

Creating a Sense of Wonder in Chemistry

David Mitchell

The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. He to whom this emotion is a stranger, who can no longer pause to WONDER and stand rapt in awe, is as good as dead: his eyes are closed....To know that what is impenetrable to us really exists, manifesting itself as the highest wisdom and the most radiant beauty which our dull faculties can comprehend only in their most primitive forms-this knowledge, this feeling, is at the center of true religiousness.

- Albert Einstein

Wonder is an experience which blossoms in the soul when one is suddenly surprised and amazed by the attentive consideration of something rare, astonishing, and extraordinary. When we feel wonder we feel enlivened through our own vitality and feel a direct connection with an archetypal spark in the Universe. Wonder is the seed of knowledge.

The ancient Greek civilization knew its educational aims. The foundation for all learning was wonder—otherwise there would be no impulse to explore. In the early years of a child's education, poetry, music and movement were developed so that in more mature years there would be an understanding for mathematics and philosophy. To guide the social life, the religious leaders gave moral instruction through the great dramas written by Euripides, Aeschylus, and Sophocles.

The seventeenth-century mathematician and philosopher René Descartes considered wonder a universal human experience. To him the importance of wonder was intellectual rather than religious.¹ Wonder compelled people to study objects until they became familiar and understandable. For this reason, wonder was an important feeling to be attained by scientists who were observing natural phenomena.

Robert Boyle, the British chemist and physicist, for example, decided to observe natural and artificial phosphors; he included in his study not only exotic stones and precious diamonds, but also less elegant substances such as putrefying meat and fish, and even a distillate from human urine. Late one night his servant discovered a rotting veal shank in the larder that was glowing green; he summoned Boyle who worked through the night recording the color and intensity of the light emitting from each part of the meat. Boyle was energized with wonder at the phenomena he was recording. Many scientific discoveries during this time were made based on wonder and careful observation.

During the eighteenth century, social and religious changes turned wonder into the hallmark of the unsophisticated and credulous. Wonder was discarded as the frivolous activity promoted by magicians. The appreciation of wonder as the foundation of scientific inquiry ended. Intellectuals became infuriated when undiscerning priests, medical quacks, and political revolutionaries invoked natural wonders like comets and meteor showers as signs of divine intervention. Wonder began to be associated with ignorance and bad taste, and the intelligentsia became more and more materialistic their thinking.

We are now at a turning point. There was a historical necessity for thinking to pass through the stage of materialism. The nadir has been reached, and some of the symptoms are apathy and incidences of violence in our schools. The quality of empathy is in the process of being snuffed out like a candle flame, and this leads to apathy, or indifference, which is the archenemy of education. The antidote for apathy is the cultivation of empathy and gratitude while allowing students to experience the wonder within the natural world. Gratitude focuses one outwardly. Ingratitude causes estrangement; it cuts one off from the world. The new millennium is desperate for novel ideas about the teaching of science; the souls of youth ask to be kindled with creative passion.

Gratitude is an internal disposition to see the wonder of the world about us, to recognize good things as bounty bestowed, and to delight in the beauty and goodness of things given. Empathy allows an individual to merge with others experiencing their experiences and founding new community. Gratitude is both a spur to learning and by-product of it. The intellectual journey begins exactly where the virtue of gratitude begins—in wonder: wonder at the unknown, awe-filled appreciation of the mysteries that surround us. The preschooler asks, "Why do flowers have colors? Why is the sky blue?" The older student wonders, "How is it that music lifts my heart and spirit? Why does a painting touch me to the inner core of my being?" Teachers need to fan this spark of "wonder" by providing the students with knowledge. The students need to engage in a participatory science. Discovering concepts does not extinguish wonder but rather fuels it, intensifies it, and elevates it to a new level.

Teachers need to inspire students with biographies of men and women who saw life as a gift and who struggled through adversity to achieve their goals. We need to share stories about individuals who have come from little but have accomplished much. We need to relate about those who came from plenitude and yet felt the need to give to others. We should stress the works and lives of those who have chosen to give back to humanity—to be faithful stewards of the earth and of their fellow human beings.

We must move away from materialistic fixed models and create living, inner pictures that can sustain the students through life. For example, in astronomy we might ask the students how many stars they think they can see from a hill on a dark night. After collecting their answers we might then ask them how many grains of sand they have in their hand when they scoop a handful from the beach. They may be surprised when they learn that it is ten thousand grains. That is also approximately the number of stars they can see with their naked eye on a dark night; yet there are as many stars in the heavens as there are grains of sand on the earth.

Or we might borrow an example from a book entitled *Earthsearch* by John Cassidy.² He instructs us to find a large open space and place a soccer ball in the center to represent the sun. He then directs us to walk 10 paces in a straight line, stick a common pin in the ground. The head of the pin stands for the planet Mercury. Then take another 9 paces beyond Mercury and put down a peppercorn to represent Venus. Step 7 more paces and drop another peppercorn for Earth. One inch away from Earth, another pinhead represents the Moon. Take 14 more paces and place a peppercorn for Mars, then 95 paces to Jupiter, and place a ping-pong ball. Take 112 paces further and place a marble to represent Saturn.

He then inquires, "How far would you have to walk to reach the nearest star, Proxima Centauri?" He instructs you to pick up another soccer ball to represent it and set off for a walk of 4,200 miles. As for the nearest other galaxy, Andromeda, he suggests, don't even consider it!

These two exercises become part of one forever. They create a lasting image in the soul and open you to the enormity of life. They invoke wonder.

Science teaching needs to utilize new techniques based on the old wisdom. This requires a combination of kindling the sparks of imagination, quieting the soul so the inspiration can be heard, and presenting intellectual material so that intuitive truths can be experienced. When we do this we attend to both content and character. We help students move from apathy to wonder, from wonder to knowing, and from knowing to gratitude.

This article is an excerpt from David Mitchell's latest book, The Wonders of Waldorf Chemistry, which was recently published by the Association of Waldorf Schools of North America

¹See *Wonder, the Rainbow and the Aesthetics of Rare Experiences*, by Philip Fisher, Cambridge, MA: Harvard University Press, 1999.

² See *Earthsearch* by John Cassidy, Palo Alto, CA: Klutz Inc., 1994

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In 1998 David Mitchell was awarded AMGEN Corporation's Teacher of the Year award. He currently works full-time for the Association of Waldorf Schools of North America as Chairman of Publications, and he is a member of AWSNA's leadership committee.