

Education and collaboration in fundamental science as bridges between nations

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Summary

Peaceful collaboration between nations is often an essential element in scientific investigation and exploration. Even when divided by differences in political, ethnic and religious systems, territorial claims or even war, nations may still have common interests when it comes to pursuing science, which can be illustrated by various examples. Since, unlike man-made laws, the laws of nature are irrevocable and absolute, agreements can be reached concerning the scientific results in spite of all differences. Scientific collaborations of different nations all across the globe can also be extremely beneficial in enhancing mutual understanding and as such be conducive for peace and collaboration in other areas. Bringing science to regions where science has not yet been appreciated as much as it should will not only be of tremendous economical importance, but also help to achieve a better understanding there of the world we inhabit and of all the potentialities for a peaceful coexistence of all its inhabitants. Many global problems such as war, poverty, availability of resources such as food, water, energy and provision of health can only be addressed in full collaborations of all nations.

Full keynote speech

Diversity as the source of progress

Our world is characterized by differences. All nations on this planet are conspicuously different. The people living in these nations all differ from one another. This, of course, is a good thing. Because of differences there is trade between nations, there is discussion

between people, and differences in time allow for progress to take place. Differences are the basis for the process of evolution, the very basis of life.

Also the progress in scientific thinking can only come about when different people come together with different ideas, investigate different mysteries and follow different approaches to stumble upon solutions. Some scientists spend their lives hiking through difficult terrain, some build delicate microscopes, others build gigantic machines for their investigations, and others do experiments only in their imagination. Some investigators work with the most meticulous accuracy, others follow wild and sloppy ideas. They all investigate the same world, the world in which we live. This world is so vast and complex, that all of these approaches for its investigation are justified; there is place for all these people. Different nations with different ethnic, religious and cultural backgrounds all participate in the same endeavor, and all of them are sometimes successful while many attempts at disclosing the truth fail.

There are a few things that all scientific searches have in common: We build on each other's experiences, and we communicate our results to our colleagues. Science is a collective exercise. Only by being open and by using the openness of others can one contribute to the scientific adventure in a meaningful way.

Science and technology as pivots for development

From what I just said it should be clear that science is not a privilege of the happy few, it cannot be confined to the white males in the industrialized countries. Thanks to a process called globalization, thanks to the internet, we can look at a future in which underprivileged people from developing countries can have access to modern scientific knowledge, a future in which all have equal possibilities to learn and to be educated. Sure, there still are gigantic obstacles blocking these opportunities for large numbers of people, but I also would like to stress the enormously promising possibilities, and I like to look ahead and speculate on how the world might come to a change.

What I said not only holds for science, but also for commerce, culture, arts, sport. However, I believe that the scientific exchanges will have the deepest and most lasting effects in the more distant future. Science and technology are the most essential pivots for development, and by embracing the most modern findings nations can maneuver themselves in a position to join with the industrialization process and the associated wealth, where wealth is meant in the widest sense of the world: living a healthy life in a clean environment and a stable and just social system is often an even more satisfactory form of wealth than the possession of exorbitant amounts of currency. Countries that today are counted among the poorest of the underdeveloped regions can change tomorrow.

All they need to do is join the rich nations with all the power they have and learn about their technological and scientific achievements. The obstacles are well-known: unstable, violent and corrupt political systems, ruthless military power and criminal organizations are deliberately blocking progress. If these could be replaced tomorrow, poverty, suppression and war could come to an end tomorrow. From a purely scientific point of view, this planet has more than the resources needed to keep its population healthy and secure, even if this population were to grow even further. Science is showing us the way.

Science in developing countries

What kinds of science should people in the poorest, underdeveloped regions try to do? There is an enormous amount of choice. Of course, one's mind drifts to those sciences from which they can benefit directly; it would be wise for them to spend research efforts on environmental issues, especially their own environment, the science and technology of water distribution, quality, availability and use, the availability and exploitation of energy resources, food production methods, health issues, climate, and issues for the social sciences: the combat of poverty, class inequality, corruption and crime for instance.

However, it would be wrong to focus only on the sciences that have obvious direct applications. If the Western world would have done that, our science at present would

still have been about how to produce cheaper and more efficient candles, in the fanciest colors perhaps, while we still would not have electric light in all its varieties as we have today. However even that is not exactly the right argument for poor countries to go into modern, pure science. The correct argument is that this is the only way to generate a class of highly skilled scientists and educators, who would be the only ones able to lead the country into the 21st century. The poorest countries in general feel no restraint in buying the newest high-tech weaponry from the West, therefore the least thing they should do to balance that is also buy the peaceful technologies of modern science and participate with as much vigor as they can.

India and China are doing this, and even though some of us in the West still regard them as third world nations, they are making serious attempts to do the most fashionable things such as sending humans into space, firing spacecraft to the Moon and building the most state-of-the-art particle accelerator facilities. These countries possess a large enough economy to be able to afford such adventures, but, in particular India, received serious criticism for not spending the money on more urgent issues such as health and hunger. This criticism is misplaced. Scientific research of the top shelf will tremendously enhance the visibility of these countries abroad, will keep the most skillful scientists within their borders and generate an invaluable boost to the motivation of youngsters to get the best possible results in their education, just to ensure that they too will be part of the show.

Examples of successful international scientific collaborations

Abdus Salam, the 1979 Nobel Laureate for Physics, saw this right: "It is a political decision of those in power, those who decide on the destiny of humanity in the underprivileged regions of the Earth whether or not they will take steps to let their people to create, master and utilize modern science and technology". In 1964 Salam founded the International Centre for Theoretical Physics in Trieste, Italy. This centre, now called the Abdus Salam Center for Theoretical Physics, operates under a tripartite agreement among the Italian Government and two United Nations Agencies, UNESCO and IAEA. Its mission is to foster advanced studies and research, especially in developing countries.

While the name of the centre reflects its beginnings, its activities today encompass most areas of physical sciences including applications.

The ICTP thus focuses on developing nations. However, it does produce top class physical results, and it can compete perfectly well with all other research institutes in the developed world. Some purely Western international scientific laboratories such as CERN, Geneva, allow physicists from non-member states to participate in their scientific programs. Non-member states currently involved in CERN programs are: Algeria, Argentina, Armenia, Australia, Azerbaijan, Belarus, Brazil, Canada, Chile, China, Colombia, Croatia, Cuba, Cyprus, Estonia, Georgia, Iceland, Iran, Ireland, Lithuania, Mexico, Montenegro, Morocco, New Zealand, Pakistan, Peru, Romania, Serbia, Slovenia, South Africa, South Korea, Taiwan, Thailand, Ukraine and Vietnam. Top science is being brought home to these nations, and they all profit from this.

Another institution where we do our best to accommodate people from developing nations is the system of international summer schools in Europe. France has such institutes in Cargese, Corsica, and Les Houches in the French Alps. In Italy I am co-directing the Erice Schools of Subnuclear Physics together with the charismatic Italian professor Antonino Zichichi. This school is unique in that it keeps a balanced mix between purely theoretical investigations and fundamental experimental research, discussing the most essential developments in all big laboratories in the world.

In Europe many of these scientific research schools enjoyed generous grants from NATO. At the time I thought that this was a brilliant move of this peace keeping organization; after all there is nothing better for peace than joint meetings between elite inhabitants of many different nations. Indeed, NATO insisted on the participation of scientists from the Eastern countries with some given percentages. However, much later this turned out to be a prototype example of paracceding, a word that stands for: "doing the right thing for the wrong reason". NATO insisted on the participation of scientists from the nations at the other side of the Iron Curtain just because it was thought that this might be a way to have military secrets leak out towards the West - a very naive

supposition to put it mildly. But I do think that schools of this sort brought more understanding between nations, an understanding nourished by intensive scientific contact - one of the "bridges" that this presentation is about.

Obstacles of development and progress

If economic wealth would have been more equally distributed across the planet, if there hadn't been social inequality and class distinctions, if it were just a question of applying science and technology, there would be no poverty, enough food, water, shelter and health care for everyone on this planet, even if the population were to grow further. Today's "credit crisis", if good for anything, certainly shows that large amounts of cash exist in the rich countries that could have been applied for generating or improving the infrastructure needed to alleviate the needs of the poor, not by just handing them money, but by improving the quality of health care and education and, of course, by investigating and addressing the issues that lead to war and social disruption. Often these are religious issues, a topic that I will address again briefly.

Of course, scientists do not have the power to redistribute economical wealth, and our world cannot be turned into an utopia overnight. What we can do is address the education problem, bring our message across to the people and the politicians in power. This is what I am trying to do now.

In effect, science has the capacity of bringing people together with altogether different backgrounds and even nations that are at war with one another. A perfect example is the SESAME project.

The idea of an international synchrotron light source in the Middle East was first proposed in 1997 by Herman Winick of the Stanford Linear Accelerator Center (Stanford University, USA) and Gustaf-Adolf Voss of the German Synchrotron (Deutsches Elektronen Synchrotron) during two seminars organized in 1997 in Italy and in 1998 in

Sweden by Tord Ekelof with the CERN-based Middle East Scientific Co-operation group headed by Sergio Fubini

The German particle laboratory DESY at Hamburg had just decided to decommission one of its facilities, BESSY 1, of which a newer version was being built in Berlin. The German government agreed to donate the components to SESAME, provided the dismantling was taken care of by the latter. UNESCO got involved and held a meeting in Paris in 1999 of delegates from the Middle East and other regions. Jordan, which has been selected to host the center, is providing the land as well as funds for the construction of the building. The groundbreaking ceremony was held in January 2003 and construction work began the following July. The component parts of BESSY 1 have been shipped from Germany to Jordan. UNESCO is the depository of the SESAME Statutes. In January 2003 the center's creation was formally sealed following an exchange of correspondence between Koïchiro Matsuura, Director-General of UNESCO, and UNESCO's member states. The first President of SESAME was Herwig Schopper from Germany (a former director general of CERN).

Member states are Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority, Turkey.

A pending member is Iraq.

Observers are France, Germany, Greece, Italy, Kuwait, Portugal, the Russian Federation, Sweden, UK, USA.

A pending observer status has Japan.

Inevitably, smaller nations with smaller budgets tend to prefer purely theoretical research rather than getting involved with expensive experiments. This is all right as a start, there is nothing wrong with theoretical research, it is a lot better than nothing (I am a theoretical physicist myself), but I do insist that the bold step towards hard experimental science must also be taken. It is not easy. When I visited China 20 years ago, I saw high-tech particle laboratories, where instead of electric devices pulleys and other hand

operated machines were used. Now China is closing its gap with the Western world, sending space ships to the Moon.

Science and religion

There is also outright opposition against the scientific method. This takes on several forms. Religions tend to bar scientific findings as threats to their beliefs. We have a history of that in Western Europe. Most opposition has since disappeared with a few notable exceptions:

1. Evolution theory: It contradicts standard religious beliefs in various ways. First, it sheds a very different light on the origin of mankind and its relation to animals as well as establishing a vastly longer time span that evolution has taken up. But even more importantly: Evolution theory gives a much more detailed explanation of animal and human behavior. Behavior is not imposed by laws declared by a divine being or his prophets, but by laws of Nature, which can be understood by logical reasoning.

2. The nature, size and age of the Universe: Science also shows that its existence is far longer in time than the creation stories, and it de-emphasizes the relevance of human existence, or in fact even any form of life, in the Universe. Most religious people however are less concerned about the latter discrepancies, and they can accommodate them in their belief system.

3. The way science addresses issues such as birth control, abortion, euthanasia and questions of sexual behavior: The natural scientific approach is that life at different stages of its development should be valued differently. A fetus of a few weeks old and an elderly person close to his or her death should be valued differently from a healthy person in the climax of his life span. Religions usually refuse to differentiate. It is difficult of course to differentiate between humans, since history, even that of modern times, often shows the disastrous consequences, and whenever religious systems provide rules to live

by, exact equality is usually the best choice that we can agree upon. However, questions as to how to judge the very beginning or the very end of our lives have to be addressed.

Now, other religions and nations add their own problems with science. During my visit of Riyadh I noted that the Saudis tended to restrict themselves only to very traditional themes: Lunar science (allowing Arab scientists to study lunar rocks for instance), topography (giving them access to GPS technology) and cryptography (allowing mathematicians to study number theories). These tendencies should be discontinued. Arab people, just like the people in all other nations, should be strongly encouraged to study all aspects of modern science.

I sincerely hope that the internet revolution will accomplish this. With full access to all sites of the worldwide web investigators should no longer be inhibited in any way. Governments however must also encourage their scientists to become acquainted with all aspects of modern science. Continuing on this line of thought I also hope that the internet will be instrumental in establishing a more democratic world order, although of course many other things might happen. Anyone can add his or her messages to the internet, and consequently it is possible to be entirely misled. All I can say is that I have good hopes for the good intentions of a majority of internet authors and chatters.

Real and pseudo science

Not only is there opposition against some well established fields of science; there are also charlatans who hope to become the messiahs of entirely new fields, often directly contradicting established science. We know of numerous examples. My initial remarks about diversity also apply here: People are vastly different from one another. It is difficult to describe in a few lines all these different personalities who attempt to overthrow some established piece of wisdom. What they often do have in common is a lack of self-discipline and self-criticism that would normally lead one to compare one's result with those of professional scientists. Once you start to believe that your own concoction is superior, there appears to be no way back. You then are a maverick self-proclaimed

scientist, and what often emerges next is a severe feeling of pain and injustice: Professional science is not taking any notice at all of the maverick's "new ideas".

Since Albert Einstein was such a mythical figure, his theories of relativity are often the subject of maverick theories. Fortunately, relativity theory is so clearly understood by most theoretical physicists that they can make short work of the "crackpots" here. Sometimes refutation takes more effort. From time to time a scientist unable to accept the refutation of his or her ideas may become fairly violent, but these really are exceptions. Sometimes the borderline between real science and pseudoscience is not easy to draw. There are also stubborn examples of "pseudoscience" or "metaphysics", see for instance the extensive research attempts concerning paranormal phenomena. They are called "paranormal" because they are in conflict with the "normal" phenomena, which are successfully described by science in all their details. In my view "paranormal" means "not properly fitting in the scientific picture" and as such needs to be severely questioned. It is the experience of a vast majority of scientists that scientific findings are not in conflict with one another, and whenever it happens that conflicts seem to be observed, this usually is due to inaccuracies. We are humans and as such not immune against human failures. The best advice I can give is always to stay as critical as possible, particularly when results are claimed that seem to be irreconcilable with what we thought we knew. It does happen of course, very occasionally, that new approaches lead to new insights that overthrow the old establishments, but more often these are gradual improvements and not revolutions at all. It is important that I spent a few words on pseudo-scientists on this occasion, since, sadly, developing countries often provide rich breeding grounds for such people. More remarks about good science and bad science can be found on my web pages.

Education as the basis for progress and development

Science cannot do without the highest quality of education. Our society, even those of underprivileged countries, is based on science. Only those nations that invest heavily in

the education of their people at all levels will be able to generate their own scientific elite, and only those nations can subsequently take their future in their own hands.

In fact, I have often been asked how can it be that the Netherlands, with 16 million people at present, but only 5.1 million in the beginning of the 20th century, had so many outstanding scientists including several Nobel Laureates, particularly in the first half of the 20th century? We had Van 't Hoff, Lorentz, Zeeman, van der Waals, Kamerlingh Onnes, Einthoven, Eijkman, Debije, Zernike. In the biography of Kamerlingh Onnes, written by Dirk van Delft, it is obvious why these people were outstanding. In 1863 a new educational system had been introduced by the politician Johan Rudolf Thorbecke (1798-1872) who realized that the existing classical education system, which only existed for a happy elite, was not suitable for the larger part of the population. They should have what was to be called a Higher Civilian School (HBS). There the modern languages would be taught together with math, physics, chemistry and all other topics that would be useful to them. A whole new generation of civilians emerged, who had perfect control of Dutch, English, French and German. Scientists such as Zeeman and Kamerlingh Onnes could not only read all papers in these languages, but also address the authors in their own tongue. They also started their research with high skills in mathematics, physics and chemistry. Thus, it should have been no surprise that excellent scientists emerged from this background.

Unfortunately, today too many "experts" have reformed the educational system in the Netherlands to such a degree that now a majority of the inhabitants receive a highly criticized kind of education, but highly skilled pupils no longer get what they would want, and the numbers of excellent students and researchers are decreasing. Of course, also the circumstances in my country are changing. Only one language, English, is needed to be able to do good science, so that physicists from English speaking nations are having a slight advantage, while nearly the entire globe now manages to communicate in that language. But the lesson is clear: Concentrate on good education.

Good education begins at the earliest ages: kindergarten, primary school, secondary school. Until age 16 or 18 education should be the very priority for all children, after which they might wish to continue to specialize by choosing from a wide range of possible professional educations.

Education must also be seen as a bastion against extremism. Extreme ideas of religious, nationalistic or ethnic nature usually foster from ignorance. Youngsters with good educations are much more exposed to people from nations with different cultural and ethnic backgrounds and are more prone to the idea that the entire planet is inhabited by only one human race: Homo sapiens. In this sense then science can also act as a bridge between nations. Extreme excitement is raised by the most glorious aspects of science, the Nobel Prizes and humanity's attempts to conquer outer space.

Finally, I return to the subject of religion. It is sad to observe, time and again, that humanity takes its refuge to beliefs from sources that one is not allowed to question and that are sometimes at odds with scientific findings in a blatant fashion. These belief systems often inspire to commit violence, not because a religion itself provokes to violence, but because believers see no other way to impose their religious views. A major fraction of humanity cannot live without some sort of religion, because religions answer three sets of questions.

The first set concerns the question why we are here, what is the purpose of life, how did life get started and how will it end.

The second set of questions is about justice: Why are wrong-doers not always punished and why are honesty, sincerity and love not always rewarded. Is there an after life where these apparent shortcomings are corrected?

The third set of questions is one of morale: How should we behave, how can we please our creator so that we may expect our after-life rewards?

In my opinion there is room for religious feelings with which one can address such questions without being at odds with any scientific finding. But reality is a bit harsher than the pleasant, but incorrect answers given by most religions. The answers given in the old books are wanting, in my opinion, just because these books were written at a time that many scientific facts were simply not yet known. I personally would correct for that in the following way:

The first set of questions, as to what life's purpose is, has actually been answered by the biological sciences. Living creatures aim at continuing their life form. Our human behavior is naturally geared towards prolongation of human presence on Earth and possibly to spread our presence to other regions in the Universe. Our presence, in a slowly evolving form, may continue for millions of years.

The second set of questions, concerning justice, in which I include the question as to what will happen to our "soul" after we die, should have the following scientific answer: We have no soul in the sense that some religions want us to believe, but we do live on after we die: We live on in the remembrance of our loved ones. I remember my father and my mother, who have died some time ago, and the images of them in my brain are the souls with which they continue to live. Someone who has been good will be remembered in a positive way, and that is the blessing their "souls" receive after they die. People who make a more lasting impact on their loved ones, friends and fellow countrymen have a longer afterlife in that sense.

This then also leads the way to answering the third set of questions, how to behave. Our ultimate aim should be to leave a positive memory of our deeds in the minds of others, in the most general sense. Suicide bombers thus surely end up in hell: They will be the villain in the minds of all those who lost their beloved ones for reasons that are difficult to comprehend.

I am not a missionary. Nobody has to embrace my religion because I would be preaching it, but I say these things merely to explain the attitude that I would recommend to a

scientist when he or she wishes to supplement a scientific worldview with a spiritual one without arousing internal conflicts.

Science will not come to an end. There will always be subjects to investigate, phenomena that arouse our curiosity. Science is a universal undertaking, and as such it has the capacity of joining and uniting people. I realize that some of what I said may have sounded naïve. Even with science problems, disagreements and war will not go away overnight, but I hope that I succeeded in conveying the message that a scientific attitude will be the best starting point to making a difference.