Humanities & Arts to the Rescue of Science

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Abstract

The future of science may depend on how education responds to the growing negativism that students and the public show towards science. What is the value of our current teaching methods, if in helping students achieve higher test scores, they also generate a life long disdain of science? Achieving a positive attitude towards science must become a major objective of all future teaching methods if we are to reverse the current trend. We can accomplish this by bridging the divide of the Two Cultures that C. P. Snow warned us about, using an innovative method that integrates science with relevant elements from the humanities and the arts. An art gallery can be used effectively as an extension of a science classroom. When properly analyzed, a theater or dance performance, a painting, a novel, a poem, or a film, can enrich and reinforce a science concept beyond traditional lab exercises. When elements of history of science are integrated appropriately in the curriculum, they humanize what is otherwise perceived as a dry, mechanical and impersonal discipline. The author will describe the many benefits and limitations, as well as unexpected discoveries that he has made in his experience with this method.

Introduction

The 20th century is considered by many as the most active period in human history, not only in terms of exploration, discovery and change, but sadly also through war and destruction. This was also a century that witnessed the fastest growth in specialization, a professional quality that is an essential precondition to modern advancements. The spectacular innovations in science, medicine, and technology were made possible through the hard work and creative imagination of specialists and thinkers within a narrow discipline and focused onto specific challenges. But specialization has its shortcomings, as articulated by C. P. Snow, who raised the issue more than fifty years ago. In his 1955 classic essay ***The Two Cultures,*** C. P. Snow warned us about the dangers of specialization that can lead to an intellectual polarization or division between the cultures of those in science and those in the humanities.

But what exactly were the dangers that Snow warned us about? One of these dangers has a political flavor. Most politicians are educated in fields outside of science, which can be a serious handicap in government affairs. Snow wrote [1]

"It is dangerous to have two cultures which can't or don't communicate. In a time when science is determining much of our destiny, that is whether we live or die, it is dangerous in the most practical terms. Scientists can give bad advice and decision-makers can't know whether it is good or bad. All this makes the political process more complex, and in some ways more dangerous…"

[1] The Two Cultures and a Second Look by C. P. Snow, Cambridge University Press 1969, page 98.

This problem becomes a perpetuator of poverty in underdeveloped countries whose government officials may have little understanding of science and technology. Snow considers the application of science and technology as a prerequisite for the economic advancement of any country. He nearly reflected his concerns in the title of his book [2]

"Before I wrote the lecture I thought of calling it "The Rich and the Poor", and I rather wish that I hadn't changed my mind. The scientific revolution is the only method by which most people can gain the primal things (years of life, freedom from hunger, survival for children) - the primal things which we take for granted and which have in reality come to us through having had our own scientific revolution not so long ago."

To Snow, much of the blame for the creation of these two cultures lies in our educational systems. Although the isolation of the cultures of science and humanities are caused by educational systems, Snow is more critical of those in the humanities for failing to understand science rather than those in the sciences who don't know the humanities. He wrote [3]

"Once or twice I have been provoked by people who consider themselves highly educated. I then asked them how many of them could describe the Second Law of Thermodynamics. The response was both cold and negative. Yet I was asking something that is the scientific equivalent of: Have you read a work of Shakespeare?"

Snow makes the problem of science illiteracy by those in the arts and humanities more poignant later in his essay[4] "If I had asked an even simpler question - such as, 'What do you mean by mass, or acceleration, which is the scientific equivalent of saying, Can you read?' - not more than one in ten of the highly educated would have felt that I was speaking the same language."

There is little sarcasm or metaphor in his brief and limited criticism of scientists lacking the most basic of knowledge in the humanities and arts. Snow could easily have asked scientists if they knew the meaning of terms such as existentialism, cubism or futurism, and recognized them as

[2] The Two Cultures and a Second Look by C. P. Snow, Cambridge University Press 1969, page 80
[3] The Two Cultures and a Second Look by C. P. Snow, Cambridge University Press 1969, page 15
[4] The Two Cultures and a Second Look by C. P. Snow, Cambridge University Press 1969, page 15

important milestones akin to relativity and quantum theory. Snow does not challenge the scientists and this is unfortunate. The problem of the Two-Culture divide will not be solved if only the non-science professionals understand science. It can be fully solved, however, if scientists, engineers and doctors also learn about the arts and humanities. Only then will the bridge between the two camps be fully operational and bring about an intellectual balance and a remedy to specializations.

I agree with Snow that education is crucial in bridging the Two-Culture divide, but I am also disappointed that his solution falls short and lacks imagination, specificity and depth. His proposition provides a comprehensive form of education for only a selected few, or as he calls them, "a larger proportion of our better minds. [5]"Changes in education are not going to produce miracles. …With good fortune however, we can educate a large proportion of our better minds so that they are not ignorant of imaginative experience, both in the arts and in science, not ignorant either of the endowments of applied science, of the remediable suffering of most of their fellow humans, and of the responsibilities which once they are seen, cannot be denied."

Albert Einstein, in a letter published by the *New York Times* in October of 1952, three years before Snow's Two Cultures essay, expressed similar concerns about the push toward specialization that is done at the expense of other forms of knowledge. Einstein proposed an education that cultivates not only the mind, but also develops aesthetic appreciation and compassion for others. [6]

"It is not enough to teach man a specialty. Through it he may become a useful machine but not a harmoniously developed personality. It is essential that the student acquire an understanding of a feeling for values. He must acquire a vivid sense of the beautiful and of the morally good. Otherwise he - with his specialized knowledge - more closely resembles a well-trained dog than a harmoniously developed person. He must learn to understand the motives of human beings, their illusions, and their sufferings in order to acquire a proper relationship to individual fellow-

[5] The Two Cultures and a Second Look by C. P. Snow, Cambridge University Press 1969, page 100
[6] Ideas and Opinions by Albert Einstein, Bonanza Books (Crown Publishers) 1954, page 66 A. Einstein letter to New York Times, October 5, 1952

men and to the community. .... This is what I have in mind when I recommend the "humanities" as important, not just dry specialized knowledge in the fields of history and philosophy."

We must revamp education on both sides of the Atlantic. Unfortunately, the problem is most severe in Europe where specialization begins in high school and narrows even further at the university. Snow admits that the early specialization in Britain is at the very heart of the problem.[7] "At eighteen, our science specialists know more science than their contemporaries anywhere, though they know less of anything else."

The European university system is in dire need of a readjustment. Without diluting the rigor of the major, it needs to restore the intellectual balance it had before the 20th century. It is important to remember that education should not just prepare students for a profession, but for life itself. We should strive for the Einstein model where specialization does not stifle the rest of the education of the individual. Those who major in science, engineering and medicine, for example, can greatly improve their education with appropriate components in the humanities, including history and ethics. One course that I highly recommend for all students regardless of major is the history of science. Several years ago I wrote an essay on the importance of the history of science for ***Physics World***, the magazine of the Institute of Physics. These are some of the arguments that support my proposal: [8]

" • History of science testifies to the ongoing evolution and revolutions of science. Such awareness protects scientists from the sins of dogmatism, that arrogant belief that science is infallible, unchallenged and final. It reminds us that although natural phenomena remain the same, our explanations of them change with time. It will encourage young scientists not to worship what is already known but to question it. But it also reminds us that it is in the very nature of science to generate new questions, wonder and fascination about the unknown. Imagination, healthy skepticism, mystery, wonder and even humility, they are all parts of the real science.

• History of science celebrates the human element. We use terms such as Newton's laws of motion, Maxwell's equations, Planck's constant and such units as Joule or Kelvin, each and every one of them honoring a great physicist. Yet we rarely mention anything about the

[7] The Two Cultures and a Second Look by C. P. Snow, Cambridge University Press 1969, page 34
[8] The Physics World, Vol.13 # 9, September 2000, page 64

biography, personality or humanity of those brilliant physicists. Knowing something about the very people who gave us science, their lives, struggles, and sometimes even the persecutions that they suffered, will add a warm, even heroic, human quality to an otherwise dry and mechanical discipline."

I believe that an appropriately designed and well-taught history of science course will improve the poor attitude many college students have towards science. I believe the future of science will be more secure if the public understands and better relates to science. The non-science students of today are destined to become tomorrow's government legislators, journalists, and business executives. Science will have friends in high places if these professionals had a great science education experience at college. As professionals, but also as members of the general public, they will praise, criticize and make crucial decisions about the funding of science. Improving the human element of science will also remind the public that science is meant to serve all people and we can claim ownership to it. One of the early advocates of the humanization of science was Nobel laureate physicist I. I. Rabi, who wrote [9]

"Science is an adventure of the whole human race to learn to live in and perhaps to love the universe in which they are. To be part of it is to understand, to understand oneself, to begin to feel that there is a capacity within man far beyond what he felt he had, of an infinite extension of human possibilities…"I propose that science be taught at whatever level, from the lowest to the highest, in the humanistic way. It should be taught with a certain historical understanding, with a certain philosophical understanding, with a social understanding and a human understanding in the sense of the biography, the nature of the people who made this construction, the triumphs, the trials, the tribulations."

One of the advantages of the American model of education compared to the European is that all students regardless of major must take a required core often known as General Studies, which includes select courses in science, humanities, social studies, communication and computational skills. Yet even this model, despite its good intentions of "liberating the mind" has its shortcomings. Despite the wonderful objectives set by these different courses, the intellectual

[9] The Project Physics Course, Edited by Rutherford, Holton & Watson, Published by Holt, Rinehart and Winston inc. 1972, page ix

glue that holds this knowledge together is often missing. Most of the time, these courses are nothing more than slices of specialized knowledge from designated disciplines that students safely deposit in separate and disconnected boxes in their minds.

I believe that most college curricula have failed to cultivate the importance, skills and joy associated with the pursuit of synthesis. Shortcuts in scholarship and our infatuation with specialization may have severely damaged our desire and ability to seek, discover and celebrate interdisciplinary connections. As we are being overwhelmed by information in this digital and internet era, we retreat more and more, preferring the security and comfort of our narrow fields of specialization. We have lost our focus on the most basic premise in education — that effective knowledge is not how much we know, but how well we use and integrate what we know. We must encourage teachers to become intellectual bridge-builders of disciplines. Students must learn to be discoverers of subtle but meaningful connections between disciplines that will enhance their education.

I decided to become a bridge builder in the summer of 1975 after viewing the classic BBC television production of the ***Ascent of Man*** by Jacob Bronowski, an experience that forced me to rethink what it means to be educated. I realized that after nearly eight years of study and research in physics, I was still ignorant about the origins and humanity of my own discipline. In order to link science with the humanities, I needed to learn the history of science and for that I pursued a master's degree in the History of Science upon completion of my Ph.D in physics. My first real bridge-building experience was at the University of Florida, where I spent two years assisting in the development of special humanities courses designed for students in engineering, science, medicine and law. This project, known as the Humanities Perspectives for the Professions, was funded by a grant from the National Endowment for the Humanities. Later on at Stetson University, I began integrating physics with relevant elements from the humanities and the arts for the honors program. I witnessed a handful of students in my physics for non-scientists course switch their majors to physics each semester. They were discovering that physics is interesting and important. Enriching science education by appropriately integrating it with elements of arts and humanities has been my educational philosophy and pedagogy ever since.

While in Florida, I had the privilege of meeting two brilliant renaissance thinkers, Earl J. McGrath and Buckminster Fuller. Both believed that imagination and the ability to discover interconnections is at the very heart of creative and constructive thinking. Earl J. McGrath, who served as U.S. Commissioner of Education under Presidents Truman and Eisenhower, used an episode from his childhood to emphasize the importance of synthesis and integration. He remembered as a young student his teacher hold out an object covered by a handkerchief, explaining that this small item in his hand represented the entire curriculum for the semester, including science, geography, chemistry, geology, economics, world history, biology and art. The students leaned forward to peek and guess what it was that they would study for an entire semester. They were amazed when the teacher removed the handkerchief to reveal a lump of coal. The coal was the "intellectual glue" that kept the curriculum united in a meaningful way. They were to learn about the physical and chemical properties that enable coal to burn, where the largest deposits of it were located, the wars and industrial revolutions it had caused, how mining and burning it affects health and the environment, and how it could be used in art. This curriculum was brilliantly interconnected around one central theme. We need to explore this approach and apply elements of it to our teaching of science. Like the lump of coal in the story of McGrath, we must treat science as a centerpiece with multiple connections when we teach it to non-science students. They need to discover its intricate connections and appreciate its impact, from the technological to the economic, the political and the artistic. Only when we discover this rich and complex dynamic of science can we truly appreciate its importance. Hopefully after such an experience our students will have a life-long interest in science.

Many teaching methods exist to achieve synthesis and interdisciplinary experiences in science. Two of the courses I designed and have taught over the years share common characteristics, but their most significant feature is the emphasis each places on integrating science with the humanities and the arts.

In the first course, ***Einstein: His Science and Humanity,*** Einstein is used as the centerpiece for the study of modern physics and cosmology, but we also explore the technological spin-offs of his theories, including nuclear technology, lasers and solar cells. We also examine some of Einstein's humanity, his position on such matters as the atomic bomb and disarmament, science and religion, racism, education and world peace. This genius emerges not only as a brilliant scientist, but also as a concerned citizen and a crusader against injustice, persecution and militarism. To engage students in a deeper understanding of the impact of science they participate in three debates: The benefits and dangers of nuclear reactors; the decision to drop the bomb and the responsibility of scientists; and whether science and religion should be viewed as foes or allies. Students are asked to defend either side of the debate. Another peripheral topic that we examine is the possible connections or independent parallel discoveries made by science and art. A stronger science-art connection is made through an unorthodox assignment, the art project on science. This semester-long assignment requires students to choose any art form and integrate it with a science concept of their choice from the course. Students use their artistic or media skills to depict not only what they learned, but also to express feelings and opinions generated during the learning process, particularly those that stem from the mystery, awe and wonder or even criticism of science. These artistic expressions of science serve multiple purposes. For these young artists, this assignment becomes their first bridge-building effort between science and art, and the exercise helps dissolve artificial barriers developed over the years between the disciplines. It also frees their minds and enhances creativity. Einstein and the bomb, the mysteries of a black hole, the strange world of quantum physics, Einstein and God or the strange predictions of special and general relativity — these are some of the many topics that students are fascinated by and choose to depict in different art forms. Students display their understanding of the science concepts through paintings, poems, short films, sculptures, theatrical plays, music compositions, computer animations and even dance performances.[10] In my twenty years of teaching this course, I am always impressed by the originality and creativity of these projects, as well as the passionate connection that students make with science through this art project. These are the same students who begin the semester with lukewarm, if not cold feelings towards science.

But the value of this type of artistic expression of science goes beyond art and affects science itself. Students are reminded that a single piece of their artwork may one day transform the public opinion of science better than the work of a thousand scientists. Our faith in our students' capabilities to transform society with their art is boldly embedded in our educational philosophy.

[10] Artistic Expressions in Science and Mathematics, by P. Papacosta and A. Hanson, Journal of College

In the opening sentences of Columbia College's mission statement we consider our students as ***"the authors of their culture."*** Many of these students, as artists and masters of media communications, will go on to shape our culture. Many of them acknowledge years later how deeply ingrained the class debates and art projects remain in their minds and how they impact their way of thinking. For many of these students, courses like ***Einstein*** may be the very last science course they will ever take and the overall experience, good or bad, can stay with them for a lifetime. Therefore, it is imperative that special efforts are made to ensure that student attitudes toward science are transformed from those of fear, disdain or mere apathy to those of exciting engagement and the desire to continue to learn. When students are allowed to express science through a medium in which they feel confident and comfortable, their connection becomes personal and intimate and can create a life-long learning adventure. Improving the attitudes that all students have towards science, a neglected element of science education for many years, may turn out to be the very key to the survival of the discipline. These students will become the public at large, but also the legislators, the corporate executives and the media shapers of society. Without public support science is bound to suffer. Expansion and growth of science can only be assured with strong public support.

The origins of the second course, ***Space, Time and the Arts,*** are traced back to a series of monthly symposia, organized with a colleague, a dancer/choreographer who loves physics. We identified four themes worth discussing — space, time, energy and light — one for each symposium. We invited ten colleagues from different disciplines (ex. music, film, photography, poetry, painting, theater, etc.), to a restaurant once each month to eat, relax and discuss one of these topics. These long and lively dinners became one of the most enjoyable experiences from my many years in academia. Socrates and Plato would have been proud of us. After an individual presentation of how each of us interprets the topic in his or her own discipline, we engaged in a spirited discussion of questions and arguments. Meaningful connections and patterns of similarities between the disciplines began to emerge, delightfully surprising many of us. As a result, collaborative efforts between colleagues from different disciplines were developed, including the course ***Space, Time and the Arts.*** A generous grant from the Provost allowed four of us from different disciplines (physics, dance, music and film) to spend an entire month in the summer of 2001 researching meaningful connections and metaphors of multidisciplinary expressions of space and time. The course explores the fundamentals of the physics of space and time, including theories about gravity, relativity, quantum theory and cosmology, comparing them to art movements such as impressionism, cubism, futurism and fauvism. Students learn that just as scientists challenge concepts of space and time, so do artists, in their own way and often independently. The course examines the concepts using multiple lenses to produce an image that complements our understanding of space and time. Professional artists are often invited to describe the way they express space and time in their art.

A poet explains how critical the spatial distribution of words on the printed page is to the poem. A dance instructor describes how great choreographers like Paxton and Merce Cunningham integrated concepts of physics in their work, such as gravity, relativity and quantum theory. A filmmaker explains how modern cinematographers often choose to use a non-linear time-line to tell a story and how some directors use space as “an organic active character” in the story.

This course saw the birth of a brand new assignment that utilizes the renowned Art Institute of Chicago, located just steps away from Columbia College. Students are asked to visit and identify paintings that prominently feature space or time, each one expressed in the Newtonian, relativistic or in quantum physics analogy. Students respond extremely well to this assignment. They admit that as unorthodox as the assignment may be, the examination of paintings through the lenses of art and physics causes no intellectual conflict. On the contrary, this unusual study strengthens the students’ understanding of both physics and art as they try to study a painting from both the artistic and scientific perspective and extract artistic metaphors of science. They also research the artists to discover whether they may have been influenced by physics. In some cases, such as the comparison of cubism and relativity, students appreciate how the concept of space was challenged independently and at the same time by Einstein and Picasso. They also learn that the latest research by Arthur Miller[11] suggests that both Einstein and Picasso may have been influenced by the mathematical theories of Poincare, a French mathematician. A most reassuring comment from the students is that they never before thought of an art gallery as an extension to a science laboratory. Unlike the standard expectations of a lab that requires the use

[11] Einstein, Picasso by Arthur Miller, Physics Education Special Feature: Physics and Art, Nov. 2004, pp 484 - 489. (This article is based on the author’s book entitled: “Einstein, Picasso: Space, Time

of instruments to collect and analyze data, the examination of paintings in an art gallery reinforces the understanding of physics in a very different way. The gallery assignment does not necessarily replace the lab, but it reinforces the science lesson in a way that no experiment can accomplish. The success of this assignment suggests that it can be extended to other disciplines besides physics. A properly designed art gallery assignment can be used to enrich the teaching of mathematics, astronomy, biology and even much more convincingly, those of mythology, history and theology.

The community of science has slowly begun to recognize and appreciate the importance and benefits of interdisciplinary alliances with the humanities and the arts. More scientists and their professional organizations are gingerly stepping into a mindset that was once considered foreign and even inappropriate. When C.P. Snow directed non-scientists to bridge the gap between the disciplines in his Two Cultures essay, he failed us because he did not make the same passionate calling to the scientists.

I am proud to state that in my thirty years of work in academia, I have been speaking out to encourage scientists to build bridges with artists and those in the humanities. I did this sometimes even at my own professional peril and on few occasions, I actually paid a hefty price for preaching such “heresy.”

No one expects that the humanities and arts will replace science or change its methodology and objectives. Rather, the humanities and the arts will take the inspirational element of science to millions in a way that is more effective than the traditional, dry style of scientific vernacular. Scientists must recognize the powerful impact that the arts can have in shaping public opinion about many issues, including science. They must realize that a relevant piece of art — whether it takes the form of a painting or a song, a poem or a play — may shape the public image of science in a much more effective way than the sincere efforts and good work of a thousand scientists. In projects focusing on the eradication of diseases, environmental issues and energy conservation, the arts have become essential partners in effective communications to the masses.

Art has been known to help define the public image of science, even help promote it, for more than a hundred years. Jules Verne’s wonderful science fiction stories fascinated young people everywhere and inspired some of them to commit their education and professional lives to space, science and technology. Two such rocket scientists are Robert Goddard, the first to use liquid rocket fuel, and Werner von Braun, who designed the giant Saturn V rocket that took us to the moon. When India decided to travel to space in the 1970s, its objective was to establish satellite communication in its villages. Through the use of theatrical plays, it broadcasted valuable information about matters of health, family planning, agriculture, nutrition and natural disasters to its population in both urban and rural areas. The magnificent landscape photographs of Ansel Adams invigorated the movement that led to the preservation of many national parks in the U.S. Recently, there has been encouraging news of more traffic on the bridge that connects C.P. Snow's cultures. Rambert Company, Britain's oldest contemporary dance company, was commissioned in 2005 by the Institute of Physics to choreograph and perform a piece called ***Constant Speed***, as part of the Einstein Centennial celebration. In the U.S., the dance company of Liz Lerman has lately been performing ***Ferocious Beauty: Genome***, a dance expression about the power, potential benefits and dangers of genetic engineering. In Michael Frayn's Tony Award-winning play, ***Copenhagen***, the human element of an affectionate relationship between two physics giants, a teacher and his student, drives the play, but also generates interest in nuclear physics and the development of the atom bomb. We hear of Nobel prize scientists who in the second half of their lives explore the connections between science and art. The late astrophysicist S. Chandrasekhar wrote about the beauty in science and art[12] and the chemist Roald Hoffmann, is known for using chemical vocabulary and metaphor in his poems. Recently Gwyneth Lewis, the National Poet of Wales, spent a term as a poet in residence at Cardiff University's School of Physics and Astronomy, in an arrangement that provided her with tutoring with the condition that she would compose a poem on astronomy.[13] My own college supports interdisciplinary collaborations in a variety of ways. Columbia College Chicago recently hosted an exhibit called Physics Artisans at Fermi Laboratory, where the tracks of particles made in collisions by particle accelerators were presented as an art form. Our Book and Paper Center has often hosted exhibits that were of interest to artists as well as scientists. I have often participated in special sessions of physics and the arts at annual American Association of

[12] Beauty and the quest for beauty in science, by S. Chandrasekhar, Physics Today, Vol.32 No.7 July 1979, pp 25-30

[13] Finding a poetic language to describe the universe, by Heather Pinnell, Interactions: The newspaper of the physics community (published by IOP, Institute of Physics) May 2006, page 8

Physics Teachers events that feature physicists who venture into the art world and artists who are fascinated by physics.

Conferences that bring together traditional disciplines with arts and humanities are also growing. In the summer of 2004, I attended the Fifth Annual Conference of the International Society of the Arts, Mathematics and Architecture, where I presented a paper on the scientific and artistic expressions of space. In the summer of 2005 I participated in the Fifth International Conference of Inspiration of Astronomical Phenomena. More than one hundred scholars, artists, physicists and astronomers, museum and gallery curators, film makers, dancers, poets and novelists, professors and students from different countries bonded over the shared love for the cosmos and the cosmic phenomena. The cosmic representations found in classic paintings, poems and literature were discussed; films and dance performances specially created to celebrate the cosmos were presented; and astronomy's rich connections to astrology and religion were explored. My own presentation entitled "Cosmic Art" showed how students in my classes use their art to express their fascination, understanding, or sense of mystery about the cosmos. This was the McGrath model all over again, except this time, rather than using a lump of coal, the cosmos became the centerpiece and the "intellectual glue" that brought so many disciplines together.

The best gift of the arts and humanities to science is to help awaken those noble feeling of fascination and inspiration about the workings of nature as revealed to us by science. These feelings become the fuel of our curiosity engine that will enable us to become life-long lovers and explorers of science. We are born with an insatiable curiosity, a childhood instinct to want to discover how nature works. In our childhood everything is an adventure and an exploration. Yet most young people lose this interest in their teenage years. Is it a result of a poor high school experience, or just hormonal changes that sets different priorities in our thoughts and actions? Perhaps our high school system of education has killed that natural enthusiasm and curiosity. Nothing can be more counterproductive to learning than a mind without curiosity. To a young student like Einstein, who suffered at the hands of the regimental German education system, the school resembled barracks and the teachers acted like lieutenants. To Einstein, what is mostly needed in schools is to ensure that the system constantly fans the flames of curiosity in students. He wrote[14]

" It is almost a miracle that modern teaching methods have not yet entirely strangled the holy curiosity of inquiry; for what this delicate little plant needs more than anything, besides stimulation, is freedom."

Any scientist will attest that his or her journey to science started in childhood by the fascination of something, a butterfly or a train, insects, rocks or the clouds. For Einstein, it was a compass he received from his father when he was five years old. We need to restore those childhood feelings of fascination and curiosity that drove us to learn. The humanities and the arts can help us reignite those feelings in science. We need to use our imagination and our creative intellectual resources to set in place viable intellectual bridges between disciplines. Both of C.P. Snow's cultures need to reach out to each other and to the public at large. Einstein said it best when he criticized scientists who choose to work in isolation and fail to share their science with the public. In the forward of the book ***The Universe and Dr. Einstein*** by Lincoln Barnett, Einstein wrote: [15]

"It is of great importance that the general public be given an opportunity to experience - consciously and intelligently - the efforts and results of scientific research. It is not sufficient that each result be taken up, elaborated, and applied by a few specialists in the field. Restricting the body of knowledge to a small group deadens the philosophical spirit of a people and leads to spiritual poverty."

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[14] 1879 - 1979 The Einstein Centennial Exhibit. American Institute of Physics (AIP), 1979
[15] The Universe and Dr. Einstein, by Lincoln Barnett, TIME Inc. Book Division, 1962, page xvii