# Bucky Fuller, Behavior Analysis in Education and Things We Think We Know Which Aren't So

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Many of us, as Behavior Analysts, have been involved in the delivery of superior educational technology. Whether the particular approach be Direct Instruction, Opportunity to Respond, Precision Teaching, combinations of the above, or a general Behavior Analysis model, we can and have produced measurably superior instruction compared to much of traditional education. As delivery system specialists, however, we sometimes overlook the more comprehensive question: What should we teach?

## Six Sample Problems

Some answers seem relatively simple. We should teach our children attitudes of science and principles of Universe. Empiricism. Parsimony. Where does the sun rise and set? From what direction does a northwest wind blow? What directions constitute the three dimensions of space? How does one figure the value of pi? What regular geometrical solid with six square sides provides the basis for volumetric measure throughout science and everyday use? What's the simplest way to say "three to the second power"?

## Six Faulty Answers

What makes the problem more complex? We have uncritically accepted faulty assumptions underlying space and structure, as sampled by the questions listed above. Things we think we know aren't really so. We think they're so because we haven't challenged the assumptions. The following answers typify the process: The sun rises in the East and sets in the West. A northwest wind blows from the Northwest. Up-down, left-right, and front-back constitute the three dimensions of space. Pi equals the circumference of a sphere divided by its diameter. The solid with six square sides is a cube. The simplest way to say "three to the second power" is "three squared." Within each of these answers lay faulty assumptions that weaken our chances to interpret the integrity of Universe.

## Enter Bucky Fuller

The individual sensitive to faulty assumptions in the above problems, R. Buckminster Fuller (1895-1983), never called himself a behavior analyst. Instead, he used the term "comprehensive anticipatory design scientist." Fuller's accomplishments included the geodesic dome, the Dymaxion Car, Dymaxion House, Dymaxion Map, World Game, and octet truss. All his accomplishments used principles of nature reassociated for a specific purpose. He believed that reforming the environment would be easier than trying to reform human behaviors (Fuller, 1992). He also coined he term "Spaceship Earth" and elaborated the principles of tensegrity and synergetic geometry. People around the world lauded Fuller's efforts, prompting the comment over a decade ago (Wilson, 1982) that Fuller had become "as widely respected and loved internationally as Leonardo, Beethoven or Santa Claus."

## Empiricism, Parsimony and Reification

Empiricism and parsimony represent two crucial attitudes of science (Whaley and Surratt, 1968). Using an empirical approach, one tries to observe and experiment, deriving knowledge from experience in Universe, rather than relying solely on intuitive behavior (Johnston & Pennypacker, 1980). With a parsimonious approach, one seeks the simplest explanations possible that fit the data of Nature. Reification, on the other hand, involves the creation of abstractions that can be mistakenly conceived as real, but which do not have referents in Universe (Malott & Whaley, 1976). Some reifications can be quite subtle.

## Fuller the Empiricist

From his earliest days in school, Fuller found it difficult accepting the geometrical axioms that his teachers taught and that mathematicians assumed. By age 32 in 1927, he decided to live out life as an experiment, trying to find out only by experience what worked and what didn't. "...I developed a system of question asking in which I ruled that I must always answer the questions from experience" (Applewhite, 1986, p.704).

### Fuller the Parsimonious

Parsimony, to Fuller, represented an underlying fundamental design principle of Universe. He found it difficult to imagine Nature calculating the value of pi to produce each of the millions of bubbles when water cascaded over rocks. "Nature does not employ such uneconomical means in her design strategies, only twentieth-century scientists and high school math departments. Nature does not use unresolvable numbers in her designs (Fuller, 1992, pg. 192)."

### Spaceship Earth and the Sun

Where does the sun rise and set? We make the assumption that it does rise and set when we use that particular faulty terminology. Almost all of us know better. We realize that the earth spins on its axis as it revolves around the sun, while both travel through space. Our language seems stuck in prescientific habits. Why not use terms that describe the situations more precisely? Fuller suggested "sunsight" and "sunclipse" as possible replacements to allow a better correspondence between language and physical reality (Fuller, 1981).

### Wind Moves by Suction

From what direction does a northwest wind blow? Wind doesn't move by being blown. Fuller explains "When the wind is said to be blowing from the northwest, it is in fact being tensionally drawn by a low-pressure center southeast of the observer. If you think you are bravely facing into the wind, you are in fact looking in exactly the opposite direction of the causative event (Fuller, 1992, p.105).

### The Four Dimensions of Space

What directions constitute the three dimensions of space? Fuller's empirical parsimony trek led him to search for Nature's coordinate system, and what he found did not coincide with the right-angled three-dimensional model. Our three-dimensioned orientation seems to have originated in days when humans believed earth to be flat. The obvious directions to segment space went up-down, left-right, and front-back. Mathematicians locked in ninety degrees as the natural angle, and this perpendicular orientation constrained space to three dimensions. When Fuller looked empirically at how Nature worked, he found that one can describe four dimensions simply if one avoids the perpendicular angle trap (Edmundson, 1987). The tetrahedron, for example, with a pattern of four triangular faces, four corners and six edges—provides one alternative. Each of the four faces lies in the plane of one of the four dimensions.

### Nature Doesn't Use Pi

How does one figure the value of pi? Fuller questioned the parsimony of irrational, unresolved numbers. Empirically they do not show up in chemical combinations of atoms and molecules. Nature associates in simple, whole rational numbers: $H_2O$, not $H_\pi O$. He therefore chose not to play a mathematical game, because spheres are theoretical rather than real constituents of Universe. The mathematician's theoretical sphere has <u>all</u> points on its surface equidistant from the center, but that leaves no room for "holes". There can be no perfect spheres because continuous surfaces do not exist. Every observed sphere, just as every observed so-called "solid", turns out to be mostly emptiness (Edmundson, 1987).

### Nature Doesn't Use Cubes

What regular geometrical solid with six square sides provides the basis for volumetric measure throughout science and everyday use? Since "solids" do not exist in Universe, this question first lacks a referent in experience. Even as a "pattern", the cube is not the building block of choice in Universe, because it lacks structural stability and is not the simplest system. The tetrahedron represents a simpler and more stable choice, as can be demonstrated with models of the two different systems. Scientists assigned the cube its role. Within our XYZ three-dimensional coordinate thinking, scarcely anyone questions its appropriateness. Employing the cube as the unit of volume produces cumbersome and often irrational quantities compared to the volumes of other polyhedra. By specifying the volume of a tetrahedron as one unit, Fuller found that other ordered polyhedra have precise whole-number volume ratios (Fuller, 1992).

## Three Triangled

What's the simplest way to say "three to the second power"(or "three to the third power")? We've used squares and cubes for so long that humans assume that these multiplicative functions reflect a unique and exclusive relationship. "Three squared" can be generated experientially by drawing a square, trisecting each side and connecting the trisection points. When one counts the smaller squares thus generated, the number comes to nine. However, drawing a triangle and following the same procedure produces the same result more simply. The simpler figure generates nine triangles. Likewise, raising a number to the third power, typically called "cubing", can be demonstrated to be more simply, "tetrahedoning". Nature always operates most economically. Therefore "triangling" and "tetrahedoning" seem more appropriate than "squaring" and "cubing."

## Exit Bucky Fuller

As a Comprehensive Anticipatory Design Scientist, Bucky Fuller promoted the principles of empiricism and parsimony throughout his life by advocating the coordination of human senses and language with what we find out about Universe. Little progress seems to have been made along these lines in the decade since his death. Many of Fuller's ideas have received a notable paucity of serious critical evaluation (Applewhite, 1986).This needs to change. If we continue to teach our children "dark-ages" thinking with a disregard for empirical choices among explanations and assumptions, we handicap them with education. Failure to eradicate the faulty assumptions embedded in our verbal behavior will likely lock us into limited opportunities for growth, regardless of our technological teaching expertise.

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