Low achiever	45	14.58±4.30	45.77	0.933#
	High achiever	46	14.61±4.73	46.23	
Total W score	Low achiever	45	5.58±5.21	40.74	0.059#
	High achiever	46	7.63±5.45	51.14	

*Unpaired student's *t*-test; #Mann–Whitney *U*-test. SD: Standard deviation; NA: Not available

When the right and left hemispheric preference scores were compared between low and high achievers, none showed the statistical significant difference ($P > 0.05$).

Table 4 and Figure 1 show a comparison of hemispheric scores with academic achievement in the practical exams. It revealed that the low achievers had a higher R score (27.09 ± 7.45), lower L score (14.40 ± 4.54), and lower W score (6.02 ± 6.27) as compared to the high achievers. When the right and left hemispheric scores of students were compared between the high and low achievers in the practical exams, none showed statistical significant difference ($P > 0.05$).

Table 4: Comparison of hemispheric preference scores with academic achievement in practical exam using Mann–Whitney *U*-test

	Achiever in practical exam	*n*	Mean	Mean rank	Mann–Whitney *U*	*P*
Total R score	Low achiever	45	27.09±7.45	49.36	929.0	0.314
	High achiever	47	26.45±4.58	43.77		
Total L score	Low achiever	45	14.40±4.54	45.81	1026.5	0.808
	High achiever	47	14.64±4.82	47.16		
TotalW score	Low achiever	45	6.02±6.27	42.67	885.0	0.175
	High achieve	47	7.36±5.78	50.17		

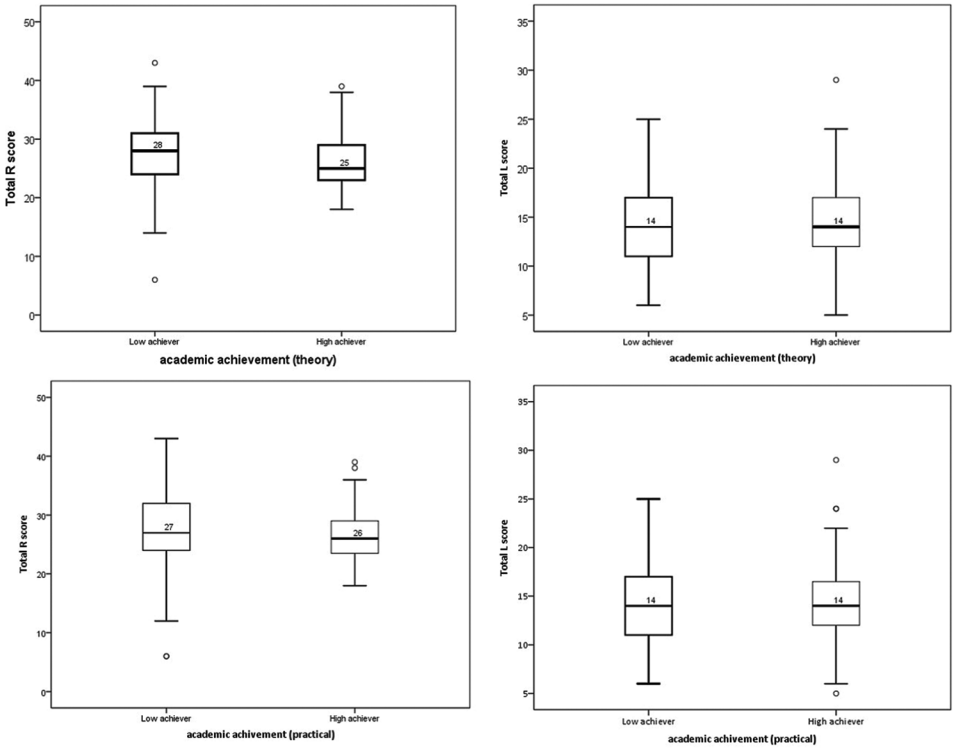

Figure 1: Box plot displaying the comparison of academic achievement with right and left hemispheric preference scores

Table 5 showed the comparison of academic performance between students' nationalities, gender, and course of study. The score on the practical exam was significantly higher among the Nepalese students than the Indian students. The gender-wise comparison showed that males achieved a significantly higher score than females ($P < 0.05$). Similarly, exam scores also differed significantly between students studying MBBS and BDS ($P < 0.001$).

Table 6 displayed the bivariate correlation between hemispheric scores and academic performance in theory and practical exams. Theory exam scores and practical exam scores were positively correlated ($r = 0.94$) and significant at the 0.01 level ($P < 0.001$). The total R score was negatively correlated with the academic score for theory ($r = -0.108$) and practical exams ($r = -0.122$). Unlike the R score, the total L score was positively correlated with the academic score for theory ($r = 0.041$) and practical exams ($r = 0.037$). There were no statistically significant correlations between hemispheric scores and academic performance.

Discussion

The purpose of the undergraduate medical education is to help students acquire the knowledge, skills, and attitudes required for the profession. The curriculum of each medical university should define these domains of learning outcomes. The curriculum of MBBS and BDS course at BPKIHS is divided into phase I (preclinical) and phase II (clinical). In both phases, students are assessed by theory and practical exams. During the preclinical years of medical education, students have to learn and face exams in many subjects, i.e., anatomy, physiology, biochemistry, pharmacology, microbiology, and pathology. Preclinical students are assessed by asking short answer questions, multiple-choice questions, and problem-based questions for theory exams.

Table 5: Comparison of academic score between nationality, gender and course of study

	Score in practical exam	*P*	Score in theory exam	*P*
Nationality	59.20±16.09 (Nepalese)	0.003*	57.35±12.31 (Nepalese)	0.075
	52.79±10.69 (Indian)		54.06±8.36 (Indian)	
Gender	59.03±16.02 (male)	0.027*	58.38±10.67 (male)	0.018
	55.11±13.29 (female)		53.74±11.87 (female)	
Course of study	61.21±12.33 (MBBS)	<0.001*	59.89±9.92 (MBBS)	<0.001
	48.71±16.93 (BDS)		48.55±10.64 (BDS)	

*Mann–Whitney *U*-test

Table 6: Bivariate correlation between quantitative variables (academic performance and hemispheric scores) using spearman and pearson correlation coefficient

	Score in practical (%)	Score in theory (%)	Total R score	Total L score	Total W score
Score in practical (%)					
Correlation coefficient					
Significant (two-tailed)					
Score in theory (%)					
Correlation coefficient	0.939**				
Significant (two-tailed)	<0.001				
Total R score					
Correlation coefficient	−0.112	−0.108#			
Significant (two-tailed)	0.193	0.209#			
Total L score					
Correlation coefficient	0.037	0.041	−0.154		
Significant (two-tailed)	0.670	0.636	0.072		
Total W score					
Correlation coefficient	0.149	0.167*	−0.592**	−0.482**	
Significant (two-tailed)	0.082	0.050	<0.001	<0.001	

*Correlation is significant at the 0.05 level; #Pearson correlation coefficient; **Correlation is significant at the 0.01 level

Similarly, objective structured practical exams (OSPE) and oral examinations or viva voce are used for practical exams.[24]

Individual differences of students in their learning patterns, academic ability, achievement level, and hemispheric preferences are key issues for an instructor to identify the specific instructional or teaching method that will be effective for the specific type of learners.[12,25,26] For this reason, it is critical to identify students' hemispheric preference which refers to preference of either of the cerebral hemispheres (right or left) for processing information and retaining it.[8] The current study included 137 students from the first year of MBBS (n = 95) and BDS (n = 42) courses. The mean age of the students was 20.16 ± 1.38 years.

According to the present study, students who scored higher on the theory and practical exams had higher L scores than the students who scored lower; but the difference was not statistically significant [Table 3]. There are very few studies comparing academic performance with hemispheric preference score. A study performed by Koju *et al*. among 400 medical students showed that left hemispheric preference was found in those students who achieved higher scores in the exam compared to those who showed right hemispheric preference. Despite this difference, it was not statistically significant.[14]The results of the current study also support the assumption that integrated brain function is necessary for solving the task or questions given during assessment. Though the difference was not statistically significant, the students who achieved higher scores on theory and practical exams had higher W scores than those who achieved lower scores. A few other studies also concluded that there is no statistically significant association between academic performance and hemispheric preference.[27,28]

To do well on the exam, a student needs a good balance of right and left hemispheric function. Oflaz concluded that right-brained and left-brained students performed differently on English vocabulary tests and English reading tests. Right-brained students were better performers when the task was to understand instructions and visual signs, while left-brained students were better in tasks related to understanding by making logical reasoning.[29] Good verbal memory, knowledge expression, language processing and comprehension, rational thinking, and logical word expression are needed for answering most of the questions. The left hemisphere is believed to be dominant for these functions.[20-22] Drawing

the diagrams and identifying the specimen/objects during a practical exam (for example OSPE) require spatial orientation, tactile awareness, retention of a visual pattern, and drawing the visual pattern by recalling its shape and geometry is important to answer the questions assessing psychomotor domain of learning, which is controlled preferably by the right hemisphere.[3,23]

Teachers' knowledge of the students' hemisphere scores could assist them in creating the activities or assignments that meet students' needs, in improving the efficiency of their teaching approach, in designing the curriculum, and in recommending the learning tactics to the students.[17]

This is the only cross-sectional study that looked at students' brain dominance score between high and low academic achievers. It is lacking in the incorporation of the specific task to the students with different hemispheric preferences to observe the effect of the same in problem solving. It is recommended to conduct the study incorporating the specific tasks.

Conclusion

Preclinical medical student studying MBBS and BDS had differences in hemispheric scores (right, left and whole brain) and study habits. Individual method of study was the major method of study. The left hemispheric (L) score and whole brain (W) scores were found to be higher in high achievers. While, right hemispheric score (R score) was lower among high achievers. None of the differences was statistically significant.

Ethical approval and informed consent

The Institutional Review Committee (IRC) of BPKIHS approved the study (Reference: IRC/1500/019). The SOLAT questionnaire was provided to the students after obtaining informed consent. Emphasis was given to the issue of confidentiality of the information about participants' characteristics.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Sperry RW. Cerebral organization and behavior: The split brain behaves in many respects like two separate brains, providing new research possibilities. Science 1961;133:1749-57.
2. Lenneberg EH. Biological Foundation of Language. New York: Wiley; 1967.
3. Torrance EP. Some evidence regarding development of cerebral lateralization. Percept Mot Skills 1987;64:261-2.
4. Morton BE. Brain executive laterality and hemisity. Personal Neurosci 2020;3:e10.
5. Torrance EP, Rockenstein ZL. Styles of Thinking and Creativity. Learning Strategies and Learning Styles. Boston MA: Springer US; 1988. p. 275-90.
6. Sah R. Effectiveness of Computer Assisted Instruction in Science with Reference to Selected Learner s Variables at Secondary Level Kumaun University; 2014. Available from: http://hdl.handle.net/10603/20765. [Last accessed on 2019 Jan 12].
7. Morton BE. Left and right brain-oriented hemisity subjects show opposite behavioral preferences. Front Physiol 2012;3:407.
8. Kane N, Kane M. Comparison of right & left hemisphere functions. Gift Child Q 1979;23:157-67.
9. Hayat AA, Salehi A, Kojuri J. Medical student's academic performance: The role of academic emotions and motivation. J Adv Med Educ Prof 2018;6:168-75.
10. Khanal L, Giri J, Shah S, Koirala S, Rimal J. Influence of learning-style preferences in academic performance in the subject of human anatomy: An institution-based study among preclinical medical students. Adv Med Educ Pract 2019;10:343-55.
11. Jafari H, Aghaei A, Khatony A. Relationship between study habits and academic achievement in students of medical sciences in Kermanshah-Iran. Adv Med Educ Pract 2019;10:637-43.
12. Das A, Bhattacharya S, Chakraborty A. Seven factors affecting medical undergraduate student' performance in academics: A study using Ron fry questionnaire in Eastern India. J Adv Med Educ Prof 2020;8:158-64.
13. Khalil MK, Hawkins HG, Crespo LM, Buggy J. The relationship between Learning and Study Strategies Inventory (LASSI) and academic performance in medical schools. Med Sci Educ 2017;27:315-20.
14. Koju B, Joshi LR, Chaudhary S, Shrestha A. Hemispheric brain preference and academic parameters in medical students: A cross-sectional study. J Lumbini Med Coll 2019;7:37-43.
15. Carberry C, McCombe G, Tobin H, Stokes D, Last J, Bury G, *et al*. Curriculum initiatives to enhance research skills acquisition by medical students: A scoping review. BMC Med Educ 2021;21:312.
16. Shah N, Desai C, Jorwekar G, Badyal D, Singh T. Competency-based medical education: An overview and application in pharmacology. Indian J Pharmacol 2016;48:S5-9.
17. Donnon T. Quantitative research methods in medical education. In: Walsh K. editor. Oxford Textbook of Medical Education. Oxford Textbook. Oxford ed. Oxford: Oxford Academic; 2013. Available from: https://doi.org/10.1093/med/97801996526790.003.0053. [Last accessed on 2019 Mar 23].
18. Sathian B, Sreedharan J, Roy B, Banerjee I, Supram HS. Relevance of sampling techniques in medical research. J Biomed Sci 2015;2:3-6.
19. Dean A, Sullivan K, Soe M. OpenEpi: Open Source Epidemiologic Statistics for Public Health Version; 2013. Available From: http://www.openepi.com. [Last accessed on 2019 Jan 20].
20. Khan AS, Sing A. A study of learning and thinking style of higher secondary school students in relation to their academic performance. Int J Multidiscip Res Dev 2016;3:318-22.
21. Uplane M, Rokade G. Effectiveness of Interactive teaching strategies based on learner's learning style on science achievement. Int J Sci Res 2014;3:768-73.
22. Venkataramana D. Style of Learning and Thinking, Administer's Manual. New Delhi: M/s Psy-Com Services; 1994.
23. Gupta M, Suman. Learning and thinking style as a major determinant of academic achievement among school students: An analytical study. Educ Quest Int J Educ Appl Soc Sci 2017;8:495-506.
24. Curriculum Review Committee. The MBBS curriculum of BP Koirala Institute of Health Sciences Dharan. 2nd edition; 2014.
25. Dunn R, Cavanaugh DP, Eberle BM, Zenhausern R. Hemispheric preference: The newest element of learning style. Am Biol Teach

1982;44:291-4.
26. Gorthey JH. Relationships between Learning Styles and Academic Achievement and Brain Hemispheric Dominance and Academic Performance in Business and Accounting Courses. Winona State University; 1993. Available from: https://eric.ed.gov/?id=ED374412. [Last accessed on 2019 Jun 12].
27. Anjum SH. A study of style of learning and thinking of urban and rural students of Aurangabad District. Sch Res J Interdiscip Stud 2014;2:2350-6.
28. Ali RM, Kor LK. Association between brain hemispheri city, learning styles and confidence in using graphics calculator for mathematics. Eurasia J Math Sci Technol Educ 2007;3:127-31.
29. Oflaz M. The effect of right and left brain dominance in language learning. Procedia Soc Behav Sci 2011;15:1507-13.