PowerPoint presentation in learning physiology by undergraduates with different learning styles

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Ankad RB, Shashikala GV, Herur A, Manjula R, Chinagudi S, Patil S. PowerPoint presentation in learning physiology by undergraduates with different learning styles. Adv Physiol Educ 39: 367–371, 2015; doi:10.1152/advan.00119.2015.—PowerPoint presentations (PPTs) have become routine in medical colleges because of their flexible and varied presentation capabilities. Research indicates that students prefer PPTs over the chalk-and-talk method, and there is a lot of debate over advantages and disadvantages of PPTs. However, there is no clear evidence that PPTs improve student learning/performance. Furthermore, there are a variety of learning styles with sex differences in classrooms. It is the responsibility of teacher/facilitator and student to be aware of learning style preferences to improve learning. The present study asked the following research question: do PPTs equally affect the learning of students with different learning styles in a mixed sex classroom? After we assessed students’ predominant learning style according to the sensory modality that one most prefers to use when learning, a test was conducted before and after a PPT to assess student performance. The results were analyzed using Student’s t-test and ANOVA with a Bonferroni post hoc test. A z-test showed no sex differences in preferred learning styles. There was significant increase in posttest performance compared with that of the pretest in all types of learners of both sexes. There was also a nonsignificant relationship among sex, learning style, and performance after the PPT. A PPT is equally effective for students with different learning style preferences and supports mixed sex classrooms.

PowerPoint presentation; learning styles; students’ performance; sensory modality

THE QUALITY OF PHYSIOLOGY EDUCATION in undergraduates is important as it will serve them in their chosen career or in postgraduate education. Therefore, there is a strong need to improve learning and retention during undergraduate education to ensure that students are prepared to handle the challenges that they will face both in future courses and after graduation. Hence, physiology instructors need to improve instruction by adapting teaching approaches to meet the different learning style preferences of students to improve their learning, retention, and motivation (7).

Learning style preferences are the manner and conditions under which learners most efficiently and effectively perceive, process, store, and recall what they are attempting to learn (27). Learning style preferences of students can be defined and assessed according to the sensory modality that one most prefers to use when learning. As Bruner (6) and Piaget (22) observed, the four different sensory modalities that humans use to assimilate information are visual (V), auditory (A), reading/writing (R), and kinesthetic (K), collectively termed “VARK.” Students with visual preferences learn best using pictures, graphs, diagrams, etc. Auditory or aural learners prefer to listen to and discuss material. Those with read/write preferences learn best with textual materials. Finally, kinesthetic learners internalize information best when they are involved physically (e.g., touching and manipulating materials). Student learners are capable of using all of these sensory modes of learning; however, each individual has a unique preference (unimodal) or set of preferences (multimodal: bi, tri, or quadrimal), in which one mode is often dominant (27). Flemming then built on this concept by developing an online questionnaire (11) that categorizes learning styles on the basis of one’s VARK modality preferences. Those interested in using the questionnaire simply visit the pertinent website (11) and answer the 16 specific questions, and the program then automatically compiles the results and determines a user’s sensory modality preference(s). Recent studies that have investigated learning style preferences in physiology students have used a version of Flemming’s VARK questionnaire to determine their students’ sensory modality preferences and found that the majority of their physiology students had multimodal preferences. In contrast, Meechan-Andrews (20) found that the majority of physiology students preferred to use only one VARK modality when learning information (unimodal). Yet another study conducted by Wehrwein et al. (27) found that the majority of their male physiology students had multimodal preferences, whereas the majority of their female students had unimodal preferences. It is important to point out that the unimodal preferences found both in female students in the Wehrwein et al. study (27) and in all students in the Meechen-Andrews study (20) were fairly small (i.e., 54% of the students in both studies preferred unimodal learning vs. 46% preferred multimodal learning). Three studies (1, 5, 24) found no significant difference in preferences between male and female students.

In the present study, the decision was taken to have students’ self-assess their own sensory modality preference for the reason that the purpose of this study was not to compare the proportion of multimodal and unimodal learners but to simplify the design to more effectively investigate potential interactions with sex and performance/learning after a PowerPoint presentation. This study also focused on (i.e., limited students to) the single sensory modality that students most preferred. The Dobson study (10) also considered the students’ self-assessment of their own sensory modality preference instead of Flemming’s questionnaire for finding the relationship among sex, learning style, and course performance in undergraduate students. The present study is different from the Dobson study (10) in assessing undergraduate physiology student performance before and after lecture using a PowerPoint presentation instead of course performance.
Knowing the student’s learning style preferences and sex differences in learning will aid in the development of the most effective teaching approaches (27). In the classroom, a wide variety of teaching methods can help reach the diversity of learners. In classrooms, a teacher’s basic instructional tools for displaying information are chalkboards, multipurpose boards, pegboards, bulletin boards, flip charts, and transparencies with an overhead projector (TOHP) (14). Recently, the use of electronic presentations has become common, and Microsoft PowerPoint is now the most popular instructional aid. Researchers have examined students’ preferences and benefits of these types of presentations. Studies (21, 23, 25) have found that students prefer PowerPoint presentations to TOHP and chalk-and-talk presentations. Supporters have claimed that PowerPoint presentations improve learning (13, 23), invoke audience interest (25), and aid explanations of complex illustrations (9). Detractors charge that PowerPoint presentations inhibit presenter-audience interactions (21) and that, in some instances, the content of the PowerPoint presentation distract the students (4). Thus, there is a lot of debate over the advantages and disadvantages of PowerPoint presentations. However, there is no clear evidence that PowerPoint presentations improve student learning/performance. An extensive study (25) comparing a PowerPoint presentation and TOHP observed no difference in student performance in tests, whereas in other studies (2, 13), there was a marked improvement in examination results when a PowerPoint presentation replaced the chalk-and-talk method. Whatever the scenario, PowerPoint presentations are the most preferred instructional aid over the chalk-and-talk method among medical teachers (26). In our physiology department as well, we are using PowerPoint presentations routinely to deliver lectures. The unique purpose of the present study was to investigate the relationship among preferred learning style, sex, and performance/learning after a PowerPoint presentation to students and thus to know if PowerPoint presentations equally affect the learning/performace of undergraduate physiology students with different learning style preferences in a mixed sex classroom.

**MATERIALS AND METHODS**

The present study was conducted in the Department of Physiology, S. Nijalingappa Medical College (Navanagar, Bagalkot, Karnataka, India). Ethical clearance for the study protocol was obtained from the institutional ethics committee. All students who attended the class were included in the study. Students that participated in this study were first-year medical undergraduate students who took admission to this college in 2014 through common entrance exams after passing preuniversity exams on chemistry, physics, and biology. Hence, all students were comparable in terms of previous educational background. Informed consent was obtained from all students. Learning style preference was assessed based on the sensory modality in which a student prefers to take in new information. Although students are capable of using all modes of learning (V, A, R, and K), each learner has a unique preference or set of preferences, in which one mode is often dominant (27). Hence, students were asked to self-assess their predominant learning preferences by selecting the following statements:

1. **V:** seeing text or diagrams helps me to take in new information.
2. **A:** hearing the material helps me to take in new information.
3. **R:** reading down what I hear or read helps me to take new information.
4. **K:** touching or observing a physical model helps me to take in new information.

Basic details, such as age and sex of students, were also noted. All students were made to seat comfortably in a classroom, which had 150 chairs arranged in a gallery type of seating. There was a large presentation area for the instructor. A projection screen was located at the center of the presentation area at an angle to the students. The nearest person was ~10 ft from the screen, and the farthest person was ~30 ft from the screen.

Before the lecture began, a pretest was conducted with 10 multiple-choice questions that would be discussed in detail during lecture. Pretest scores were considered as control scores. Pretest scores were not revealed to the subjects until the completion of the posttest. Students were not informed about the topic to be discussed in the class before or about the posttest. Students had already been exposed to PowerPoint presentations in different topics before and thus were not new to lectures using PowerPoint.

PowerPoint presentations were run on a Hitachi model CP-EX2500 overhead projector. In order for the material to be legible, all lights were switched off in the room and the contrast setting on the projector was set to the highest level.

A lecture on the topic of physiology of hearing in which “fundamentals of sound production and the role of external and middle ear in transmission of sound waves” was given for 50 min using the PowerPoint projector. The specific learning objectives of the topic prepared for undergraduates were as follows:

1. To know the functional anatomy of the hearing apparatus.
2. To know the physical properties of sound.
3. To know the mechanism of hearing related to the external and middle ear.

The presentation included 25 slides, among which 13 slides were diagrams and the remaining slides had written material related to the topic. Each slide had either one diagram or written material in six to eight lines with sufficient spacing between lines. Each letter was ~2–3 in. in height and width. None of the slides had sound effects or diagrams/pictures not related to the topic. Students were not given any handouts regarding the topic but were allowed to write down notes from PowerPoint slides during the delivery of the lecture. The instructor delivered the lecture using a microphone. The instructor received no complaints from students about the legibility, audibility, or lighting in the room; to confirm this, two staff members were made to seat in the last row behind the students.

A posttest was conducted with same 10 multiple-choice questions, but the order of questions and sequence of choices were changed to avoid copying and alter the pretest answers. The same questions on the pretest were used in the posttest because we considered pretest scores as control scores and to avoid confounding factors of selecting different questions in the posttest.

The number of students who preferred each mode of learning style was divided by the total number of students to determine the percentage of students in each category of learning style. A z-test was applied to determine sex differences in preferred learning style. Pretest and posttest results are presented as means ± SD. Student’s t-tests were used to determine the significance of study parameters between pre-/posttest scores (paired t-test) and between sexes (unpaired t-test). To determine the effect of PowerPoint presentations on prior knowledge, students of each sex were divided into two groups (below and above mean/average score) based on their mean/average scores in the pretest. The difference of scores between the posttest and pretest was considered to determine the significance using an unpaired t-test between below and above average pretest score groups in each sex and also to determine sex differences in the differences of score in each learning style group. Statistical comparisons between preferred sensory modality and student scores on the pretest, posttest, and difference of score were conducted using ANOVA with Bonferroni post hoc tests using SPSS 20 version. P values of <0.05 were considered statistically significant.

**How We Teach: Classroom And Laboratory Research Projects**

**PowerPoint Presentation in Different Learning Styles**

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RESULTS

Of the 150 students, 97 students (59 male students and 38 female students) attended the class. The percentage of students preferring each predominant learning style is shown in Table 1. The R learning style was the most preferred and the K learning style was the least preferred style of learning for both sexes. There were no significant sex differences in preferences of learning style (Table 1).

The present study found a significant increase in the performance in the posttest compared with the pretest for both male and female students irrespective of their preferred learning style. There was a significant difference in pretest performance for male and female students, in contrast to a nonsignificant difference in posttest performance (Table 2). For both sexes, students with below average pretest scores performed significantly better in the posttest compared with students with above average pretest scores (Table 3). The present study also showed nonsignificant sex differences in the difference of score between the posttest and pretest in each learning style (Table 4).

The interactions between learning style preferences and scores (means ± SD) in the pretest, posttest, and difference of score are shown in Fig. 1. Bonferroni post hoc tests revealed nonsignificant change in scores between each preferred style learners in the pretest, posttest, and difference of score of the posttest and pretest.

DISCUSSION

The present study assessed sex differences in learning style preferences among undergraduate physiology students and showed no sex differences. Although previous studies have investigated the relationship between preferred learning style and sex in physiology courses (1, 5, 10, 24, 27), only two studies found significant differences. The Wehrwein et al. study (27) reported that the majority of male students preferred multimodal instruction [specifically, four modes (VARK)], whereas the majority of female students preferred a single modality. This contrasting result could be due to differences in the method of assessing the learning styles in the Wehrwein et al. study (27) and the present study. The Wehrwein et al. study (27) considered the VARK questionnaire for assessing learning styles where students were given a choice to mark more than one option for each question (if preferred), and thus the scoring and statistical validity of the VARK questionnaire were study limitations. To overcome this, we considered the predominant style of learning by asking students to self-assess and opt for one mode of learning so that their performance could be assessed statistically. In addition, the sex differences in preferences of learning styles reported in the Wehrwein et al. study (27) were not statistically analyzed. The Dobson study (10) reported that both female and male students most preferred the V sensory modality, but there were considerable differences in the second most preferred modality between the two groups. Female students preferred the A sensory modality, whereas male students preferred the R sensory modality. The K sensory modality was the least preferred, with a very small proportion for both male and female students. The present study is similar to the Dobson study (10) in asking the students to self-assess and to select a single VARK modality, but this study found the R sensory modality to be the most preferred and the K sensory modality the least preferred for both sexes. Although the Dobson study (10) and present study involved undergraduate students, the present study considered only first-year medical students, whereas the Dobson study (10) involved first- and second-year students.

The present study showed an improvement in the posttest performance compared with pretest performance for both male and female students. This showed a positive impact of the PowerPoint presentation on students’ immediate performance and learning. This finding is in accordance with research studies that reported that the performance of students in exams and their grades were improved by the use of multimedia presentations (2, 13, 15, 23, 25). These previous studies either compared the impact of using multimedia on academic achievement compared with that of using the chalk-and-talk method and transparencies or compared different types of PowerPoint presentations on student performance. Student per-

Table 2. Sex differences in pretest and posttest performance of students

<table>
<thead>
<tr>
<th></th>
<th>Male Students</th>
<th>Female Students</th>
<th>t Value</th>
<th>P Value</th>
<th>Effect Size (Cohen’s d)</th>
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<tbody>
<tr>
<td>Pretest</td>
<td>41.19 ± 15.32%</td>
<td>33.68 ± 33.68%</td>
<td>2.42</td>
<td>0.017 (significant)</td>
<td>0.31</td>
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<tr>
<td>Posttest</td>
<td>61.70 ± 15.99%</td>
<td>62.10 ± 16.79%</td>
<td>0.121</td>
<td>0.904 (not significant)</td>
<td>0.02</td>
</tr>
<tr>
<td>t value</td>
<td>10.49</td>
<td>10.49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>0.000 (highly significant)</td>
<td>0.000 (highly significant)</td>
<td>1.31</td>
<td>1.068</td>
<td></td>
</tr>
</tbody>
</table>

Pretest and posttest scores are means ± SD. Interpretation of effect size (20): 0–0.2 = no effect, 0.2–0.5 = small effect, 0.5–0.8 = intermediate effect, and >0.8 = large effect.
performance was tested after a few weeks of exposure to PowerPoint presentations; hence, the better performance could also be due to students’ self-directed efforts. These studies also did not considered sex differences and the relationship of performance with respect to different learning style preferences of students. The present study is novel from these previous studies in considering only a single lecture using a PowerPoint presentation and its effect on immediate performance/learning of students with different learning style preferences in a mixed sex classroom. However, the present study did not compare student performance after different modes of teaching.

The present study also showed sex differences in the performance of the pretest, whereas in the posttest, there was no significant change in the performance of both sexes. This implies that a PowerPoint presentation is an equally effective mode of teaching for both male and female students.

Furthermore, the amount of knowledge a person already has could play a role in whether graphics are useful. Lee et al. (16) indicated that the amount of beginning knowledge may have an effect on whether multimedia or traditional lecture is better; however, their findings indicated mixed results as to which type of presentation is better. Another study (8) found no moderating effect of beginning level of knowledge. Finally, Mayer and Gallini (19) found that students with low prior knowledge benefited on conceptual recall and problem solving but not verbatim recall when given graphics describing both the components and action taking place. Students with high prior knowledge only benefited from the graphics on problem solving (4). The present study also showed in both sexes, students with below average prior knowledge (pretest score) performed better in the posttest after the PowerPoint presentation. However, the present study did not consider the opinion of students regarding the benefits gained by them to perform better.

Another major finding of this study was the nonsignificant relationship between preferred sensory modality and students’ performance after the PowerPoint presentation. Although there was an improvement in the posttest performance of V, A, R, and K learners, the mean score of K learners was less compared with the other three type of learners in the pretest, posttest, and difference of score between the posttest and pretest, which was statistically nonsignificant. These results of the study are in contrast to the findings of the Dobson study (10), which also considered the relationship among learning style, sex, and performance after a course in which computer animations were one of the resources and that results indicated that female and male students’ preferred different sensory modalities and that those with different sensory modality preferences performed differently in the course.

If PowerPoint presentations are well organized and well structured (contain texts, pictures, animation, voices, and video), they can provide an interactive environment for the active engagement of students, thereby motivating them to attend lectures when presentation graphics are used compared with chalk-and-talk presentations (13, 18, 23). Therefore, students can learn better or retain the material from class more. PowerPoint presentations are useful in showing complicated three-dimensional diagrams and can save the time taken to draw complicated diagrams on a blackboard during class. Students can write down notes and imagine complex structures, which will benefit them to understand and learn fast (9). This is supported by the equal performance of V, A, and R learners. Although the decreased performance of K learners was nonsignificant from that of the other three types of learners, the present study was not able to explain the better performance of K learners in the posttest compared with the pretest. Although studies have indicated that the students believed their notes were useful, their notes were not examined in this study. Future research should be undertaken to examine whether PowerPoint presentations affect the manner in which students take and organize their notes.

Thus, it is the responsibility of the teacher/facilitator and student to be aware of learning style preferences to improve learning, to overcome the predisposition of many facilitators to treat all students in a similar way (12), and to motivate

<table>
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<tr>
<th>Table 4. Sex comparison in difference of score between the posttest and pretest for each preferred learning style</th>
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<tr>
<td>Learning Style</td>
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<tr>
<td>------------------</td>
</tr>
<tr>
<td>Visual</td>
</tr>
<tr>
<td>Auditory</td>
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<tr>
<td>Read-write</td>
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<td>Kinesesthetic</td>
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Values are means ± SD.
facilitators to move from their preferred mode(s) to using others. This will help in reach more students because of a better match between facilitator and learner styles (3). Teaching by PowerPoint presentations is effective in this aspect.

The present study demonstrates that PowerPoint presentations, as an audiovisual aid, is not only effective for A and V learners but also equally effective for R and K learners and supports mixed sex classrooms. As instructors, we need to assess and understand the manner of reaching all students by understanding ways to present information in multiple modes using PowerPoint presentations as an effective educational tool.

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

AUTHOR CONTRIBUTIONS

REFERENCES