

## EDUCATION IN AND THROUGH SCIENTIFIC RESEARCH

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### Abstract

Considering that, when performing scientific research, any young investigator may enrich the knowledge in the field of his specialization, the role of the educator is that of opening new perspectives and of efficiently implementing the rules of a team work, of stimulating the desire to know more, the imagination and the initiative, in parallels with a strict observance of the ethical regulations characteristic to scientific research. One may therefore appreciate that education in and through research involves both working effectively together the young ones and one's personal example on the observance of the regulations and working conditions of the team, on opening new perspectives for a pluri- and inter-disciplinary training of the young ones, expected to become high-levelled professionals.

### 1. INTRODUCTION

As an essential aspect of academic training, scientific research provides – probably – the most efficient ways for education and self-education, as due to the multiple contact and communication possibilities it involves.

Defined as a human activity performed for obtaining information on the manner in which the theoretical or practical problems characteristic to a certain field may be solved, by the application of the best and most reliable methods now at hand, scientific research aims at attaining knowledge that may be recognized as possessing the value of genuine truth. Scientific spirit - one of the main achievements of human adventure - is indispensable in what it is defined, in terms of a UNESCO report, as "to learn to know". According to the international commission of education for the XXIst century, the essential four pillars for a new type of education are: to learn to know, to learn to create, to learn to live with the others and to learn to exist. *"Early initiation in science is salutary, as it assures access, from the very beginning of human life, to the inexhaustible richness of the scientific spirit, based*

*on interrogation, refusal of any prefabricated answer and of any certitude which contradicts facts"*<sup>1</sup>.

In any domain or discipline, the applied scientific methods involve examination of all stages indispensable in the pursuit of truth, the first one being, obviously, a correct definition of the theme and of its related problems. There follows information-documentation, elaboration and testing of hypotheses and, finally, formulation of the conclusions reached. All these stages require time, imagination, effort and initiative.

The team selected for solving a certain theme is usually formed of a group leader and a staff including a more or less numerous number of young researchers, students, candidates for a doctor's degree, each one playing a well-established part for a suitable development of the activity of the whole group.

The most adequate solution capable of assuring an efficient collaboration and approaching among persons of different age, position and scientific orientation is an open discussion with the whole group and solidarity in the action of finding solutions, in the strive for success, for a complex and integral upgrading of the efforts made and of the scientific results obtained. As, undoubtedly, the experience of the team leader and of the members conversant with the theme is of special importance in orienting the research, the possible new perspectives opened by the young group of the team, along with accessing of some adjacent domains valorize their enthusiasm, scientific curiosity, their thirst to know more and to go beyond the established patterns.

The contribution of a team work to education-training is important by the advantages it provides, including knowledge already accumulated from other activities (lectures, practical

applications, seminars), while challenging more serious study of the available references, stimulating the appetite for the discovery of the new as early as the documentation stage, transforms the professor-student relation into a more open one, the former having frequently things to learn together with his students.

## **2. ELEMENTS OF ETHICS IN SCIENTIFIC RESEARCH**

A first step of education through research involves knowledge and observance of the rules of *professional ethics*, in general, of the ethics of scientific research, in particular. Even if, apparently, they appear as elementary and easy to grasp, these rules are frequently infringed, either willingly or not, so that they have to be permanently reminded to all beginners in research activities, be they students or young investigators, candidates for a doctor's degree or post-doc specialists.

The ethical code in scientific research, development and innovation is aimed at promoting the principles, responsibilities and working procedures, so that such activities should be performed according to the principles adopted by the international scientific community, which is expected to assure a suitable attitude of the researchers, involving: a strict observance of the law, granting of the freedom of science, research and education, and of taking upon responsibilities.

Promotion of moral values such as: academic freedom, responsibility, personal autonomy, justice and impartiality, recognition of the other ones' merits, professionalism, intellectual honesty, transparency, respect and tolerance represents the main objective of such an ethical code, the observance of which grants the progress of scientific research. Instauration of a favourable climate for the initiation, development and successful finalization of any research depends on each member of the team in part, however, the main role in such cases is to be played by the group leader, coordinator, professor, project manager, whose educative

responsibility necessarily involves impartiality, exigence, control. He is expected to inspire the team with the courage of daring hypotheses and of anticipating the new or the already familiar approaches and themes.

The basic requirements a researcher has to meet are generally assimilated and perfected also within the team, the role played by the educator being once again essential. These conditions involve: respect for the contributions of the predecessors, partners and competitors, respect for intellectual property, honesty towards the others and towards one's own person, cooperation and true fellowship, sincere exchange of ideas, strict observance of the established deadlines. In the evaluation of the scientific results obtained, the originality and quality of the scientific products should prevail *versus* quantity, that is why the quantitative evaluation criteria should be correlated with those referring to the originality and efficiency of the knowledge process. All these will assure the final increase of the value of the scientific products obtained.

The standards of a corresponding behaviour in scientific research refuse a series of actions upon which the coordinator-educator should insist in training of the beginners. Thus, hiding or elimination of unwanted results, "manufacturing" of results or their substitution with fictitious data, distorted interpretation of results, plagiarism of results, incorrect assignment of the quality of author to a paper, hiding of information, failure to recognize one's own errors, the lack of impartiality in evaluating things, etc., all represent shortcomings that should be eliminated.

In the medical field, to such requirements some specific considerations should be added, related to the ethics of clinical investigations. The necessity of an experimental protocol in the beginning of each clinical study, information and the free consent of the subjects participating to the study, of well-established inclusion or non-inclusion criteria, of the manner in which the results should be expressed and their precision stated, make the difference between a correct and an incorrect investigation.

### **3. PLURIDISCIPLINARITY AND TRANSDISCIPLINARITY**

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The contribution of scientific research to the general training of a young student is manifested mainly as a thorough knowledge of the domain selected for research, as well as of some adjacent fields, which will assure a correct solving of problems at high standards. Quite frequently, initiation is required in one or more disciplines not approached in previous studies, which grants an as rigorous as possible interpretation of the obtained results. Nowadays, the unprecedented expansion of knowledge in all fields makes adaptation a most acute problem to be solved, the term here involved being that of *pluridisciplinarity*.

*Interdisciplinarity*, representing the transfer of methods from one discipline to another is a *must* of any modern scientific investigation. Thus, the transfer of the methods of nuclear physics to medicine provided new treatments against cancer, the transfer of statistical processing of data to medicine created the domain of medical statistics, and application of informatics in any field of research generated new disciplines of applied informatics. Here involved is therefore the interaction of various disciplines, with common objectives, similar to those of the synthesis that follows analysis<sup>2</sup>.

Nowadays, *transdisciplinarity* is viewed as a new vision upon the world, the notion having been established by the necessity to extend the frontiers among disciplines, and to go beyond pluri- and interdisciplinarity. In the beginning of a new century and of a new millenium, human civilization faces globalization, in both scientific information and science, and scientific research. The need for scientific investigation, for scientific information is continuously propagating from one domain to another, necessitating considerable efforts, usually unbearable for small groups, prepared for limited areas of research. The final objective of a transdisciplinarily-approached problem goes beyond the limits imposed by one or several disciplines, frequently facilitating amazing correlations, as science is in a permanent and ever-increasing interaction

with the other global problems of mankind. This leads to a unitary knowledge and to valuable generalizations, capable of revolutionizing some sectors of human activity, of enriching knowledge for a better understanding of world's unitary character and for discovering the common elements of some facts and phenomena.

An irrefutable remedy against routine and intellectual stone-stillness is the "courage of having a fresh perspective upon the newly-acquired knowledge and to cumulate not only new information but also new manners of thinking and behaviour"<sup>2</sup>.

### **4. COMMUNICATION-VISIBILITY-RECOGNITION IN SCIENTIFIC RESEARCH**

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Scientific information represents the *raw material* for the creation of other new scientific data, thus contributing to enriching their volume at worldwide level. Nowadays, the volume of scientific information has enormously increased, the contemporary human society being already facing an unprecedented informational explosion, if considering only the fact that, annually, the number of scientific publications, patents and inventions exceeds some millions.

That is why, the users of scientific information should possess some specific documentation knowledge, such as: a thorough familiarization with the documentation network and with the publications offering scientific information, basic notions for assuring an optimum communication with the staff involved in the network – both at home and abroad - the ability to use the instruments provided by the documentation structure.

Within a research team, whichever its size, communication among its members is essential for a correct establishment of the main guide marks of the investigation in course, of the stages necessary for problems'solving, for reducing the information-documentation times, for interpretation of the intermediary results, etc.

Communication with the people outside the team involved in some other research is the key to success, along with the extended visibility of

the activity developed in some scientific domain. Checking of the validity of the theories put forward, of the corectness of the applied methods and of the reproducibility of the results obtained may be attained exclusively by their presentation in publications, conferences, participations to scientific manifestations. The biunivocal correlation between visibility and quality of research, and the influence of the latter upon the international recognition of the scientific product is plotted synthetically in figure 1.

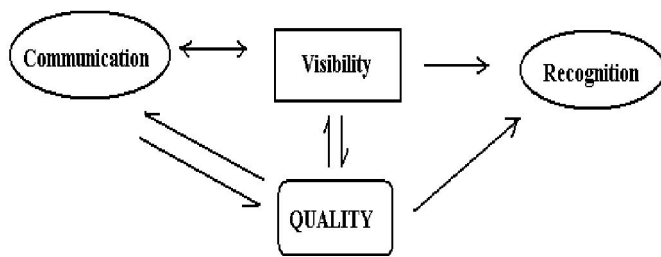


Figure 1

Education of the young researchers for high-quality scientific research and courageous presentation of their own ideas and results represents a major objective of the education and research institutions. Such directions develop their consciousness of belonging to a team, their honesty and strictness in performing the tasks they are given and in reporting of results.

## CONCLUSIONS

Scientific research represents a cohesion factor among the members of a research team,

contributing both to their training on the themes proposed and to their education, by making them familiar with the team work, respect for the others, openness and communication.

Cultivation and development of some features indispensable to a responsible investigator, observant of the ethical norms of behaviour and good practice should be the task of the educator – university professor or experienced senior researcher – on also considering the enthusiasm, courage and curiosity of the young ones.

Scientific research contributes to enriching the knowledge acquired in school, and also to using it for solving the research theme. In this connection, an enlarged research team will undoubtedly benefit from the advantages of pluri- and inter-disciplinarity, so that the results obtained will meet the criteria imposed by an unanimous recognition in the community of science.

The main condition assuring a high-quality investigation involves an adequate communication among the members of the research team, a prompt upgrading of the results obtained, by their communication at scientific meetings or by their publishing, the recognition of the scientific level of one’s efforts being the final task of any researcher.

## Endnotes

1. Basarab Nicolescu, *Transdisciplinaritatea*, Polirom 1999, p. 154.
2. Solomon Marcus, *Paradigme universale*, Paralela 45, 2011), p. 27.