The Power of Story

Based on the science results in the 1996 and 2000 National Assessment of Educational Progress (NAEP), it seems that little has changed in the past several years. While fourth-graders' scores held steady, slightly more eighth-graders reached the proficient level and slightly fewer 12th-graders reached the basic level. If science is indeed a national priority, we must think carefully about how to improve. According to George D. Nelson of the American Association for the Advancement of Science, a critical—yet often overlooked—component of science courses is a conscious effort to tie students' "knowledge into a coherent picture of how the world works and how we have come to know it."

One of today's great scientists, Edward Wilson, agrees. Wilson proposes teaching science through the power of story. As Wilson explains in this first article, the universal love of stories is not a coincidence; our brains function by constructing narratives. Adults and children alike live, learn, and relate to others through stories. Unlike other forms of writing, stories engage our emotions and imagination in the process of learning. "The story," according to educational theory professor Kieran Egan, "not only conveys information and describes events and actions, but it also engages our emotions. 'Story' does not necessarily imply a fictional narrative; rather, it involves the narrative shaping of any content."

In "The Story of the Atom," which follows this article, writer Joy Hakim catches us up in the scientific detective work that eventually convinces the world that the atom exists. Unlike the science texts that we labored over in school, this story drew us in, carried us through difficult concepts, and left us with a whole new understanding of the atom. In other words, we learned a lot!

Paired with experiments and other materials, the stories of science offer an engaging, coherent anchor for our science courses. They also reveal a fascinating aspect of scientific discoveries that is often missed by non-scientists. According to Hakim, "The great scientists always seem to have a sense of story. They are looking for patterns, for connecting links between theories, and those who achieve are those who take the imaginative leaps, combining experimental data with ideas, finding nature's story."

—EDITORS

By Edward O. Wilson

Let me tell you a story. It is about two ants. In the early 1960s, when I was a young professor of zoology at Harvard University, one of the vexing mysteries of evolution was the origin of ants. Ants are the most abundant of insects, the most effective predators of other insects, and the busiest scavengers of small dead animals. They transport the seeds of thousands of plant species, and they turn and enrich more soil than earthworms. In totality (they number roughly in the million billions and weigh about as much as all of humanity), they are among the key players of Earth's terrestrial environment. Of equal general interest, they have attained their dominion by means of the most advanced social organization known among animals. I had chosen these insects for the focus of my research. It was the culmination of a fascination that dated back to childhood. Now, I spent a

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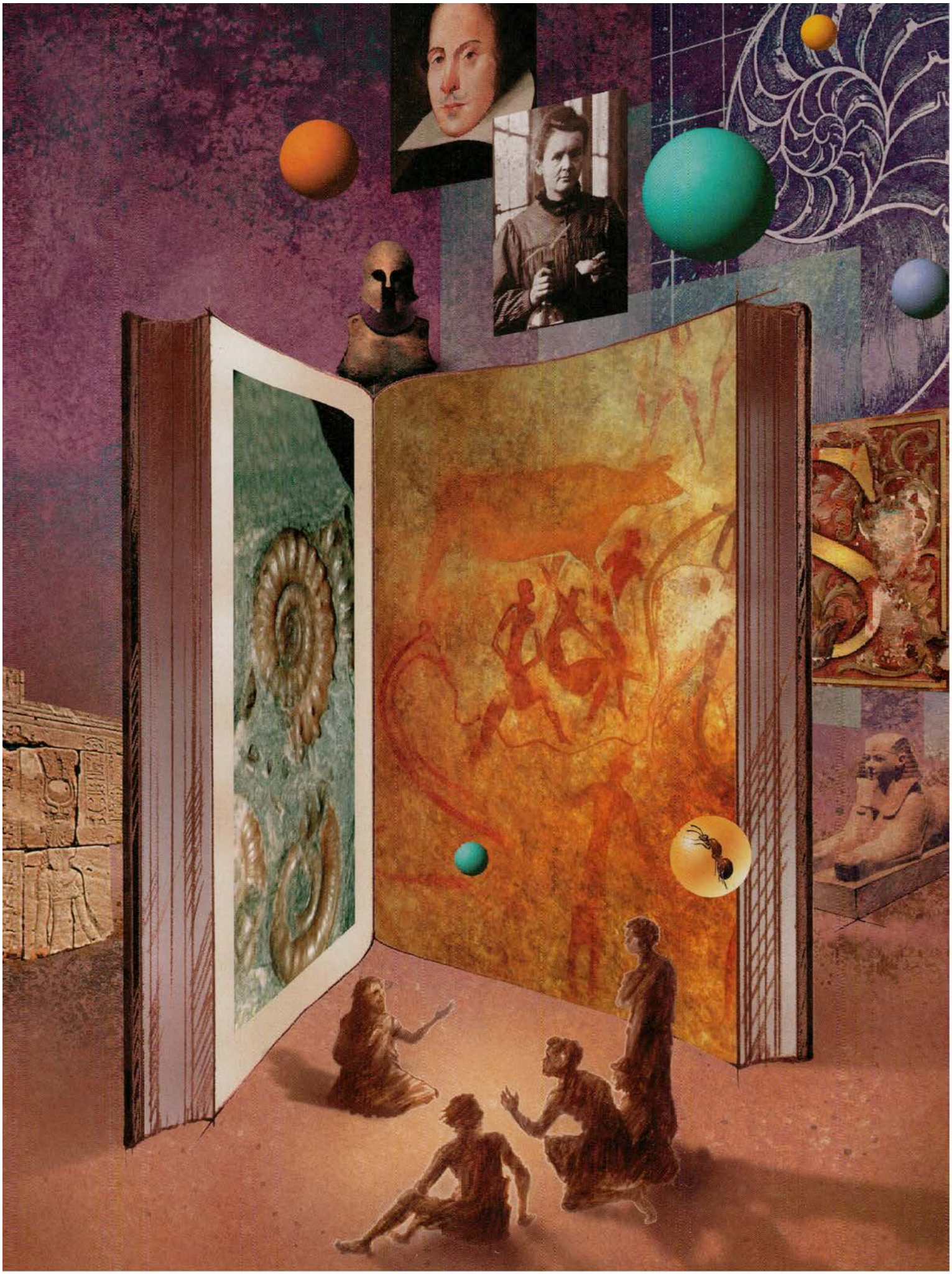

lot of time thinking about how they came to be.

At first, the problem seemed insoluble because the oldest known ants, found in fossil deposits up to 57 million years old, were already advanced anatomically. In fact, they were quite similar to the modern forms all around us. And just as today, these ancient ants were among the most diverse and abundant of insects. It was as though an opaque curtain had been lowered to block our view of everything that occurred before. All we had to work with was the tail end of evolution. I was afraid I would never see a real "Ur-species" (primitive ant) in my lifetime.

Then, as so often happens in science, a chance event changed everything. One Sunday morning in 1967, a middle-aged couple, Mr. and Mrs. Edmund Frey, were strolling along the base of the seaside bluffs at Cliffwood Beach, N.J., collecting bits of amber. In one lump they rescued, clear as yellow glass, were two beautifully preserved ants.

The Freys were willing to share their find, and soon the two specimens found their way to me for examination. There they came close to disaster. As I nervously fumbled the amber piece out of its mailing box, I dropped it to the floor, where it broke into two halves. Luck stayed with me, however. The break was as clean as though made by a jeweler, and each piece contained an undamaged specimen. Within minutes, I determined that the ants were the long-sought Holy Grail of ant paleontology, or at least very close to it. They were more primitive than all other known ants, living and fossil. Moreover, in a dramatic confirmation of evolution as a predictive theory, they possessed most of the intermediate traits that according to our earlier deductions should connect modern ants to the nonsocial wasps.

Science consists of millions of stories like the finding of New Jersey's dawn ants. These accounts—some electrifying, most pedestrian—become science when they can be tested and woven into cause-and-effect explanations to become part of humanity's material worldview. But they also constitute a fascinating narrative, which can be the key to helping the non-scientist understand the great ideas of science.

We all live by narrative, every day and every minute of our lives. Narrative is the human way of working through a chaotic and unforgiving world. The narrative genius of *Homo sapiens* is an accommodation to the inherent inability of the three pounds of our sensory system and brain to process more than a minute fraction of the information the environment pours into them. In order to keep the organism alive, that fraction must be intensely and accurately selective. The stories we tell ourselves and others are our survival manuals.

As two leading researchers in social cognition have said, "Storytelling is not something we just happen to do. It is something we virtually have to do if we want to remember anything at all." Over the past three decades, cognitive psychology has emerged as a promising arena for understanding how we perceive, remember, and feel about the world around us. Researchers have learned that stories—both the ones stored in our memories and those we generate as we interact with the world—are essential to each of these aspects of learning. Facts presented in stories, as opposed to lists, are much easier to remember. Likewise, facts that stir up intense emotions are quickly and easily stored in our brains (think, for example, how easily your students remember what happened in Hiroshima), and well-told stories are a great way to tie emotions to facts. Researchers have also demonstrated that the common marks of good storytelling—metaphors and analogies that draw the audience in—work because they allow the audience to tie the story to previous knowledge and experience.

With new tools and models, neuroscientists have joined cognitive psychologists in drawing closer to an understanding of the conscious mind as a narrative generator. Working on the same questions from different perspectives, neuroscientists, cognitive psychologists, and even evolutionary biologists are converging on a common theory of the brain: It develops stories to filter and make sense of the flood of information that we are exposed to every day. Working at a frantic pace, the brain summons memories—past stories—to help screen and organize the incoming chaos into narrative fragments. Only a tiny fraction of these are then selected for higher-order processing in the prefrontal cortex. That fraction constitutes the theater of running symbolic imagery we call the conscious mind. The brain is also engaged in a continuous cycle of folding new fragments of the story into one's memory while letting others go (forgetting). Across generations, the most important among these fragments are communicated widely and converted into history, literature, and the oral tradition.

In contrast, the scientific method is not natural to the human mind. The phenomena it explicates are by and large unfamiliar to ordinary experience. New scientific facts and workable theories, the silver and gold of the scientific enterprise, come slow and hard, less like nuggets lying on a streambed than ore dug from mines. To enjoy them while maintaining an effective critical attitude requires mental discipline.

The reason, again, is the innate constraints of the human brain. Gossip and music flow easily through the human mind because the brain is genetically predisposed to receive them. Theirs is a Paleolithic cogency. Calculus and reagent chemistry, in contrast, come hard, like ballet on pointe. They became relevant only in modern, postevolutionary times. Of the hundreds of fellow scientists I have known for more than 50 years, from graduate students to Nobelists, all generally prefer at random moments of their lives to listen to gossip and music rather than to scientific lectures. Trust me: Physics is hard even for physicists.

So, how can we make science human and enjoyable without betraying its nature? The answer lies in humans' innate capacity to understand narrative. Consider the case of science writing. Along with Burkhard Bilger, I edited *The Best American Science and Nature Writing, 2001*. How did the authors succeed in conveying complicated, essential science to a broad audience? By two means: They present the phenomena as a narrative, whether historical, evolutionary, or phenomenological, and they treat the scientists as protagonists in a story that contains, at least in muted form, the mythic elements of challenge and triumph.

To wring honest journalism and literature from honest sci-

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ence, the writer must overcome formidable difficulties. First is the immensity and exponential growth of primary material itself, which, for more than 300 years, has experienced a phenomenally short doubling time of 15 years. Science has spread its reach into every conceivable aspect of material existence, from the origin of the universe to the creative process of the mind itself. Its relentless pursuit of detail and theory long ago outstripped the minds of individual scientists themselves to hold it. So fragmented are the disciplines and specialized the language resulting from the growth that experts in one subject often cannot grasp the technical reports of experts in closely similar specialties. Insect neuroendocrinologists, for example, have a hard time understanding mammalian neuroendocrinologists, and the reverse.

A second obstacle to converting science into literature is the standard format of research reportage in the technical journals. Scientific results are by necessity couched in specialized language, trimmed for brevity and delivered raw. Metaphor is unwelcome except in small doses.

In pure literature, metaphor and personal style are, in polar contrast, everything. The creative writer, unlike the scientist, seeks channels of cognitional and emotional expression already deeply carved by instinct and culture. Imagery, phrasing, and analogy in pure literature are not crafted to report empirical facts. They are instead the vehicles by which the writer transfers his own feelings directly into the minds of his readers in order to evoke the same emotional response. Originality and power of metaphor, not new facts and theory, are coins of the realm in creative writing. Metaphor in the best writing strikes the mind in an idiosyncratic manner: Its effect ripples out in a hypertext of culture-bound meaning, yet it triggers emotions that transcend culture.

To illustrate the difference, I've contrived the following imaginary examples of the two forms of writing applied to the same subject—the search for life in a deep cave:

> SCIENCE: The central shaft of the cavern descends from the vegetated rim to the oblique slope of fallen rock at the bottom, reaching a maximum depth of 86 meters before giving way to a lateral channel. On the floor of this latter passageway we found a small assemblage of troglobitic invertebrates, including two previously undescribed eyeless species of the carabid subfamily *embidini* (see also Harrison, in press).

> LETTERS: After an hour's rappel through the Hadean darkness we at last reached the floor of the shaft almost 300 feet below the fern-lined rim. From there we worked our way downward across a screelike rubble at the very bottom. Our headlamps picked out the lateral cavern exactly where Romer's 1926 map claimed it to be. Rick pushed ahead and within minutes shouted back that he had found blind, white cave inhabitants. When we caught up, he pointed to scurrying insects he said were springtails and, to round out the day, at least two species of ground beetles new to science.

Because science, told as a story, can intrigue and inform the non-scientific minds among us, it has the potential to bridge the two cultures into which civilization is split—the sciences and the humanities. For educators, stories are an exciting way to draw young minds into the scientific culture. One way of teaching science, which I adopted during 40 years of teaching at Harvard, is to begin with the big topics that mean something immediate and important to students. These are the same topics that great works of literature and philosophy attempt to address. For example: What is life? What's the meaning of life? In the case of Joy Hakim's story of the atom that follows, what's our world made of? How do we find out? And so on. Once you've got the attention of the audience, then you break the big questions down into stories, little dramas, that expose the trial and error process of science and the ideas that animate and move it forward.

Most educated people who are not professionals in the field do not understand science and technology, despite the profound effect of these juggernauts of modernity on every aspect of their lives. Symmetrically, most scientists are semiliterate journeymen with respect to the humanities. They are thus correspondingly removed from the heart and spirit of our species. This split is a huge problem. It is, if you will permit a scientist a strong narrative-laden metaphor, the central challenge of education in the 21st century. □