Learning style-based teaching harvests a superior comprehension of respiratory physiology

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1Department of Physiology, Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamilnadu, India; 2Department of Paediatrics, Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamilnadu, India; and 3Department of Physiology, Chennai Medical College Hospital and Research Center, Trichy, Tamilnadu, India

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Anbarasi M, Rajkumar G, Krishnakumar S, Rajendran P, Venkatesan R, Dinesh T, Mohan J, Venkidasamy S. Learning style-based teaching harvests a superior comprehension of respiratory physiology. Adv Physiol Educ 39: 214–217, 2015; doi:10.1152/advan.00157.2014.—Students entering medical college generally show a vast diversity in their school education. It becomes the responsibility of teachers to motivate students and meet the needs of all diversities. One such measure is teaching students in their own preferred learning style. The present study was aimed to incorporate a learning style-based teaching-learning program for medical students and to reveal its significance and utility. Learning styles of students were assessed online using the visual-auditory-kinesthetic (VAK) learning style self-assessment questionnaire. When respiratory physiology was taught, students were divided into three groups, namely, visual (n = 34), auditory (n = 44), and kinesthetic (n = 28), based on their learning style. A fourth group (the traditional group; n = 40) was formed by choosing students randomly from the above three groups. Visual, auditory, and kinesthetic groups were taught following the appropriate teaching-learning strategies. The traditional group was taught via the routine didactic lecture method. The effectiveness of this intervention was evaluated by a pretest and two posttests, posttest 1 immediately after the intervention and posttest 2 after a month. In posttest 1, one-way ANOVA showed a significant statistical difference (P = 0.005). Post hoc analysis showed significance between the kinesthetic group and traditional group (P = 0.002). One-way ANOVA showed a significant difference in posttest 2 scores (P < 0.0001). Post hoc analysis showed significance between the three learning style-based groups compared with the traditional group [visual vs. traditional groups (p = 0.002), auditory vs. traditional groups (p = 0.03), and kinesthetic vs. traditional groups (p = 0.001)]. This study emphasizes that teaching methods tailored to students’ style of learning definitely improve their understanding, performance, and retrieval of the subject.

VAK learning style: learning style-based teaching; didactic lecture; mechanics of ventilation

Students entering medical college generally show a vast diversity in their school education in terms of board of education, medium of instruction, teaching-learning methods adapted in schools, cultural environment, parental motivation, and their own learning preferences (12). In the midst of all this diversity, the one common problem that every medical student faces in his/her earlier phase is difficulty in understanding the vast expanse of basic science subjects like anatomy, physiology, and biochemistry. This reflects in their performance and hence paves way for a lack of confidence and depression among students who were excelling in their secondary school education. The majority of students get over this problem in due course, but still a few students are demotivated and exhibit scholastic backwardness. It becomes the responsibility of teachers and instructors to motivate students and meet the needs of all diversities. One such measure is teaching students in their own preferred learning styles (2).

Learning style refers to an individual’s preferred method of gaining knowledge. It is the complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store, and recall what they are attempting to learn (9). To date, there are many models and methods of assessing learning styles, such as Kolb’s learning style inventory (10), Fleming and Mills’ visual-auditory-reading/writing-kinesthetic (VARK) model (5), Gardner’s multiple intelligence theory (6), Honey and Mumford’s learning styles (8), and so on. The visual-auditory-kinesthetic (VAK) model is used to assess the learning style of the individual based on the sensory modality preferred by him/her to perceive information. It refers to visual, auditory, and kinesthetic modalities that were expanded into VARK by Fleming (4) to include reading/writing as an additional mixed sensory modality. The objectives of the present study were to assess the learning styles of students using a self-assessment questionnaire based on the VAK model (3), prepare teaching materials using appropriate learning strategies for different kind of learners, and teach the students. The present study was also aimed to compare the traditional teaching method with learning style-based teaching methods.

MATERIALS AND METHODS

The study was based around an indigenously developed educational interventional program conducted in the Department of Physiology during the module of respiratory physiology. The study was approved by the Institutional Ethics Committee. A particular topic on “mechanics of respiration” was chosen on the basis of “difficult to understand topics” from the feedback given by paraclinical and clinical students and from peer group feedback. The subtopics and concepts covered under mechanics of respiration were prepared by the authors and validated by the senior professors. It included such subtopics as muscles and movements of breathing, pressure changes during respiration, compliance of the lungs, alveolar surface tension, and surfactant.

Learning styles of 150 students were assessed using the VAK learning styles self-assessment questionnaire (3). A total of 146 students participated in this interventional study, whereas 4 students abstained themselves due to poor health conditions. Students were clearly informed about the nature and need of the study. They were

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also informed that the assessment taken by the students did not have any academic value, for which they agreed and participated willingly. When respiratory physiology was taught, students were divided into four groups: visual, auditory, kinesthetic, and traditional. The first three learning style-based groups [visual (n = 34), auditory (n = 44), and kinesthetic (n = 28) groups] were based on their learning style. The fourth group (the traditional group; n = 40) was formed by choosing students randomly from the above three groups. Before the teaching session, all students in the four groups were subjected to a pretest to assess their baseline knowledge on the subject. The pretest was in the form of multiple-choice questions (15 in number with maximum marks of 15), which were piloted to a small group of students and item analyzed before students were subjected to them. The mean difficulty index was found to be 60%, and the discrimination index was 0.35.

The methods of teaching for the three different groups were carefully prepared according to their different learning strategies. For the visual group, students were taught on the above-mentioned subtopics with animated videos, bright and colorful pictures, and PowerPoint slides. For the auditory group, oral presentations, demonstrations, oral recitations, debates, and discussions were conducted. For the kinesthetic group, models and hands-on experiments were done using simple apparatuses and available resources (14, 13).

To explain the muscles of respiration and movements of ribs, a model was made using thermocol and wires, and the volunteering students were asked to work on it and appreciate the movements. A model of the lung was made with a plastic bottle and balloons and the effect of negative pressure was demonstrated to them. To explain surface tension, a paper clip was made to float on water in a petri dish. The effect of surfactant was explained by adding soap solution in the petri dish, and students were asked to observe the sinking of the paper clip. Students then repeated the procedure. The concept of surface tension and law of Laplace was also explained with a blown balloon, and students were asked to interpret the tension of the balloon near the neck and its expanded part. The law of Laplace was also felt by students as described by Haddad and Brito (7) as a simple act. Students were asked to stand at a distance facing each other both holding the ends of a large towel. A textbook was placed in the center of the towel, and students were asked to appreciate the tension at varying distance between them. The walls of the hollow structure were depicted by the ends of the towel and the distending pressure was depicted by the textbook, and the tension on the walls was analogous to the tension felt by students in their hands holding the towel.

The concept of compliance was taught as a hands-on workshop. The experimental setup, as shown in Fig. 1A, was devised based on the model done by Weissenberg and Lavy (15) with simple modifications by our team.

A rubber tube (of a blood pressure apparatus) was modified into the shape of a “T” using connectors. One end was tied to a balloon and immersed in water contained in a large graduated glass beaker. The other end was connected to the mercury manometer of the regular blood pressure apparatus. The vertical limb of the T tube was fitted with an air pump. Compressing the air pump inflated the balloon and displaced the water. From the change in the level of water, the volume of air inflated was noted (Archimedes’ principle). The simultaneous rise in pressure was also noted from the mercury manometer. To measure compliance and hysteresis, the student was asked to inflate the balloon in steps of 50 ml, and the pressure increment was noted. This was repeated for about five increments, and the volumes and pressures were noted. The balloon was then deflated in steps of 50 ml, and the pressure decrements were noted similarly. Students were asked to record the volume and pressure changes during inflation and deflation and then chart them in a graph (Fig. 1B). Active participation of the students was ensured throughout the teaching period.

The traditional group was taught with the routine didactic lecture using PowerPoint images without pictures, videos, or animations. At the end of the session, students were asked to take posttest 1, with the same set of questions as the pretest, and then assessed. Feedback from students was also obtained regarding this teaching-learning methodology and its effectiveness. Students were informed that posttest 2 would be after few weeks without disclosing the exact date and pattern of assessment. Posttest 2, with the same multiple-choice questions, was given to the students after a month with the idea of assessing their recall ability. During this gap of 1 mo, no reinforce-
ment of the topic in the form of tests or assignments was made to the students. Scores on the pretest, posttest 1, and posttest 2 were analyzed statistically between the four groups by one-way ANOVA using SPSS software 21.0. Post hoc analyses were done using Tukey’s test. Percentage analysis of feedback was done using Excel.

RESULTS

The pattern of the learning styles of the students is shown in Fig. 2. Scores on the pretest, posttest 1, and posttest 2 are shown in Table 1.

Post hoc analysis (done by Tukey’s test) of posttest 1 scores showed a significant difference between the kinesthetic and traditional groups ( \( P \leq 0.002 \)). Similar post hoc analysis of posttest 2 scores showed significance between the visual and traditional groups ( \( P \leq 0.002 \)), auditory and traditional groups ( \( P = 0.03 \)), and kinesthetic and traditional groups ( \( P = 0.001 \)).

Assessment of student feedback is shown in Fig. 3 as the percentage of students choosing the choice of “yes” for a few questions. The overall rating of the program was also obtained as feedback using a Likert scale (Fig. 3).

DISCUSSION

Analysis of individual learning style is very critical in improving the understanding and hence performance of every student. Assessment of learning styles in our study revealed that almost half of the students were auditory learners. In addition, 12% of the students were bimodal learners and 1% of the students were multimodal learners. In contrast, two studies, one from the United States (11) and another study from Turkey (1), using the same VARK model of learning style assessment in first-year medical students showed that majority of first-year students (nearly 63% in both studies) preferred multiple modes. This difference in the preference of learning styles might have occurred because of the different strategies of school education.

Pretest score analysis showed no significant difference between the groups, meaning that the students all had comparable

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**Table 1. Scores on the pretest, posttest 1, and posttest 2 of the students**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest (Maximum Marks: 15)</th>
<th>Posttest 1 (Maximum Marks: 15)</th>
<th>Posttest 2 (Maximum Marks: 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual group</td>
<td>5.18 ± 2.02</td>
<td>9.06 ± 1.63</td>
<td>8.76 ± 1.74</td>
</tr>
<tr>
<td>Auditory group</td>
<td>5.25 ± 2.18</td>
<td>9.18 ± 1.97</td>
<td>8.34 ± 1.45</td>
</tr>
<tr>
<td>Kinesthetic group</td>
<td>4.61 ± 1.81</td>
<td>10.29 ± 2.45</td>
<td>8.89 ± 1.73</td>
</tr>
<tr>
<td>Traditional group</td>
<td>5.02 ± 1.94</td>
<td>8.50 ± 1.9</td>
<td>7.30 ± 1.86</td>
</tr>
<tr>
<td>One-way ANOVA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( F ) value</td>
<td>0.648</td>
<td>4.514</td>
<td>6.664</td>
</tr>
<tr>
<td>( P ) value</td>
<td>0.585</td>
<td>0.005*</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

All values are means ± SD. *Statistically significant.

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Fig. 3. Student feedback on the learning style-based teaching methods.
baseline knowledge on the topic. Scores on posttest 1 were greater in the visual, auditory, and kinesthetic groups compared with traditional group, although scores were statistically significant between the kinesthetic and traditional groups. This shows the kinesthetic learning strategy is better than the traditional teaching method as the former induced more active learning. A similar study by Breckler and Yu (2) also showed increased performance by kinesthetic students involved in a hands-on kinesthetic activity for learning the oxygen-carrying capacity of blood compared with nonkinesthetic learners who were involved in traditional learning. Another study by Rao and DiCarlo (14) was also conclusive of the same outcome. It was also said that the depth of learning, analytic thinking, and recall capacity of the students were prolonged with active learning than with traditional lecture methodologies (14). The probable reason for the decrease in the scores in posttest 2 compared with posttest 1 is that the memory of any new information learned, without reinforcement, tends to be lost over time (Ebbinghaus hypothesis). In the present study, we compared the recall ability of students of learning style-based groups with those in the traditional group. The fact that posttest 2 scores were significantly higher in all three learning style-based groups compared with the traditional group brought us to the conclusion that the active learning provided by learning style-based teaching is helpful for the long-term retrieval of the subject. Even though reinforcement of the topic was not given during the gap of 1 mo, the amount of passive learning by the students could not be assessed, which became a confounding factor to this study. Still, since the bias was common to all groups of the students, we conclude that the learning style-based teaching method is better than the traditional teaching method for long-term retrieval and performance.

The more interesting information to be realized from this study is that students greatly enjoyed and actively took part in all learning style-based groups. The fact that there were no missing students in the pretest, posttest 1, and posttest 2 was evidence of the students’ involvement and enthusiasm. Conclusions and recommendations. Medical students, when taught in their preferred learning style, learned and performed better than those taught with the traditional lecturing method. Hence, it is very important to tailor teaching material in such a manner that it involves interest in all students in a mixed group of learners. Learning style-based teaching is certain to help students’ understanding, although it requires additional manpower and material and is time consuming. In the present study, only one topic was discussed with this methodology; hence, it may be quite unclear to extrapolate the results to entire physiology. While it might not be practically tenable to undertake the teaching of the entire syllabus by dividing a class into learning style-based groups, we suggest that multiple audio, video, and kinesthetic resources be made available to students. They may then be encouraged to use learning style-specific resources for learning to enhance their academic performance and improve their understanding of subjects.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS


REFERENCES