Artistic, Visual Thought Processes Supporting High Achievement

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Abstract

This interdisciplinary, conceptual analysis addresses the nature and benefits of artistic processes in learning and work. While recognizing various forms of artistry, the emphasis is on visual-spatial thinking. The benefits of this kind of thinking in academic and professional activities include the simplification of massively complex writing, improvement of psychological functioning, and the magnification of creative work in various professions, especially in science, technology, engineering, and mathematics (STEM) fields. Visual-spatial thinking also is a strength that often helps twice-exceptional individuals overcome their learning difficulties. Several thinking and learning strategies are explored, including visual data animation, concept cartooning, visual metaphor, and musical translation of written material. Some ways that visual-spatial thinking can help overcome the problems generated by dogmatic school reform also are scrutinized.

Keywords: Concept cartoons; dogmatism; STEM; twice exceptional; visual metaphor; visual-spatial thinking.

Artistic, visual thought processes supporting high achievement

Experiences with the arts can have very positive effects on student learning, and on the work of adult professionals. But the arts can be marginalized when dogmatic, self-appointed school "reformers" portray them as far less important than subject areas that deal with the mechanics of literacy and mathematical processes measured by narrow, superficial standardized testing (Berliner, 2009, 2011, 2012; Ravitch, 2010, 2013; Ravitch et al., 2022). Fortunately, the artistic strategies discussed in this analysis can be used to fight back against these forms of dogmatism while supporting the development of impressive talents.

Working in the arts also can improve our psychological functioning. Insights from the study of neuroaesthetics, which are derived from neuroscience and psychology, have been used to show how aesthetic appreciation controls, adjusts, and synthesizes various cognitive processes (Vessel, 2021). For example, Magsamen and Ross (2023) used the science of neuroaesthetics as a window into creativity and well-being. They illustrated how participation in the arts improves our sense of purpose and our health while enabling us to live together more effectively. In just one example from their analysis they showed how participating in an artistic project reduces stress levels and strengthens learning, memory, and other cognitive processes.

In order to explore these positive aspects of artistic work, this analysis delves into the dynamics of some artistic activities to illustrate how they strengthen memory, content learning in various subjects, the development of aspirations and talents, and the growth of a long-term sense of purpose. All of the various forms of the arts (e.g., drawing, painting, sculpture, music, dance, theater, poetry) can strengthen learning. Some processes that rely on visual thinking are emphasized in this paper. Of special interest is the process of *mode switching,* which means the translation of thoughts from one form of thinking to another (Ambrose, 2009; Cohen, 1994). For example, students who learn how to mode switch can efficiently master a large amount of academic content by turning important written ideas into symbolism in drawings or paintings they create (details available in later sections).

Literature review

Artistic, visual-spatial thinking needs to be addressed and its importance recognized because it can bring considerable benefits to students in the K-12 system and in college, as well as adults working in various fields. It can strengthen brain functioning and cognition in various ways (Bolwerk et al. 2014; Eisner, 2002; Feinstein, 1982). Impressive examples of these enhancements come from the visual "thought experiments" used by some eminent scientists (see the forthcoming depictions of scientific visualizations produced by Albert Einstein and August Kekule).

Visual thinking takes place when an individual uses mental pictures to understand written or mathematical ideas, and to do creative work with those images (see Kalbfleisch, 2013). This kind of processing is especially important for achievement in STEM fields, or more accurately STEAM fields (science, technology, engineering, *arts,* mathematics) (Anderson, 2017; Miller, 1978, 1986, 1989, 1996, 2001; Makkonen et al., 2022; McGrath & Brown, 2005; Rocke, 2010; Root-Bernstein, 2014; Root-Bernstein et al., 2008; Root-Bernstein & Root-Bernstein, 2013, 2021; Webb et al., 2007). For example, Anderson (2017) illustrates the functioning of isomorphology, which is a method of inquiry based on drawing. It enables scholars to explore and illustrate ways in which forms of animal, vegetable and mineral structures can be similar or different. In another example, Rocke (2010) shows how visual, mental images enabled scientists to come up with more accurate ways of understanding objects and phenomena that elude our senses, such as the structure and dynamics of atoms and molecules.

Similar insights emerge from literature in the history and philosophy of science. As an example, "Scientists strongly prefer the visual mode of thought in their research" (Miller, 1996, p. 281). Those with strong visual thinking abilities are "capable of moving engineering and physical science disciplines forward" (Wai et al., 2009, p. 817). Visual learning strengthens work in engineering (McGrath & Brown, 2005). It also magnifies higher-order thinking skills in biology (Milner-Bolotin & Nashon, 2012).

According to Holton (1998) imagination is an important element of scientific achievement. The ability to construct and interpret images in the mind is at the core of scientific thought experiments. When carrying out these experiments, scientists use their imagination to create and modify visualizations in their minds so they can explore and strengthen their understanding of phenomena that are difficult or even impossible to investigate through empirical inquiry. For example, in his paradigm shifting work in the field of physics Albert Einstein was able to imagine an observer attempting to catch up to a point on a wave of light to help with the development of the special theory of relativity (Miller, 1996). Another example of a thought experiment is chemist August Kekule's clarification of the structure of benzene through the use of an intuitive, dream-like vision of a snake bending to devour its own tail (Rocke, 2010).

The STEM-visual thinking connection is especially strong when it comes to outstanding mathematical ability (Dunn et al., 2020; Giaquinto, 2007; Van Garderen, 2016). Maor and Jost (2013) provide an intriguing example of this connection with an aesthetically pleasing visual history of geometry illustrating the connections between mathematics and art. O'Boyle (2008), a neuroscientist, shows how young people who are gifted in mathematics tend to rely on brain-based processes that produce powerful, visual-spatial thinking. These processes include enhanced interhemispheric communication and cooperation, and heightened brain activation that can indicate highly developed attentional and executive functions. When students benefit from these strengths, their thinking can be more impressive than that of many intelligent adults.

Visual-spatial talent also helps individuals who have great difficulty learning in school and functioning in the adult world. A significant number of gifted individuals are twice exceptional (2e) with visual thinking as their strength (Grandin, 2022; Olenchak et al., 2016; West, 2009, 2014, 2017). They combine powerful visual abilities with a weakness (e.g., ADHD, ADD, autism spectrum disorder, learning disabilities). The strength and the weakness hide each other. The strength pushes 2e individuals up toward impressive achievement while the weakness pulls them down so they end up looking average to teachers and parents who do not know much about 2e.

Recognizing and embracing the value of visual thinking also can strengthen cognitive diversity. Economist and complexity theorist Scott Page (2007, 2010, 2017) analyzed the results of many research projects on group problem solving in various kinds of organizations, and found that when dealing with complex problems, cognitively diverse teams of professionals are superior to more homogenous teams, even when the latter are of superior intelligence. A cognitively diverse team includes individuals who differ from one another in terms of their backgrounds, belief systems, theoretical perspectives, and problem-solving methods. those differences do not exist in a homogenous team. If a team in an organization does not include visual thinkers, it will be less cognitively diverse than a team that has one or a few of them. So enhancing the problem-solving abilities of government agencies, corporations, NGOs, school systems, and other organizations is another very good reason for helping young people develop their artistic, visual thinking abilities.

Visual thinking enhances learning in various subject areas in school (Yenawine, 2013). But in spite of its importance to high-level achievement, it usually has been ignored in gifted education and in general education; consequently, educators and policy makers should emphasize it in the years to come (Andersen, 2014; Kalbfleisch, 2013; Silverman, 2002). Some of this emphasis can come from explorations of various artistic processes that have been employed by skilled visual thinkers. The following sections explore some of these artistic processes and the benefits that can accrue from them.

Mode switching

Students and academic researchers can strengthen their learning and creativity when they employ processes that enable them to translate thought from one modality to another (Ambrose, 2009; Cohen, 1994; Sousanis, 2015). These thought modalities include verbal, visual, musical, and kinesthetic information processing. The translation process involves turning written material into visual images, videos, musical lyrics, or dance movements. The active switching from one thought modality to another requires considerable concentration and creative thinking. This enables the creators and their audiences to invigorate their thinking while mastering academic content and committing it to long-term memory. Some examples of mode switching processes include visual metaphor, concept cartooning, visual data animation, and musical translation (see Ambrose, 2024). The following sections include descriptions of several mode-switching strategies and their benefits.

Visual data animation

Tech-savvy individuals can combine visual thinking with technology to create visual data animations. Through this process, they translate enormous amounts of information into moving figures that burn important ideas into the long-term memory of audience members (see Rosling & Zhang, 2011). An example comes from the work of Hans Rosling, a prominent scholar of global health, who captured thousands of pages of research data in the form of expanding, shrinking, rising and falling color-coded circles that portrayed the evolution of health and wealth in 200 countries over 200 years (see BBC Four, 2011) (video at this link: https://www.youtube.com/watch?v=jbkSRLYSojo&t=157s). He created this visual data animation as far back as 2010. With technological advances in recent years the process can be even stronger. This highly creative strategy can strengthen learning because the videos are intriguing and memorable. It also can encourage citizens to work toward improving conditions in their societies because complex data about enormous, 21^{st}-century problems becomes visible and understandable.

Musical translation

Music can enhance cognitive processes. For example, it can invigorate scientific thinking (Root-Bernstein, 2001) and enhance the efficiency of learning (Berk, 2008; Restak, 2001). It also can be used as a catalyst for bolstering the production of outstanding visual art. For example, the eminent artist Vincent van Gogh incorporated music in the production of his paintings (Veldhorst, 2018). Those with musical talents and inclinations can translate large amounts of academic material into songs. The wording in the songs conveys the essence of the academic material in highly memorable ways. Those who create these songs benefit from the memory enhancing translation process because they can play the songs within their minds during exams and in the writing of academic works. One example is a musical portrayal of the tension and conflict between two great inventors, Thomas Edison and Nicola Tesla (see ERB, 2013) (video at this link:
https://www.youtube.com/watch?v=gJ1Mz7kGVf0).

Throughout their musical performance the creative individuals representing Edison and Tesla, humorously and skillfully insult one another through the song while dancing around. They insult each other because Tesla worked for Edison for a while and then they ended up in a bitter rivalry (Cawthorn, 2016; Martin & Birnes, 2017). The entertaining video performance makes the academic content translation stick in long-term memory.

Concept cartoons

An amusing, enjoyable artistic communication and learning process involves the creation of cartoon-like drawings or paintings that can strengthen learning, especially in STEM (Naylor & Keogh, 2000). Concept cartoons can capture and convey important academic ideas in humorous, ironic, satirical form. Students with some artistic talent can gain inspiration from the opportunity to use their visual thinking to illustrate their mastery of complex ideas in entertaining ways. To create concept cartoons, participants ponder the nature of the academic ideas they are trying to capture and then come up with various ways to turn those ideas into images. Then they draw or paint those images and make some notes about what the symbolism represents.

In one example, the author of this article studied the unethical actions that often emerge from billionaire-supported ideological think tanks that have the purpose of shifting the minds of the public away from the needs and wants of most citizens toward the political positions favored by the selfish funders. While some think tanks are designed for ethical purposes most are not (Roper et al., 2016; Welner et al., 2010; Wilson & Kamol, 2021), so the author decided to counteract them through the use of concept cartooning. Then he created some drawings of cartoon characters eventually settling on one idea – a fish-man hybrid, Gil Flounderfib, who works in an ideological think tank. Figure 1 shows Mr. Flounderfib and explains the corrupt work he does.

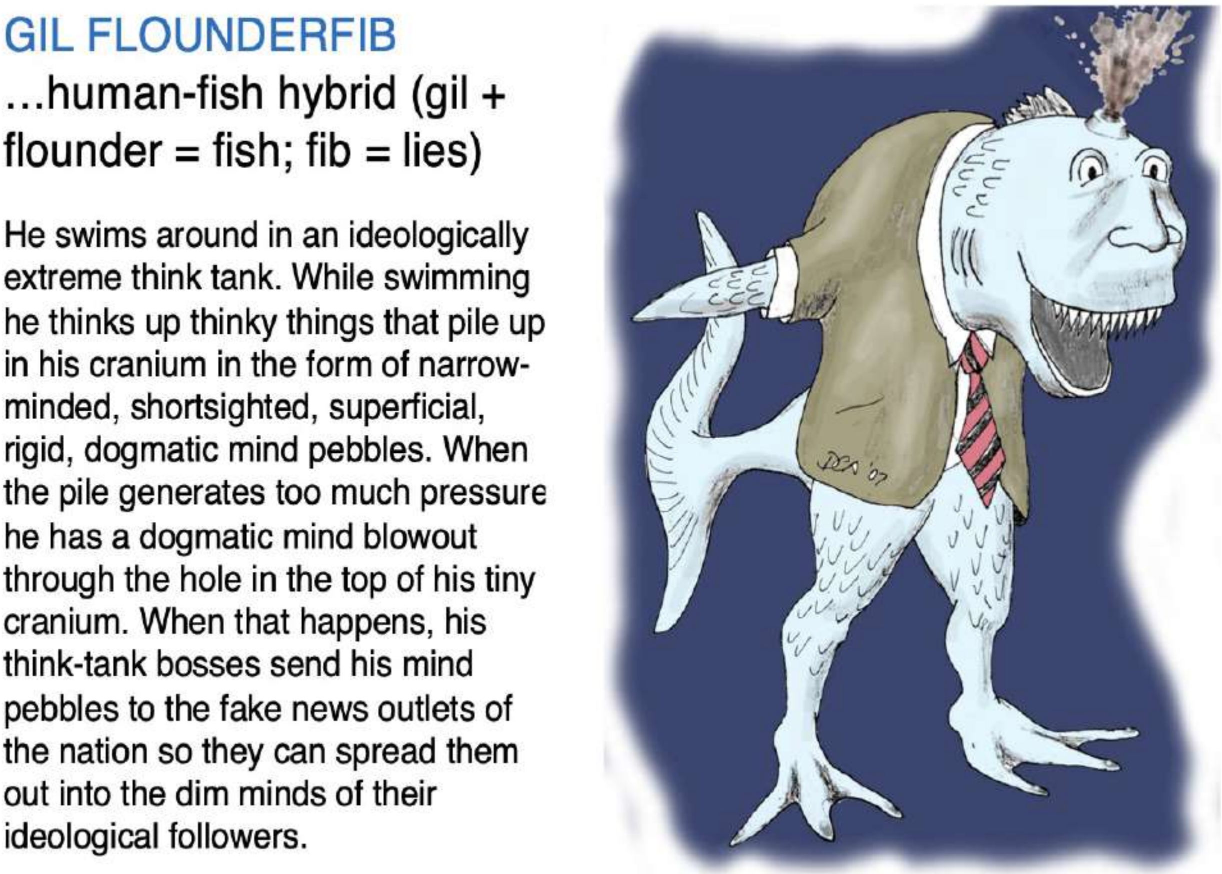

Figure 1: A concept cartoon illustrating the dogmatic thoughts and actions of professional ideologues who work in think tanks. (from Ambrose, 2009a)

Visual metaphor

Awareness of a very powerful visual thinking strategy emerged from the work of developmental psychologist Howard Gruber (1974, 1978, 1989; Gruber & Wallace, 2001). He studied the products of high achievers who accomplished impressive work, often in STEM fields. For example, he found that Charles Darwin used creative metaphorical images to simplify the complexities of phenomena he was exploring. These metaphorical "images of wide scope" (IOWS) creatively captured the essence of large amounts of complex ideas and data so they could be understood and used for research purposes and to facilitate innovation.

Hoffmann (2006, 2018), a Nobel laureate chemist, reinforced the importance of metaphorical imagery as a tool that scientists use to make their discoveries. In one example he metaphorically clarifies the way in which the greenhouse gas carbon dioxide (CO_2) molecules heat the rest of the atmosphere when we think of the molecule acting as a gym rat exercising and periodically kicking an approaching O_2 dumbbell. Another is a landscape metaphor of climbing up and over a hill to represent the energy involved in a chemical reaction.

A few scholars have used IOWS to support their work and convey their discoveries. For example, Siler (1990, 1997, 2011; also see Ambrose, 2023), an interdisciplinary scholar and artist, has captured complex scientific, technological phenomena in metaphorical illustrations. IOWS also have being used for simplifying and conveying the complexities embedded in the applications of scientific research to organizational leadership (Ambrose, 1995), the convolutions of the dogmatism embedded in school reform (Ambrose, 1996, 2017), and the intricacies of strategic planning (Ambrose, 1998). To elaborate on this, figure 2 illustrates how a visual metaphor captures the essence of the dogmatic school reform movements. There are a number of metaphors within the visual metaphor that help illustrate how the various forms of dogmatic thought and action actually work against success in education. Here are just a few of them. Students sit passively on an assembly line. Achieving success in life is portrayed as finding one's way through a complex maze. Teaching is shown as pouring rather meaningless information bits into a student's cranium.

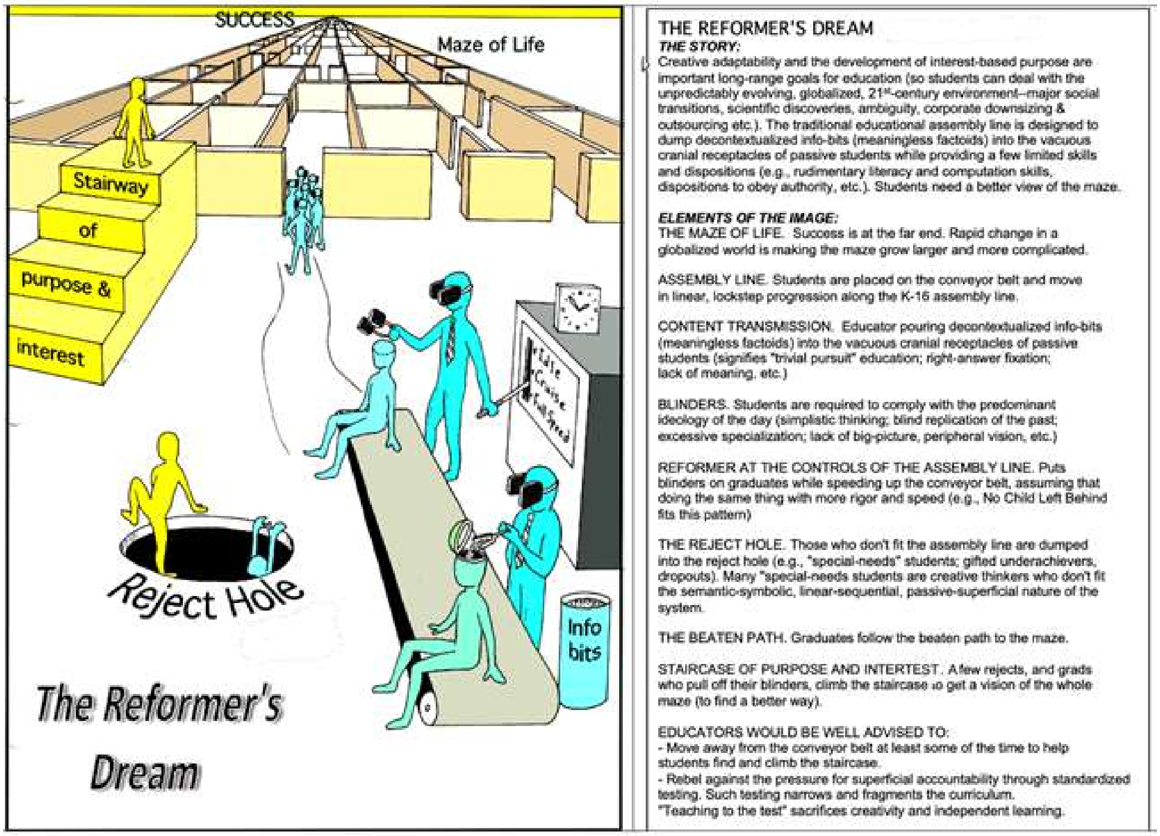

Figure 2: A Visual metaphor illustrating the complexity and dynamics of dogmatic school reform initiatives. (from Ambrose, 2024a)

The creative IOWS instructional and learning process is similar to concept cartooning, but it is much more complex because it enables participants to capture and synthesize huge amounts of written academic material in the form of metaphorical paintings or drawings (Ambrose, 1992, 2009, 2024; Cohen, 1994). When individuals create visual metaphors they strengthen their long-term memory of the academic material because the intriguing symbols in the images are difficult to forget. The process of coming up with the symbolism representing written concepts, and actually drawing or painting the images, is memory enhancing.

The fascinating nature of some visual metaphors also makes them useful for conveying complex ideas to audiences. It's difficult for most members of various societies to understand highly complex 21st-century phenomena. Examples of these phenomena, which are drawn from Ambrose and Sternberg (2016), Sternberg and Ambrose (2021), and Sternberg, Ambrose and Karami (2022) include the advancement of STEM discoveries through global scientific networking; the massive destruction caused by climate change, looming resource shortages, and the erosion of democracies around the world, among others. But the visual metaphorical renderings can simplify them. For this reason, the images have high potential for making citizens more aware of huge problems and opportunities, and more willing to deal with them effectively (Ambrose, 2009b). Here are a few examples of visual images that could serve as thought experiments for entire populations in problem-plagued societies. The undermining of democracy due to extreme political polarization might appear in a drawing as an …

> expedition diverging onto separate trails, acrimoniously dividing their resources in hostile terrain… corruption as expedition members stealing valuable supplies, environmental degradation as lightly snowed over chasms in a glacier the team is crossing, ideological extremism as a dense epistemic fog that inhibits vision of the terrain ahead. (Ambrose, 2009b, p. 68)

Another depiction of the nature and complexity of visual metaphor shows up in figure 3, which is a portrayal of research and theoretical work in academia. The surface of the hollow, translucent globe in the image represents the entire landscape of all academic fields. The small creatures sticking to its surface, or crawling on it, are the theorists and researchers in various fields. For example, the field of gifted education would show up as a patch of patterns on one part of the globe with other nearby patches representing closely aligned fields, such as psychology and cognitive neuroscience. Other fields such as chemistry, economics, and social epidemiology are farther away because they are less related to gifted education. The bullet-point description on the left side of the IOWS provides a very brief overview of some of the concepts embedded in the image.

Here is some elaboration on this visual metaphor. The sphere shows how objective rationality (the atmosphere above the surface) relies heavily on intuitive insights derived from lightning bolts from the subconscious (the depths of the inner realm within the globe). The highest achieving scholars are the creatively intelligent giants who stretch deep into the intuitive core of the sphere to derive impressive intuitive power from creative syntheses of enormous amounts of information they have collected over the years. They also reach high into the objective-rational realm represented by the four layers shown in the atmosphere surrounding the sphere. This enables them to connect ideas from the ground-level troposphere layer where practical work takes place in the field, up into the research stratosphere where empirical investigation prevails, and higher yet into the theoretical mesosphere. Finally, they stretch all the way up into the philosophical exosphere where philosophical frameworks drift around near outer space. This aspect of the visual metaphor illustrates how important it is to connect theoretical and philosophical perspectives with research and practice so practical work can be done more effectively.

The smallest amoeba-like creatures that are stuck on the surface in particular locations, derive their limited energy from the frost patterns, which represent the growing, evolving knowledge base of various academic fields. These creatures stand in one place because they lack the vision and power to move around on the surface. The ground creepers are moderately successful scholars who have developed limited reputations by stretching themselves in a single direction along narrow, dogmatic valleys where they can hide from the impact of other perspectives in their fields (the freezing zeitgeist winds). In order for a field to avoid becoming bound up in dogmatism it needs a few creatively intelligent giants who can holistically perceive the patterns in their fields while envisioning new territories for exploration.

Figure 3: A Visual metaphor showing the nature and dynamics of academic research and theory development. (from Ambrose, 2024a)

The complete description of this IOWS is many pages long and cannot fit into this manuscript. The more complex description connects the image with thousands of pages of research and theory. This IOWS is one of many included in a volume on visual metaphor (see Ambrose, 2024a).

Concluding thoughts

Visual thinking, especially data visualizations, IOWS, and concept cartoons, can invigorate learning while also making the world a better place in the 21st-century. Individuals and groups can use these imaginative thought processes to make people aware of 21st-century problems so they can work to fix them (see Börner, 2021; Lynford, 2022). For example, a visual metaphor in the focus chapter of volume illustrating the enormous problems and opportunities that have emerged in the early 21st century shows a wave of globalization coming toward us with "macro-opportunities" on the top of the wave and "macroproblems" on the underside (Ambrose & Sternberg, 2016). This wave shows readers that we have to do a better job of developing 21st-century skills so we can make a leap to the crest of the wave where unprecedented success resides. If we can't do that we will be crushed by the macroproblems on the underside of the wave and our lives will be poor, nasty, brutish, and short. Those who gain understanding of 21st-century conditions from this visual metaphor will be inclined to work harder on the development of 21st-century skills and knowledge.

Educators and policy makers need to pay more attention to the high potential of visual thinking in educational processes. Metaphors and analogies are powerful tools for teaching most content in any subject area (Wormeli, 2009). For example, yet another visual metaphor portrays humanity as a large group walking backward on a path through the 20th century landscape toward a cliff where they will destroy themselves if they don't gain forward-looking vision of the 21st-century (Ambrose, 2024). This visual metaphor is based on scholarship in history, sociology, and political science. This magnifies the importance of IOWS, because they emerge from the use of metaphorical thinking. Integration of the arts with other subject areas can strengthen understanding of complex concepts and make connections between diverse ideas (Goldberg, 2021).

Ten of 57 creative and critical thinking strategies in a forthcoming volume can strengthen visual thinking (Ambrose, 2024b). Three of them (concept cartoons, visual metaphors, and visual data animation) are discussed in this article. Among other purposes, some of the other strategies can enable powerful memory enhancement, imaginative story development, and elaborate outlines of thoughts pertaining to complex phenomena.

Rather than relying so heavily on the assessments of verbal and computational abilities through standardized testing, educators can strengthen those abilities while expanding the functioning of students' imaginations through the use of visual thought processes, as well as other artistic capacities. Doing this could enhance motivation for most students while also making it more likely that the next Temple Grandin and Albert Einstein will discover and develop their impressive hidden abilities.

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About the Author

Don Ambrose is professor of graduate studies at Rider University and editor of the Roeper Review, an international research journal serving the fields of gifted education and creativity studies. He serves on the editorial boards of major journals in creative intelligence fields and for several book series. Don has initiated and led numerous interdisciplinary scholarly projects involving eminent researchers and theorists from various fields including gifted education, general education, creativity studies, cognitive science, ethical philosophy, psychology, political science, economics, law, history, sociology, architecture, theoretical physics, and critical thinking. Examples of topics addressed by the many books he has published include interdisciplinary explorations of creative intelligence; the moral-ethical dimensions of giftedness; 21st-century globalization and its effects on creative intelligence; innovative, holistic education for the gifted; applications of complexity theory to high ability, transformational giftedness; and panoramic overviews of the gifted education field. Honors include the Mensa Lifetime Achievement award, Distinguished Scholar award from the National Association for Gifted Children (NAGC); Hall of Fame award from the New Jersey Association for Gifted Children; Creativity Award from the International Center for Innovation in Education; selection to the Routledge/Taylor & Francis Educational Expert Panel; Outstanding Book Chapter award from the American Creativity Association; the Research Briefs article of the year award from the Research and Evaluation Division of the NAGC; the Iorio Research Prize for outstanding scholarship; and the Frank N. Elliott Award for outstanding university service. Don has done invited keynote presentations throughout the world. Projects currently under construction include the invention of new creative and critical thinking strategies based on constructs derived from various academic disciplines.

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