Short attention span theater: Instructional design for optimal learning

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The average human is only able to hold about 7 chunks of information at a time in their active ("working") memory, and if they're trying to do something with that information (organize it, compare it, evaluate it) rather than simply storing it away, they are only able to manage 2 or 3 tidbits at once. New information held in working memory, if not rehearsed, is typically lost within about 15-30 seconds. On the other hand, the capacity of long-term memory is essentially limitless. Understanding how the human brain takes in information, processes it, and stores it is key to developing effective trainings, especially those involving multi-media components or interactivity. This article will share what I've learned about effective "instructional design" principles as I worked with colleagues over the previous year to develop two different interactive online trainings, one about improving retention and engagement rates for clients in substance use disorder treatment and the other about medicinal cannabis and chronic pain (for clinicians), using the multimedia training development software Articulate Storyline.

Keywords

E-learning; Instructional design; Multimedia; Training; Cognitive theory

Conscientious instructional design is one of the most vital components of effective trainings, and never has it been more relevant than in the age of Internet-based education. Now that so much learning is done individually, delivered via technology and multi-media channels instead of in a more dynamic classroom or instructor/group environment, using good techniques in the

development phase has become all the more important.

Instructional design theory is rooted in cognitive and behavioral psychology, relying in large part on how the brain takes in and processes information. The more a developer learns about the acquisition and retention of knowledge for a learner, the more efficient, effective, and appealing that education will be.

Over the last year or so, I have had the opportunity to work on two projects that involved the development of online, multi-media training modules. The first was related to a Retention Toolkit that the Alcohol & Drug Abuse Institute developed for a state agency looking to increase retention in outpatient treatment statewide; the second was a two-part online training for physicians and other health care providers about medicinal cannabis. Never having designed anything like this before, I spent a great deal of time talking to an instructional design consultant for the cannabis project, and then combing through the research on instructional design concepts and best practices.

The field of instructional design is vast, but some of the basic concepts are fairly straight-forward and easy to apply not just to online training development but to any multi-media education, including conference presentations, webinars, and more. This article will provide an overview of some of those basics and best practices, as well as some explicit examples of good versus better instructional design.

Cognitive Load

A major component of instructional design is what is called "cognitive theory," or the theory of how a brain takes in, processes, and stores information. This is tied very closely to the terms "cognitive load" or "cognitive overload," which come up frequently in the research on instructional design theory. Cognitive overload is exactly what it sounds like: it's what happens when a human brain is presented with too much information at the same time, effectively making it impossible for it to process much of anything at all.

Online, multi-media trainings are highly susceptible to cognitive overload because they typically employ such varied presentation techniques. Using both audio and visual components subjects the brain to a lot of input all at once; how you balance those inputs to facilitate retention of the learning task is key to successful design.

When taking in new information, the human brain's working or active, "conscious" memory is severely limited in both capacity and duration (Sorden, S. D., 2005). That is, working memory can only hold about six or seven chunks of information at any given time. Additionally, if you are processing that information (organizing it, comparing it, evaluating it, e.g.) rather than simply storing it, you're only able to manage two or three chunks at a time. New information held in working memory, if not rehearsed, is typically lost within about 15-30 seconds. The capacity of long-term memory, on the other hand, is essentially limitless.

That means the goal when trying to teach someone something new is to facilitate the transition of that something from working memory to long-term memory. Unfortunately, there are a lot of places where that transfer can go wrong.

Two important elements to keep in mind when trying to avoid overloading your learner are (1) the concept of "two channel" inputs for information and (2) the three types of cognitive demands in learning. By keeping both these components in mind as you develop your content, you can analyze how much and what kind of input the learner is being exposed to at any given moment, and juggle the various components to help mitigate some of the demands on their brain.

Two Channels

The human information-processing system has two major channels for information input: an auditory channel for

processing things you hear, and a visual channel for processing things you see (Mayer & Moreno, 2003).

Each of these two channels has a limited capacity; a learner can only take in so much with either their eyes or their ears at one time, and if one channel is being overloaded, they cease being able to take much in at all. Spreading input out over both channels is more effective than relying on either one alone (Mayer & Moreno, 2003). However, when designing a multi-media training where both audio and visual components are utilized, it's important to be conscious of how much information is being presented via each channel both individually and together – and, even more importantly, how well that information works together to present the necessary material. The more the audio and visual components are integrated to convey the same information, the easier it will be for the learner's brain to process and store that information. On the other hand, if the audio and visual components are divergent in content, neither one will end up being effectively retained.

Three Cognitive Demands

In addition to the two-channel concept, a good instructional designer must also keep in mind the three types of cognitive demands involved in learning: essential processing, incidental processing, and representation holding (Mayer & Moreno, 2003).

Essential processing refers to the procedures required for making sense of the important material – the "need to know" information. Of the three types of processing, this is the one most vital to learning. An example of such information would be a slide that just contains nothing but step-by-step instructions on how to accomplish a task.

Incidental processing refers to the processes that are not required for making sense of the presented material, but which are called upon by the design of the learning task itself. For example, picture our slide with simple step-by-step instructions, but now imagine background music accompanying it. While you may theorize that background music would help increase the learner's interest in the task, in reality the music is "incidental" to that task, and therefore is wasting a little bit of that limited cognitive processing space. That's not to say there is no place for background music or other engaging design elements, but where and how those are used is something that requires balance in terms of cognitive demands.

Representation holding, the last type of cognitive processing, refers to the processes required in holding a mental representation of something in working memory over time. For example, if we added to our presentation some images illustrating each step, but put those illustrations on a second slide, the learner would have to maintain a "representation" of the instructions from the first slide while looking at the second in order to make sense of those illustrations.

Reliance on representation holding, like incidental processing, isn't always preventable but should be avoided when possible. When it can't, a presenter should examine the balance of other cognitive demands in the task – the other processes (essential, incidental, or other representation demands) and the load on the learner's "two channels" – and see what else can be shifted to help compensate.

Keeping these two elements in mind, let's look at some specific examples of some common issues with trainings and what can be done to mitigate them.

Problem: Split Attention

Consider a slide that has step-by-step instructions on how to perform a task (in this example, how to use the Windows Snipping Tool, an application that lets you capture images from your computer screen), along with some basic, corresponding graphics.

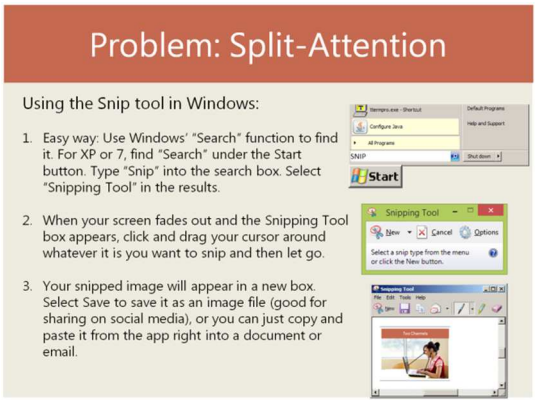

Fig 1. Step-by-step instructions with corresponding graphics, illustrating a "split-attention" problem.

While this is a fairly standard approach, this slide relies solely on a single channel of input (the eyes), and also requires that channel's attention to be split between the content on the left (text) and the content on the right (images). That makes two things for the visual channel to try to integrate, and nothing for the auditory.

Solution

Use both channels to spread the information being presented over two modalities instead of forcing the learner to integrate too much via one (Artino, A. R., 2008). Start by taking out the text and replacing it with audio narration of each step instead. Now the eyes only have to take in one element (images), while the ears take in the other (instructions). Now that the input has been spread over both channels, the brain is taking on a much more balanced load.

Problem: Too Much Information!

With our new slide, featuring only the three graphics for each of our three steps plus audio narration for the full content running in the background, we're one step closer to better instructional design, but we still need to further consider what's going on for the learner. There are three pictures to look at on this single slide, plus three separate pieces of instruction coming into their ears, forcing the audience to attempt to match what they see with what they hear.

Solution

Break the content into smaller chunks. Instead of providing all three images and the full narration simultaneously, start with the first image on screen while the learner listens, then have the second image appear next to the first as the narration meets that step, finally following up with the third. This reduces cognitive load on the learner by presenting information in smaller parts that can be fully processed before the next segment appears (Mayer & Moreno, 2003).

Problem: STILL Too Much Information!

Even this, however, is still placing more of a burden on the learner's brain than necessary. Though every piece of information presented is essential to the overall learning task, some parts of the information are more relevant than others. Additionally, the information is coming all at once, with no time between steps for the learner to process what's been received.

Solution

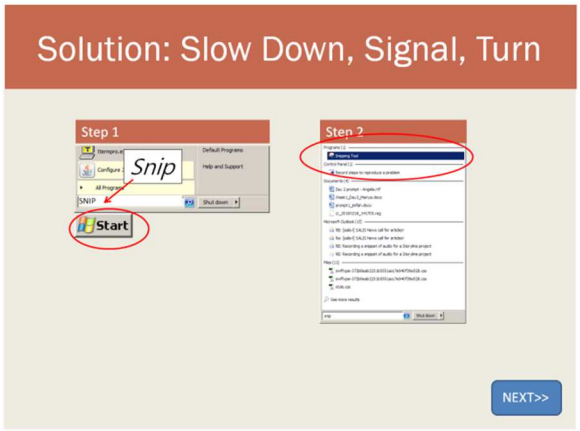

Fig 2. Break each step down further, adding signalling text and graphics to focus attention on the most relevant parts at each stage

Slow each step down and add signals to help the learner identify the most important elements. Instead of presenting all three steps

in a single slide, separate them into individual slides and, timed to the audio narration, highlight the most relevant elements of each step using text or graphics (arrows, circles, etc.). Allow the learner to move to the next step when ready (using a "next" button between slides, for example). By adding signals, the most critical parts of each step are emphasized for better retention. Allowing the learner to control the pace of the task reduces the risk of boredom for faster learners and the risk of being overwhelmed for slower ones. When adding additional visual elements to the slides, be sure to keep relevant things together visually in order to avoid the split attention problem illustrated in the original slide (the need for readers to move their eyes back and forth from the text on the left to the images on the right). Circling parts the learner should focus on helps keep their eyes trained on only the most relevant part of the slide for each step. Text signals should also be placed as closely to the corresponding images as possible.

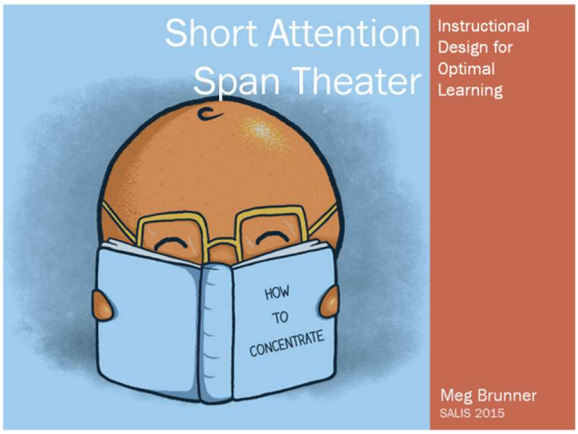

Fig 3. Take the online, multi-media demo of the Snipping Tool training developed for the SALIS Conference using e-learning software Articulate Storyline.

Now that we've broken the task into both audio and visual elements, separated each step, added signaling to direct the learner's attention to the most important cues, and added learner-directed pacing, we have improved this training dramatically, easing the cognitive burden on our learner while still keeping the education engaging. By carefully dissecting the task and examining the way the learner's brain would process each component, we have been able to simplify each step, making it much more likely that our student will retain and process what they are seeing and hearing. For an example of how you could take this training another step further, take a look at the final module developed to illustrate these concepts, created using the e-learning software Articulate Storyline. (Please note that this demo was prepared for use in the original presentation and does include some extraneous elements for fun that would be removed for a more "official" training!)

Summary

Examining the way the human brain processes information provides several useful models for effective instructional design. As technology continues to improve and increasing numbers of individuals turn to the Internet for education outside of the classroom setting, instructional designers must employ the most effective, efficient ways to present information. Though it can be difficult to resist the inclusion of flashy animation and other special effects, in most cases these elements prove more distracting than useful. Good computer-based instructional design employs a balance of multi-media elements and relies less on the capabilities of the technology at hand, and more on the capabilities of the learner's mind.

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