

Public Understanding of Life Sciences A Cornerstone for the Today's Democracies

K. E. Simitopoulou and N.I.Xirotiris

GENERAL CONCEPT

In the continuing war against death, disease and poverty, the major weapon of our species is science. To not see that is to have closed eyes.

Julian Tobias (1910-1963)

In these few words Julian Tobias summarizes the importance of Science in our high tech societies and the appreciation it deserves.

The recent explosive progress in life sciences and informatics brings these two fields in the front of social evolution and gradually (but rapidly) influence our every day life.

Pioneer research and consumption of biotechnological products and services, both closely related to economy, push the policy makers and the governments, at least in the Western societies, towards a more intensive use and appreciation of biotechnology. Yet, given the globalisation of the world economy, the political decisions made in the developed countries, directly influence the welfare and the environmental status of the rest of the world.

Therefore, the quality our technologically depended Democracy is crucial for the future of our societies, but it has an extended impact to all the people of this planet as well.

Undoubtedly, today's Democracy, is far from being the perfect system of governing, with many weak points in its application. However, it is the best political model ever implemented, as it is based on clear principles and it incorporates control procedures that guarantee the respect of human rights.

However, the more complicated our world becomes, in terms of technological advance, the more difficult is for the citizens to participate in political decisions depended upon scientific information.

Nowadays, more than ever in the human history, citizens are challenged to make conscious and intelligent decisions about questions arising from both their natural and cultural environment.

- How the spread of epidemic diseases should be faced?
- What about the privacy of genetic information?
- Should the genetic information be patented? By whom? Under what terms?
- What could be the consequences of the broad

use of Genetically Modified Organisms?

- How the biological, legal or moral consequences of the new reproductive technologies could be prevented?

It seems that the wide public in general has no sufficient educational background to go through such questions, including high class conventionally educated people. The existence today of pseudo-scientific ideas, of astrology, of religious sects, of samanism etc. is unpleasantly surprising.¹

REASONS FOR THE LOW LEVEL OF PUBLIC UNDERSTANDING OF SCIENCE

A series of actual reasons related to this situation could be mentioned:

Due to the traditional split between Humanities and Science, (Humanities versus Science actually) there is a rather primitive relationship between public and science. The context, the methodology and the related studies of these fields have pursued opposite directions, while little efforts have been made to bridge the gap. Even university graduates (mainly from Humanities) sometimes hardly have an integrated knowledge of the aforementioned issues. Yet, it is easily accepted that an educated person "cannot understand" Mathematics or Physics for instance, while somebody who has never read a classic novel is also easily characterized as "illiterate".

Unfortunately, many among the decision makers lack of scientific education. Thus the governments are guided, or at least strongly influenced, by arguments and ideologies reflecting particular profits and exploitation intents, or, in best cases, by fuzzy aspects generated by unclear knowledge.

On the other side, groups of sensitive people who are deeply and honestly concerned about the implication of science in society, are often "pooled" by an "anti-developing", loudistic spirit. Science is accused as the source of large-scale disasters, consequently the deterioration of research is proposed as the appropriate solution for the humanity's welfare. Thus, regardless the good intents, more confusion is created to the public debate.

Science, due to the self-isolation of scientists, is considered by the wide public a restricted

“sanctuary” under the absolute authority of the particular class of researchers. Scientists are described as peculiar people, closed in their laboratories, communicating through incomprehensive codes and producing our future according to their interests, in our absence.

Education, supposed to be responsible for the people’s preparation for their effective incorporation in their social structure, is characterised by inertia, inequalities and seems to be inadequate under the contemporary circumstances.

Conventional educational systems, usually ignore, or hide, some truths referring to Science and technology. The neutrality of Science for instance, or its exclusive orientation towards the human kind progress, are some of the widely accepted, even false, ideas. The historical framework, the temporary social circumstances under which particular scientific achievements were reached, the scientists’ personalities etc, are hardly mentioned. The extreme acceleration and the cruel competition of the scientific progress, although crucial for the establishment of our “brave new world”, remain in the margins of the public’s interests.

The involvement of the mass media in the presentation of scientific issues is not always adequate. The lack of specially educated journalists, the involvement of particular profits pushing to selective presentations of scientific subjects and the low quality of the provided scientific information, are some of the reasons. Thus, the media’s approach is often idealistic and sentimental instead of being reasonable and intensifies people’s confusion in political or moral dilemmas related to biotechnological issues.

IMPACT OF SCIENTIFIC KNOWLEDGE ON THE QUALITY OF DEMOCRACY

Therefore, one major factor influencing the quality of Democracy, namely the properly informed and conscious citizen, is still a rare case. A lot of effort should be put in order to ameliorate the public understanding generally in Science and particularly in life sciences.

The aforementioned description explains also the researchers’ awareness about the continuation of the public funds devoted to research, and justifies the creation of alliances between Universities, research institutes and industries, aiming to promote public understanding on the benefits of biotechnology.²

Indeed, many such initiatives and good

practices concerning the screening of public opinion and the promotion of public understanding have arose in advanced countries. However, particular motives are often hidden behind these movements, related to the maintenance of the funding opportunities and the increase of the biotechnological products’ consumption.

Despite of the aforementioned doubts, Science constitutes itself an ultimate democratic system. A potential cornerstone of democratic function and for this reason it should be easily approachable to the wide public, regardless the direct relationship between public opinion and financial issues.

Scientific knowledge should be promoted because:

Its development demands the free circulation of ideas, Its values oppose to mysticism, being continuously exposed to doubts, critics and potential reformation. (*Ubi dubium ibi libertas*).

While Science brings power to its knowledgeable, it does not offer any particular advantage or privilege. It encourages anti-conventional aspects and strong disagreements and productive debates. It proceeds by rationalism, documentation, collective action and high spiritual honesty.

These are the core traits of Democracy, as well, Consequently, dealing with Science, understanding Science, constitutes in parallel a practice of free thinking and rational decision-making, thus preparing “conscious” democratic citizens.

According to Carl Sagan³, there are four major reasons for a coordinated effort to disseminate Science by all means (through mass media, PC programmes, lectures addressed both to the formal students and to the wide public):

1. In spite of the – existing – possibilities of misuse, Science could be the golden outlet of the third world from its misery and poverty.
2. Science feeds our awareness of the technology generated dangers, threatening our environment, which our existence is depended from.
3. Science provides us with an objective, although fragmental and incomplete, knowledge about our origins and our nature, about the common destiny of our species, our planet, our universe. It is the best tool of *homo* to approach his main question through time: Who we are, where we come from, where are we going to?
4. The values of Science and the values of Democracy are linked and often inseparable. The seeds of their early beginning grew up in the same epoque and place. In Ancient Greece of the 7th and 6th century B.C.

RECORDING THE TODAY'S SITUATION - SOME INTERESTING CASES

A recent educational research in UK, funded by Wellcome Trust (performed under the supervision of Dr. Jenny Lewis) focused on the knowledge and understanding of basic genetics and gene technology of young people aged 15-16, in Yorkshire region.

The results showed that the level of understanding of basic genetic concepts was very low. Despite this poor understanding, the majority of the young people could, given limited but tightly focused teaching about the specific context, engage with complex issues related to gene technology and come to reasoned views which they could justify.⁴

Wellcome Trust has also funded another research focusing on two directions: a) The various ways in which the facts, issues and policies involved in science are brought to the attention of the public and b) what are the attitudes of the general public towards science. The results are discussed in the paper entitled "Review of Science Communication and public attitudes to Science in Britain".

The general outcome is briefly discussed below:

- a) Many science communicators accept that a better coordination is needed to maximise the impact of the scientific information provided. There is a conflict among different bodies involved in science communication, since the information offered is "provider driven".
- b) A key finding of the survey is the identification of 6 different attitudinal clusters, deduced through factor and cluster analysis of 40 attitude statements provided by 1839 individuals.
 1. *Confident Believers*: (17%) Interested in science because of its benefits. They have faith in the regulatory system and they believe that they can influence the Government. They tend to be well off. Well educated. middle aged. Settled mainly in the south of Britain.
 2. *Technophiles*: (20%) Well educated in Science. pro science but sceptical of politicians. They know how to find the proper information but they need reassuring of the effectiveness of regulations.
 3. *Supporters*: (17%) Relatively young, they are "amazed" by the technological progress and they feel self-confident to cope with rapid change. They trust that the Government has got things under control.
 4. *Concerned*: (13%) Mostly female (60%). They have a realistic and positive attitude to life but they are very sceptical to those in authority.

Middle income, home centered, interested in a wide range of topical issues, aware for the future (of their children).

5. *Not sure*: (17%) Low income, low education level (semi and unskilled workers, depended upon state benefits). They are neither anti- nor pro- science, largely because the benefits of science are not apparent in their daily lives.
6. *Totally Indifferent*: (15 %) Mainly over 65, low social level women and manual workers. They are not particularly interested in political and topical issues, nor for science, even if they recognise its importance to young people.

Some general conclusions could be inferred at first sight:

At national level (in UK), there is lack of a framework within which people can access and judge information about new science.

The variety of attitudes implies the necessity of differentiated educational approaches for each particular group. A co-ordination and collaboration between relevant organisations should be promoted, in order to get an optimum output.

Although these general assumptions have been produced in a technologically advanced centre, they could also provide the background for a proper educational strategy even to satellite countries (in terms of biotechnological research and economy), which, sooner or later, follow the international developments with an expected delay.

In 1996, a research entitled "Europeans and Biotechnology" was conducted for Eurobarometer, with the participation of 16,246 people aged over 15, aiming to record the relevant opinions and attitudes of the mean European.

The survey has produced a series of interesting results:

For example, while the common rational implies that the better people are informed about a specific scientific or technological development the more they are willing to support it, the results showed quite the opposite. In comparison to a similar survey of 1993, people in 1996 were less optimistic regarding the capacity of biotechnology and genetic engineering to improve living conditions, even if the public's knowledge had increased in the mean time.

Surprisingly people from countries with low tradition on biotechnological research (from Greece or Portugal, for instance), seem to be more supporting biotechnology and less aware about its potential threats than English or Dutch.

The graph (at the end) shows that the European public highly appreciates the usefulness of bio-

technology in early detection of diseases and medicines accordingly supporting the encouragement of research, without strong ethical objections. However, the applications in food and transplants are less favoured in the public's preferences.

In Details:

1. In all Member states the two most useful applications of modern biotechnology are thought to be the production of pharmaceuticals and the development of genetic tests.
2. In contrast, the two developments generally considered least useful are the use of modern biotechnology in food production and the introduction of human genes into animals to produce organs for transplantation.
3. Among to applications under question, those which were perceived as being the most useful were also those which considered the less dangerous and vice-versa.
4. Only a minority found genetic manipulations for organ transplantation into man morally acceptable.
5. The more useful for society the applications of Biotechnology were supposed to be, the more morally acceptable were considered.
6. Fewer than one out of four Europeans believes that current regulations are sufficient to protect people from risks connected to Biotechnology.
7. When it comes to "telling the truth about modern biotechnology", Europeans tend to have least confidence in political parties, industry and religious organisations. However, four Europeans out of ten consider that religious organisations should be allowed their say with regard to the relevant regulation.

CASE STUDY: THE SWISS BIOTECHNOLOGY REFERENDUM

On June 7, 1998, after a relevant Referendum, Switzerland voted by a 2:1 majority not to ban genetic engineering. The whole issue started with a popular initiative, the Gene Protection Initiative (GPI), which tried to implement the prohibition of all transgenic animals, the banning of all field releases of transgenic crops and the prevention of patenting certain inventions of biotechnology.

Before the popular vote took place, the Parliament committed itself to enact a strict regulatory framework, aiming to avoid banning. This was one of the most intensive campaigns ever performed. as it lasted two and a half years.⁵

The issues under question were:

1. No transgenic animals should be allowed, not even for biomedical research.
2. The release of all transgenic organisms should be banned.
3. The patenting of transgenic plants and animals should be forbidden, as well as the products and processes derived from them.

The beginning was in May 1992, when the Gene Protection Initiative (GPI) started the collection of signatures, achieving a total of 111000 signatures by October 1993, a sufficient number in order to demand a referendum.

According to the Swiss Constitution, a series of parliamentary debates took place in order to formulate a counter proposal, which led, in February 1998, to the governmental decision on the voting date (7th of June 1998).

In the mean time both sides had started their informative campaigns, gradually intensifying their efforts to persuade voters.

GPI was supported by various environmental groups. (Pro Natura, Green peace, WWF, Medical Doctors for Environmental Protection etc.). animal welfare organisations, organic farmers, consumer groups, several NGOs for developing countries and some left Politicians.

Their main arguments focused on the potential risks for human health and environment, on ethical issues concerning the violation of the genome, (of both humans and animals) as well as on the threatening dominance of multinational companies.

On the opposite side a strong alliance was established, including researchers in the life sciences (employed by Universities and Industry, or by organisations like GENE SWISSE), the Lobby for the promotion of Swiss Industry, Scientific Academies, professional associations, (like those of scientists and medical doctors, National Farmers' Association etc.). All Major political parties of the right also supported their aspects.

They defended the research progress and the biotechnological industry, claiming that a potential win of GPI's aspects should lead to a massive loss of job places and that a negative economic impact in spin-off enterprises of the third world should be expected. A decrease of pharmaceutical products of high importance for the human welfare, could also result from the deterioration of biotechnological activities.

Referring to the high quality biotechnological studies in Switzerland, they predicted a fall of the educational level in universities and training centers,

with the consequent inability to attract high quality students and researchers.

Finally they underlined the danger of isolation of their country from the international scene of the advanced world.

For a long period both sides kept promoting the publicity of their aspects, by all means. Weekly articles in the newspapers, public debates on the TV, distribution of informative pamphlets etc. Even a demonstration of scientists and researchers, something very unusual for Switzerland, was organised few days before the crucial referendum date.

The outcome of this intensive campaign was a complete swing in the public opinion in favour of the biotechnology defenders. While at the beginning the gallops predicted a percentage of 62% pro and 39% contra GPI statements, the referendum result gave 67% to the alliance of biotechnology supporters, rejecting the GPI arguments with 33%.

A first conclusion from this experience refers to the impact of the mass media to the promotion of public understanding of science. The indisputable democratic structures of Switzerland were once more documented.

THE RELATIONSHIP OF DEMOCRACY WITH PUBLIC UNDERSTANDING OF SCIENCE

However, the fact that only 41 % of the active population participated in the final procedure, arises some questions about the majority's awareness. Why the majority was absent from such a crucial issue? The hypothesis that most people remained neutral by purpose, after their proper scientific guidance, seems rather unstable, given the importance of the subject under question. Anyway, whatever the reason(s) of their silence, there is a signal of "something rotten" in the "kingdom of the perfect Democracy".

The perfect voting procedures, do not, by themselves alone, guarantee the quality of the political resume. Democracy is based, most of all, on the active, well informed and concerned citizens. The preparation of this kind of citizen is the major emergency for our prosperous societies, where the spiritual laziness and the non-stop consumption are usually promoted unequally in comparison to ethical principles and moral values.

Under the contemporary circumstances the latter need to be reviewed (so as to be compatible to our hi-tech societies), broadly accepted (as a common spiritual property for all people) and properly cultivated to the new generations. Here is the role of

public understanding of Science and here is the duty of its promoters.

Otherwise, we will never be sure about the real value, or the future impact, of "democratic" decisions, neither we could prevent their consequences.

Nowadays, more than ever, the cultural environment, rapidly transformed due to biotechnology, becomes an extremely important factor for the biological structure and the biodiversity of the human species itself. Co-evolutionary approaches, taking under consideration the simultaneous Nature-Nurture evolution should be applied in the creation of a global strategy on the issue of public understanding of Science. Any temporary profits evoked by economic, ethnic, or pure technocratic estimations should be excluded from such a planning. Fragmental initiatives deriving exclusively from the centres of the advanced science, which ignore the demand of a broader participation of people, will become ineffectual for a global sustainable development of our planet.

PROMOTING PUBLIC UNDERSTANDING OF SCIENCE – EXAMPLES OF GOOD PRACTICE

Finally, the promotion of public understanding of Science (and Biotechnology in particular) could not be viewed only as a matter of methodology, outside a wider concept including the philosophy, the strategy, the target groups and mainly the expected impact of any effort of familiarisation with Science.

A policy for the promotion of public understanding at national or international level could aim, for instance, to inform the consumers of biotechnological products and services in order to protect them from possible dangers due to misuse.

This increases the self-protection of individuals, but it does not cultivate a global spirit of responsibility, integrating the whole society, the whole bio-system, and the awareness for the future generations. Benefiting from the today's scientific progress for a global and sustainable development, pre-requests the inter-linkage between democratic structures and scientific achievements.

Many very successful examples of good practice concerning the promotion of public understanding could be listed⁶. Educational material and presentations methodologically perfect, attractive, informative, simplified, approachable even by young children is available on the web.

The European Initiative for Biotechnology Education (EIBE), for instance, has produced a series

of educational material. excellent in terms of attractiveness, quality of information and easy understanding.

The 20 different units present in the main EIBE web site deal with the major issues of contemporary Biotechnology, addressed to the secondary education students and teachers and to the wide public as well. EIBE also suggests activities and tricks that help anyone to approach the today's science, e.g. the presentation of a scene drama play based on bioethical debates and the creation of a tableware game, entitled "The Enzyme Game".

The latter is worth to be mentioned for some reasons.

Actually the game is a biotechnological version of the well known tableware game "monopolis". The players are supposed to produce one enzyme each. Detailed information is given to each player about the properties, the function, the preparation methods and the economic aspects related to each particular enzyme. During their competition, the players pass through a series of difficulties, which they can overcome by paying a symbolic amount of money every time. The winner is the one who first succeeds to produce his (her) enzyme at the lower cost. Creativeness, early interest for organisms' biological paths, cultivation of memory and scientific knowledge are perfectly stimulated through the game. However, the "protestant" spirit, which penetrates the western dominant scientific concept, is more than obvious.

EPILOGUE

During the preparation of the present paper, a lot of progress has been made in the field of Biotechnological research. There is a vast, non-stop acceleration to this field, with undoubtedly serious and not always predictable impact to the co-evolution of our species, as well as to the co-evolution of our bio-system. The sooner countermeasures should be adopted, the better. The cultivation of a rational approach in the promotion of Science's public understanding constitutes a priority. Advanced technological centres generate relevant initiatives. However, such an "one way" promotion does not always concern about the impact of biotechnological innovations to our whole worldwide village. The participation of any individual all over the world in the decision making is a crucial issue. The only available tool to prepare an essential people's participation, is intensive scientific education by all means. Proper national and international educational policies are needed, based on balanced appreciation

of both scientific achievements and moral principles. The main challenge arises from the fact that historically, the creation, acceptance and dissemination of moral principles is a time consuming procedure, whose rhythms lag behind the technological progress.

Nevertheless, classic principles like the individual's appreciation, the majority's aspects respect, the right for criticism, the establishment of legal frameworks and the individuals' duty to participate in public affairs, actually principles accepted in the early Democracy of ancient Greece, should "vaccinate" our modern societies. Public understanding of Science is the contemporary vaccination against the misuse of nowadays' Scientific achievements. To that respect, the relevant comments of Albert Zaquard⁷ are always welcome:

"The role of Science is to offer new ways of action to man. Moreover, to help man to control this action. The spiritual clarity is more indispensable than effectiveness. But this clarity has no weight as far as it is engaged within the laboratories. Science could become a tool of liberation, but it could also become a tool of tyranny. To avoid this malformation all those who deal with science must share their knowledge in such a way to be understood by anyone!!"

KEYWORDS Life Sciences. Biotechnology. Education. Public Understanding. Quality of Democracy

ABSTRACT A global promotion of public understanding of Science is more than urgent under today's circumstances, characterised by the accelerated interference of biotechnology in our lives. Many negative consequences, like mysticism, racist behaviours, misguided consumption, cruel competition etc., derive from the departure of people from the scientific knowledge, gradually leading our societies to a totalitarian, biotechnologically manipulated, world. This should be prevented through an intensive and properly planned educational effort. Rationalism, objectivity and transparency are promoted through scientific education, which is needed both for the specialists and the wide public. As the influence of life sciences increases, the more crucial becomes the issue of their public understanding, in order to prepare properly educated and conscious citizens. Historically the humankind has experienced Democracy as the best viable political system, in spite of its weak points. Democracy's protection and amelioration, finally its quality, depends crucially upon the development of public understanding of Science.

NOTES

1. It is worth mentioning a relevant research of 1984 in USA (published in the American Biology Teacher Journal) which revealed that 52% of secondary school pupils consider that they are able to guess the other people thoughts, 29% that we can communicate with dead persons, 30 % believe in Ghosts.
2. Related initiatives have been undertaken by individuals

- (Vollrath 1990, Bronowski 1990, Longino 1990 Musschenga 1985), or respective centers (AAAS 1989 NABT 1982 BSCS 1982 Hastings Institute 1980, Woodrow Wilson Foundation 1991)
3. The Demon-Haunted World: Science as a candle in the Dark, 1995, Greek edition ESOPTRON 1995
 4. Young People's understanding of, and attitudes to, "the new genetics" – by Jenny Lewis – <http://education.leeds.ac.uk/projects/lis/young.htm>
 5. Efb Task Group on Public Perceptions of Biotechnology
 6. A visit to the Web sites of HGP and EIBE is recommended.
 7. A. Zaquard: «au peril de la science? Interogations d' un geneticien»

RECOMMENDED WEB-SITES

<http://www.2think.org/sagan.shtml>
<http://www.humanist.net/publications/humanist/dawkins.html>
<http://www.santafe.edu/~shalizi/Dawkins/viruses-of-the-mind.html>
http://europa.eu.int/comm/research/index_en.html
http://ucbiotech.org/resources/biotech/talks/misc/APS_tlk.html
<http://www.nytimes.com/2001/11/11/business/yourmoney/11CARE.html?todayshadlines>
<http://www.bbc.co.uk/education/medicine/swcontent.html>
<http://www.boku.ac.at/iam/ebe/greece.htm>
<http://www.ornl.gov/hgmis/>
<http://www.ornl.gov/hgmis/project/about.html>
<http://www.rdg.ac.uk/EIBE/>

<http://www.amnh.org/>
<http://www.foundation.novartis.com/>
<http://www.jic.bbsrc.ac.uk/exhibitions/bio-future/>
<http://www.britishcouncil.org/virtual/science/biotechnology/biotin.htm>
<http://biotech.acadie.net/english/volume4/internet.html>
<http://psci-com.org.uk/browse/detail/8a07f2e22f8569cb73eebad5a52471d8.html>
http://www.expocentral.com/science/industry_science_biology_biotechnology.html
<http://www.sciencemuseum.org.uk/on-line/tour/mid-s-m-on-tour.asp>
<http://www.dmgworldmedia.com/sector.asp?sectorid=72>
<http://bancroft.berkeley.edu/events/onlineexhibits.html>
<http://bancroft.berkeley.edu/Exhibits/Biotech/25.html>
http://www.eurogentec.be/code/en/key_facts_exhi.htm
<http://www.dti.gov.uk/ost/ostbusiness/puset/sciconn/p07.htm>
<http://www.boku.ac.at/iam/ebe/spain.htm>
<http://www.dti.gov.uk/ost/scimu.htm>
<http://www.bbsrc.ac.uk/>
<http://www.kluyver.stm.tudelft.nl/efb/tgppb/main.htm>
http://psci-com.org.uk/psicomlit/biblio_archive/BIBNOV1999.html
<http://www4.ncbi.nlm.nih.gov/>
<http://www.foeurope.org/biotechnology/about.htm>
<http://filebox.vt.edu/cals/cses/chagedor/percep.html>
<http://www.britishcouncil.org/virtual/science/public/publ17.htm>
<http://www.scipol.demon.co.uk/spp.htm>

Authors' Address: K. E. Simitopoulou and N.I.Xirotiris, Laboratory of Anthropology DUTH P.O.Box 209- GR 69100 Komotini, GREECE
Email: simit@he.duth.gr