

Practical Strategies for Effective Lectures

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Abstract

Lecturing is an essential teaching skill for scientists and health care professionals in pulmonary, critical care, and sleep medicine. However, few medical or scientific educators have received training in contemporary techniques or technology for large audience presentation. Interactive lecturing outperforms traditional, passive-style lecturing in educational outcomes, and is being increasingly incorporated into large group presentations. Evidence-based techniques range from the very simple, such as inserting pauses for audience discussion, to more technologically advanced approaches such as electronic audience response systems. Alternative software platforms such as Prezi can overcome some of the visual limits that the ubiquitous PowerPoint imposes on complex scientific narratives, and newer technology formats can help foster the interactive learning environment. Regardless of the technology, adherence to good principles of

instructional design, multimedia learning, visualization of quantitative data, and informational public speaking can improve any lecture. The storyline must be clear, logical, and simplified compared with how it might be prepared for scientific publication. Succinct outline and summary slides can provide a roadmap for the audience. Changes of pace, and summaries or other cognitive breaks inserted every 15–20 minutes can renew attention. Graphics that emphasize clear, digestible data graphs or images over tables, and simple, focused tables over text slides, are more readily absorbed. Text slides should minimize words, using simple fonts in colors that contrast to a plain background. Adherence to these well-established principles and addition of some new approaches and technologies will yield an engaging lecture worth attending.

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Delivering a great contemporary lecture requires scientists and health care professionals to meet multiple standards, many of which are novel to even accomplished speakers. Presenters must have educational content organized and presented in effective audiovisual formats, and use technology appropriately to convey their message. Although large group lecturing remains an efficient means to disseminate educational, clinical, and scientific information to audiences of any size, the format has long been criticized for audience passivity and diminished

knowledge retention (1–6). As a result, there is now increasing emphasis on engaging the audience via interactive learning modalities. Because these methods of delivering a lecture are new and unfamiliar to many speakers, we discuss these strategies to improve on traditional lectures.

In this review, we discuss the growing evidence supporting a role for active learning and describe best practices for large group presentations. We include a review of audience response systems (ARS), provide strategies for enhancing slide design, and

discuss how to organize and deliver effective lectures. Although much of this discussion is focused on the most commonly used presentation platform, PowerPoint, we also review alternative software platforms that can enhance audience engagement.

The Rationale for Active Learning

Interactive teaching that demands learner engagement has repeatedly demonstrated measurable benefits over traditional passive

lectures (1–8). Whereas in traditional lectures, information flows unidirectionally from the speaker to the audience, active learning requires engagement and/or interaction with the audience and promotes a bidirectional flow of ideas and content (1). This requires the audience to reflect on or manipulate information in real time, either individually or in groups (1–3). These learner-centered experiences delegate some control of pace and focus to the learner, and give the speaker feedback on whether the audience is grasping key concepts (1–4). This contrasts to traditional teacher-centered lectures, in which the timing and focus are controlled by the lecturer who, as a result, often has less appreciation of the audience’s comprehension of the material (1–4).

Active learning outperforms passive approaches. Studies involving physicians (6) and medical (3), undergraduate (4, 5), and graduate (7) students demonstrate consistent benefits including improved attention span, promotion of higher order learning, and improved performance on written examinations (4, 5, 7), and the benefits can be attributed to the nature of engagement rather than the extra time spent per topic (8). Interactive techniques, such as those described below, require that speakers pause, allow time for audience reflection, and revisit challenging concepts. Relinquishing control to the audience in this manner can be uncomfortable for the speaker, but is required to maintain a learner-centered environment (1, 3, 7).

Contemporary Methods for Engaging Audiences

These improved outcomes were attained using multiple active learning formats. *Interactive lecturing* (1, 3) uses teacher–learner and learner–learner interactions to promote active incorporation of material presented during the lecture. After a brief didactic segment, the speaker poses questions to the audience and fosters open discussion among learners, using a number of methods elaborated on below. The fostering of deep learning and critical thinking from this type of questioning is one advantage of problem-based learning curricula (1, 9).

Even simple techniques can be beneficial. Retention is improved when 2-minute pauses are inserted during

a lecture to allow learners to review or discuss their notes (10). In a large group setting, for example, educators can ask their audience to *pause and reflect* by themselves or with colleagues after every 10–15 minutes of material presented (3).

Peer instruction relies on student interactions to complement the educational process (11). As the name implies, the learner’s peers provide instruction during opportunities for collaboration set aside within the didactic. This technique requires the learner to apply the material delivered by the speaker and explain that application or concept to his or her colleague (5). This think-pair-share (12, 13) approach creates teachers out of the learners, but does

require the speaker to pose engaging questions to properly initiate the learning encounter.

Properly timing active learning tools within a lecture affects the usefulness of these strategies. Retention of information in traditional lectures declines after only 10 minutes, and is highest for material presented at the beginning and the end of the talk (14, 15). This so-called *primacy-recency* effect suggests the optimal timing of engaging activities (14). ARS questions or activities such as peer instruction should occur every 10–15 minutes, or at a minimum in the middle of the lecture when retention is at its nadir (Figure 1A). Alternatively, the 60-minute lecture can be

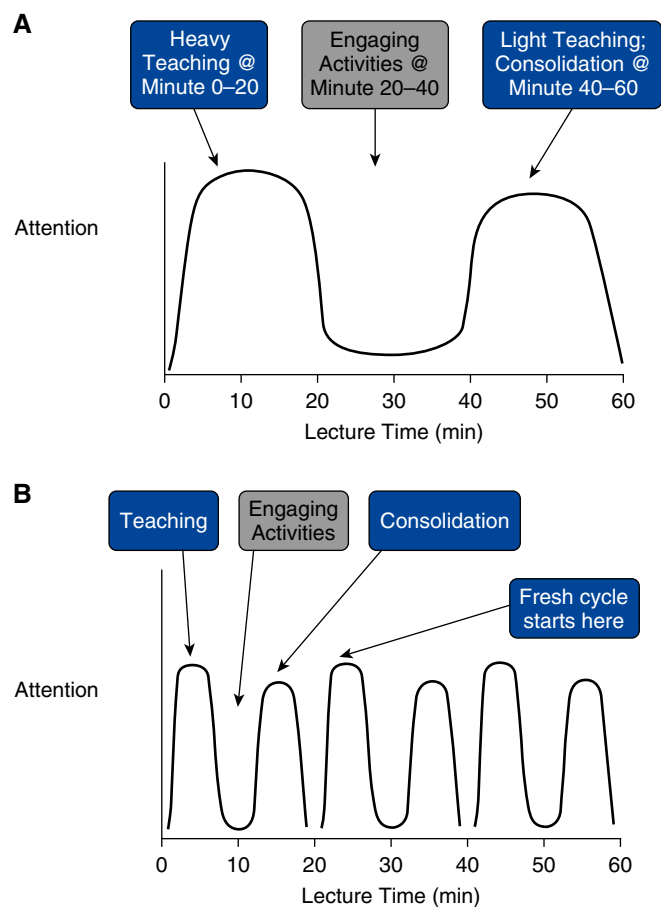


Figure 1. Using the “primacy-recency effect” to optimize engaging activities in a lecture. (A) Proper positioning of audience participation within a lecture. The *gray line* depicts the level of audience attention during a 60-minute lecture and includes periods of high attention and low attention. The *blue boxes* highlight the proper timing for instruction (prime time) relative to the level of attention, and the *gray box* (down time) highlights the appropriate placement for engaging activities to activate the audience. (B) Use of multiple prime time-down time cycles. To counteract low attention periods, a 60-minute lecture can also be divided into three segments lasting 20 minutes each. The engaging activities are then placed in the middle of each 20-minute cycle. New and multiple speakers can be used for each cycle. Modified with permission from References 14.

divided into multiple 10- to 15-minute primetime–downtime cycles so that each includes a combination of didactics and engaging activities (Figure 1B).

Using Audience Response Systems to Promote Interactive Learning

Audience response systems (ARS) are versatile, but are more technically demanding to incorporate into lectures than other active learning methods (16–19) and warrant additional comment. The anonymity conveyed by ARS allows educators to assess what their audience has learned without embarrassing individuals who volunteer incorrect answers. By informing the speaker and the audience member what they do and do not understand, ARS can stimulate interactive discussions (16) or highlight the need to review concepts that may have confused the audience. Survey polls or “ice breaker” questions can be used to introduce ARS to those unfamiliar with the tool (17) and both formative (nongraded) and summative (graded) assessments can be implemented.

There are three broad strategies for implementing ARS: classroom monitoring, audience-paced instruction, and peer instruction (18). *Classroom monitoring* includes activities such as attendance surveillance through participation in nongraded activities and solicitation of opinions via polling. *Audience-paced instruction* applies the principles of contingent teaching, allowing the content to be directed by the readiness of the audience. In its simplest form, participants can decide whether they are ready to move on to a new topic (19). *Peer instruction* is greatly

enhanced when using ARS as learner interactions and learner efficiency are promoted via feedback that ARS modalities provide (17, 19). For example, histograms of the audience’s choices can be displayed *without* indicating a correct answer, after which audience members then discuss the question with their peers before resubmitting their answer (11). Because the learners are often more aware than the speaker about what is confusing them, peer-to-peer instruction often directs learners to converge on the correct answer (19).

Successful integration of ARS requires comfort with the technology and careful preparation. High-quality ARS questions should address common areas of confusion, have specific learning goals, and elicit a wide range of responses, but need not have a single correct answer (16). Platforms such as TurningPoint (Table 1) embed answer histograms into PowerPoint slides. Many systems require that students have access to the ARS hardware (electronic clickers) although options such as Poll Everywhere (Table 1) allow users to respond with smart phones, tablet devices, or laptop computers provided Internet connectivity can be assured.

Organization and Delivery of the Large Group Session

Effective large group sessions require attention to both the organization of the content and its delivery. Working with the session organizer to identify the goals and objectives for the lecture and the target audience will help organize the lecture and frame the content. It is essential to plan a narrative from which the learning

objectives are apparent even without a formal objectives slide (20). Complexity must be tailored to the audience (21). A talk on acute respiratory distress syndrome, for example, requires vastly differing complexity and focus when delivered to an American Thoracic Society International Conference audience, or a group of medical students. Failure to pitch the content appropriately will rapidly disengage large segments of the audience. Even in a well-aimed talk, a brief overview should be included to recapture audience members who may be less well informed. Maintain audience attention by anchoring the presentation to a coherent narrative structure. After drawing the audience into the lecture with, for example, a clinical case or research question, provide a roadmap for what follows with an outline slide. Periodic reference to this roadmap will remind the listeners of what was covered and what topics remain to be discussed.

Although often violated, it is professionally responsible to respect time constraints. A common rule of thumb is to plan one slide per minute of speaking time. In practice, however, the appropriate number of slides varies based on their complexity and the lecturer’s speaking style. A common tendency is to keep adding detail to talks, but retention is limited in lectures and speakers should consider ways to pare down the content. The only way to ensure talks can be delivered within the allotted time is to rehearse (22). When budgeting time, consider whether questions are addressed during or after the talk. If inadequate time remains, use tools such as Presenter View or hyperlinks to later presentation sections to seamlessly skip ahead (*see* <https://support.office.com/en-US/>

Table 1. Newer presentation platforms and adjunct tools

Tool	Description	Website
Prezi Sli.do	Spatial graphic organization presentation tool Adjunct ARS tool that can be added on to Prezi and enable anonymous polling	http://prezi.com https://www.sli.do
TurningPoint	Adjunct ARS tool that incorporates clickers and visual display of polling into applications such as PowerPoint	https://www.turningtechnologies.com/polling-solutions/turningpoint
Poll Everywhere Haiku Deck Emaze	ARS for mobile devices Visually oriented presentation tool Multimedia presentation tool	http://www.poll everywhere.com https://www.haikudeck.com http://www.emaze.com

Definition of abbreviation: ARS = audience response system.

article/Video-Use-Presenter-view-21652818-CB30-4965-8DC7-B72F17E4C86D).

When delivering the lecture, avoid approaches that tend to disengage the audience, such as turning toward the screen and reading the material rather than addressing the audience. By rehearsing, speakers gain familiarity with their material and maintain eye contact with the audience rather than the screen (22). Laser pointers should be used to point at specific elements of the slide, not scribbling or leading the audience word-by-word through text slides.

If the narrative divides the topic into segments, transition slides ease the listener between them (23). These transitions provide the audience time to process new information (23), update them on where they are in the progression of the talk, and allow opportunities for questions. Transition slides might consist of the original outline slide, roadmap slides featuring an overview image like a regulatory pathway with progressive steps added, or other forms of a visual milestone. Finally, the lecture should not end abruptly after the last content slide. Instead, it should conclude with a summary of the main points from the presentation (22).

Techniques for Effective Slide and Graphic Design

Because audiences receive two data streams simultaneously, one aural and one visual, it is important to ensure that the slide content supports and balances the spoken word (24). Although science is inherently complex, overly complex slides that demand close study distract the audience from what is being said and impair comprehension. This demands thoughtful but disciplined simplification of the visual presentation to maximize absorption and retention.

Despite debates regarding its effectiveness, PowerPoint has endured as a fixture for professional presentations and speakers must be able to ensure optimal visual presentation within this format (23). PowerPoint provides myriad options for slide backgrounds, but many distract from the slide content. Backgrounds should be monochromatic and nontextured. Darker colors are often suggested for dark rooms to avoid the glare of a bright white background, but the room lighting is often

unknown when the talk is prepared. Slide background and text colors should have high contrast (25). Avoid black text on blue backgrounds or yellow on white. Red/green combinations appear as shades of gray to the colorblind. Red on blue or green appear to shimmer at the color margins, making this a poor choice for lettering. The standard color themes provided by PowerPoint usually provide a safe palette of compatible colors (see Figure E1 in the online supplement).

The relative readability of sans serif (e.g., Arial, Helvetica) versus serif fonts (e.g., Times New Roman) is debated, but many recommend sans serif fonts for projected text (26, 27). Informal fonts such as Comic Sans are typically inappropriate for professional presentations. Alternative font colors, capitalization, or italics may be used sparingly for emphasis.

Bullet point outlines are a common tactic, but the number of words should be minimized to avoid passive slide reading (28). Write telegraphic bulleted outlines rather than complete sentences. Bulleted lists intrinsically convey only two concepts: membership (something is part of a list) and hierarchy (some members are indented relative to others). Lay out text slides to reflect those relationships, but let them serve only as a framework while the audience listens to the explanation.

Whenever possible, data should be displayed as graphs or images rather than as text or tables (25). A common error is to copy tables or images from publications directly onto a slide. Tables and images prepared for publication assume the reader can study them at length, and shift attention back and forth between the text, caption, and image or table. Lecture audiences lack those opportunities. Rather than using tables from publications, construct new tables that focus on key data. If published images are used, crop out captions and extraneous panels or data series not being discussed. Enhance figures by using color or arrows to highlight key information (see Figure E2 in the online supplement).

Primary data should be plotted in the format that suits them best, as common graphical errors can misrepresent the findings (23, 25, 29). Bar graphs, for example, emphasize the height of adjacent bars and are best for categorical data with just a few categories. Line graphs are better

choices when comparison of changes across the whole abscissa is desired. For large group presentation, data graphs should be simplified to their bare essence. Label lines and bars directly on the graph to avoid forcing the audience to look back and forth to a legend on the side. Three-dimensional bars confound quantitative comparison and should not be used for two-dimensional data. Other visual clutter such as shadows, unnecessary tick marks, and grid lines should be deleted (see Figure E3 in the online supplement).

Many data slides can be designed in the assertion-plus-evidence format, which has been shown to improve retention of a slide's main message (30). Replace a bland and uninformative slide title with a short declarative statement of the slide's "take-home message" and place the evidence supporting this primary message below the title (Figure 2).

PowerPoint offers many design features that can detract from a scientific message. Animation within slides can provide emphasis, illustrate physical changes, or replace images in sequence as they are discussed, but should be used sparingly. Animated transitions between slides (push, dissolve, etc.) should not be used. Finally, resist non sequiturs. Images on individual slides should relate directly to the slide's message, and transition slide images should relate to the narrative of the talk. Images of vacations, family pets, or children distract the listener and should be avoided.

Alternative Software Tools for Large Group Presentations

The usefulness of PowerPoint has been debated since its debut, as critics argue it encourages passive lectures that consist mainly of speakers reading from bulleted lists (28, 31–33). The reliance on text over images makes it difficult to illustrate complex relationships or organize key points within a larger conceptual framework, and PowerPoint does not provide native tools for audience interaction and engagement (28). Few data support superior learning effectiveness of PowerPoint as compared with older tools such as 35-mm slides and the chalkboard (32).

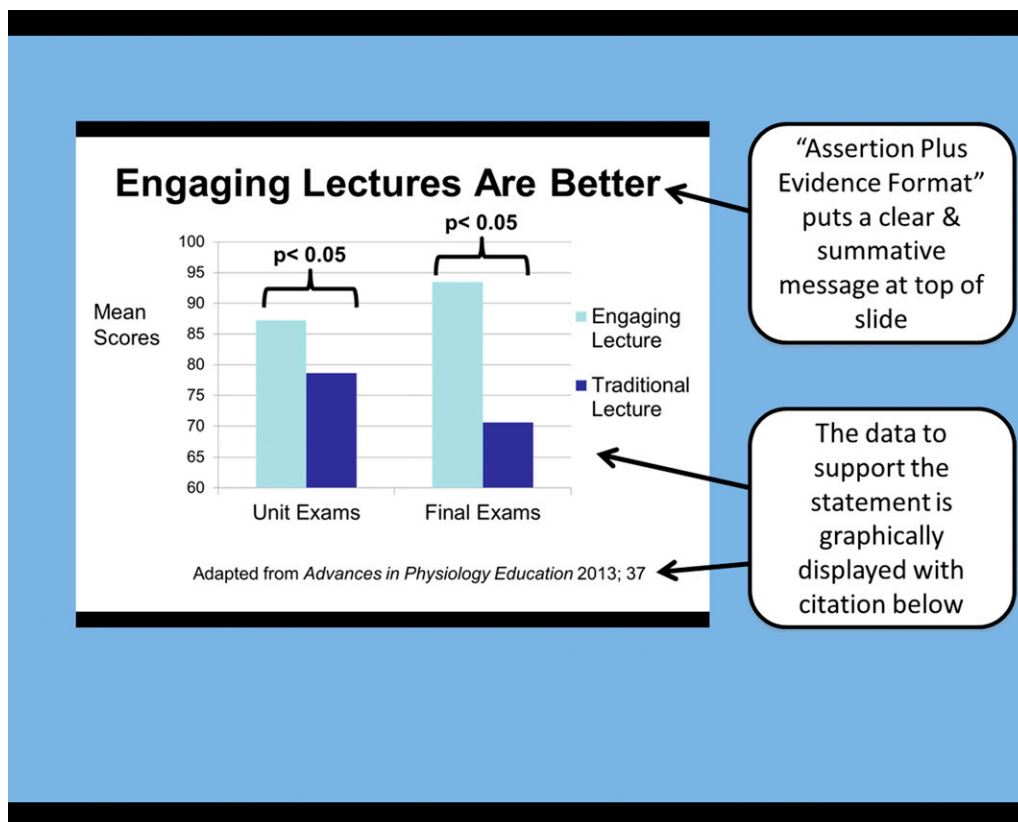


Figure 2. “Assertion-plus-evidence” format for data slides. The title of the slide is composed of a short declarative statement containing the primary message while the evidence and data are displayed beneath the title to support this message. This technique has been shown to improve retention of the primary message. In this example, the title promotes the declarative theme that engaging lectures produce better outcomes when compared with traditional passive lectures that do not incorporate any audience participation. While the speaker can go on to describe the differences between these style of lectures during the presentation, the overall message is hard to miss. Created with data from References 7 and 30.

In response to these problems, newer presentation tools have emerged that provide opportunities for more engaging lectures (Table 1). One such alternative is Prezi, a web-based tool that presents information using spatial organization on a single canvas rather than a deck of consecutive slides. Even though the limited available evidence suggests well-constructed PowerPoint and Prezi presentations result in similar learning outcomes (34), Prezi allows speakers to visually emphasize the hierarchy between “big picture” ideas and their supportive content elements (35), and students have found Prezi to be more engaging than other lecture modalities (36). The nonlinear nature of Prezi allows the speaker to cover lecture content in varying order, as opposed to the relatively fixed path of a PowerPoint presentation (35). Audience-guided instruction is available in other digital platforms (18), but Prezi’s adaptability and nonlinear efficiency facilitate

audience-directed instruction (36). Videos and images can easily be added to the overall canvas. The presentation is cloud-based, so it can be presented from any computer with Internet access, but requires a nominal fee to securely store presentations. Prezi does have a substantial learning curve for new users and may not be supported by all venues or audiovisual staff (*see* <https://prezi.com/tyc6ay3pocdp/teaching-effectively-with-technology/#>).

Table 1 also lists software adjuncts that can be used to enhance the functionality and interactivity of established platforms such as PowerPoint and Prezi. Poll Everywhere, an ARS tool mentioned earlier, can be integrated into PowerPoint to enhance audience participation, improve evaluation response rates, facilitate attendance taking, and facilitate student engagement (37, 38). In addition to supporting simple multiple choice questions, Poll Everywhere allows image-

based and free text polls, which conventional hardware-based ARS typically cannot provide. Sli.do is a similar service that integrates with Prezi. In addition to basic polling, it allows the audience to submit and vote on questions anonymously. Table 1 also lists other graphic platform options (Emaze and Haiku Deck), but because they lack evidence regarding their usefulness, they are not discussed further here.

Newer technologies do not always meet the needs of the presentation, so always review good instructional design practices consistent with the principles of multimedia learning and then select and apply the tools and features that best serve the instructional goals of the presentation (24, 39). To ensure a good presentation, avoid using more than one new tool or major feature at a time and rehearse with the technology to ensure a seamless experience. Consult with session organizers or audiovisual staff beforehand

to verify that the venue can accommodate the technology. Because any technology can fail, have an alternative delivery strategy available.

Conclusions

This review has considered a variety of tactics to enhance the quality of large group lectures. Passive, teacher-centered lectures

are being phased out of medical curricula, replaced by more evidenced-based, learner-centered methods that require the audience to process and apply the information they are receiving. These methods can range from simple strategies such as adding reflective pauses, to more complex tools such as ARS that allow real-time speaker feedback and learner assessment. By appropriately

incorporating technology; adhering to principles of delivery, organization, and slide design; and integrating active learning techniques, speakers can ensure the delivered content is retained and implemented in professional practice. ■

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