

## Connecting Visuals to Written Text and Written Text to Visuals in Science

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**Abstract:** This article describes how an interdisciplinary science class uses visuals in ways that can be adapted across disciplines and academic levels. The key to the use of visuals is that they are integral to the learning of the students, whether we begin with visuals to improve writing and thinking or use written texts as the basis for visual interpretation. The article is based on our research and teaching of *Oceans: Past and Present* as a core senior course at The McCallie School. Through specific projects and learning activities we argue that visuals, "seeing," and re-visioning all become tools to advance understanding, to improve writing and learning, and to promote synthesis and evaluation of written texts. Through collaboration, connections between visuals and music, or visuals and metaphorical language to reinforce concepts, we learn right along with our students, a risky but rewarding experience.

Using visuals in science isn't an unusual concept. Biologists use diagrams, cross-sections, and graphs for lab reports all the time, and students can easily label, plot, and place words on them. What we want to discuss is something beyond memorizing and fitting information into computerized formats; we deepen and enrich the learning experience by making critical connections between visuals and written text. Although our examples focus on activities used in one class, the use of visuals in this science class can be adapted across disciplines and academic levels. In our team-taught interdisciplinary science course *Oceans: Past and Present*, visuals, "seeing," and re-visioning all become tools to advance understanding; these elements are the vehicles through which we bring the ocean to our landlocked classroom. Sometimes we start with the visuals, but other times a written text becomes the basis for visual interpretation. Either way, visuals improve writing and learning, and promote synthesis and evaluation of written texts to demonstrate critical understanding of ideas.

On the first day of class, we administer O'Brien's *Specific Diagnostic Studies* (1998) learning style profile, which identifies preferred modalities. Invariably, over half of our students demonstrate a visual preference for the processing of information. We see these results as an opportunity to harness their visual skills in the service of developing and advancing their abilities as writers (Dunn and Dunn, 1978; Smith, 1998). Interestingly, while their visual skills could be applied in their writing, which involves use of the visual as a means of interpretation, we also learn that writing can further their ability to "see" in a new way by applying more details. First, we give students a selection of

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quotations related to the ocean ([Appendix A](#)). They must first interpret a certain text, then communicate that interpretation through the use of visuals exclusively.

Frank Smith states that the power of imagination or visualization opens up fast tracks for learning (88). Based on our studies (Egan and Nadamer, 1988; Brookfield and Preskill, 1999), we realize the importance of collaborative responses to text and visuals; therefore, we have students observe each other's visual and respond to it in completely objective terms ("I see ..."). As noted by McQuade and McQuade (2003), "It's easy to make assumptions about something you're looking at or reading without taking the time to base your statements on what you can actually see" (9). Each member of the class responds in sequence during this exercise, building upon what has been said previously for several rounds. For instance, "I see a blue line with three red dots above it," then "I see white space above and below the blue line with red dots above it." Next, we go around the room asking interpretive questions ("I wonder if . . ."). These statements require more thinking and connection to the particular quotation and visual. For example, "I wonder if the blue line represents the calm sea," followed by "Do you think the red dots represent the 'oceans' in space that we are exploring?" This opening activity validates the use of visual learning for those who best learn that way, while it also gives verbal learners permission to take the risk of using visuals to interpret a text. The collaborative responses reflect back to the text through the lens of a visual interpretation to enhance communication of abstract ideas with concrete details. The depth of thinking that develops often far exceeds what one student could do alone (Perkins, 1986; Winner, 1991).

After students follow the protocol of "what do I see" and "I wonder . . .," they begin debriefing. At that point, the "artist" who has created the visual response to the quotation responds. Are his/her classmates accurate in what they have seen? Is his/her visual interpreted as he had intended? Has he/she learned anything new from the responses of classmates about his/her visual communication of ideas? Frequently, the artist responds, "I did not intend that, but it makes me think more about what I am trying to communicate from the original text." Within this newly established, multimodal learning community an environment is created in which critical ideas can be expressed through collaboration (Zaraca, 1995).

Next, we move from interpretation/communication of the visual to demonstrating how to understand a concept through the use of visuals and text. The concept of ecological interdependence is essential to the study of oceans, so we use this as our first theme of the semester, (followed by the theme of survival and the study of ocean communities). After asking students to come up with their own definition of ecological interdependence, we begin viewing two important videos, both with strong narrative voices that open the world of the ocean to our students in entirely different ways. One, "Open Ocean" (2002) from *Blue Planet*, narrated by David Attenborough, focuses on research and visual reporting from a primarily objective perspective. In contrast, "Unknown Seas" (2001) from *Land of the Tiger*, narrated by Valmik Thapar, gives a personal account of the waters around India through the use of visuals, musical interpretations, and the poetic language of the writer/narrator. Visually, both movies are spectacular, and students react to the photography with strong individual and class responses of laughter, surprise and curiosity. Students also watch with intensity as they learn novel concepts about the ocean, such as the symbiotic relationship among shearwaters, swordfish and tuna or elephants swimming to get from island to island.

Since we want our students not just to grasp the vastness of the topic, but also to collect specific information within, we have sought a way to cultivate the habit of reflection while our students watch the video. The act of journal writing is an effective tool to promote this kind of thinking, but such writing usually occurs after the viewing (Bean, 1996; Childers & Lowry, 1997). We wondered if there

could be a reflective prompt we could pose (a product of active metacognition), while students experience the video? After some experimentation, the answer became obvious: use a visual format to document a visual experience. We use a graphic organizer or a visual form that offers a structure, a lens, through which to experience the video (Kim, Vaughn, Wanzek, & Wei, 2004; Parks & Black, 1992; Peterson, 2004; Witherell & McMackin, 2002). The questions it prompts foster a more active form of watching; students record observations (i.e., content from the video) and pose questions about specific content (examples of ecological interdependence).

From this point, we return to forming a valid definition of ecological interdependence (Perkins and Unger, 1998). Based on their common experience of viewing "Open Ocean," students individually consider creating a new definition, which they share with a partner to revise into a team definition. As part of this process, we introduce them to new scientific terms, biotic and abiotic, so the class can refine their definitions as they examine the work of every team. The next day each student submits another draft at the beginning of class, and all drafts are typed onto one document for analysis. In different teams, students decide whether any of the definitions will work as the class definition or whether they want to create another. As we explore the options, again and again students make reference to the video as a stimulus for finding the appropriate definition (Davis, 1996). For instance, this year's class has created a working definition:

Ecological dependence is a balance of interrelationships, both biotic and abiotic, within an environment in which components depend on one another for self-preservation.

The original sentence one team had presented lacks the terms biotic and abiotic, which members of the class have added. Originally, the wording said "each other" instead of "one another," but members of the class argued that the dependency could involve more than two components. How often do science classes involve such lively debates of language? It was students' reference to examples from the visuals that acted as the stimulus for their re-vision.

In the second video, "Unknown Seas," the graphic organizer helps students focus on an awareness of recognizing connections between visuals and music, or visuals and metaphorical language to reinforce examples of ecological interdependence. We observe students beginning to probe deeply into what they have experienced, going from visual to experiential (Smith, 1998). What proves interesting to us is how the fast-paced, almost fleeting, nature of the images in the video--tuna darting into a fish ball; fish scales, the remains of a predatory feast, descending into the abyss; female turtles coming ashore to lay eggs--become rich fodder for exploration in students' writing. Inevitably, they want to know more: How does that come to be? Why is it like that? Is it similar in other places? How can this impact my life? As McQuade and McQuade (2003) point out, "An observation is, in effect, a neutral nonjudgmental and verifiable statement" (9): the graphic organizers are a net that captures their watching and thinking. The "catch" they examine further; writing becomes the tool through which their "haul" is cleaned and prepared for others' consumption. The questions that our students pose in their graphic organizers as a result of observing the visuals sometimes blossom into research projects. For instance, students go on to pursue such diverse topics as the relationship between the use of the metaphor of the ocean for love or loneliness in the lyrics of popular songs, or the creation of a brochure for the Tennessee Aquarium on the impact we have on the ocean and the ocean has on us even though we are not close to it.

As rich as their questions and ensuing research become from the viewing of "Open Ocean" and "Unknown Seas," we do not want our students' thinking to stop there. We know that learning is a social act, and the community can foster a richer exploration of ideas (Bean, 1996; Bransford, Brown & Cocking, 2000; Brookfield & Preskill, 1999; Lowry & Childers, 2001). As each student shares with

the larger group the questions that arose for them, they receive feedback/reaction to their ideas that increase their comfort with critical response. This response results in further probing, thinking, reflecting, and discussing. Smith (1998) suggests that we "observe them when they are engaged in some communal activity involving art, science, reading, writing, and just plain thinking and ingenuity" (86). As we observe our students, we look for how they can apply their knowledge to a new context. Have they developed a level of expertise with ideas to transfer their newfound knowledge to a different situation? Can they demonstrate deep understanding that goes beyond their immediate visual experience (Bransford, Brown & Cocking, 2000; *The Learning Classroom*, 2003)?

We further answer these questions by creating another form of assessment: a set of writing assignments whose intent is to demonstrate a grasp of the principles of ecological interdependence ([Appendix B](#)). Students choose from several options, all dependent on the original visuals, the videos, as well as their knowledge of ecological interdependence, and clear communication in written form (Allen, 1998). When asked about the options they have chosen, students respond that they have selected the option that holds the most interest for them even though it may take them longer to complete (Childers & Lowry, 2000). That is, the visual learners who are artistic choose to create a detailed design of an aquarium with a written commentary that demonstrates their clear understanding of ecological interdependence in the same way that other students might spend more time selecting music that demonstrates the visual ecological interdependence they have seen in the videos with a written commentary. These various writing assignments ask our students to adapt their learning to novel situations. We are urging them to "experiment: to question, evaluate and interpret ideas they are trying to comprehend for the first time" (Sommers & Salz, 2004, 128). They also force us to think deeper about how to recognize their understanding; we are learning right along with our students because we are also doing the assignments and getting their feedback as well. We engage in these activities ourselves, "demonstrating," as Smith (1998) says, "how important they are to [us]" (86).

Building on students' understanding of how to interpret the quotations we had given them the first day, we continue using visuals to decode other texts as well. Shuman and Wolfe (1990) note that as with writing and composition in music, "drawing or painting has to do with ordering objects in space ... All forms of composition assist in the process of clarifying and ordering thought and feeling, in creating and understanding concepts" in short, in learning" (7). In another example of using visuals as an important part of interpreting written text, we read aloud Alicia Ostriker's (1997) poem "Move" from the introduction to Carl Safina's *Song for the Blue Ocean*, our class text. In a systematic way, we "view" the poem together, reading it aloud twice, then commenting on what we see in the text. After identifying our observations, we then as a group pose questions beginning with "I wonder why..." After this communal exploration of the text, we divide the class into various groups. One group is given the charge: demonstrate your understanding of the text using only visuals. When asked to reflect on their understanding of the poem in writing, we have discovered that their insights are richer and deeper as a result of having first engaged in a visual mode of thinking. The interpretations that emerge from this process are evocative and spark many stimulating dialogs among participants, focusing on concepts of nature, life processes of turtle, salmon, and humans. They even make connections that reflect back to the "Unknown Seas" video. Upon writing these reflections, many students "see" the poem in a new way: the writing has generated fresh thinking about the work. For instance, one student wrote, "This poem instills a sense of hope for the preservation of sane minds and the virginity of humanity in an inhumane world." Others commented, "The creatures in the ocean act on instinct and don't have to deal with the uncertainty that comes with being able to choose what to do"; and "the power of nature is evident here. It shows that everything is working together as a unit and that the moves we make can hurt the ocean."

Throughout the semester, we use email and blog activities to synthesize visual and verbal information from videos, texts, and the Internet (Redish, 1996). For instance, one year as part of our survival theme, students viewed *Shackleton's Voyage of Endurance* (2002) based on Shackleton's Antarctic expedition and went to the accompanying website documentation (<http://www.pbs.org/wgbh/nova/shackleton/>). After viewing the movie, reading the website interview with Shackleton's daughter, and perusing photographs and biographies of each person on board the *Endurance*, students randomly selected the name of a crew member. Students searched other sources, including authentic photographs taken during the expedition, then wrote three journal entries as if they were that crew member. Each set of entries had to connect to accurate dates, visuals, and authentic details (Allen, 1998). For example, in [Appendix C](#) Donte has adopted the persona of the artist George Marston and responded in his journal to historical and scientific information through the "eyes" of the artist. Visuals have enhanced and deepened his comprehension of the journey of Shackleton and his crew (Perkins and Unger, 1998); his project reflects what students learn as they communicate in this class: the words and visuals are symbiotic. Classmates also read the journal entries aloud as if they had just been discovered. During this process, students have developed close relationships, virtually, with a real person who had survived ocean conditions beyond their belief. Without the visuals to connect to their reading and research, the writing would not reflect the detail or authenticity of the research to the students' own experience and knowledge (Winner, 1991).

In Tufte's *The Visual Display of Quantitative Information* (2001), the author stresses an important concept: be as thoughtful in your presentation of data as you are in designing your experiments. For our students, PowerPoint illustrates an obvious connection between visual and verbal texts on slides (Jonassen, 1994), and makes them conscious of their multimodal communication. Students have become more comfortable with this medium over the years, so that they are not as likely to be fixated on the "bells and whistles" instead of content (Kurtzman, Lowry, Obrecht, & Childers, 1998).

All of our students inevitably turn toward visuals to support and present their original research in writing and oral presentations. We work with our students to be mindful of how they are using visuals, particularly in relation to the audience they may be addressing. In one example, students learned the importance of the dictum "know your audience" when they decided to present their work to a 6th grade class. This activity reminded them that they must consider how to communicate their written and visual lesson for a specific purpose and a real audience. One student wrote in his reflection, "I thought I was done with all the research, but in reality I had to begin again because of the challenges of presenting to the 6th graders." Interestingly, they spent most of their time pondering how visuals would be most effective in explaining their ideas. In one instance, a visual containing quantitative data was deemed inappropriate for the audience. We prompted them with the questions "What is important about this visual? What are you seeking to accomplish with it?" Our students realized that the trend in the data and the implications of that trend were of great importance. Therefore, they recast the visual for their particular audience in order to better convey the idea it represented (Tufte, 2001).

The need for clear connections using appropriate visuals to reinforce the key points in words became a top priority, but students also had difficulty gauging what their audience already knew about their topic. As a result, they designed a questionnaire to tailor their presentation to that age group. They began their work by brainstorming questions based on their own experience as 6<sup>th</sup> or 7<sup>th</sup> graders: What would they understand? What visuals would help them learn? Why should they care? Students were engaged our students were in this "thinking about thinking" (The Learning Classroom, 2003). It resulted in a level of learning that we did not anticipate. We critiqued each other's work during the process to make sure we were also meeting the class evaluation criteria ([Appendix D](#)). After all, the 6<sup>th</sup> or 7<sup>th</sup> graders would be evaluating them, too, and they were a more critical audience!

What do all of these examples have to do with teaching students at elementary, secondary, college, university, or graduate levels? First of all, the basic concepts are the same. Students who may tend to be visual learners, as well as those who are verbal learners, need to experience deeper understanding, more critical thinking, and application of knowledge through lessons that enable them to process both visually and verbally. The specific material or discipline is all that differs. That is, visuals support writing, but also writing supports visualizing in this two-directional flow. Dialogues that include both visuals and text create ownership in students' learning, which in turn produces engagement, and allows all students to improve their writing, visualizing, and critical thinking skills.

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