A picture is worth a thousand words (at least): The effective use of visuals in the economics classroom

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ABSTRACT

Much attention has been devoted to improving teaching pedagogy in economics: yet, one area that has generally lagged is the effective use of visuals. Evidence from cognitive and brain science suggests that the common approach of placing text onto slides does not improve student retention. This paper ties the literature from cognitive and brain science with that of economic education to show how visuals are more complementary to spoken lectures than words. This, in turn, leads to improved learning outcomes and a more enjoyable learning experience. The paper concludes with a concise summary of best practices, emphasizing easy-to-implement design techniques.

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1. Introduction

One of the most significant changes in education over the last two decades is the transformation of the classroom lecture, from a “chalk-and-talk” format that has existed for centuries to an active learning approach. One technology that has revolutionized this change is presentation software such as PowerPoint and its equivalents, which has allowed the chalkboard (a static medium conveying
words and basic visuals) to be replaced with a dynamic medium, allowing for multiple visuals including words, pictures, audio, video, animation, and video.

Advances in technology can dramatically improve the efficiency of the learning process, as information is conveyed more easily through a verbal and visual channel, a process by which cognitive and brain science has shown to improve understanding and retention. This literature has subsequently been studied and adapted to the education literature, which has shown that the effective use of visuals can result in improved learning outcomes in the classroom.

It is therefore surprising that in practice, the use of visuals in the economics classroom has been at best loosely embraced. Visuals in economics have longed focused on graphs and less on other forms of visuals, such as photographs and animations, which complement the ability to convey analytical concepts common within the discipline. Anecdotally, there has been a slow acceptance in the use of non-graphical visuals in the economics classroom. Evidence includes publisher-provided PowerPoint slides that commonly consist of bullet points as opposed to more dynamic forms of visuals. Further anecdotal evidence is seen at research-focused economics conferences, where “pictures” are rarely used in research presentations.

The disconnect between the cognitive and brain science research on visuals and actual practice in the economics classroom makes this an important topic for two key reasons. First, technologies allowing instructors to incorporate more visuals into the learning process have not been effectively exploited. And second, less obvious but equally important, is that today’s college students, mostly born after the Internet revolution, are very accustomed to visuals and multimedia.

The purpose of this paper is to summarize the contributions of the cognitive and brain science research and how it ties to the literature on economic education. We then adapt these methods into a discussion of best practices for instructors to incorporate visual techniques easily and effectively into classroom presentations.

The remainder of the paper is as follows: Section 2 presents the case for visual presentations by summarizing research in cognitive and brain science. Section 3 highlights the research on visuals and presentation software in economic education. Section 4 summarizes the literature by presenting the key principles when using visuals in the classroom. Section 5 presents best practices in creating classroom visuals within the economics discipline, and Section 6 concludes.

2. The case for visual presentations

For centuries, the dominant form of presenting instructional messages has been words: read in books, spoken in lectures, and written on blackboards. Verbal modes of presentation have dominated the way we explain concepts to others, and therefore, how educators teach. The introduction of the personal computer had the potential to question the conventional wisdom of using words to transmit educational messages. Nevertheless, the initial effort was not to use this technology to question the supremacy of words, but rather to reinforce it by applying the same model to the new medium.

The consequence of this is PowerPoint presentations used every day in the classroom that simply fill slide after slide with the same words that used to appear in books and on the blackboard, rather than imagining new ways to present information. As a result, this new medium of conveying knowledge to students has generally not improved the effectiveness of teaching, making some question the role of technology as a catalyst for positive change in education.

Within the economics discipline, visual imagery in the form of graphs and charts has historically formed the backbone of the subject. With multimedia, these images can be expanded to pictures, video, and animation. Yet, some instructors believe that pictures merely add “fluff” to content, while others are unwilling to invest time and effort to develop dynamic visual content which is often perceived as more time-consuming to create than text-based content.

Although any presentation is inherently visual, since one must use eyes to see it, we define a “visual presentation” as one that relies mostly on pictures (e.g., photos, diagrams, animations, concept maps, etc.) instead of words to deliver its main educational message. With that distinction in mind, the goal of this section is to offer a rationale for visual presentations using decades of research in both cognitive and brain science with respect to two areas of our brain function: vision and memory. We then tie
these implications to the literature on economic education to generate a list of principles for effective visual presentations in the following section.

2.1. We see in pictures

The first biological argument for visual presentations is that we see in pictures. One reason why text is less capable than pictures to deliver any message is because the brain sees words as lots of tiny pictures. Data clearly show that a word is unreadable unless the brain can identify simple features in the letters (Pelli et al., 2003). Hence, reading creates a bottleneck. To our cortex, there is no such thing as words. Instead, when people read, they create mental images of what the text is conveying.

Not surprisingly, researchers have found that the more visual the input becomes, the more likely it is to be recognized—and recalled. The phenomenon has been referred to as the pictorial superiority effect, or PSE (Stenberg, 2006; Endestad et al., 2003; McBride and Dosher, 2002). For instance, experiments have shown that people can remember hundreds of pictures with at least 90% accuracy several days post-exposure, even though subjects saw each picture for just a few seconds. Even after a year, recognition rates hovered around 63% (Standing et al., 1970). Other experiments have shown that adding a picture to a text-only message increased recollection by about 65% percent (Nickerson, 1968; Read and Barnsley, 1977).

Hence, the first implication of this theory is that educators should replace text with pictures whenever possible. For example, a sentence reading “the demand curve is downward sloping” is a less effective visual than showing a graphical demand curve, which is subsequently less effective than an image illustrating a business with high prices and no customers.

2.2. Seeing is hard work

Historically, vision was thought to be a rather straightforward process—taking place mostly in the cornea and the retina. Eyes were imagined to serve as little cameras, capturing events as they happen and sending that image to the brain. Today, however, we know the process is much more complicated; specifically, it is the brain, not the eye, that plays the key role in seeing.

Although the process starts in the retina, it serves as an active “sense-maker” of the world around us. Specialized nerve cells deep within the retina interpret the patterns of photons striking the retina, assemble the patterns into partial tracks and then send these tracks to the back of our heads (Carlson, 2007; Medina, 2008). But these tracks are not complete, but rather partial abstractions of specific features of the visual environment. The rest of the “picture” is filled in by the visual cortex, a large complex region within the occipital lobe. Most of what we call “seeing” takes place here (Roska et al., 2006; Fried et al., 2005).

Through a complex process, the virtual cortex takes the incomplete information from the retina and completes it using information stored in other parts of the brain. The ventral stream recognizes what an object is and what color it possesses, and the dorsal stream recognizes the location of the object in the visual field and whether it is moving.

This entire process takes place within a blink of an eye, and therefore requires substantial brain capacity to function. This accentuates the supreme role vision has over all other senses at the time of assimilating information.

Because the process of seeing is so complicated, anything that an instructor can do to aid the learner in this process would have positive effects in terms of understanding and recall. Instructors should therefore be intentional about the way they present information visually to students. For instance, people pay close attention to the color, size, orientation, and motion of visual objects. Such visual features should be prominent when creating visual presentations.

2.3. Seeing takes place in the brain

People see with their brains. The brain accomplishes the task of seeing by reconstructing the information it receives from the eyes with previous knowledge stored in different corners of the memory. As Medina (2008) states: “Far from being a camera, the brain is actively deconstructing the
Information given to it by the eyes, pushing it through a series of filters, and then reconstructing what it thinks it sees. Or what it thinks you should see!"

The implication that this theory of vision has for teaching and learning is an important one. If the process of vision is not as reliable as once thought, then how visual techniques are used becomes increasingly important in conveying knowledge. If students must browse through their memory banks to complete a visual object, then efforts to speed up this process, such as the use of cues, will have great instructional value.

Cues are useful because they give students clear hints about the type of memory they are looking for when browsing through their long-term memory. For example, a picture of a crowded shop can mean many things to different students, such as popularity, lack of competition, and inefficiency. Anchoring the picture with a cue (such as the word “shortage”) would then allow students to quickly focus on the concept being conveyed.

2.4. Words and pictures are not two sides of the same coin

The other argument for visual presentations comes from cognitive science; specifically, the dual coding and cognitive load theories. Dual coding theory suggests that people receive and process information through two distinct channels: a verbal channel, which processes verbal material, and a visual channel, which processes pictorial material and nonverbal sounds (Paivio, 1986, 2006).

Both channels are interrelated. For instance, on-screen text may initially be processed in the verbal channel because it is presented in words, but many readers are able to mentally convert these words to images, which are processed through the visual channel. Further, the two channels complement rather than compete with each other, as shown in Fig. 1.

Dual-coding theory leads to two implications for visual presentations. First, because of the complementary effects of the two channels, adding a picture to any verbal message can enhance the processing of this message by one’s working memory. In other words, a message made up of just words is not utilizing a channel for conveying the message to one’s working memory. Second, a message that enters the working memory mainly as text has the potential to overwhelm the verbal channel, making the process more difficult. In practical terms, a blank slide can be more effective in conveying a concept than one filled with many lines of text.

The same logic applies to repeating the narrated verbal message with written words. The emphasis of words (this time through two different presentation sensors: auditory and visual) has the potential to overload the verbal channel rather than its intention to enhance the message.

2.5. There is only so much working memory can do

The limitation of the verbal channel is enhanced by our second cognitive argument for visual presentations: cognitive load theory. This model suggests that humans are limited in the amount of information that can be processed in each channel at one time. When an illustration is presented, the learner is able to hold only a few images in working memory at any one time, reflecting portions of the presented material rather than an exact copy (Baddeley, 1992, 1999; Sweller, 1999; Clark et al., 2005).

For example, when a student is presented with a PowerPoint slide with bullet points describing a [Fig. 1. Memory and the cognitive case for adding pictures to educational lectures.]
sequence of events following a change in the supply of milk (e.g., a decrease in the supply of milk, causing the price of milk to increase, leading to a fall in the supply of cheese, and subsequently an increase in the price of cheese), she might retain only one or two of those events in working memory.

Cognitive load theory has one major implication for visual presentations: extraneous information should be avoided. The brain is not effective at retaining too many details in working memory for even a limited amount of time. Therefore, cognitive load theory suggests that visual messages of any kind, including text as well as pictures, should err on the side of simplicity. In other words, although the frequent use of pictures can enhance retention, using too many pictures at once (e.g., within a single slide) creates a distraction that makes it harder to retain the message in working memory.

In sum, improving visual presentations involves the difficult task of eliminating as much non-essential content as possible. One must critically review each slide and make hard choices about what one can and cannot do with visuals. If a complicated visual (such as a diagram with seven or eight different curves) still results, one must be ready to leave that visual on the screen for enough time for students to assimilate it.

These principles that result from cognitive and brain science research have profound value in how humans learn and remember. Therefore, applying these concepts to the education literature is a natural response, which we turn to next.

3. Visual presentations in economic education

The literature on economic education has long focused on pedagogical techniques that aim to improve the ability of students to grasp and retain concepts that are analytical in nature. The increased attention to the teaching of economics has led organizations such as the American Economic Association to host an annual teaching conference that has grown significantly in prominence and attendance since its debut in 2011.

A compendium of topics on economic education, edited by Hoyt and McGoldrick (2012), contains contributions from dozens of active researchers in the area of economic education, covering nearly 80 topics on the subject. However, one topic that was not emphasized was the importance of visuals as a pedagogical tool in the economics classroom. In this section, we tie the research on cognitive and brain science to that of the education (primarily economics) literature. We focus our discussion on PowerPoint, since that is the most popular presentation software used by instructors. Nevertheless, our conclusions can be easily expanded to any other presentation software.

Early research on the effectiveness of PowerPoint slides, especially in the economics classroom, has largely assumed that PowerPoint slides are text-based (e.g., containing bullet points). For example, Parks (1999) argued that PowerPoint is an effective classroom tool when an instructor's handwriting is poor, and therefore slides are more useful when they are made available to students as handouts. However, the study points to a drawback that some students treat the handouts as a substitute to regular note taking. A subsequent study by Chen and Lin (2008) showed that allowing students to download PowerPoint slides prior to class improves student performance for those who attend class, but not those who are absent, suggesting that PowerPoint slides are more complementary to lectures than substitutes. Still, the issue of broadening the use of PowerPoint to include visuals had not been studied well.

More recent studies have questioned the traditional role of PowerPoint slides in the classroom. Maxwell (2007) argued that the use of bullet points within PowerPoint slides ought to be avoided, because it leads to instructors “reading slides out loud.” Maxwell argued that slides must contain distinctive content that does not replicate the instructor’s words, thereby allowing the medium to complement the spoken lecture. Supporting this argument, Clark (2008) showed that PowerPoint slides are pedagogically effective because they provide variety and an opportunity to stimulate interest in the learning environment that words alone cannot accomplish.

What, then, does the literature say about the type of visuals that should be used? Boatman et al. (2008) presented empirical findings suggesting that students in introductory economic courses prefer non-graphical visuals, and that their use has a positive effect on learning outcomes. This follows the findings of Cohn et al. (2001) which found that the use of graphs alone did not improve learning
outcomes. Subsequent studies showed how different forms of visuals, such as art (Watts and Christopher, 2012), can be effective in conveying economic concepts.

Although it is not possible to summarize all of the existing education research on visuals, the snapshot above highlights a few key issues that can be tied to the cognitive and brain science research described earlier. Although this literature review is far from exhaustive, it points to important conclusions regarding the effective use of visuals in the classroom.

4. Summary of key assumptions and principles in the use of visuals in the classroom

Tying the conclusions of cognitive and brain science research with the economic education literature, we summarize five main assumptions based on biological and cognitive tenants as follows.

4.1. Biological assumptions

- Picture superiority (PS): the brain sees everything, even words, as pictures.
- Vision complexity (VC): the biological processes involved in seeing are complex. They begin in the eyes, but the critical parts take place in the back of the brain.
- Mental visual restructuring (MVR): in order to “see”, the brain must fill out incomplete signals sent by the eyes with previous knowledge stored in the memory.

4.2. Cognitive tenants

- Dual channel (DC): information is processed through a visual and verbal channel, two distinct channels that are interrelated but do not compete with each other.
- Cognitive load (CL): the ability to hold and process information through each channel is limited.

Using these assumptions along with the characteristics inherent to economic education, we can summarize the strategies for creating effective visual presentations with six key principles. Students learn better when visual presentations:

1. Use more pictures and less text.
2. Are intentional about the attributes of the visual aids, particularly in regards to color, orientation, size, and movement.
3. Include simple cues along with ambiguous images.
4. Include pictures and text rather than text alone.
5. Do not repeat the verbal message contained in narration by the speaker.
6. Exclude extraneous information and distractions.

We now apply these principles to a discussion of how visuals can be more effective in the economics classroom. It is important to note that the suggestions provided are far from complete. Instead, we focus on techniques that are effective yet easy to implement, providing the greatest return to one's time.

5. Best practices for visual presentations in economics

A common concern raised regarding the use of visuals, even among instructors who believe in their pedagogical value, is that the time commitment required to construct visual slides is too substantial to warrant their extensive use in presentations and lectures. In this section, we attempt to ease these concerns by presenting a few best practices in creating visually effective slides. The examples we illustrate in this section are created in PowerPoint, though the same techniques apply regardless of the software used. Most importantly, we emphasize techniques that offer the maximum effect for the minimum time investment. Many of the examples shown take no more time than what is required to prepare a presentation that is predominantly text-based.
5.1. Optimal picture selection

The first step to creating visual presentations is selecting pictures that best convey the concept being taught. Numerous sources exist, including those that are fee-based and those that are free. Popular fee-based sources include Getty Images, Corbis Images, Shutterstock, iStockphoto, and Dreamstime. Advantages of fee-based sources include higher resolution images, along with the freedom to use images in more mediums of instruction. Popular free image sites include Google Images, Creative Commons, Everystockphoto, and Freefoto. The Appendix provides a more comprehensive list of image sources.

A common issue regarding the use of free image sources is whether copyright laws are being adhered to. In the United States, the 2002 TEACH Act clarified the rules for using copyrighted images for instructional purposes, and gives greater freedom to use copyright images in the classroom as long as images are not viewable by the public or published into course materials. Still, it is prudent to err on the side of caution with regards to copyrights whenever images are being used.

When selecting images, a few important points should be kept in mind: (1) avoid pictures that are small in file size (less than 250 kb), as such images become blurry when enlarged on a slide; (2) avoid changing the original dimensions of the picture; doing so makes images appear out of proportion; and (3) avoid pictures with distracting features, such as large faces, excessive colors, etc.

5.2. Slide design

Once pictures are selected that best convey the concepts to be discussed, the next step is to place them onto slides alongside text. It is here where many presentation slides become less effective due to common mistakes such as placing excessive text on slides, using too small fonts, incorporating an excessive number of pictures or non-relevant text or pictures, and so forth.

When working with pictures, it is generally a useful technique to bleed the picture off the page. Fig. 2 illustrates two examples of slides that use the bleeding technique and slides that do not.

In Fig. 2, the left panels show framed images. Although framing is a popular technique, it creates a distortion in the viewer’s brain. When a viewer sees an incomplete picture of dogs, the brain completes the image in her mind, even when the entire picture is not shown. However, the ability of the brain to complete images is deterred when the frame blocks the continuation of the image, making the image incomplete. The right panels, on the other hand, bleed the image off the slide. By doing so, no obstacle exists between the portion of the dogs shown and the brain’s ability to complete the image.

Another best practice is the rule of thirds, a technique commonly used by photographers. Fig. 3 presents a slide that has been divided into thirds both vertically and horizontally. According to the rule of thirds, a person’s ability to focus best lies along the sight lines created by the thirds, rather than in the middle of a slide. For this reason, key objects and words that need to be emphasized are best placed along the intersection of the vertical and horizontal sight lines. Interestingly, these intersections are known in photography as powerpoints.

The left panel in Fig. 3 shows a placement of text and image within the middle column of the slide. Further, the stick holding the carrot is shown floating in midair, another example of how the brain views such images as atypical. The right panel shows a placement of text and image close to the powerpoints of the slide, thus creating a more visually effective slide. Further, the bleeding technique is used, allowing the brain to visualize the stick being held, even if not explicitly shown on the slide.

A final point to mention with regards to slide design is the appropriate use of contrast. Contrast can be accomplished by various means, such as the use of contrasting colors, sizes, or placement of objects. However, contrast can be harmful if overused. Fig. 4 illustrates two cases of contrast. The left panel illustrates a case where contrast is overused: too many colors and too many fonts and sizes become distracting to the viewer. The right panel shows an effective use of contrast in terms of color, size, and placement of objects on the PowerPoints of the slide.

The techniques described in this section are by no means exhaustive nor do they suggest a complete blueprint of how to design effective visual slides. However, each technique, if used appropriately, can improve the effectiveness of the slide design, leading to improved information retention by students.
5.3. Effective use of text on slides

Although text is the most common element used by instructors within presentation slides, it is often used in a manner that better represents a word processing document or a handout than a presentation slide.

When a presenter attempts to include as much detail on a concept as possible into a slide, the slide essentially becomes a substitute for a page in a book. In other words, the slide forces the instructor and student to read the text within the slide line by line, detracting from the ability to quickly gain the main point of the concept. Fig. 5 illustrates this point using two different slides to convey the concept.
of the supply curve. The left panel describes the supply curve in remarkable detail in words, while the right panel presents a visual description of the concept.

Although the choice of the “ideal” slide is far from unanimous, the arguments presented in this paper suggest that the right panel better conveys the concept of supply in a manner students can easily remember and relate to by tying the concept to a realistic example. Supporters of text-intensive slides might argue that the left panel serves as a more comprehensive learning tool by providing extensive details, especially if the slides are provided to students. Yet, such details already are provided in textbooks. The more effective use of slides is to present concepts in a manner that improves understanding and retention. Text-intensive slides are less apt to accomplish this goal.

In cases in which abundant amounts of information needs to be provided (such as data tables, statistics, or numerical facts), it often is more effective to highlight key results on the slide, while leaving the bulk of the information on an actual handout to be given to the viewer. One way to condense messy data is to present the data in a visual form. Fig. 6 illustrates this technique using a common data table frequently used in seminars and lectures. The left panel presents the data in detailed numerical form, while the right panel presents the same data, but in condensed fashion and in a visual format that allows the brain to make conclusions about the data presented.

In sum, the effective use of text within slides often requires fewer words to allow a viewer’s brain to retain information and use visual cues to make appropriate connections between words and the concept these words are trying to convey. To do so, instructors must be willing to use text sparingly, focusing only on words that are most critical to the understanding of the concept, and allowing the visual connections created in the slides to fulfill the learning process in a more effective way.
6. Conclusion

The use of presentation software such as PowerPoint, Keynote, Prezi, and others has changed the way economics is taught in the classroom. Because economics is a discipline fundamentally dependent on visuals such as graphs, figures, and tables, a common mistake made in presentations and lectures is to simply replicate the full graph, figure, or table onto a slide, or otherwise describing the visual in words without including the visual. In either case, the purpose and power of the presentation software is not being utilized to its full extent; in these cases, the software is used merely to show material, but not to present material.

This paper makes a strong argument for the use of effective visuals within a presentation. Visuals can take on many forms, including pictures, animation, and video; but visuals also involve the incorporation of word usage, placement, and contrast within slides. The effective use of visuals has been found to not only promote retention of information, but also aid significantly in the understanding of concepts by allowing the brain to make visual connections between images and concepts.

Still, the academic profession has arguably been slow to incorporate visuals into lectures and presentations, often due to skepticism of their effects on learning, but also due to the misconception that it requires an excessive time commitment to change the style of slides commonly used for the past two decades. This paper provides ample evidence from neuroscience and cognitive research along with best practices to refute criticisms of the visual-based approach. A greater appreciation for visuals and an acknowledgment of their pedagogical value may again change the way economists teach, to an approach that students are accustomed to and will benefit by way of improved learning and retention.

Appendix A. Appendix: List of popular image sources (fee-based and free sites)

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