NO MORE BULLET POINTS

Research-Based Tips for Better Presentations

By Mitch Ricketts

I VIVIDLY REMEMBER WHEN I FIRST EXPERIENCED a PowerPoint presentation. Initially, I was awestruck by the new technology; colorful images appeared, animated text bounced on screen and a comprehensive topic outline unfolded before my eyes. The screen-based presentation felt complete and self-contained. The presenter also displayed a new and methodical manner of speaking: systematically expounding on each bullet point at the moment it was revealed. I thought, "This is new. This is different. I've never witnessed a presentation like this before."

Quickly, however, my fascination turned to disappointment. Less than 15 minutes after the program began, I noticed I was no longer paying attention to the message. In fact, the overload of on-screen text and interpretive commentary left my mind numb and my interest waning. By the end of session, I had decided this new communication method was ineffective and I vowed to never use PowerPoint in my future presentations.

Of course, I eventually changed my mind and now use the program often. But I do not use bullet points. This may seem strange to younger professionals who grew up in an era when bulleted lectures were standard practice. However, years of scientific inquiry have demonstrated that bullet points may not represent the best way to communicate. Specifically, researchers have found that comprehension often suffers when learners get lost in a barrage of distilled facts and generalizations. Bullet-point lectures rarely engage audiences in critical active learning strategies such as discussion, debate, introspection, social interaction and problem-solving. Additionally, bullet lectures often combine displayed text, spoken words and images in ways that may actually hinder comprehension and make learning more difficult (Jordan & Papp, 2013).

KEY TAKEAWAYS

- **Active training techniques are effective because they engage learners in tasks that promote deep thought, discussion, problem solving, social interaction and hands-on learning.**
- **Passive training is less effective because learners are relegated to merely listening and watching as an instructor does the mental, social and physical work.**
- **Bullet-point lectures may be poorly suited for meaningful training because they usually adopt a passive learning model and tend to combine spoken words and displayed text in ways that may actually decrease comprehension.**
- **PowerPoint can promote active learning when we eliminate lengthy bullet lists and use instructional images to guide group discussions, problem-solving activities and hands-on experiences.**

Better Training Methods With PowerPoint

This article considers methods for improving PowerPoint presentations by eliminating bullet lists. In place of on-screen text, it considers the role of instructional images such as drawings, photos, brief video clips and diagrams. Text on slides is limited to concise headings and labels that provide context or guide attention to important elements in the images. Discussion of training content takes the form of spoken words rather than displayed text. Finally, the total number of slides is limited to prevent audiences from becoming lost in detail. In fact, no slide is included unless it is necessary to promote deep thought, discussion or the understanding necessary to prepare learners for more active educational experiences.

This approach to training emerges from scientific investigations of human learning, including the following well-established findings:

1) Learning is more complete when presenters avoid lecturing and strive instead to create active learning experiences such as group discussions, problem-solving and hands-on activities (Campbell & Mayer, 2009; Kim, Phillips, Pinsky, et al., 2006;

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Kober, 2015; Kontra, Lyons, Fischer, et al., 2015; Loyens, Jones, Mikkers, et al., 2015; Prince, 2004).

2) Learners often comprehend information more fully when key concepts are illustrated with relevant images such as drawings, photos, brief video clips, diagrams, flowcharts, tables and graphs (Horvath, 2014; Houts, Doak, Doak, et al., 2006).

3) Images, spoken words and displayed text may affect learning differently depending on how they are combined in presentations. For example, learners often benefit more from a combination of images and spoken words, rather than images and on-screen text (Low & Sweller, 2014). Furthermore, presenters may actually hinder learners' comprehension if they display extensive text (e.g., bullet lists) while speaking, even if simply explaining or repeating the on-screen text (Kalyuga & Sweller, 2014). In addition, presenters may hinder comprehension if displaying unnecessary images simply to make the presentation more attractive or entertaining (Rey, 2012; Tangen, Constable, Durrant, et al., 2011).

Active Learning Techniques

Educators often classify teaching techniques according to underlying philosophies about the roles of teachers and learners (Freire, 1998; Knowles, Holton & Swanson, 2015). Passive techniques such as lecturing arise from teacher-centered philosophies in which the instructor adopts the role of expert and learners play the part of the uninformed. In teacher-centered philosophies, the instructor's job is to transfer knowledge into the minds of students. The students' task is to receive and store that knowledge. The ultimate goal of teacher-centered education is for learners to remember the instructor's information.

Active learning techniques such as discussion, problem solving and hands-on experiences arise from a learner-centered philosophy in which instructors and students work as partners to understand the personal relevance of information. Learner-centered goals include remembering, comprehending, thinking critically, experiencing insight and applying information in everyday life.

A vast body of research has demonstrated that active-learning techniques can improve learners' memory, comprehension, interest, engagement and application of knowledge (Campbell & Mayer, 2009; Gardner & Belland, 2012; Kim, et al., 2006; Kober, 2015; Kontra, et al., 2015; Loyens, et al., 2015; Markant, Ruggeri, Gureckis, et al., 2016; Prince, 2004).

Active learning can assume a wide variety of formats. For example, presenters can stimulate group discussions by asking questions of learners (instead of simply telling them the answers). They can also encourage discussions by bringing up surprising facts and controversial issues, or by asking about relevant workplace concerns and personal experiences.

Other examples of active learning include problem-solving exercises in which small teams of learners analyze case studies to identify complications and develop solutions. Active-learning experiences may also take the form of hands-on practice of new skills. Additional learning activities may include team competitions, peer instruction, asking volunteers to share lessons they have learned through personal experience, and myriad meaningful exercises in critical thinking and reasoned action.

Combining Words & Images to Increase Comprehension

Besides making training more active and learner centered, educators can improve presentations by limiting on-screen text (e.g., bullets) and making better use of informative images. To assist in this effort, look to the field of multimedia learning for its vast body

FIGURE 1
FORMATS IN MULTIMEDIA LEARNING

Multimedia learning theory distinguishes between verbal and visual media based on the neurological processes that extract meaning from information (rather than the auditory and visual senses involved). Multimedia presentations combine words (the verbal medium) and images (the visual medium) to increase comprehension.

Verbal Medium
Words (written or spoken) comprise one medium of communication (Slide 1.a).

Visual Medium
Images (photos, videos, drawings, graphs) comprise a separate communication medium (Slide 1.b).

Multimedia (Verbal & Visual)
Words combined with images comprise multimedia communication (Slide 1.c).

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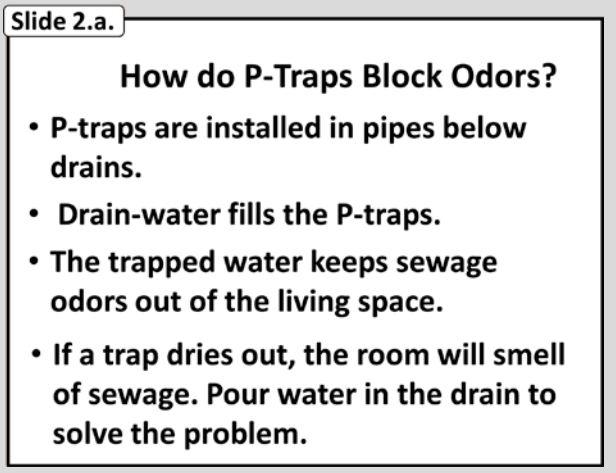
FIGURE 2
TRADITIONAL BULLET-LIST SLIDE

Bullet Lists May Lead to Ineffective Communication
Lectures based on bullet slides may reduce comprehension due to the redundant presentation of displayed text and spoken words. Bulleted lectures also create passive (rather than active) learning experiences. Finally, bulleted lectures fail to combine nonverbal images and spoken words in ways that increase comprehension.

Poor Slide Design



ANIMATIONS IN POWERPOINT

Advances in technology have made instructional animations increasingly common in PowerPoint presentations. Animations differ from live-action videos in several respects (Lowe & Schnotz, 2014). For example, moving images in animations are created from drawings and other constructive artwork, while videos consist of moving images captured and recorded from the physical world. The constructive nature of animations allows for abstract, nonrepresentational images, as well as literal depictions of people, things and events. Furthermore, animations can illustrate perspectives, sequences, hidden workings and other information that may not be apparent in ordinary videos and still images.

In recent decades, investigators have examined the cognitive processes by which people learn from animations. To date, findings have been inconsistent and it is not yet possible to identify situations when animations may be most helpful to learners. Two meta-analyses (statistical examinations of accumulated research data) have identified a small but beneficial overall effect for learning from animations compared with learning from static images (Berney & Bétrancourt, 2016; Höffler & Leutner, 2007). In spite of agreeing on a limited general benefit, however, the meta-analyses support different conclusions regarding situations when animations may lead to deeper learning. Whereas Höffler and Leutner report better learning of "procedural-motor" knowledge from animations, Berney and Bétrancourt found no such effect (procedural-motor knowledge involves manual tasks such as applying bandages, folding paper in origami or disassembling machine guns). Instead, Berney and Bétrancourt found improved learning mainly in situations that do not reflect normal OSH training practices. Specifically, Berney and Bétrancourt report the benefit of animations was most pronounced when instruction was entirely visual, with neither written text nor spoken narration.

Overall, little scientific consensus exists about realistic situations in which animations may confer greater (or lesser) learning benefits compared with still images. Inconclusive findings may reflect differences in scientific methodology as well as our limited understanding of human information-processing in varied learning tasks. To reach definitive conclusions, researchers must employ more advanced approaches. In the words of two leading scholars:

> Research on learning from animation has long suffered from the influence of simplistic notions about the effectiveness of animation. Many studies had the sole aim of investigating whether learning from animation leads to better results than learning from static pictures. With the benefit of hindsight, such comparisons proved to be naïve because results under one set of conditions usually could not be generalized to other conditions. . . . It is therefore too simplistic to assume that animations are better than static pictures for learning. However, it is also too simplistic to assume that animation is not beneficial for learning at all. We need a more sophisticated approach. (Lowe & Schnotz, 2014, pp. 540-541)

It appears that firm conclusions will have to wait for research to progress in coming years.

of research on techniques that combine words and images in ways that promote understanding (Mayer, 2014b). The techniques of multimedia learning apply to printed materials, live presentations and videos. This article examines selected issues based on their potential for improving live presentations with PowerPoint.

Considered together, three lines of multimedia research suggest we should abandon wordy bullet lists and replace them with learning activities motivated by relevant instructional images. This research is summarized in the propositions known as the multimedia principle, the modality principle and the redundancy principle.

Multimedia Principle

Communication efforts may employ different media. In multimedia learning theory, words comprise a single medium: verbal. Nonverbal images comprise a separate medium: visual. Combining words and images results in a multimedia presentation (Figure 1, p. 35).

The multimedia principle (also known as the multimedia effect) reflects the finding that people tend to learn better from a combination of words and images, rather than words alone (Butcher, 2014; Carney & Levin, 2002). As an example of early experimental tests of the multimedia principle, Mayer and Anderson (1991) examined instructional materials explaining the design of bicycle air pumps. The authors discovered that learners understood pump design better if they studied materials that included instructional images and verbal descriptions (rather than images or verbal descriptions alone). Further research has demonstrated the multimedia principle holds true in various learning settings for topics involving health, science, technology and other subjects (Butcher, 2014; Houts, et al., 2006; Schnotz, 2014).

The multimedia principle has broad applicability. However, the combination of words and images benefits some learners more than others. For example, word-image combinations often provide the greatest benefit to learners with low prior knowledge of a topic and to learners who struggle with language barriers. In contrast, learners with high prior knowledge may increase their understanding even when images are absent (Butcher, 2014; Houts, et al., 2006; Schnotz, 2014).

Modality & Redundancy Principles

Whereas the multimedia principle demonstrates the need for words and images, the modality principle refers to the finding that learners may benefit more from spoken words rather than displayed text in multimedia presentations (Low & Sweller, 2014; Mayer & Pilegard, 2014).

As an early example of research on the modality principle, Mayer and Moreno (1998) developed computer animations explaining how lightning forms in clouds. Some research participants viewed on-screen animations combined with spoken (narrated) instruction. Other participants viewed the on-screen animations, but instruction consisted of on-screen text (instead of spoken words). The researchers found that participants scored better on tests of comprehension when they learned about lightning formation from animations and spoken (rather than displayed) instructional text.

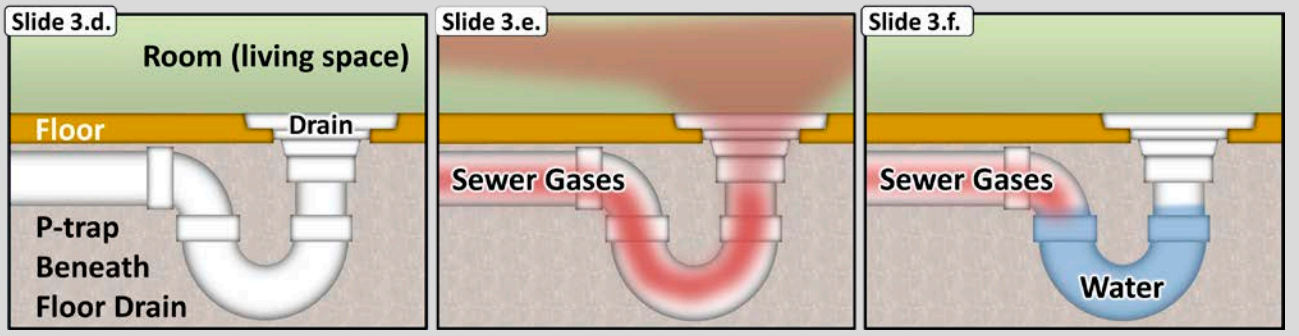
The modality principle has been validated in many settings for various learning topics (Low & Sweller, 2014; Mayer & Pilegard, 2014; Schnotz, 2014). Still, some caveats are in order: The modality principle applies mainly to brief, fast-paced presentations such as live workplace training. When instruction is lengthy or complex, trainees will soon forget many details. Thus, presenters should supplement live training with printed takeaway materials if they expect trainees to study or review important information later.

FIGURE 3
RELEVANT IMAGES INCREASE COMPREHENSION

Image-based slides and active learning strategies help audiences develop richer understanding of important concepts. Replace bullet lists with images that illustrate key concepts, stimulate discussion and prepare learners for hands-on activities.

Relevant photos illustrate important concepts, such as P-traps and floor drains.

Relevant diagrams may show hidden inner workings.



Slide 3.d: Cross-sectional view of a P-trap under a drain.

Slide 3.e: Sewer gases enter a living space when the trap is dry.

Slide 3.f: Water-filled P-trap seals the drain and blocks odors.

Although the modality principle demonstrates deeper learning from images and spoken (rather than written or displayed) words, we still might ask, "Why not use spoken words and displayed text with images?" After all, this would provide two streams of verbal information instead of just one. The surprising answer is summarized in the redundancy principle.

The redundancy principle represents the finding that learners may struggle to comprehend meaning if presenters display extensive text while they speak (Kalyuga & Sweller, 2014; Mayer & Fiorella, 2014). As an example of early research on the redundancy principle, Mousavi, Low and Sweller (1995) examined instructional materials involving concepts in geometry. Some research participants learned to solve geometry problems using materials that contained images and spoken words. Others learned from materials that contained the same images and spoken words plus printed text (the text was identical to the spoken information). Remarkably, Mousavi and colleagues found that people learned more from instructional materials when the redundant printed text was omitted. The redundancy principle has since been verified in a wide variety of instructional settings (Kalyuga & Sweller, 2014).

The redundancy principle represents one of the most surprising and counterintuitive findings in the field of multimedia learning. Although common sense may suggest that learners could benefit by reading along with spoken presentations, research demonstrates this is not always the case. When we read and listen to words simultaneously (even if they are the same words), our minds must process each separate stream of information and combine both streams in a way that preserves and integrates meaning (Kalyuga & Sweller, 2014). This can overload working memory and make it hard to understand information, especially when a learner reads faster or slower than the speaker.

Figure 2 (p. 35) offers an example of how redundancy can impair comprehension in a PowerPoint presentation. Slide 2.a represents a typical bullet list a trainer might use to instruct custodians and maintenance personnel about the control of sewage odors in buildings. In typical bullet-lecture style, the trainer is likely to explain each fact as the audience listens and reads along. Since the on-screen text is a redundant summary of the trainer's spoken words, learners must mentally process and reconcile each information stream, even though the displayed text fails to impart any additional knowledge. Some learners will struggle with this task and their comprehension may be impaired. In addition to the redundancy problem, slide 2.a is likely to be ineffective because it lends itself mainly to passive lecturing techniques.

For many, reading while listening impairs comprehension. However, the redundancy principle has exceptions. For example, learners may benefit when slides display brief textual headings, labels, unfamiliar technical terms or occasional short summary statements. This is because speech and brief text can be mentally integrated without creating excessive demands on working memory (Adesope & Nesbit, 2012; Kalyuga & Sweller, 2014; Mayer & Fiorella, 2014). Also, learners with hearing impairments or other special needs may require printed materials or simultaneous translation into alternate formats.

In accordance with the multimedia, modality and redundancy principles, Figure 3 illustrates how presenters can eliminate lengthy on-screen text to allow for spoken words and images in PowerPoint.

FIGURE 4

BRIEF VIDEO CLIPS STIMULATE DISCUSSION

Instead of showing a lengthy video (which may create a passive spectator experience), try showing brief clips. With each clip, pose guiding questions to spark active learning, stimulate discussion or prepare for hands-on activities.

Some clips stimulate discussion by raising questions.

Video clip 4.a.

Clip 4.a. Discussion questions:
- **What orange-brown gas is spewing from the vent of this agricultural storage bag?**
- **Is the gas hazardous?**
- **Is it safe to work in the area or drive through the plume?**
- **What material is stored in the big white bag?**

Other clips stimulate discussion by providing answers.

Video clip 4.b.

Clip 4.b. The morning before the gas appeared, a silage chopper was cutting corn plants and loading the chopped corn (silage) into trucks in a nearby field.

Clip 4.c. Freshly cut silage.

Video clip 4.c.

Video clip 4.d.

Clip 4.d. The trucks dumped the fresh silage into bagging machines, which packed the silage into long, sturdy plastic bags. Chopped plant material ferments within the bags to become a high-energy forage for cattle.

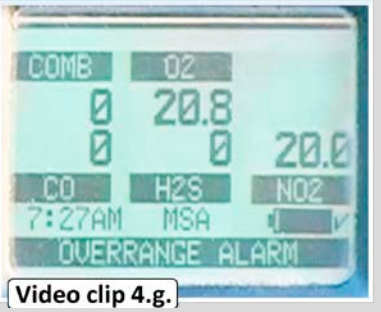
Clip 4.e. Vents on the bags are designed to release gases produced by aerobic bacteria.

Video clip 4.e.

Video clip 4.f.

Clip 4.f. A day after bagging, toxic gases pour out, including visible nitrogen dioxide (NO_2).

Clip 4.g. A gas monitor in the open air nearby shows an over-range alarm, indicating the NO_2 concentration exceeds the IDLH of 20 ppm. Air near the bag is unsafe.



Video clip 4.g.

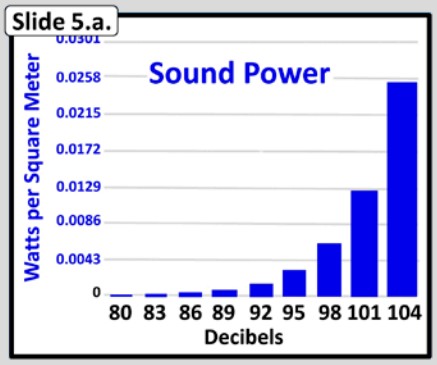
In Figure 3 (p. 37), a series of six image-based slides replaces the bullet points of the single slide in Figure 2 (p. 35). The image-based slides of Figure 3 improve audience comprehension and help the trainer use active learning techniques such as questioning and group discussion (in place of lecturing). For example, with slide 3.a of Figure 3, the trainer might ask, "Who can tell us what this is?" With slide 3.b, the trainer might ask, "Why is this called a P-trap?" Before showing slides 3.c and 3.d, the trainer might ask, "Where do we encounter P-traps?" Before discussing slides 3.e and 3.f, the trainer might ask, "What is the purpose of a P-trap? How does it work? How will indoor air quality be affected if the trap goes dry? How do we maintain the P-trap?"

By asking appropriate questions, the trainer can elicit from participants all the information from a bullet list without actually showing the bullets. Moreover, by answering questions, engaging in discussion and telling their own stories, trainees engage in meaningful, active learning. The trainer can conclude the discussion in this case with a relevant hands-on learning activity in which trainees locate, inspect and refill P-traps in the training facility or in their own work areas. As trainees leave, they can receive printed handouts (with words and images) for permanent access to the key information about P-traps. Ideally, handouts are provided at dismissal or when needed during training so they will not detract from other learning experiences.

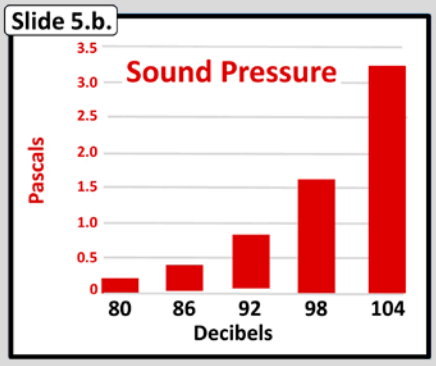
FIGURE 5
CHARTS CLARIFY CHALLENGING MATHEMATICAL CONCEPTS

Charts, coupled with discussion, increase comprehension and create active multimedia learning experiences. To avoid lecture and encourage active learning, ask workers to consider the charts and discuss the relationships they see.

Slide 5.a.



Slide 5.b.



Slide 5.c.

Decibels (dB)	Sound Power Watts per square meter (W/m^2)	Sound Pressure Pascals (Pa)
140	100.0	200.0
120	1.0	20.0
100	0.01	2.0
80	0.0001	0.2
60	0.000001	0.02
40	0.00000001	0.002
20	0.0000000001	0.0002
0	0.000000000001	0.00002

Discussing Noise Exposures in Decibels
Slides 5.a through 5.c can help workers understand the significance of seemingly small changes in decibels (dB): Small increases at the upper end of the dB scale represent very large increases in hazardous sound power and sound pressure. In contrast, changes at the lower end of the scale may be inconsequential.

Relevant instructional images can take many forms besides photos and drawings. For example, trainers may use brief video clips (Figure 4). To avoid passive viewing of a lengthy narrated film, use short clips without narration to promote discussion and critical thinking. For example, while showing clip 4.a, the trainer can ask the audience questions. The questions are designed to trigger curiosity and engagement. In addition, some audience members may volunteer stories about times when they have witnessed similar events. After engaging the audience with clip 4.a, the trainer can show each succeeding clip, stopping at strategic points to ask discussion questions related to important facts. This transforms what might otherwise be a passive film-viewing session into an engaging active-learning experience.

Relevant images may also take the form of charts or other diagrams as shown in Figure 5. Here, charts and graphs illustrate the surprising increases in sound power and pressure that accompany small changes at the upper end of the decibel scale. Instead of lecturing about the logarithmic nature of decibel scales, the trainer can ask guiding questions to help learners gain personal insight into the damaging impact of a few additional decibels in noisy workplaces.

Coherence Principle

The coherence principle is based on research demonstrating that audiences understand the main points better when presenters omit unnecessary information (Mayer & Fiorella, 2014). Each audience member has a limited amount of attention and memory, and overall comprehension may suffer if mental resources are wasted on unnecessary details.

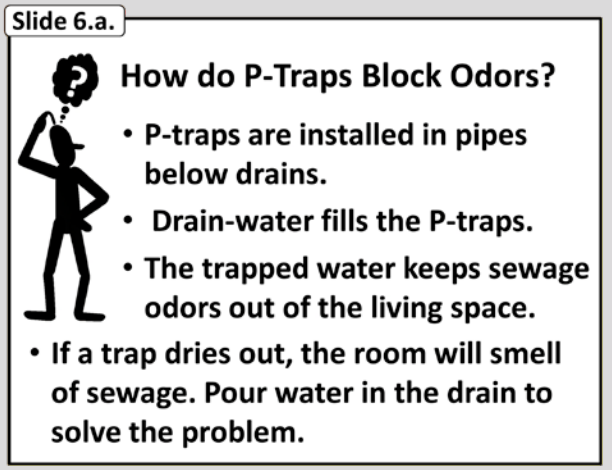
Educators can apply the coherence principle by ensuring that training sessions focus on a small number of the most important points (rather than developing comprehensive presentations that include every possible issue). Also avoid sidetracking audiences with irrelevant "seductive details," such as captivating stories and images that fail to convey the main points of a message (Rey, 2012; Tangen, et al., 2011). The seductive detail effect is the well-established finding that audiences tend to remember information that is entertaining, surprising and interesting often at the expense of more pertinent (but less alluring) aspects of a communication. In safety training, the most engaging and memorable information tends to be stories, images, discussions and hands-on activities; thus, ensure that each of these is designed to exemplify the primary lessons the audience should remember rather than tangential issues.

FIGURE 6
IRRELEVANT IMAGES

Irrelevant Images May Decrease Comprehension
Do not add unnecessary images to slides. In this example, the pondering stick figure does not illustrate any necessary information. Irrelevant images are distracting and may decrease comprehension. Also, no matter how they are decorated, bullet lists usually lead to passive lecturing techniques and distracting verbal redundancy.

Poor Slide Design

Slide 6.a.



As an example of an unnecessary seductive detail, consider the slide in Figure 6. The pondering stick figure is purely decorative and fails to convey meaningful information about the topic. Such irrelevant images are distracting and may decrease comprehension. (Furthermore, because of the lengthy on-screen text, slide 6.a will likely be ineffective even with a relevant image.)

Signaling Principle

The signaling principle represents the finding that people tend to understand presentations better when they emphasize

INTERACTIVE PRESENTATION ELEMENTS: CAN "CLICKERS" HELP?

Active learning strategies encompass a broad range of teaching techniques that increase learners' interactions with the educational environment. These interactions may include mutual exchanges with fellow learners, meaningful dialogue with instructors, practical experience with learning tools and goal-oriented exploration of information sources. Active instructional strategies engage learners as full participants in the educational process (rather than restricting their role to merely listening and observing as the instructor does the work).

Two commonly employed methods of active learning include posing questions to learners (instead of merely telling the facts) and small group discussions in which learners deliberate with peers. Question-posing and small group discussions, along with other active strategies, are associated with deeper learning in a variety of contexts (Kyriakides, Christoforou & Charalambous, 2013; Schroeder, Scott, Tolson, et al., 2007).

Increasingly, educators are supplementing question-posing strategies and small group discussions with electronic clickers (a.k.a., audience response systems, instant response systems, student response systems). Instructors who use clickers often pause at strategic points to display questions on screen, often in true-false, multiple-choice or matching formats. Students then respond by pushing buttons on handheld clickers. Each student's clicker transmits a signal to a central electronic device, which tallies and displays the responses. This activity is similar to an anonymous, electronic show of hands. Instructors often supplement clicker-based questioning by asking students to deliberate with neighbors before or after clicking (in other words, students may engage in small-group discussions).

Scholars have begun to examine whether clickers convey instructional benefits beyond those already observed for traditional question-posing and group discussions (see Chien, Chang & Chang, 2016; Hunsu, Adesope & Bayly, 2016). Since clicker technology is a relatively new development, research is in its infancy. In short, current investigations have provided mixed results: While some studies have reported gains in learning, others have reported no improvements or even diminished learning when clickers are used.

To clarify conflicting findings, scientists employ the statistical technique of meta-analysis, which combines the accumulated data from many studies into a single, more reliable result. Two meta-analyses on clickers each support very different conclusions. In an analysis of the combined results from 53 different studies, Hunsu, et al. (2016), found no gains in cognitive learning outcomes (academic achievement and transfer/application of knowledge) when clicker-based instruction was compared with equivalent nonclicker teaching methods. In contrast, Chien, et al. (2016), meta-analyzed data from 28 published research articles and reported definite gains in learning among students in classes taught with clickers.

We might ask how two meta-analytic studies published in the same year could reach such different conclusions. The answer may lie in the varied research methods employed. For example, the meta-analysis by Hunsu and colleagues (which found no gains in cognitive learning outcomes) included a much broader body of research; aggregated results into one independent effect size per outcome, per study; and eliminated studies in which clicker- and nonclicker-based instruction differed substantially with respect to opportunities for class discussion, question-posing, and other educational strategies. In contrast, the meta-analysis by Chien and colleagues (which reported definite gains in cognitive learning) examined a smaller number of source studies; was restricted to published reports (which tend to describe only significant findings); included multiple effect sizes for the same outcome variables and the same participants within studies (resulting in nonindependent measures); and included studies in which clicker and nonclicker groups received instruction that differed substantially on factors unrelated to clicker use. In addition, the two meta-analyses used different statistical models and differed in the transparency with which they reported the effect sizes derived from their source studies.

Although question-posing and small-group discussion have been shown to increase learning, we will not know whether clickers can enhance these effects until investigators reach a consensus on appropriate experimental methods. Still, early adopters will be encouraged to learn that Hunsu, et al., found clear noncognitive benefits for clicker-based instruction in their meta-analysis (Chien, et al., did not examine these effects). For example, Hunsu, et al., identified a substantial clicker-associated boost in learners' self-efficacy (compared with learners exposed to equivalent nonclicker teaching methods). Hunsu, et al., characterized self-efficacy as learners' confidence about quiz performance, comfort with communicating in groups and willingness to volunteer opinions on controversial issues. Hunsu, et al., also found small but significant positive effects of clickers on additional noncognitive variables, including perceived quality of instruction, attendance, learner engagement and learner participation (compared with equivalent nonclicker instruction).

In sum, limited evidence exists that the use of clickers may lead to greater confidence and engagement of learners in educational settings. However, it is too soon to know whether clicker-based instruction improves retention of information, test scores or application/transfer of knowledge when compared with old-fashioned, nontechnological methods of question-posing and discussion.

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critical details in instructional images with highlighting, arrows, labels or other markers of significance (Mayer & Fiorella, 2014; van Gog, 2014; Xie, Wang, Zhou, et al., 2016). Research indicates that without signals, novice learners may ignore important information. Accordingly, presenters must draw attention to critical concepts in the most direct and straightforward manner possible.

As examples of signaling, consider the arrow and textual label in Figure 7, slide 7.d. Other examples of brief textual labels are included in Figure 1, slide 1.c; and Figure 3, slides 3.b through 3.f. As another example of signaling, consider the yellow highlights that draw attention to the breaking chain in Figure 7, slide 7.e. Trainers may also make judicious use of brief headings to signal a particular concept or theme in images (Figure 5, slides 5.a and 5.b). Finally, it may be helpful to display a brief summary sentence to conclude a group discussion (Figure 7, slide 7.e) or brief on-screen instructions for an upcoming active learning experience (Figure 8, slide 8.a, p. 42) (Alley, Schreiber, Ramsdell, et al., 2006; Pate & Posey, 2016).

Contiguity Principle

The contiguity principle reflects the finding that audiences comprehend messages better when images and corresponding words are presented together rather than separately in time and space (Ginns, 2006; Mayer & Fiorella, 2014). In the context of PowerPoint presentations, we are concerned with both temporal and spatial contiguity. Temporal contiguity demands that we show images at the same time as we are speaking about them, while spatial contiguity dictates that we place labels and explanatory text within or near corresponding images in slides and printed materials. As examples of the contiguity principle, textual labels have been placed as close as possible to matching image elements in Figure 1, slide 1.c; Figure 3, slides 3.b through 3.f; and Figure 7, slide 7.d.

FIGURE 7

CONTEXT, DETAIL, SIGNALING & SUMMARIZATION

Image-based slides can add context and detail to make learning relevant. The five slides help trainees learn to focus on critical details in the context of a realistic setting. In training sessions with playground supervisors, group discussion of these safety issues will pave the way for hands-on practice inspections to identify hazards on an actual playground.

Slides 7.a and 7.b provide context. Slide 7.c zooms in on relevant detail.

Slide 7.d uses signaling (with words and arrow) to focus attention where needed. Slide 7.e recaps the discussion with a summary statement and yellow highlighting.

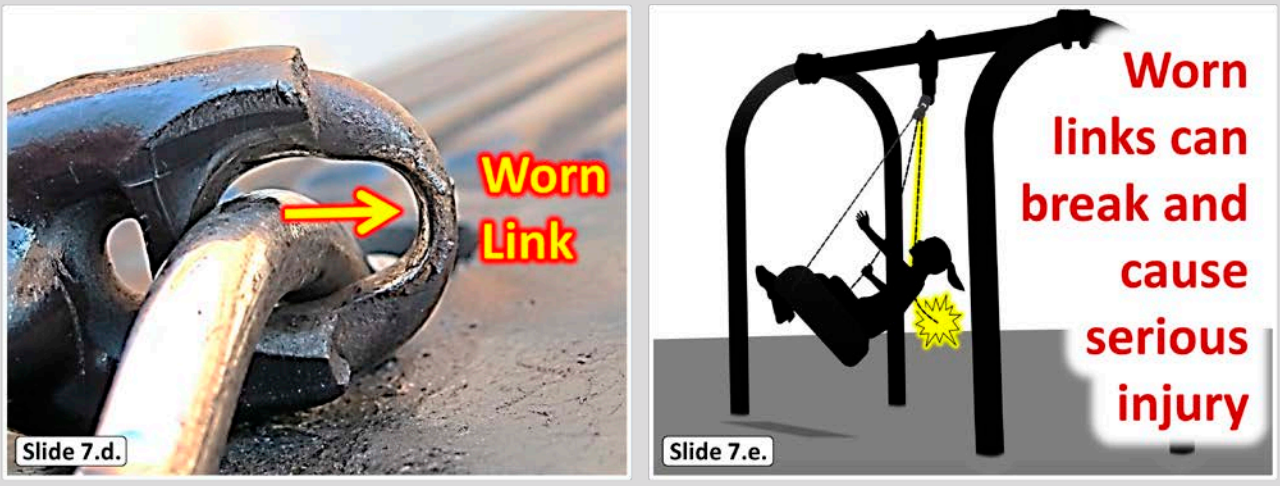
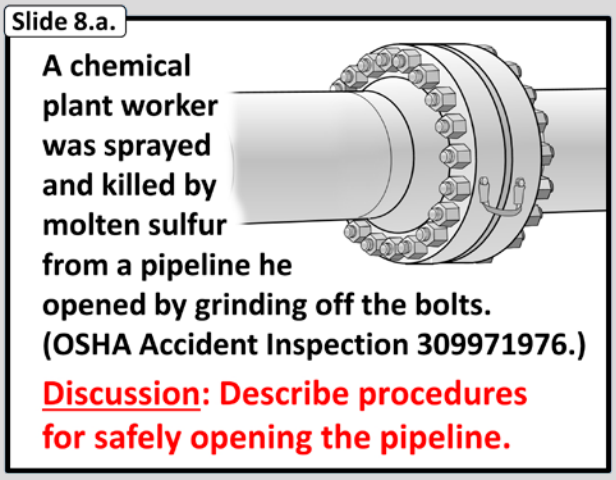


FIGURE 8

IMAGES & STORIES HELP INTRODUCE GROUP PROBLEM-SOLVING TASKS & HANDS-ON LEARNING ACTIVITIES

Case studies such as the true story depicted in Slide 8.a provide context and motivation for a variety of active learning tasks. In this case, we might employ group problem solving, discussion and a hands-on pipe-breaking activity using sections of pipeline that have been cleared of hazardous contents and conditions.

Slide 8.a.



Stories and images help add context and purpose to training activities.
Slide 8.a can be displayed at the outset of a group discussion or hands-on activity to help trainees understand the personal relevance of the training. The trainer should remain silent while participants read the slide. Avoid the temptation to read aloud (which may impart unhelpful verbal redundancy to the experience).

Pretraining Principle

The pretraining principle refers to the finding that audiences benefit when presenters define unfamiliar concepts before discussing them further (Mayer & Pilegard, 2014). Applied to PowerPoint, the pretraining principle suggests we should discuss the meaning of technical terms, acronyms and other specialized language prior to using those expressions. For example, in Figure 1 (p. 35), we should not talk about how goggles protect eyes until we first make sure our audience knows what goggles are. Similarly, in Figure 3 (p. 37) we should not speak to the function and maintenance of P-traps until we ensure that all audience members understand the general characteristics that define a P-trap (i.e., it is a section of pipe designed to trap water beneath a drain and it looks something like a face-down letter P).

Personalization Principle

The personalization principle represents the finding that people understand better when trainers communicate in a personal, conversational style rather than using formal language (Ginns, Martin & Marsh, 2013; Mayer, 2014a). One practical way to apply this principle is to use personal pronouns in presentations (e.g., you, me, us). For example, in Figure 1 (p. 35), instead of saying, "Select goggles that fit the face," say, "Select goggles that fit your face."

Segmenting Principle

The segmenting principle embodies the finding that people understand better when trainers break presentations into small sections and provide time to process each main concept before moving to the next (Mayer & Pilegard, 2014). The segmenting principle suggests that instead of giving a lengthy, unbroken presentation, educators should break the content into small chunks or units. After each chunk, employ a brief learning activity to solidify comprehension before moving on (e.g., a group discussion, problem-solving activity, hands-on task that requires participants to use new knowledge in a meaningful way). For lengthy presentations, trainers should also offer plenty of breaks to allow learners to stretch and use restrooms.

Conclusion

In recent decades, PowerPoint presentations have become the norm for conveying information in face-to-face training and informational meetings. PowerPoint presentations often take the form of bulleted lectures in which the trainer discusses an outline of facts as the audience reads along. Unfortunately, bulleted lectures tend to result in ineffective passive learning. Furthermore, bulleted lectures give rise to verbal redundancy that may diminish comprehension by overtaxing attention and memory.

Research demonstrates that trainers can improve comprehension by developing active-learning experiences using PowerPoint. We can accomplish this by eliminating bulleted lectures and creating image-based presentations that stimulate deep thought and serve as springboards for discussion, problem solving, social interaction and hands-on activities. Specifically, educators can employ the multimedia, modality and redundancy principles by communicating through on-screen images and spoken words. We can draw on the coherence principle by focusing on a few main points, while eliminating unnecessary information. We can utilize the signaling principle with highlighting, textual labels, arrows and other markers of significance. We can apply the congruity principle by presenting visual and verbal information together in space and time. We can harness the pretraining principle by ensuring that the audience understands important concepts before discussing them further. We can implement the personalization principle by using informal language such as personal pronouns. Finally, we can practice the segmenting principle by breaking presentations into brief sections separated by relevant exercises to help audiences process each main concept before moving on. **PSJ**

References

Adesope, O.O. & Nesbit, J.C. (2012). Verbal redundancy in multimedia learning environments: A meta-analysis. *Journal of Educational Psychology, 104*(1), 250-263.

Alley, M., Schreiber, M., Ramsdell, K., et al. (2006). How the design of headlines in presentation slides affects audience retention. *Technical Communication, 53*(2), 225-234.

Ayres, P. & Sweller, J. (2014). The split-attention principle in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 206-226). New York, NY: Cambridge University Press.

Berney, S. & Bétrancourt, M. (2016). Does animation enhance learning? A meta-analysis. *Computers and Education, 101*, 150-167.

Butcher, K.R. (2014). The multimedia principle. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 174-205). New York, NY: Cambridge University Press.

Campbell, J. & Mayer, R.E. (2009). Questioning as an instructional method: Does it affect learning from lectures? *Applied Cognitive Psychology, 23*(6), 747-759.

Carney, R.N. & Levin, J.R. (2002). Pictorial illustrations still improve students' learning from text. *Educational Psychology Review, 14*(1), 5-26.

Chien, Y.-T., Chang, Y.-H., Chang, C.-Y. (2016). Do we click in the right way? A meta-analytic review of clicker-integrated instruction. *Educational Research Review, 17*, 1-18.

Freire, P. (1998). *Pedagogy of the oppressed* (M.B. Ramos, Trans.). New York, NY: Continuum. (Original work published in 1970)

Gardner, J. & Belland, B.R. (2012). A conceptual framework for organizing active learning experiences in biology instruction. *Journal of Science Education and Technology, 21*(4), 465-475.

Ginns, P. (2006). Integrating information: A meta-analysis of the spatial contiguity and temporal contiguity effects. *Learning and Instruction, 16*(6), 511-525.

Ginns, P., Martin, A.J. & Marsh, H.W. (2013). Designing instructional text in a conversational style: A meta-analysis. *Educational Psychology Review, 25*(4), 445-472.

Höffler, T.N. & Leutner, D. (2007). Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction, 17*(6), 722-738.

Horvath, J.C. (2014). The neuroscience of PowerPoint. *Mind, Brain and Education, 8*(3), 137-143.

Houts, P.S., Doak, C.C., Doak, L.G., et al. (2006). The role of pictures in improving health communication: A review of research on attention, comprehension, recall and adherence. *Patient Education and Counseling, 61*(2), 173-190.

Hunsu, N.J., Adesope, O. & Bayly, D.J. (2016). A meta-analysis of the effects of audience response systems (clicker-based technologies) on cognition and affect. *Computers and Education, 94*, 102-119.

Jordan, L.A. & Papp, R. (2013). PowerPoint: It's not "yes" or "no"—it's "when" and "how." *Research in Higher Education Journal, 22*, 1-12.

Kalyuga, S. & Sweller, J. (2014). The redundancy principle in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 247-262). New York, NY: Cambridge University Press.

Kim, S., Phillips, W.R., Pinsky, L., et al. (2006). A conceptual framework for developing teaching cases: A review and synthesis of the literature across disciplines. *Medical Education, 40*(9), 867-876.

Knowles, M.S., Holton, E.F., III & Swanson, R.A. (2015). *The adult learner: The definitive classic in adult education and human resource development* (8th ed.). New York, NY: Routledge.

Kober, N. (2015). *Reaching students: What research says about effective instruction in undergraduate science and engineering.* Washington, DC: The National Academies Press.

Kontra, C., Lyons, D.J., Fischer, S.M., et al. (2015). Physical experience enhances science learning. *Psychological Science, 26*(6), 737-749.

Kyriakides, L., Christoforou, C. & Charalambous, C.Y. (2013). What matters for student learning outcomes: A meta-analysis of studies exploring factors of effective teaching. *Teaching and Teacher Education, 36*, 143-152.

Low, R. & Sweller, J. (2014). The modality principle in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 227-246). New York, NY: Cambridge University Press.

Lowe, R.K. & Schnotz, W. (2014). Animation principles in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 513-546). New York, NY: Cambridge University Press.

Loyens, S.M., Jones, S.H., Mikkers, J., et al. (2015). Problem-based learning as a facilitator of conceptual change. *Learning and Instruction, 38*, 34-42.

Markant, D.B., Ruggeri, A., Gureckis, T.M., et al. (2016). Enhanced memory as a common effect of active learning. *Mind, Brain and Education, 10*(3), 142-152.

Mayer, R.E. (2014a). Principles based on social cues in multimedia learning: Personalization, voice, image and embodiment principles. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 345-368). New York, NY: Cambridge University Press.

Mayer, R.E. (Ed.). (2014b). *The Cambridge handbook of multimedia learning* (2nd ed.). New York, NY: Cambridge University Press.

Mayer, R.E. & Anderson, R.B. (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. *Journal of Educational Psychology, 83*(4), 484-490.

Mayer, R.E. & Fiorella, L. (2014). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity and temporal contiguity principles. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 279-315). New York, NY: Cambridge University Press.

Mayer, R.E. & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology, 90*(2), 312-320.

Mayer, R.E. & Pilegard, C. (2014). Principles for managing essential processing in multimedia learning: Segmenting, pretraining and modality principles. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 316-344). New York, NY: Cambridge University Press.

Mousavi, S.Y., Low, R. & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology, 87*(2), 319-334.

Pate, A. & Posey, S. (2016). Effects of applying multimedia design principles in PowerPoint lecture redesign. *Currents in Pharmacy Teaching and Learning, 8*, 235-239.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education, 93*(3), 223-231.

Rey, G.D. (2012). A review of research and a meta-analysis of the seductive detail effect. *Educational Research Review, 7*, 216-237.

Schnotz, W. (2014). Integrated model of text and picture comprehension. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 72-103). New York, NY: Cambridge University Press.

Schroeder, C.M., Scott, T.P., Tolson, H., et al. (2007). A meta-analysis of national research: Effects of teaching strategies on student achievement in science in the United States. *Journal of Research in Science Teaching, 44*(10), 1436-1460.

Tangen, J.M., Constable, M.D., Durrant, E., et al. (2011). The role of interest and images in slideware presentations. *Computers and Education, 56*(3), 865-872.

van Gog, T. (2014). The signaling (or cueing) principle in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed.) (pp. 263-278). New York, NY: Cambridge University Press.

Xie, H., Wang, F., Zhou, Z., et al. (2016). Cueing effect in multimedia learning: A meta-analysis. *Acta Psychologica Sinica, 48*(5), 540-555.

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