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3 **Assessing learning styles of medical students using Kolb's**
4 **learning style inventory and their association with preferred**
5 **teaching methodologies**

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10
11 **Abstract**

12 **Objective:** To determine the frequency of learning styles of medical students
13 and their association with preferred teaching methodologies.

14 **Methods:** The cross-sectional study was conducted at Baqai Medical College,
15 Gadap, Karachi, from July to October 2019, and comprised medical students
16 regardless of age, gender and academic year. David Kolb's learning style
17 questionnaire, along with another questionnaire, was used to collect data. Data
18 was analysed using SPSS 23.

19 **Results:** Of the 523 students, 213(40.7%) were males and 310(59.3%) were
20 females. The overall mean age was 21.5 ± 1.69 years. Of the total, 268(51.7%)
21 students were divergers, 118(22.8%) assimilators, 86(16.6%) accomodators and
22 46(8.9%) were convergers. There was a significant association between learning
23 styles and selected teaching methodologies ($p < 0.05$).

24 **Conclusion:** Majority students were found to be divergers and assimilators.
25 Aligning instructional strategies with learning styles will improve learning and
26 academic performance.

27 **Key Words:** Learning, Problem-based learning, Teaching methods, Students,
28 Medical.

29 **Introduction**

30 Globally, the traditional teacher-centred learning (TCL) approach has gradually
31 given way to student-centred learning (SCL) and the focus is now on teaching
32 methods that establish better communications between the students and the
33 teacher.¹ Moreover, being aware of one's own learning style helps to
34 understand one's strengths and weaknesses and to develop instructional
35 strategies which can be an expansion of both learning styles and preferred
36 teaching methodologies. Since each individual learns in a distinctive way, one
37 needs to identify the diverse means of gaining knowledge and information used
38 by various people. Many variables, such as culture, personality type,
39 educational specialisation, career choice or current job, may affect learning
40 styles and teaching strategies². In the given context, understanding the learning
41 styles of the students is of utmost importance for better and effective teaching.
42 The Learning Style Inventory (LSI) has been developed over time and is
43 considered an important tool in this regard.²
44 Identifying the learning styles is useful for medical students since it gives an
45 idea of how to teach specific skills.³
46 In 1984, David Kolb proposed the experiential learning theory (ELT), with
47 focus on the principle role of experience differentiating ELT from other
48 learning theories.^{2,4,5} Kolb's theory defines the perceiving continuum for
49 grasping and the processing continuum for transformation in order for learning
50 to occur.² The combination of these two continuums creates four quadrants
51 representing learning styles²: Diverging in which the learner uses concrete
52 experience, feeling and watching; Assimilating in which the learner uses
53 abstract conceptualisation, thinking and watching; Converging in which the
54 learner uses abstract conceptualisation, thinking and doing; and
55 Accommodating in which the learner uses concrete experience, feeling and
56 doing². As per the model, it is postulated that a learner usually moves through
57 all the learning quadrants in different situations and with the passage of time

58 adapts to one or two learning styles.^{1,2} Understanding students' learning styles
59 could be beneficial for both the students and the teacher since it helps the
60 students to realise the pros and cons of their preferred learning style, and could
61 also help the teacher in evaluating approaches.^{6,7}

62 According to research, people with specific learning styles are drawn towards
63 particular subject areas that may have an effect on their future preferences for
64 specific teaching methods.^{8,9}

65 The current study was planned to assess the frequency of learning styles of
66 medical students and their association with preferred teaching methodologies.

67

68 **Subjects and Methods**

69 The cross-sectional study was conducted at Baqai Medical College, Baqai
70 Medical University, Gadap, Karachi, from July to October 2019. After approval
71 from the institutional ethics review committee, the sample size was calculated
72 while keeping the frequency of the study outcome at 50% for the most liberal
73 estimate with 95% confidence level and 5% precision. The sample was raised
74 from among male and female medical students from 1st year to final year who
75 volunteered to take part in the study.. Those who did not volunteer were
76 excluded.

77 The self-administered data-collection tool did not request any identifying
78 information and tserial number of the questionnaire was used as the identifying
79 variable. The independent variables of the study were gender, year of study, and
80 preferred teaching methodology, while learning style was the dependent
81 variable.

82 The study questionnaire was administered to all the enrolled undergraduate
83 medical students on the campus. LSI 3.1 has been previously well-validated
84 among medical students². The 12-point questionnaire had four choices for each
85 prompt, which the examinees ranked by similarity to their learning style on a

86 five-point Likert scale. LSI has earlier been shown to be a reliable and a valid
87 assessment tool with Cronbach's alpha coefficients ranging from 0.77 to 0.84.²
88 The second part of the questionnaire was to assess students' preferences for
89 teaching methodologies. All the students had appropriate exposure to all the
90 teaching methodologies like one-way lecture, interactive lectures, small group
91 discussions (SGDs), student's presentation in tutorials, problem-based learning
92 (PBL), demonstration on models and specimens (DMS) and self-study. It
93 included selecting the best teaching methodology and also scoring all the
94 methodologies regarding usefulness in learning on a five-point Likert scale from
95 5 = strongly agree to 1 = strongly disagree (Annexure).

96 Data was analysed using SPSS 23. Mean values and standard deviations (SDs)
97 were calculated for basic characteristics, while frequencies and percentages
98 were calculated for gender, learning styles and teaching methodologies. The
99 association of various learning styles with preferred teaching methodologies
100 was assessed by using Pearson chi-square tests. Statistical significance was set
101 at $p < 0.05$.

102

103 **Results**

104 Of the 523 students, 213(40.7%) were males and 310(59.3%) were females. The
105 overall mean age was 21.5 ± 1.69 years (range: 17-28 years). Both traditional
106 and PBL methodologies were preferred by 187(35.8%) students, while
107 106(20.3%) preferred PBL and 52(9.9%) preferred traditional methodologies
108 (Table 1).

109 Of the 523 questionnaires answered, 518(99%) were received duly filled
110 and data related to them was used for subsequent analyses. Among the
111 participants, 268(51.7%) were divergers, 118(22.8%) assimilators, 86(16.6%)
112 accomodators and 46(8.9%) were convergers (Figure).

113 Gender distribution and learning styles were not significantly associated
114 ($p=0.724$), but the year of study was significantly associated with learning styles
115 ($p<0.001$) (Table 2).

116 There was a significant association between learning styles and some preferred
117 teaching methodologies (Table 3).

118

119 **Discussion**

120 The importance of understanding the learning style preferences of students is
121 well-documented in the context of achieving academic excellence.¹⁰ To the best
122 of our knowledge, however, no relevant study was previously done in Pakistan
123 to assess the preferred learning styles of medical students and their association
124 with duration or year of study. The dominant learning style in our medical
125 students was found to be diverging (51.7%), which is similar to that seen in
126 other studies in the region.^{11, 12} Similar studies in Turkey, Saudi Arabia and
127 Pakistan have reported a predominance of the diverging and accommodating
128 styles, which could be explained by cultural similarities of these countries.¹²⁻¹⁴
129 Likewise, a study reported divergent style to be the most preferred learning
130 style of nursing students.¹⁵ Divergers seek knowledge through experiences and
131 change it by employing reflective observation.¹⁶ It is a positive finding that
132 more than half of the medical students in the current study were categorised as
133 divergers as it indicated that they were sensitive to others' feelings. Such
134 individuals are also known to prefer people-oriented professions, such as
135 becoming physicians.^{16, 17}

136 Assimilators comprised 22.8% of the participants in the current study, followed
137 by 16.6% accommodators 8.9% convergers. In other studies using the Kolb LSI,
138 medical students generally showed learning style characteristics similar to the
139 current study.^{12, 18}

140 Studies have shown that the most common learning styles reported in medical
141 students are assimilating, converging and accommodating.^{10,19} Moreover,

142 nursing students have been reported to predominantly have diverging learning
143 style by a few studies.^{17, 20}

144 The current study did not report any association between gender and learning
145 styles. In contrast, studies have reported both these variables to be
146 associated.^{21,22} A few other studies using earlier LSI versions did not report any
147 gender-related differences in learning styles, which is in line with our
148 findings.^{23, 24}

149 The current study showed a significant association between the year of study
150 and learning styles of students, while one study recently demonstrated that the
151 learning styles of medical students changed during the time period of the
152 study.²⁵

153 The current study has two important limitations. First, it was carried out at a
154 single medical college and, therefore, has limited generalisability. Second, these
155 findings should be interpreted in the context of Pakistani medical students as the
156 practice of medical education may differ significantly in different regions of the
157 world influenced by various factors.^{1, 26}

158 In the current study, the preferred teaching methodology of the students, such as
159 interactive lectures, SGDs and self-study, which were associated with specific
160 learning styles. Similar results were also reported earlier.²⁷⁻²⁹. However, , results
161 from other studies found no relationship between learning styles of medical
162 students and different teaching methods.^{12, 30}

163 Bases on the findings, it is recommended that teaching methodologies of
164 medical teachers should be diverse and aligned with the learning styles of the
165 students. Moreover, policy-makers must take into account the variety of
166 learning styles employed by the students in order to develop an effective
167 curriculum of medical institutions capable of nurturing the desired excellence
168 among the students.

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171 **Conclusion**

172 Majority of medical students were found to be divergers, followed by
173 assimilators. Among teaching methodologies, interactive lectures, SGDs and
174 self-study were found to be significantly associated with learning styles as the
175 preferred teaching methodologies, while PBL, lab and model demonstrations,
176 one-way lectures and student presentations were not associated with learning
177 styles. Finally, the learning styles of students were significantly associated with
178 their year of study.

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183

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Table 1: Characteristics of the participants.

| Characteristics (n=518) | n (%) |
|---------------------------------------|--------------|
| Age (years) | 21.5 ±1.69 |
| Gender | |
| Male | 213(40.7) |
| Female | 310(59.3) |
| Year of Study | |
| 1st Year | 69 (13.3) |
| 2nd Year | 88(16.6) |
| 3rd Year | 172(33.2) |
| 4th Year | 169 (32.6) |
| 5th Year | 22(4.2) |
| Preferred teaching methodology | |
| Problem-Based Learning | 106 (20.3) |
| Traditional | 52 (9.9) |
| Both | 187 (35.8) |
| No method identified | 178 (34.0) |

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Table 2: Learning Styles by gender and academic year.

| Variables (n=518) | Accommodator | Assimilator | Converger | Diverger | Total | p |
|-------------------|--------------|-------------|-----------|-----------|-----------|--------|
| Male | 35(16.8) | 50(24.0) | 21(10.1) | 102(49.0) | 208(100%) | 0.724 |
| Female | 51(16.5) | 68(21.9) | 25(8.1) | 166(53.5) | 310(100%) | |
| 1st Year | 13(18.8) | 15(21.7) | 11(15.9) | 30(43.5) | 69(100%) | <0.001 |
| 2nd Year | 14(16.3) | 28(32.6) | 7(8.1) | 37(43.0) | 88(100%) | |
| 3rd Year | 37(21.5) | 27(15.7) | 10(5.8) | 98(57.0) | 172(100%) | |
| 4th Year | 22(13.0) | 46(27.2) | 12(7.1) | 89(52.7) | 169(100%) | |
| 5th Year | Nil | 2(9.1) | 6(27.3) | 14(63.6) | 22(100%) | |

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Table 3: Preferred methods by learning styles.

| Preferred Methods | Kolb's Learning Styles (Agree + Strongly Agree) | | | | | p |
|-------------------------|---|-----------------------------|----------------------------|----------------------------|------------------------------|-------|
| | Accommodator | Diverger | Converger | Assimilator | Total | |
| Interactive Lecture | 43 + 12 (50%+14%) | 103 + 31 (38.4% + 11.6%) | 19 + 13 (41.3% + 28.3%) | 40 + 22 (33.9% + 18.6%) | 208 + 80 (39.8%+15.3%) | 0.013 |
| Problem Based Learning | 39 + 16 (45.3%+18.6%) | 115 + 46 (42.9% + 17.2%) | 13 + 12 (28.3% + 26.1%) | 47 + 24 (39.8% + 20.3%) | 217 + 100 (41.5%+19.1%) | 0.380 |
| Small Group Discussion | 38 + 11 (44.2%+12.8%) | 89 + 63 (33.2% + 23.5%) | 8 + 14 (1.4% + 30.4%) | 39 + 28 (33.1% + 23.7%) | 177 + 117 (33.8% + 22.8%) | 0.039 |
| Demonstration on Models | 35 + 19 (40.7%+22.1%) | 90 + 66 (33.7% + 24.7%) | 15 + 8 (32.6% + 17.4%) | 42 + 26 (35.6% + 22%) | 183 + 121 (35.1%+23.1%) | 0.831 |
| Self-Study | 38 + 14 (44.2%+16.3%) | 102 + 54 (38.1%+ 20.1%) | 13 + 14 (28.3% + 30.4%) | 36 + 21 (30.5% + 17.8%) | 193 + 103 (36.9%+19.7%) | 0.032 |
| Lab Work | 28 + 14 (32.6%+16.3%) | 76 + 47 (28.4% + 17.5%) | 13 + 9 (28.3% + 19.6%) | 37 + 21 (31.4% + 17.8%) | 154 + 93 (29.4%+17.8%) | 0.185 |
| One Way Lecture | 33 + 19 (38.8% + 22.4%) | 80 + 45 (30.4% + 17.1%) | 9 + 7 (20% + 15.6%) | 31 + 24 (26.5% + 20.5%) | 153 + 95 (29.7%+18.2%) | 0.233 |

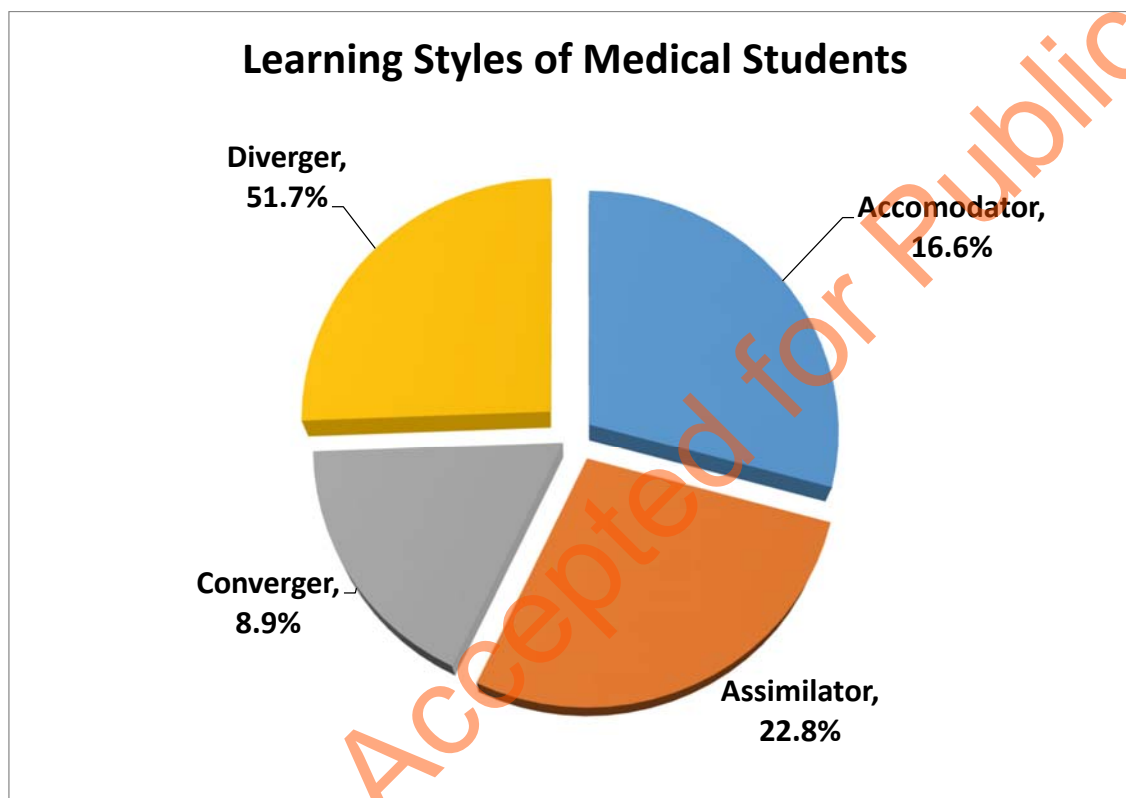
| | | | | | | |
|--------------------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|-------------------------------|-----------|
| Student Presentati on | 30 + 17 (34.9% + 19.8%) | 87 + 70 (32.5% + 26.1%) | 14 + 7 (30.4% + 26.1%) | 33 + 21 (28% + 17.8%) | 167 +116 (31.9%+22. 2%) | 0.07 7 |
|--------------------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|-------------------------------|-----------|

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289 **Figure: Learning styles of medical students.**

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293 **Annexure: Questionnaire for Kolb's Learning Style Study**294 **Form No:** _____295 **DATE:** _____296 **AGE (Years):** _____297 **GENDER:** M / F298 **DEPARTMENT:** _____299 **YEAR OF STUDY:** _____300 **Current Address (City):** _____

301 **Permanent address (City):** _____

302 **Kolb's Learning Style Inventory (Version 3.1)**

| Column 1 | Column 2 | Column 3 | Column 4 |
|----------------------------|-------------------|----------------------|-----------------|
| 1 ---- Discriminating | ----- Tentative | ----- Involved | ---- Practical |
| 2 ---- Receptive | ----- Relevant | ----- Analytical | ---- Impartial |
| 3 ---- Feeling | ----- Watching | ----- Thinking | ---- Doing |
| 4 ---- Accepting | ----- Risk Taking | ----- Evaluative | ---- Aware |
| 5 ---- Intuitive | ----- Productive | ----- Logical | --- Questioning |
| 6 ---- Abstract | ----- Observing | ----- Concrete | ---- Active |
| 7 ----- Present Oriented | ----- Reflective | ---- Future Oriented | ---- Pragmatic |
| 8 ----- Open to Experience | ----- Observative | ---- Conceptual | ---Experimental |
| 9 ----- Intense | ---- Reserved | ----- Rational | --- Responsible |

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What is your preference of teaching Methods on following scale?

| | Methods | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|----------|--------------------------------|-------------------|----------|---------|-------|----------------|
| 1 | Interactive lecture | | | | | |
| 2 | Problem based learning | | | | | |
| 3 | Small group discussion | | | | | |
| 4 | Demonstration on models | | | | | |
| 5 | Self study | | | | | |
| 6 | Lab work | | | | | |
| 7 | One way lecture | | | | | |
| 8 | Student presentation | | | | | |
| 9 | Guest speaker | | | | | |

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