Effect of Differing PowerPoint Slide Design on Multiple-Choice Test Scores for Assessment of Knowledge and Retention in a Theriogenology Course

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ABSTRACT
Third-year veterinary students in a required theriogenology diagnostics course were allowed to self-select attendance at a lecture in either the evening or the next morning. One group was presented with PowerPoint slides in a traditional format (T group), and the other group was presented with PowerPoint slides in the assertion–evidence format (A–E group), which uses a single sentence and a highly relevant graphic on each slide to ensure attention is drawn to the most important points in the presentation. Students took a multiple-choice pre-test, attended lecture, and then completed a take-home assignment. All students then completed an online multiple-choice post-test and, one month later, a different online multiple-choice test to evaluate retention. Groups did not differ on pre-test, assignment, or post-test scores, and both groups showed significant gains from pre-test to post-test and from pre-test to retention test. However, the T group showed significant decline from post-test to retention test, while the A–E group did not. Short-term differences between slide designs were most likely unaffected due to required coursework immediately after lecture, but retention of material was superior with the assertion-evidence slide design.

Key words: assessment, educational methods, outcomes, reproduction

INTRODUCTION
Traditionally, pre-clinical veterinary education has consisted of lectures and laboratories. While active learning strategies are a growing focus of education, many instructors still feel that a well-designed lecture, with or without accompanying lecture notes, is an efficient way to expose a large number of students to a body of information.

Most lectures in veterinary education are accompanied by a set of slides. Historically, slides were used to show images, including photographs and descriptive tables or graphs. With the advent of PowerPoint, people increasingly began to use that tool to show not only relevant images but also added text. Over time, PowerPoint slides have become a single tool used by many instructors to demonstrate important concepts to students through text and images, to prompt the speaker throughout the presentation, and to provide a quick handout for students by providing them with printed copies of the PowerPoint slides. This leads to the overloading of slides with too much text and the overuse of bulleted lists, which do not permit students to make connections between the data presented and instead oversimplify and fragment the information.1–7 It has been suggested that use of PowerPoint removes the focus from the instructor, decreasing direct interactions with the students that would enhance learning by generating discussion within the class and prohibiting the instructor from demonstrating non-verbal behaviors such as eye contact, smiling, movement, relaxed body posture, and vocal expressiveness, all of which are associated with increased student learning.8–10 The instructor’s focus on the formatting of PowerPoint slides may be removed from reflection on how best to present the material, perhaps because for some instructors, formatting slides is more fun than concentrating on what they are going to say.9,11 Finally, use of PowerPoint slides as handouts has not been shown to affect student ability on examinations, attention in class, or opinions regarding the teaching abilities of the instructor and may, in fact, be associated with decreased active engagement as students with such notes in hand feel that they have all the information that will be covered.12,13

Use of slides to support a presentation is not a bad pedagogical concept. The concern is that use of default templates in PowerPoint does not lead to best use of the tool. One author described it thus: “New ways of communicating call for new ways of thinking about the communication process.”14(p.264)

Cognitive load is a theory describing how adults process and store information and is defined as the degree of effort, strategy, and processing capacity that an individual must exert to understand information (Figure 1).15
Cognitive load can be discussed through the lens of short-term (working) versus long-term memory, intrinsic or extraneous load, or high to low interactivity. Short-term memory is the amount of information a given person can manipulate mentally at one time. Most work suggests that no more than four items can be managed successfully by most people. Intrinsic cognitive load is inherent in the material itself. Complex material has a high intrinsic cognitive load. Extraneous cognitive load is created by how the information is presented. If intrinsic cognitive load is high, presenters can enhance the ability of participants to learn by decreasing extraneous load by reducing the number of elements that must be held in memory at any one time. Interactivity refers to how easily the material is understood. Low-interactivity information is easily understood without need to reference other pieces of knowledge. High-interactivity elements can only be partially understood if those elements are not considered in relation to each other.

So how can we use this information about cognitive load to help us design the best slides possible for presentation of scientific material? Studies have evaluated many components of slides design, and general principles exist for background and text colors, use of bulleted lists, use of images representative of information in the study, use of decorative images including backgrounds and logos, and the amount and placement of text on the slide.

In general, there are no specific rules for background and text colors other than to make sure that they contrast with each other. Yellow letters on a tan background are not easily read, while black letters on a yellow background are easily read but may be aesthetically jarring. Bulleted lists fragment information and do not provide the audience with obvious connections between the material. Information in bulleted lists could be replaced by timelines, flowcharts, text with varying size to show incidence or otherwise highlight specific connections between textual elements, or other relational graphics.

Graphics, including photos, drawings, diagrams, graphs, videos, equations, and short tables, are a valuable component on presentation slides. It is recommended to not use clip-art images if photographs or other sorts of graphics are available because use of clip art may undercut the seriousness of the presentation and decrease the credibility of the speaker. Presentation of data both verbally and with a representative image leads to better integration of that information and increased retention compared with presentation of either alone. The graphics used must be relevant; when decorative or irrelevant images are included on slides, students find this objec-
Message, or assertion, for every slide and to explain or provide evidence for that assertion visually. This effort is only valuable if use of this slide design can be demonstrated to increase student learning.

The goal of this study was to compare use of traditional slides with assertion-evidence slides in a cohort of third-year veterinary students in a theriogenology diagnostics course.

**MATERIALS AND METHODS**

This study was evaluated by an institutional review board. Students in a required third-year theriogenology diagnostics course were offered the opportunity to attend the 2-hour lecture on small-animal theriogenology diagnostics either in the evening (5–7 p.m.) or at the regularly scheduled time the next morning (8–10 a.m.). Students self-selected which lecture they attended and completed and signed a pre-test so the instructor knew that all students attended one of the sessions and that no student attended both sessions. All students had the same course schedule throughout the time of the study.

In both sessions, a hard-copy pre-test was administered, which consisted of 10 multiple-choice questions. The same lecturer spoke at both sessions, and the same course notes were available to the students; these printed notes were not PowerPoint handouts. Students attending the evening session were presented with slides that followed a traditional phrase and bullet-point design (Figure 2a). Students in the morning session were presented with slides that used assertion-evidence design principles (Figure 2b). The pre-test was not returned to students in either group, nor were they given information about their performance on the pre-test.

Students in both sessions completed a take-home, open-resource assignment that was due 2 weeks following the first lecture date. Students were permitted to work in groups, but each student had to submit a completed assignment written in their own words. A post-test, which was identical to the pre-test, was available online for 1 week after the submission deadline for the homework assignment. Corrected assignments were not returned to the students until they had all completed this post-test. One month later, a slightly different set of multiple-choice questions was available for 1 week online to test retention.
Students were not given direction regarding whether or not they should access notes to complete the pre-test, post-test, and retention tests. Students were informed that to pass this section of the course they needed to get 15 out of 25 possible points on the take-home assignment and needed to complete the pre-test, post-test, and retention test. Students had previously completed an online learning styles evaluation. Pre-test, post-test, and retention-test scores and learning styles were compared within and between groups using the unpaired Student’s t-test. A difference in gender distribution between groups was compared using the Chi-square test. Significance was set at $p < .0500$.

**RESULTS**

Ninety-nine students participated in this study. There were 31 students in the traditional slide group (T group) and 68 students in the assertion-evidence slide group (A–E group). The T group consisted of 83% female and 17% male students, and the A–E group consisted of 74% female and 26% male students; difference in gender distribution between groups was not significant. Scores for the homework assignment did not differ between groups, at $23.7 \pm 1.6$ (mean $\pm$ SD) for the T group and $23.6 \pm 1.5$ for the A–E group.

The mean pre-test score for the T group was $3.6 \pm 1.6$ and for the A–E group was $3.7 \pm 1.3$; this difference was not significant. The mean post-test score for the T group was $6.2 \pm 1.9$ and for the A–E group was $6.6 \pm 2.0$; this difference was not significant. Both groups showed significant gains in knowledge from pre-test to post-test ($p < .0001$).

The mean retention score for the T group was $5.3 \pm 1.8$ and for the A–E group was $6.0 \pm 1.9$. This difference was significantly different ($p = .0300$). The A–E group did not show a significant decline from post-test to retention test ($p = .0500$), while the T group did show a significant decline from post-test to retention test ($p = .0300$).

Learning styles did not vary between the two groups on any of the four scales of active learning versus reflective learning, sensing versus intuitive learning, visual learning versus verbal learning, and sequential learning versus global learning. In general, students were evenly distributed between active and reflective learning and were more inclined toward the sensing, visual, and sequential ends of the other scales.

**DISCUSSION**

This study demonstrated value in the use of slides designed following specific principles that have been demonstrated to enhance student learning. The sample size could have been increased by offering the slide designs to classes in two successive years instead of splitting one class, but that would have led to increasing variability between classes in regards to other information presented before and during the course. The lack of significant differences between groups on pre-test, post-test, and assignment scores suggests that the groups were well balanced intellectually.
The group size was uneven. The schedule did not permit scheduling of two sessions at successive times within the school day, and the author wished to present both sessions, preventing them from being offered concurrently. The author wanted to ensure that the two groups had as similar educational experiences around these presentations as possible. School policy does not permit requiring students to attend an evening session without prior scheduling of such within that course, so participation in the evening session had to be voluntary. While it would have been desirable to have closer to 50 students in each group, that would not have been possible without assigning students to those groups.

Learning style, as assessed using this instrument, did not play a role in how students perceived these varying slide designs. Students did, in general, have a more visual than verbal slant to their learning styles, and although the A–E group was slightly more visual than the T group, the difference was not significant and any apparent synergy between learning style and test scores was not identified.

Veterinary educators may view themselves using various metaphors. Is knowledge a commodity that is transferred from you to the students? Are you shaping their minds? Are you leading them on a journey to discover information? Are you nurturing them to discover things for themselves? With all of these metaphors, a common thread is that the instructor is the expert who has knowledge or knows where to find it. Assertion-evidence slides make that knowledge overt, decreasing intrinsic cognitive load by organization and emphasis and decreasing extraneous cognitive load by streamlining the presentation.

Numerous studies have evaluated slide design. In one such study, the average student score on an examination after a lecture with traditional slides was 69%, while that for an examination after a lecture with assertion-evidence slides was 79% (p = .0010). Students in a similar study in an undergraduate course showed similar gains and preferred the assertion-evidence slides at a ratio of 7 to 1. Medical students were presented with presentations associated with either traditional slides or assertion-evidence slides. Both groups showed increased knowledge from pre-test to post-test, but the assertion-evidence group had a higher average post-score (p = .0081) and retention (p = .0016). One investigator proved increased gains with assertion-evidence slides and demonstrated that assertion-evidence slides and the introduction of an active learning component led to greater attendance in class.

Finally, a study was performed comparing narrated slides for established courses, a lack of confidence for giving presentations with so little visual display to prompt recall for the speaker, and requirements for specific templates in some organizations. For assertion-evidence slide design to be useful to the learner, the speaker must have a mastery of the material that permits the identification of assertions of greatest import and the creation or identification of supportive graphics, good speaking skills and practice with the slides, and the support from higher authority and the time needed to create new slide sets. This effort is of value only if it enhances learning. In this study, the value of this effort was shown by increased retention as demonstrated on a multiple-choice examination.

**CONCLUSION**

Assertion-evidence slide design uses principles from graphic design and the educational research to create slides that should enhance student learning. It has been well demonstrated that assertion-evidence slides provide fewer words per slide and fewer words projected per minute. Students retained the most information from slides with fewer words, showing the immense value of choosing select words and associated graphics for greatest effect.

**NOTES**


**REFERENCES**


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