Writing on the board as students’ preferred teaching modality in a physiology course

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Armour C, Schneid SD, Brandl K. Writing on the board as students’ preferred teaching modality in a physiology course. Adv Physiol Educ 40: 229–233, 2016; doi:10.1152/advan.00130.2015.—The introduction of PowerPoint presentation software has generated a paradigm shift in the delivery of lectures. PowerPoint has now almost entirely replaced chalkboard or whiteboard teaching at the undergraduate and graduate levels. This study investigated whether undergraduate biology students preferred to have lectures delivered by PowerPoint or written on the board as well as the reasons behind their preference. Two upper-division physiology courses were surveyed over a period of 7 yr. A total of 1,905 students (86.7%) indicated they preferred lectures delivered “writing on the board” compared to 291 students (13.3%) who preferred PowerPoint. Common themes drawn from explanations reported by students in favor of writing on the board included: 1) more appropriate pace, 2) facilitation of note taking, and 3) greater alertness and attention. Common themes in favor of PowerPoint included 1) increased convenience, 2) focus on listening, and 3) more accurate and readable notes. Based on the students’ very strong preference for writing on the board and the themes supporting that preference, we recommend that instructors incorporate elements of the writing on the board delivery style into whatever teaching modality is used. If instructors plan to use PowerPoint, the presentation should be paced, constructed, and delivered to provide the benefits of lectures written on the board. The advantages of writing on the board can be also incorporated into instruction intended to occur outside the classroom, such as animated narrated videos as part of the flipped classroom approach.

Although several new teaching methods have been implemented in the classroom of undergraduate and graduate science education, lectures remain a primary modality. Several studies have determined that more interactive teaching approaches such as small-group discussion sessions, team-based learning, and problem-based learning were considered educational best practice, and the authors recommended replacing lecture with these interactive modalities (4, 13, 22, 27, 28). However, didactic lectures are still an effective way to deliver foundational instructional content to students, particularly for large classes.

Most undergraduate and graduate instructors now use PowerPoint to deliver lecture content, with a minority of courses taught using the chalkboard or whiteboard (7, 9). PowerPoint confers some obvious advantages to both the student and instructor. For example, PowerPoint slides can be made available for the students before, during, and after class. The quality of text and diagrams is superior to an instructor’s handwriting, and animations, pictures, and videos can be easily incorporated into the PowerPoint presentation to enhance learning (25). It is also less physically demanding for an instructor to click through his/her slides than to write on the board. The adoption of PowerPoint by instructors has certainly addressed some of the shortcomings of writing on the board and is more compatible with the technological advancements in education made over the past decade. However, PowerPoint may have also introduced some of its own disadvantages while eliminating some of the key learning benefits of writing on the board.

When comparing the teaching modalities of “writing on the board” versus PowerPoint from a student’s perspective, one major difference is how students take notes. When instructors “write on the board,” students must continuously write down and think about the content. In contrast, since PowerPoint slides are made available, students can take additional notes on their laptop, which may not be as effective as longhand note taking.

“Taking notes” has two major potential benefits to the learner that have been lost with the switch to PowerPoint. The first is the more active engagement of the learner with the material because longhand note taking encourages the learner to better reflect and think about the material as it is being presented. It enhances deeper understanding and is an effective information-processing tool. The second major benefit of note taking is that it may improve later performance, because learning occurs during the production and review of the students’ own notes (2, 19).

There are limited data available on students’ preferences comparing PowerPoint and writing on the board during lecture, particularly in physiology courses. In the only published report (20), no significant difference was found after a single physiology lecture taught on the chalkboard or with PowerPoint (51% of the students preferred chalkboard and 49% chose PowerPoint). Studies performed in other science courses including anatomy, biochemistry, chemistry, and pharmacology have provided mixed results (15, 17, 24–26). One study (17) comparing the preferences of undergraduate students in a chemistry course did not detect any differences, whereas students in a biochemistry course chose the use of the chalkboard over PowerPoint. Blackboard teaching was also the preferred instructional modality in an anatomy class (15). In contrast, in a study investigating medical and dental student’s preferred teaching methods, medical students chose PowerPoint over chalkboard and overhead transparencies. No significant differences in students’ preferences were found among dental students. PowerPoint was also identified as the preferred teaching modality in undergraduate students attending a pharmacology course (24). These mixed results could be attributed in part to different study designs, topics, and levels of students. Further-
more, not all studies defined how writing on the board was done by the instructors.

Only a few studies investigating student preferences have included why the students chose one approach over another. When these results were reported, the proposed explanations were vague (e.g., “better summarization” or “clarity of words”) and did not provide any mechanistic insights into specific teaching approaches (15, 20, 25, 26).

The present study investigated the lecture modality preference (Powerpoint vs. writing on the board) of undergraduate biology students over several years, thus providing both a large cohort and insights into the stability of that preference over time. In addition, analysis of student comments identified specific themes that provide potential mechanisms for enhancing active learning elements in all modalities.

**METHODS**

*Subjects, setting, and design.* Undergraduate biology students were surveyed concerning their opinions of two different teaching modalities: writing on the board and PowerPoint. Survey data were collected over 7 yr (2008–2014) in two different upper-division physiology courses in the Division of Biological Sciences at the University of California San Diego. One physiology course included lectures and laboratory sessions and was taught three times every year. The second physiology course was a lecture-only course taught once every year. Both courses covered the physiology of the nervous, endocrine, muscular, cardiovascular, and renal systems and were taught by the same instructor who predominantly used writing on the chalkboard as his teaching method.

The survey was administered on the last day of each class, together with the final exam. Twenty-seven classes with enrollments that varied between 100 and 300 students/class were surveyed, and a total of 2,256 student responses were collected anonymously. The survey consisted of the two questions shown below:

1. Which lecture format do you prefer? Writing on the board or PowerPoint (circle one).
2. Why do you think this?

Only the responses of students circling a single format in the first question contributed to the preference data shown in Fig 1, A and B; student responses with both lecture formats circled were omitted from this analysis. All student comments concerning a circled lecture format were included the analysis shown in Tables 1 and 2; these data include student comments from responses with both teaching formats circled. An exemption was obtained from the institutional review board of the University of California San Diego for data analysis.

*Teaching method.* All lectures for both physiology courses were taught by the same professor, who presented virtually all of the course material that students were required to learn on a chalkboard. No other teaching modalities (e.g., clicker questions) were used. The lectures were organized in a detailed outline format, and diagrams were drawn from scratch on the board in a step-by-step process. The instructor stimulated student engagement by including “So what?” sections that extended the material into medical applications. During the lectures, the instructor frequently asked students if they had any questions and established eye contact with students whenever possible. Students were not allowed to take pictures of the board, and the lectures were not podcasted. Students who missed a lecture were not sure about parts of their notes were encouraged to get notes from their classmates and seek help from the instructor. The vast majority of the note taking occurred by longhand with either paper/pencil or with a tablet/stylus. Laptops were rarely used to take notes.

**RESULTS**

During the 7-yr study period, the survey was administered in 27 classes with 3,504 students. A total of 2,256 undergraduate biology students in 27 classes were asked whether they preferred to be taught using writing on the board or PowerPoint. Most students (n = 1,905 students; 87.0%, SD: 5.2%) reported that they prefer to be taught by writing on the board versus 291 students (13.0%, SD: 5.2%) that favored PowerPoint. (Students that circled both writing on the board and PowerPoint were excluded from this analysis.)

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A total of 1,709 comments were collected from the open-ended question “Why do you think this?” There were 1,406 comments provided in favor of writing on the board and 303 comments in favor of PowerPoint. Students’ responses in favor...
of writing on the board were categorized into seven themes. The three major themes in favor of writing on the board were more appropriate pace (students’ comments included “helps to keep up with material” and “get time to process,” n = 411 students, 29.2%), facilitation of note taking (students’ comments included “easier to copy,” “forces me to write,” and “writing triggers memory,” n = 357 students, 25.4%), and increased alertness and attention (students’ comments included “keeps you awake,” “don’t fall asleep,” and “keeps you focused,” n = 223, 15.9%).

Furthermore, students chose writing on the board for its more active participation (students’ comments included “more engaging,” “keep me active,” and “feel professor is working with you, involved,” n = 209, 14.9%) and its step-by-step presentation of content (students’ comments included “follow the professor’s logic better,” “see diagrams drawn from start to finish,” and “easier to follow explanation processes,” n = 124, 8.8%). Other comments in favor of writing on the board included the increased motivation to attend lecture (n = 43, 3.1%) and the reduced presentation of extraneous information (students’ comments included “focus on what’s important” and “more clear about what to know,” n = 39, 2.8%). Table 1 shows the main reasons for the preference of writing on the board.

A total of 303 comments were collected in favor of PowerPoint. Comments were categorized into five themes. The major benefit noted for PowerPoint was accessibility to the slides. The option to preprint slides and to access them during lecture increased students’ comfort with the lecture material. Students also felt that they could more easily get class materials if they missed a lecture (students’ comments included “online available,” “less problem when missing a class,” “can be printed,” and “easier to review,” n = 111, 36.6%). The second most frequent comment was a greater opportunity to focus on listening to the lecturer rather than keeping up with writing notes (n = 84, 27.7%). PowerPoint was also favored for its greater readability: both better visibility during lecture and a more accurate set of notes after lecture (students’ comments included “less details missed and errors copying,” n = 83, 27.4%). Two other themes included the ability of the instructor to create better visual aids and to animate them (n = 19, 6.3%) and that it provided the opportunity for students to preread the slides (n = 6, 2.0%). A summary of the most common themes in favor of PowerPoint is shown in Table 2.

### DISCUSSION

The main objective of the present study was to compare undergraduate biology student preferences for two major instructional approaches: writing on the board versus PowerPoint. The study revealed that students strongly preferred writing on the board to PowerPoint. To our knowledge, this is the largest study comparing physiology students’ preferences on this lecture format choice and the first study to look at the reasons behind the students’ preference in an open-ended question.

The most commonly mentioned reason for favoring writing on the board was the more appropriate pace provided by this modality, which is consistent with other studies that have surveyed students concerning these teaching modalities. However, the number of students participating in these other studies and the percentage who mentioned pacing as an advantage were not specified (24–26). Several factors contribute to appropriate pacing when writing on the board, some of which were present in student comments. First and most importantly, the information can only be taught as fast as the instructor can write. The instructor, therefore, generally moves through the content at a slower pace compared with reading and clicking through PowerPoint slides. Second, when writing on the board, instructors are less likely to present (and write) extraneous information. This allows instructional time to be more efficiently spent on material aligned with the learning objectives. In contrast, PowerPoint presentations often contain additional material not linked to the learning objectives, which may negatively impact student learning, as evidenced by the cognitive load theory (11, 18, 30). Third, when writing on the board, complex diagrams are drawn by the instructor in a step-by-step manner that allows students to follow the process and watch elements fit together into the larger framework. In PowerPoint presentations, complicated diagrams are usually presented intact and immediately discussed, preventing adequate processing of the material. This can be certainly addressed when using PowerPoint slides if the instructor produces his/her own slides and uses the animation feature to present diagrams in a step-by-step manner. However, in the interest of time, faculty members often copy diagrams from textbooks and journals and do not make their own slides from scratch. These copied diagrams also often contain extraneous material that can distract from the actual learning objective.
The second most popular argument in favor of writing on the board was the facilitation of note taking. Writing on the board provides students with the opportunity to write down organized and structured material that might contribute to their learning. In contrast, following the slides provided with a PowerPoint lecture encourages students to become passive listeners and they are less likely to generate hand-written notes. As discussed above in the introduction, note taking is a complex process in which the learner has to pay attention to what is said, comprehend the material, decide which elements to transcribe or summarize, and physically write down the notes. The coordination of multiple cognitive activities, particularly metacognitive skills, is required for successful note taking (19). Since metacognition plays a critical role in the learning process and is described as a key factor in academic performance (23), instructors should structure their learning environments to help students develop these skills (1, 5, 29, 31, 33).

In addition, writing on the board was noted to be “less boring” and to keep students “more alert” compared with PowerPoint. The physical movement of the lecturer writing on the board may help focus attention, and the note taking encouraged by this format may be the element that enforces direct student involvement with the material. The next most popular comment was the facilitation of active participation. This is a surprising result and has not yet been reported by other studies, as didactic lectures are generally thought to be “passive” teaching modalities (21). Most likely, students recognized that longhand note taking, which was the second most frequent advantage reported by students, provides active participation.

Students also listed that lectures taught on the board forced them to come to class. Several students commented that this prevented them from falling behind in the course and helped them to perform better. Although the correlation between lecture attendance and performance of the students is controversial (8, 16, 32), faculty members are generally concerned about declining lecture attendance and different strategies are currently used to increase class attendance (35).

Among the students who favored PowerPoint, the most popular advantage was the increased convenience of PowerPoint presentations. Slides can be distributed, and students found it easier to review the material when the notes were stored on their computers. Students also noted that PowerPoint presentations allowed them to attend lectures because the notes were readily available. Another listed advantage of PowerPoint presentations was the ability to focus on listening and the better comprehension of the material during lecture when they did not have to concentrate on note taking. Thus, the students’ perception of the benefit of listening without note taking differs from the discussion of the studies indicating the advantages of longhand note taking discussed above. Some of the students who favored PowerPoint because of the ability to focus on listening may have been primarily auditory learners. However, two studies that have investigated different learning preferences in undergraduate physiology students found that only a minority of these students are unimodal auditory learners (0–5%) (3, 34). Students also cited the decreased risk of missing information or copying errors as a positive effect of PowerPoint presentations. When lectures are written on the board, readability can suffer due to factors including the instructor’s handwriting and size of the classroom. Other studies have also reported the advantages of the better quality of text and diagrams in PowerPoint presentations compared with whiteboard and chalkboard presentations (24–26). In addition, a few students commented that the availability of PowerPoint slides before lecture allowed them to prepare for lectures. While this would certainly have a positive effect on learning, a recent study (6) found that only a minority of students read through lecture notes before attending a lecture.

There are several limitations in this study. First, it was conducted in a single school and the same instructor taught all of the classes surveyed. The quality of the instructor certainly determines the quality of the lecture, regardless of the teaching modality (26). Furthermore, writing on the board itself is variable. Different instructors use the board in very different ways when teaching. This can range from writing down only key points from lecture material to a detailed outline format, as was used in this study. In addition, students were comparing this instructor’s lectures with a nonspecified group of classes that used PowerPoint, which certainly introduced variability. As we only investigated the teaching modality of writing on the board by one instructor, it is possible that the results are not generalizable to other schools and other instructors. Furthermore, the results only represent the preferences and comments of students that chose to fill out the survey. This might not be representative of the whole class.

Although the preference of the students in favor of writing on the board was a consistent result over several years, it is not clear whether this teaching modality is more effective in terms of student learning.

Some recent studies have investigated the effectiveness of PowerPoint versus chalkboard in physiology and other science courses in medical school. When students were divided into three groups with every group exposed to a different teaching modality (PowerPoint, chalkboard, or the combination of both), students who were taught a physiology lecture by PowerPoint combined with chalkboard achieved significantly higher scores in a brief multiple-choice test. No difference was found in groups that were exposed to either PowerPoint or chalkboard only. This experiment was performed in two different medical schools, and the instructors within the different groups were not identical. Therefore, the limitation of the different skills of the teacher could influence the test results (14). Other studies performed in science classes did not reveal any differences in the performance of students after a lecture was taught by PowerPoint or by writing on the board (20, 24). Hence, it is not clear whether student instructional preference translates to improved learning outcomes, and research designed to answer this question would be the logical next step.

The present study revealed the students’ preference for writing on the board over PowerPoint when teaching physiology. However, it is highly unlikely that faculty would be willing to switch back from PowerPoint to the chalkboard or whiteboard, and considering the current entrenchment of PowerPoint within university curricula, this would not be a realistic recommendation. However, the consistent themes provided by student comments do shed light on some instructional best practices that can be applied to various teaching approaches including PowerPoint. These best practices would enhance the advantages that PowerPoint can provide to the students and instructors. Therefore, we recommend to instructors using PowerPoint that they first develop their presentation as if it were going to be written on the board. Slides need to be
customized, extraneous information left out, and overly complex diagrams and pictures taken directly from textbooks should be avoided. Instructors should create their own drawings that slowly build from single elements using the animation feature of PowerPoint. Instructors should also avoid an excessive amount of slides to make the pace more optimal for student learning and avoid exceeding the cognitive load of students. The slides could also be developed in a way to facilitate more active note taking to enhance the active participation of students.

Finally, with the current advancements in educational technology, instructors should also consider using alternatives to PowerPoint that better mimic writing on the board in the classroom. With the increased popularity of the flipped classroom approach, the results from this study also suggest that animated narrated videos may be preferable to PowerPoint for the asynchronous delivery of instructional content to students before engaging in active learning activities in class (10, 12).

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

AUTHOR CONTRIBUTIONS
Author contributions: C.A., S.D.S., and K.B. conception and design of research; C.A. performed experiments; C.A., S.D.S., and K.B. interpreted results of experiments; C.A. and S.D.S. edited and revised manuscript; C.A., S.D.S., and K.B. approved final version of manuscript; K.B. analyzed data; C.A., S.D.S., and K.B. interpreted results.

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