

## **Minding the Gap—Artists as Scientists, Scientists as Artists: Some Solutions to Snow’s Dilemma**

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### **Abstract**

It seems to be the curse of our times to think in terms of either-or. C.P. Snow directly addressed this in *The Two Cultures* (1964, 63–64): “I want to repeat what was intended to be my main message .that neither the scientific system of mental development, nor the traditional, is adequate for our potentialities, for the work we have in front of us, for the world in which we ought to begin to live”.

Snow decries the profound practical, intellectual and creative loss resulting from the polarization of the traditional and scientific cultures. He refers to the gap between these polarities as “a gulf of mutual incomprehension” (1964, 4) needing immediate attention because “[w]hen these two senses have grown apart, then no society is going to be able to think with wisdom” (50–51). Nobel laureate Vaclav Havel explained how such a gap could have occurred (1990, 10-11):

[S]omewhere here there is a basic tension out of which the present global crisis has grown...I'm persuaded that this conflict...is directly related to the spiritual condition of modern civilization. This condition is characterized by loss: the loss of metaphysical certainties, of an experience of the transcendental, of any superpersonal moral authority, and of any kind of higher horizon...

This paper intends to focus on the potential and the possible existing in the middle ground between the polarized extremes. It is a plea for balance born of reason and for the sake of us all.

### **Introduction**

C.P. Snow’s *The Two Cultures* was read, applauded and commented on by scholars in a surprising array of disciplines. One of them was Zoltán Kodály (1882–1967), celebrated Hungarian composer-linguist-educator who remarked:

Remember the great discussion about Snow’s book, *The Two Cultures*? It made waves in Europe and America. Over-mechanization can only have dire consequences, and concerning this subject we ought to listen to this physicist and writer who is also an observer of everyday life all in one person. After all, he sees both sides clearly (1966, 109)

Kodály and his close friend, Béla Bartók, also a composer of international stature, were actually also scientists. Together, they built a discipline around the deep analysis and classification of folksong down to the intervallic level including investigating several sticky problems about the relationships among spoken language, rhythm and melody. The resulting discipline, *comparative folksong musicology*, has stood the test of time, being now a century old and still going strong

not only in Hungary but also on an international scale. Both Kodály and Bartók the composers were strongly informed by Kodály and Bartók the scientists as they created their distinctively modern tonal system<sup>1</sup> out of the raw materials of the ancient Hungarian melodic-rhythmic language. Their scientific work was so highly regarded that a new department for it was created in 1934 within the Hungarian Academy of Sciences (Kodály 1966, 120). Today, this department, known as the Institute for Musicology, is so large that it occupies an entire building of its own, employs a large staff of scholars, has a vigorous publishing program, and is itself comprised of several sub-departments. The widely admired Hungarian music education system and national musical life are largely centered on this venerable institution.

In 1946, Zoltán Kodály was elected president of the entire Hungarian Academy of Sciences, a position he filled until 1950 (Kodály 1966, 121). Think of it—an internationally celebrated<sup>2</sup> artist heading a complex scientific organization! His election resulted in his providing a key solution to Snow's Dilemma. In an address to the assembled members of the Academy, Kodály declared:

Not only is there a close relation between the various sciences . . . it is also true that science and art cannot do without one another. The more of the artist there is in the scientist the more fitted is he for his calling, and *vice versa*. Lacking intuition and imagination, the work of a scientist will at best be pedestrian; without a sense of inner order, of constructive logic, the artist will remain on the periphery of art (in Eösze 1962, 47)

Please keep in mind that not only was Kodály a musician and a scientist, but also that his areas of scholarship included traditional folk culture. Thus we have in him someone uniquely qualified to bridge the gulf that Snow described.

### **Artist-Scientists and Scientist-Artists—Some Examples**

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<sup>1</sup> Known as the *axis system*, in which compositional keys are arranged in direct *pole-counterpole* relationships that satisfy the requirements of both functional harmony and modern serialism (Lendvai 1993, 16)

<sup>2</sup> Kodály, who already held an earned doctorate, was awarded an honorary doctorate by Oxford University in 1960, as well as by several other European and American institutions of higher learning.

History provides us with clear-cut examples of the sort of dual artistic-scientific thinking Kodály described. We cannot expect every thinker to fit the mold, nor does space allow the citing of every possible example, but the fact that there have been some demonstrates how there could be more given a correct balance in modern education according to Snow's mandate. Moreover, we continue to be plagued by our ignorance of exactly how much the Ancients did or did not know; clues to their possibly vast knowledge keep nagging at us. And we moderns continue to be stumped by many aspects of ancient structures like Stonehenge—even knowing *how* they may have built them usually tells us little about *why*. But in every age we see the evidence of a certain kind of thinking, the ability to grasp the wholeness of concepts and their contexts, a sort of “supramental consciousness,” Edgar Willems<sup>3</sup> term for the overarching role of intuition in human thought processes (1979, 11).

Ancient Greece gave us Pythagoras (569–475 B.C.) whose artistic-scientific duality remains legendary. He suggested that the Solar System operated on the principle of stars and planets moving in uniform circular motion in crystalline spherical orbits. These circles moving within circles were all arranged in ratio and proportion to each other and vibrations from where the orbits rubbed together produced the so-called *music of the spheres*. So now we have in Pythagoras a mystical mixture of science and art. A long succession of Greek thinkers improved upon Pythagoras' theory—his own pupil, Eudoxus (b. 408 B.C.); Alexander the Great's tutor, Aristotle (384–322 B.C.) and Ptolemy (c. 150 A.D.)—as they tried to resolve irregularities they observed in the movement of the planets.

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<sup>3</sup> Edgar Willems (1890–1978), Belgian-born music psychologist.

Ptolemy's elaborated theory of spherical orbits stood for the next 1500 years. Through improved scientific tools and processes, scholars began to know which parts of the Pythagorean theory were correct and which were not. The main problem for the Ancients was their assumption that the solar system was geocentric rather than heliocentric, eventually rectified by Copernicus (1473–1543 A.D.) and verified by Galileo (1564–1642 A.D.). But Pythagoras was not entirely wrong on one point: through even more advanced research tools, modern observers have found proof of Pythagoras' most unlikely claim—there *is* a music of the spheres. In the 1970's, the NASA Voyager space probes sent back astounding telemetry of solar and planetary sound emissions in the audible spectrum (in LaserLight Digital 1992, npn)! Pythagoras' basic concept was correct but the details were not, giving some credence to the scientific and artistic duality of his thinking, however mystically stated it was. It does make one wonder if and what the Ancients knew and how they knew it. It also poses the question of how much of their knowledge was scientifically derived and how much was naturally intuitive.

Continuing with our examples, we cannot ignore Albert Einstein, an accomplished violinist who was also a physicist. He once went so far as to say (in Viereck 1929, npn): “If I were not a physicist, I would probably be a musician. I often think in music. I live my daydreams in music. I see my life in terms of music.” Here we have his conscious recognition of his own duality as an artist-scientist. And at this point we are compelled to wonder if we are really dealing with a *unity* rather than a duality, a unity greater than the sum of its constituent parts. Something else Einstein said (Henderson in Einstein Archives, 33:257)<sup>4</sup> leads to such a conclusion: “After a certain high level of technical skill is achieved, science and art tend to coalesce in esthetics, plasticity and

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<sup>4</sup> To clarify, Einstein made this statement in 1923 as recollected by Archibald Henderson in 1955.

form. The greatest scientists are artists as well.” Apparently, the gap did not exist within Einstein’s mind.

A third example is Edwin H. Land (1909–1991), an optical scientist, an inventor and a recognized expert in the physical and chemical properties of color—we know him best for Polaroid lenses and instant photography. Once regarded as the world’s richest scientist, Land held 535 patents, second only to Thomas Edison (McElheny 1998, xii, 250–257). Like Einstein, Land was quite aware of his own artistic-scientific duality (Polaroid Corporate Archives 2006, npn):

I suppose that I am first of all an artistic person. I’m interested in love and affection and sharing and making beauty part of everyday life. And if I’m lucky enough to be able to earn my living by contributing to a warmer and richer world, then I feel that is awfully good luck. And if I use all of my scientific, professional abilities in doing that, I think that makes for a good life

Here is Land’s own description of how his artistic nature informs his scientific work: “You always start with a fantasy. Part of the fantasy technique is to visualize something as perfect. Then with experiments you work back from the fantasy to the reality, hacking away at the components” (in McElheny 1999, 205). He also spoke clearly of his scientific side: “An essential aspect of creativity is not being afraid to fail. Scientists made a great invention by calling their activities ‘hypotheses and experiments.’ They made it permissible to fail repeatedly until in the end they got the results they wanted” (Life August 1972, 48).

More insight into the unity of Edwin Land’s artistic-scientific duality comes from his speech at the 1979 groundbreaking ceremony for the House of the American Academy of Arts and Sciences, for which he provided the building capital and a permanent endowment: “[T]he transfer [among branches of knowledge] is not a conscious process. Models for physics may

come from music, for chemistry from physics, for art from cosmology” (McElheny 1998, 430, edited for clarity). Also insightful is Land’s eulogy at the funeral of his senior vice president at Polaroid, Stanley M. Bloom, a research chemist: “[He] was quite free from those infantile inhibitions against applying beautiful science . . . Photography offered him what he most needed, an extended continuum from science to beauty” (Ibid, 431).

*Snow’s ‘Third’ Culture Revisited*

The three cases discussed above provide us with a model of what *could* be and probably *should* be, but why are they not the norm? What keeps happening in our world that we slave away at the business of education with Tolkien’s elves in mind but keep producing something more like his orcs, millions of manipulated beings derived from the same stock, yet seemingly unaware of their actual potential and even worse, deprived of the means to achieve it? We are also now witnessing a generation educated to consume the products of science rather than be served by them. We see them everywhere, everyday, wired (or wireless!) as they are for sound and sight, yet simultaneously disconnected from the rest of humanity, headed to or from electronic screens whereupon they practice the mindless annihilation of thousands of unnamed, unvalued cyber-individuals. Like C.P. Snow, we do deplore the widening gulf between rich and poor, but is it not also the great irony of our day that so many affluent youth and adults spend their money on devices that possibly render them more impoverished in mind and heart than those who are materially poor?

In his original 1959 essay *The Two Cultures* and in his 1964 *The Two Cultures and A Second Look*, Snow clearly wrestles with whether or not there really are more than two cultures in the equation. Without intending to put words in his mouth, let us name three subcultures that continually interfere with the process of narrowing the gap between science and art, between rich

and poor. The first two are easily identified: the commercialization of technology for personal gain, and the use of technology to control, ignore or even destroy life. The third subculture is subtle yet capricious, its existence often difficult to detect or prove: the pride-ridden politics of ignorance with its methods of petty betrayal (there are Luddites on *both* sides of the gap!). As Snow pointed out, we are close to being able to solve all problems of basic survival and improving the quality of human life—we have the knowledge and tools for doing so (1964, 46–48). But how distant we seem from actually doing it—one fundamental human failing continually blocks the way: personal greed with its lust for power. Kodály frequently agonized over the obstacles self-serving people threw into the path of educational reform: “Why is it always the incompetent people that force their way to the scene of action, spoiling things to such an extent that twice as much work is needed to put things right again than would have been required to do them well at the first go!” (in Bónis 1964, 160). There are welcome exceptions, one being the hundred-dollar laptop computer developed by the MIT Media Lab specifically for educational use in developing countries (Bullis 2005, 1-2). Sadly, we know all too well how these devices could be misused if they fall into the wrong hands instead of those for whom they are intended.

If such technology may be considered to be a beneficial product of science, let us consider how to develop a proper attitude toward it, to channel it into the right hands and away from those who would misuse it. We are talking here to those who have the capacity to provide capital for scientific advancement. To what end? What is the motivation? What is a proper attitude toward technological progress? Consider two spectacular events in Biblical history: Moses receiving the Ten Commandments and Belshazzar’s Feast. What kind of science was *that*?! Did The Powers

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That Be send down their audio-visual department to install a high-definition plasma viewing screen on Mount Sinai or on the wall of the palace in Babylon just days before Moses's ascent or Belshazzar's party? What did they use for a power source? Was it wireless, too? What if the celestial power grid had failed or the batteries run out of charge? What operating system did they use? What software were they running? Would the CEO have ever said in the next board meeting: "If the 'latest technology' fails to work one more time, heads are going to roll—your 'scientific progress' has already cost me an eon of profit!"

All of us—artists *and* scientists—are simply compelled to humble ourselves before a host of unanswerable questions about a kind of living, organic science we have only succeeded in describing at best. We live on a planet molded by invisible fires, kept in motion by unseen forces and lit by inextinguishable lights over which we have no control, only the ability to give them names. And now we are reading about *Geobacter*, a newly discovered microorganism that eats up metallic groundwater pollutants while generating harvestable and useable electricity into the bargain (Sullivan 2006, 26).

How puny we are in the face of it all as we arrogantly continue to try to destroy all living relationships in order to control them! This happens because we confuse understanding the elements with having power over mankind, and pure and applied science with consumable technology and its shamelessly built-in obsolescence. How absurd to think that we have license to destroy the very lives and resources the Universe strives to sustain! We've got it all backwards—science and technology, art and beauty must serve mankind, not control it, as Asimov warned in his 1950 *I, Robot* anthology. And so we find ourselves urgently in need of

healing the rift between the traditional and scientific cultures. In C.P. Snow's own words (1964, 50–51): “It is obligatory for us . . . to look at our education with fresh eyes . . . . Isn't it time we began? . . . We have very little time. So little that I dare not guess at it.”

For many in this world, there is such a real daily deprivation of primal physical necessities that it caused Snow to declare that he had originally thought of calling his lecture *The Rich and the Poor*. To which he added: “I rather wish that I hadn't changed my mind”. He also made the point that “[t]he scientific revolution is the only method by which most people can satisfy their elemental needs” (1964, 79). But Abraham Maslow, already known for his Hierarchy of Needs, stated how only education through the arts seems to have as its goals the development of self-actualizing, whole human beings (in Avila, Combs and Purkey 1971, 226). At first glance, this may seem to contradict Snow's statement about the scientific revolution, but then Maslow continues on to say how he sees the world and its requirements for survival changing so rapidly that education must prepare people who can improvise and invent, in short, be capable of creative work without being narrowly focused only on the finished product (228). Perhaps these are the “fresh eyes” needed to recognize the educational solutions Snow was seeking.

### **Rapprochement—Natural Solutions for Closing the Gap**

*The Two Cultures* hints at a hidden message within its covers and that message is this: humans are equipped with an innate ability to combine scientific and artistic thinking from which arises a stunning array of *natural* technologies for problem solving. Snow makes it clear that balanced education in the arts and sciences is the tool to unlock and fully mobilize this array (1964, 100), a view seconded by Alfred North Whitehead (1929, 7, 11):

[T]he solution which I am urging, is to eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject-matter for education, and that is Life in all its

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manifestations . . . . You cannot put life into any schedule of general education unless you succeed in exhibiting its relation to some essential characteristic of all intelligent or emotional perception . . . . The best education is to be found in gaining the utmost information from the simplest apparatus

Somehow, we have got to link up with the natural scientific inclinations inherent in all people; even the most primitive of tribes has ways of thinking and doing that constitute their form of science. By connecting education with them where and as they are, people can hold to their valued traditions while using new knowledge to fulfill their survival needs yet retain control over their own developmental destinies. We modern Westerners tend to overlook the facts that people in general are not stupid, that they simply lack many opportunities we take for granted and that our frantic way of life may not contain all possible answers.

An event in Romania illustrates how cultures gradually move toward scientific thinking. During the past repressive regime, hundreds of lively farm villages in which people had lived for centuries were razed and their inhabitants relocated to monstrously ugly apartment blocks—“a dead garden of gray concrete”—in Bucharest. In the former villages, the old technology for preparing young women for marriage was through the oral transmission of ancient stories and legends, which grandmothers told to their granddaughters while washing clothes together at the river’s edge. In the concrete tenements, there was no river so the storytelling ceased. Faced with this threat to their cultural survival, a group of determined grandmother’s banded together and invented a new technology. They sent out the word that a designated grandmother’s little apartment would become a sewing circle where grandmothers could bring their granddaughters to sew clothes for them equivalent to the unaffordable ones in shop windows. The clothes were the lure—a very natural technology—to get the young ones inside the door. During the sewing sessions, the stories were told and the ancient cultural heritage was passed on (Estés in Campbell 2004, pp. xxxiii-xxxv). After that, you can be sure none of the granddaughters ran around the

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playground chanting “Yer granny’s a Luddite!” for their having made do with the simple resources at hand. The grandmothers’ initiative exemplifies Whitehead’s “Life in all its manifestations” that education must learn to tap into so that the closure of the gap between traditional culture and science will occur of its own accord. This is also what Bartók and Kodály knew when they forged the macrocosm of modern Hungarian composed music out of the microcosm of indigenous folksong.

In our eagerness to set things right through scientific, world-redeeming education, we must be careful to not overstep our own ignorance. The Navajo Nation, the largest native tribe in North America, have always concerned themselves with the traditional education of their rising generations. Though they have modern public schools staffed with licensed teachers and fully equipped with computers, they also have a centrally organized delivery system for teaching ancient Navajo ways, which features the traditional wedding basket as its instructional “technology.” Navajo wedding baskets are woven of sumac and willow, dyed with native plant juices, and serve as “handheld personal digital assistants” requiring no electric power and predating computer chips by many centuries. Traditional colors and designs encode the Four Sacred Directions, an individual’s life path and our “scientifically discovered” principles of cognitive development, age-appropriate education and spiral curriculum to a degree remarkably akin to any modern course in educational psychology. It would be a great tragedy to try to supplant such a powerful natural teaching tool with a machine that will always need repair, software upgrades, a power source, and probably be ultimately damaging to the environment. By the way, the Navajo language is arguably the most complex tongue on the planet: it was a factor in the Allied victory over the Axis powers in World War Two. It is tonal, agglutinative and

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otherwise subtly nuanced in mechanics and meaning, rendering it difficult enough, but its real power is its ability to describe any new technology without borrowing words from other languages. There are many lessons for artists, scientists and educators in this remarkable culture and many others like them.

We now turn to the common technological inheritance of all people everywhere, the brain. It is a remarkably powerful and flexible invention for processing and multitasking, so much so that the Holy Grail of computer science is to create a machine that will work like our minds. They will just get the job done and someone will think a new thought in a new way that will set the industry back at least a century. In his essay *The Neural Lyre*, Frederick Turner characterizes the brain's processing of information as procrustean, determinative, habituated, synthetic, active rather than passive, predictive, hierarchical, rhythmic, self-rewarding, reflexive, social and hemispherically specialized (1985, 62–72). He goes on to say how tuned to oral-aural-visual transmission of knowledge through artistic patterning the brain is (Interchapter II). All of these are evidenced in the Hungarian, Romanian and Navajo examples that have been cited. Again, the message is clear: art, science and education will provide the solutions to Snow's Dilemma only when they take into account people's need to relate new knowledge to their own cultural reality, not the other way around, and when the above-mentioned interfering sub-cultures have been minimized.

Turner's discipline is comparative literature, in which he and his associates are accomplishing a remarkable bridging of the gap by using Magnetic Resonance Imaging techniques to describe

natural human cognitive activities. They are only validating what practical arts educators have been saying for a long time, of which Edgar Willems' perspective is typical (1956, 1987, 64):

Without intelligence, there is no science or virtuosity; but without sensitivity, without emotiveness, without feeling, there is no real art . . . This distinction seems to put up impenetrable barriers between the sensory, affective and mental domains. In reality, it is nothing of the sort. These three domains coexist and constantly and deeply interpenetrate

Frank Oppenheimer, a panel member in the well-known Rockefeller discussions on the place of the arts in education, reminds us how

Science and art are both involved in recognizing patterns; they're both involved in putting these patterns together creatively in ways that no one had ever realized fit together; they both involve not just culture but nature as a whole. Neither science education nor art education is as good as it should be, and I just wonder whether one couldn't stress in this whole thing the fact that the business of noticing and recognizing patterns and of sensitizing people is common to both

The gap narrows even more with this from Iver Petersen, also a member of the Rockefeller colloquium: "Representation—the creation of symbols—is the means by which the human being organizes his experience in order to understand or communicate it; language is one way of representing or symbolizing the world; math is another; science another—and the imagery of art is still another" (1977, 57).

### **Into the Gap**

C.P. Snow has caused us to face up to a great dilemma, one he constantly reminds us we are capable of resolving. His insistence seems to imply that for him, there was something of substance *within* the gap, that it was not a barren void between two polarities. A bit of folk wisdom from the natural culture tells us where to look for what might be in the gap: "Those who do not read history are bound to repeat it." For instance, in 787 A.D., Charlemagne issued the first in a series of educational edicts proclaiming free public education in which teacher-priests should make no difference between the children of serfs and freemen "so that they might come and sit on the same benches to study grammar, music and arithmetic" (Durant 1950, 463–467).

After Charlemagne's demise, his kingdom fell into disarray and the initiative lost momentum. It was revived centuries later by Martin Luther (1483–1560), who proposed a balanced and graded public school curriculum including the study of languages, grammar, history, music, mathematics, natural science and gymnastics (in Bruce 1928, 220–225).

It is no small matter that in 1637 Oxford University published a book about universal education that foreshadowed our present topic. The book is *Praeludia Conatum Pansophicorum*—“Preludes to Pansophic Studies”—written by the great Czech-Hungarian educator, Jan Amos Comenius, an early proponent of the Royal Society and longtime friend of John Milton (Young 1932, 16–18, 59). Such contacts with other European minds only intensified Comenius' desire to improve education in his homeland of Bohemia. This desire eventually grew to global proportions, as expressed in his vision of *Panorthosia*, a plan for world peace through education and understanding, which he worked out in a universal philosophy or *Pansophia*. No less an acclaimed scientist than Jean Piaget actually credited Comenius as being one of his major inspirations, and UNESCO itself is rooted in Comenius' vision of a peaceful world enlightened and united through education made freely available to all (Brambora in Földes and Mészáros 1973, 29). Piaget wrote that “[Comenius] must be regarded as a great forerunner of modern attempts at international collaboration in the field of education, science and culture which fused nature, human activity and educational process into a single whole” (in Piaget et al. 1956, 29, edited for continuity). Practical solutions for Snow's concerns can be found in Comenius' principles of education, summarized as follows:

- The whole range of the arts and sciences should be represented in schools;
  - Systematic teaching toward short- and long-term goals fosters successful learning;
  - Proper instructional pathways to those goals must be known and followed;
  - Skills are usually developed in related pairs, such as reading *and* writing, words *and* objects, learning *and* teaching;

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- Because the arts and sciences form an “encyclopedic whole” in which they are interlinked, school curricula should be organized to enable students to discern those connections.
- Mixing methodologies within a single subject—and using too many methodologies within a school—confuses students, causing “hesitation and delay, the distaste for and lack of confidence in new subjects;”
- A proper pedagogy allows a teacher to account for the individual *and* the group at the same time by providing *meaningful* learning experiences at both levels;
- Good teachers carefully guide students through literature and the choice of literature because *too much* diversity causes lack of mastery of all of the branches of study;
- Good teaching works directly towards goals without being distracted by “everything that is not of immediate service. As the saying goes: ‘Where small means suffice, great should not be used;’”
- Every subject should be taught in definitely graded steps, that the work of one day may thus expand that of the previous day, and lead up to that of the morrow;
- Everything should be taught thoroughly, briefly, and pithily, that the understanding may be, as it were, unlocked by one key, and may then unravel fresh difficulties of its own accord;
- Everything that is useless should be invariably discarded (Ibid., 61–64)

Mostly because of interfering cultures that fomented unnecessary wars, revolutions and political failures, Comenius’ dream of world peace through education went largely unfulfilled in his day,<sup>5</sup> however the embers of his vision were to rekindle in the nineteenth century through Pestalozzi.

Swiss educator Heinrich Pestalozzi (1746–1827) was actually able to develop several schools based on many of Comenius’ ideas and augmented by his own practice-driven discoveries. Pestalozzi’s concepts of learner-centered, experience-based pedagogy and discovery learning techniques permeate many aspects of modern education, essentially introducing scientific observation and thought processes into general education. Pestalozzi’s writings detail essential relationships between the teacher, the learner and the subject matter. He particularly investigated and demonstrated the dynamic effect of *Anschauung*, the creative intuition overarching one’s development of knowledge (Jedan 1981, 48). In Snow’s context, this is what Einstein and Land have described in their syntheses of artistic and scientific thought. It is also significant to our topic to note that Pestalozzi worked all of this out with impoverished, marginalized, orphaned and displaced populations.

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<sup>5</sup> In 1995, almost 350 years after Oxford University published Comenius’ book, the European Union launched its *Comenius Project* to improve educational cooperation among its member countries.

The rapid and widespread acceptance of Pestalozzi's ideas carried education into the twentieth century, where science began to address the gap through investigating natural learning processes, the psyche of the learner and the structures of the brain. Accordingly, Comenius' and Pestalozzi's legacy passed to Jean Piaget, a Swiss scientist who became as immersed in describing the mind's inner universe as Einstein was in grappling with the nature of the outer one. Piaget constructed an epistemology of intellectual development from which emerged the new and still expanding discipline of cognitive science. His discoveries gathered in what his predecessors had hypothesized and united them under the umbrella of simple constructivism. By the end of the twentieth century, this focus on individual knowing and meaning would cause Frederick Turner to declare: "Behaviorism as a tenable explanation of human psychology has completely collapsed; human beings do appear to have a nature after all. Studies of newborns show that we come into the world with a formidable array of predispositions" (Turner 1995, 20).

It just so happens that those predispositions have a lot to do with resolving the problems Snow has defined for us. Neuroscience and psycholinguistics have matured to the point of being able to specify and describe many of the natural cognitive structures of the human mind. Consider, for example, Howard Gardner's *Theory of Multiple Intelligences*, formulated after his year of study and debate with Piaget, in which he proposed how intelligence is a complex array of autonomous ways of knowing that are at least somewhat interconnected (1983, 127). His original list of intelligences is, in order of discovery: 1) Linguistic, 2) Logical-Mathematical; 3) Musical; 4) Spatial;

5) Kinesthetic; 6) Interpersonal; and 7) Intrapersonal. Others are being added as researchers find those meeting essential criteria.

The combination of and degree to which each of us possesses any of the multiple intelligences is highly individualized—each of us has a different cognitive profile; each of us is uniquely smart. These ways of knowing exert varying degrees of influence over each other. For instance, the musical and spatial ways of knowing seem to be closely linked because musical form is essentially an architectural construct (Gardner 1983, 123). Additionally, Gardner finds that “*music may be a privileged organizer of cognitive processes, especially among young people*” (in Brummett 1997, 9, original emphases).

The implication for schooling is clear: curricula and delivery must address *all* of the ways of knowing in order to optimize the effects each one can have on the others. A quick look at Comenius’ above-stated principles of education reveal that this is not new knowledge, it’s just that Gardner had the scientific tools to prove what Comenius knew intuitively. It’s all about balance—the answer *is* the gap—powerfully attested to in this statement from Vaclav Havel, who was asked how he wrote the Nobel Prize-winning plays that helped to weaken the Soviet grip on Europe:

[S]omething close to music and musical thought enters my plays. I really enjoy things like the interweaving and mingling of motifs, phasing them in and out, developing them rhythmically, mirroring motifs in their opposites, recapitulating bits of dialogue, repeating them, interchanging them, putting words spoken by one character in the mouth of another and then back again, dialogue running backward or contradicting itself, stressing the rhythmic alternation of conversational themes. All of this, to a greater or lesser degree, can be found in my plays (Havel, 1990, 192, edited for clarity)

Havel’s statement is significant to Snow’s topic in two ways: it is an unsolicited description of how a great thinker intuitively uses his musical way of knowing to operate more efficiently

within his linguistic way of knowing, and it thereby explains why the scientific and natural-artistic cultures need each other. It adds to the accumulating evidence that notable artist-scientists and scientist-artists have become extraordinary problem-solvers because they can think within the gap, and thereby escape the trap of polarization.

### **Conclusion**

If Comenius envisioned the ideal, then Pestalozzi developed its practical applications; if Piaget recast education within the framework of modern science, then Gardner suggested how to maximize cognitive development; and if C. P. Snow foresaw the urgent need to overcome the polarization that prevents their implementation, then perhaps it is up to us to close the gap. On paper, the gap no longer exists; it is our actual practice that perpetuates the gap. The scientific culture will have to relax its monopoly of educational content and time on task while the artistic culture will have to improve or demonstrate its rigor and substance. Both will have to unite in eliminating the debilitating pollution of self-serving politics. In his book *The Culture of Hope—A New Birth of the Classical Spirit*, Frederick Turner refers to an emerging centrist “natural classicism,” “an imaginative estimate of possibility, an intellectual leap into the future” that will reunite the scientific and natural-artistic cultures (1995, 20–29). He, too, envisions the elimination of the polarities through focusing on what is between them: “We must reshape our educational system to demonstrate the unity and interconnection of all knowledge, and its essentially dynamic and active nature” (173). Remarkably, he goes on to name the very unifying element we have been seeking:

I want to propose that the experience of beauty is a recognition of the deepest tendency or theme of the universe as a whole. This may seem a very strange thing to say; but there is a gathering movement across many of the sciences that indicates that the universe does indeed have a deep theme or tendency, recognizable by the human neurobiological sensitivity to beauty, a leitmotif which we can begin very tentatively to describe, if not fully understand (217)

We have the problem, the solution and the actual tools in our hands. When shall we go to work?

Do mind the gap!

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Published by the Forum on Public Policy

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