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The Double Helix of Learning and Work*

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Editors' Note

The Double Helix of Learning and Work by Orio Giarini and Mircea Malitza is a report to the Club of Rome first published by UNESCO in 2003. It advances fundamental paradigm-changing ideas in the field of education. Drawing inspiration from the double helix structure of DNA, the authors seek to strengthen the relationship between education and employment in order to bring 'The Knowledge Society' within reach. This article contains the first chapter of the report. Successive chapters will be carried in subsequent issues of *Cadmus*.

Chapter 1
"I Learn, therefore I Change"

1.1. LIFELONG LEARNING: A BLOCKED PROJECT

A new concept of *lifelong education* emerged by the end of the second half of the Twentieth Century. Over that period, human societies had tended to place education among their top priorities. The idea that good schooling was the underlying prerequisite of modern life, welfare, and normal social integration had never seemed more obvious. The widespread interest in education was exploited by political parties, which busily produced doctrines, solutions, and reform plans. In the developed countries, education benefited from extensive support and generous facilities, while the developing countries inaugurated campaigns gainst illiteracy and for the establishment of structured education systems.

Nevertheless, dissatisfaction about the performance of educational institutions has persisted from one generation to the next. Since Philip H. Coombs published *The World Educational Crisis* (1968), the catchword has been: all countries face a severe crisis in their education systems, and all countries have solemnly launched comprehensive reforms. Few people understood that the very idea of intermittent reform was wrong and that a good school

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needed to undergo continuous reform, adjusting itself to the needs of society and to the new promises of technology after having introduced proper mechanisms for change into its institutional setup.

"Education does not conclude with graduation or a doctoral paper, but it remains open-ended."

It is difficult to expect that, all by itself, one of the most conservative structures of civil society should be able to develop a vocation for perpetual change. For centuries, people have perceived education as a fixed system through which "innocent" young people are processed in order to be returned to society after a decade or two, well-equipped with knowledge and skills that are necessary for a productive life. No matter how many efforts are made to humanize this process by imparting to it affective, moral, or aesthetic dimensions, deep down it has never changed.

Education is viewed as a system with an input and an output, and its effectiveness is measured by means of statistics, costs, infrastructure, and personnel. At its core lies a centuries-old set of subjects or disciplines in a *curriculum* that has a flow similar to that of etymology, like a river that gradually deepens and branches out. Ever since the days of ancient Greece, mathematics has been mathematics, music has been music, astronomy has been astronomy, and medicine has been medicine. Until recently, despite the dynamic evolution of the content, *i.e.,* the syllabus, one thing has been clear: the river flows into the sea, and the school is a closed chapter for those who have left it.

Hence, the revolutionary importance of the newly emerging concept. Under several different names, such as *permanent education, continuous education, recurrent education,* it states the same thing. Education does not conclude with graduation or a doctoral paper, but it remains open-ended. The graduates of classical cycles return to take up new subjects. Since the 1990s, this idea has been embodied in the principle of lifelong education or lifelong learning. It points to what was suggested several decades ago, namely learning from "the cradle to the grave".

Let us assume that adult thirst for knowledge has not been discouraged by the closed doors of the official educational or school system, which is considered to be *formal* because it is regulated by laws, ordered by professional *fora,* and recognized by means of official documents, *i.e.,* diplomas. Adults, therefore, have had to resort to *non-formal* organizations that have come in a Variety of forms: so-called peoples' universities, evening courses, and university-level special courses on arts, sports, religion, and foreign languages that entitled graduates to recognition through certificates or other such documents, however, at a lower level than that conferred by "official" diplomas. Such certificates have only acknowledged the fact that a given person has taken a certain course, without providing an additionally recognized right.

At the same time, the explosive development of the mass media, despite their pre-eminently commercial character and focus on entertainment, has been offering new sources of information and knowledge regarding such topics as history, economics, social science, and culture. That kind of acquired knowledge is not entitled even to the less authoritative rec-

ognition provided by a certificate of non-formal education. Everything that an individual can pick up from his or her family or kin group, from readings, or from watching television falls under the no less important category of *informal education.*

Lifelong education is a new and powerful concept that illustrates the changing relationship between the state and its citizens. It is not limited to individuals in a certain age group who have to go to school. Rather the entire population claims the same right, in regard to education, that it has acquired in regard to health care: lifetime access.

The term, *lifelong,* applies to education as well as to learning. The word, *learning,* was introduced over the past few decades, rather than *education,* to emphasize the primacy of the learning process, whereby the individual is supposed to play the leading role, while the notion of an educational system carries the connotation of external intervention. In such a vision, the teacher does not administer knowledge, values, and skills, but returns to *maieutics* – the Socratic method – as a means to facilitate the acquisition of knowledge by those who are interested in doing so.

The ministries of education still retain their names, there being no "ministries of learning". The whole system that is being organized, financed, and maintained by the state is education- rather than learning-based, even though the latter should, in fact, be its basis of operation. Lifelong learning does exist, even if it is an individual responsibility. Each individual resorts to whatever methods may be available to maintain the continuous functioning of learning mechanisms.

The concept of lifelong learning, however, is no longer embraced by the societies of today, simply in the sense of informal and non-formal resources. It is permeating a new vision of education as a guiding and organizing principle. Its merit is to induce a unitary/ unifying vision of all education or learning phases, from kindergarten to the doctorate, and on, for a sixty-year life span.

Lifelong learning has come into the limelight for the following simple reasons. The last few decades of the past century coincided with a spectacular explosion of human knowledge. (Here, knowledge is understood as any statement subject to universal verification and validation, a scientific theorem, or a technological recipe, blueprint, or know-how.) Science and technology provide the most accurate definition of knowledge. In a broader sense, knowledge is also acquaintance gained by experience and work, even if it is not theorized or formalized. A huge amount of practical knowledge has been transmitted from generation to generation and has been incorporated into skills to be applied.

Science and technology are the pillars of civilization, followed by universal practices such as trade and other economic activities. Cultures belong to a different sphere, that of beliefs, values, and particularities of language and history which account for their splendid variety.

It has been noted that a piece of knowledge is a perishable product. It is subject to a law similar to that applying to radioactive substance physics:the half-life principle. The school enclosure functions under a similar hypothesis: it equips persons with knowledge that is

supposed to be relevant for the rest of their lives. But the existing system appears to be shaky once school leavers discover that everything they have acquired or learned is no longer valid after a lapse of ten years. A specialist in technology would normally consider that the "shelf life of a degree in engineering is about three years". The halving time of some radioactive substances is hundreds of years, but in the case of knowledge, halving may take less than a decade. Either the inherent frailty of knowledge must be acknowledged, or a radical recycling procedure must be introduced. This last solution points to continuous or lifetime learning.

The second root of the concept is demographic. Life expectancy has increased in the developed countries beyond the age of 70. Young contingents are smaller. The whole of society is aging. The closed educational system was designed and developed for large cohorts of young people and for short active lives. As we write these lines, an 81-year-old Japanese minister is replacing a 71-year old one. The third age has started to look for ways of keeping busy, and it is demonstrating remarkable participatory impulses. Elderly people would like to keep abreast of the times, but the bastion of formal education stays closed.

The social dimension cannot be overlooked. Civil society, today, is vocal. There are numbers upon numbers of non-governmental organizations, movements for the protection of individual rights, for the emancipation of women, and for the inclusion of minorities. Not only do engineers find themselves disoriented when confronted with new technologies, but also those adults, who, when requested to give an opinion, discover that their schooling has not taught them how to communicate, to co-operate, to initiate a new project, or to found a business. Should the doors of the system to active life be thrown open, a greater concordance between theory and the actual throb of life and nature would be achieved as well as the promise of a more harmonious and less schizoid or stressful life. In fact, this last social argument supports and explains the wide attraction that lifelong education now enjoys.

> The high-tech information society is, by its very nature, a changing society that is continuously requiring the mastering of new information and new techniques usable in occupational pursuits. We have, since the early 1960s, been talking about "life-long", "permanent", or "continuing" education which means that no matter how much formal education a person has been able to acquire at the beginning of his or her life, relearning and new learning has to take place continuously throughout the rest of this person's life. Today, in some countries, the costs incurred by enterprises for the upgrading of the competencies of their personnel are of the same order of size as for the entire public system of education (Torsten Husén, "Education by the Year 2025", 1999-2000).

The key question is the following: why does this universally recognized, embraced, and proclaimed concept not work? The question is not about the effectiveness of the vast rhetorical exercise in its favour. What is being evoked is the fact that one rarely encounters a 40-, 50, or 60-year old person who returns to a university saying, "I want to go on", and who finds a welcoming open door. The system is not prepared for such an eventuality. Should this person be sent to the same college from which he or she graduated? But this person has different interests now which do not fit into the educational sphere of that college. Should the

university authorities recommend new textbooks, select bibliographies, extensive courses so that the person might keep in touch with contemporary knowledge? But he or she only needs clarifications, specific applications of that vast amount of knowledge in his or her field of interest, with a meaningful impact on his or her social roles. All this person can receive is a short summer course, designed with the best of intentions by some well-meaning professors, sometimes in collaboration with industry.

When asked about their involvement in lifelong education, universities will briefly mention such *ad hoc* courses that entitle one not to a diploma, but to a mere certificate. They do not offer an orderly learning system; they do not include the applicant into a coherent programme; and they show no interest in what he has formally learned. Why is that? Because higher education curricula stop short of any extension, they do not have open valences to future possible programmes. Programmes are invariably terminal.

This reality draws attention to an element without which the concept remains inapplicable: the curriculum has to be open at the end, while now it is fatally closed. It has to continue into the fourth stage (the other three being clearly defined: basic, secondary, and tertiary). That is, the stage of active life, when life's actor has full and mature possession of his or her capacity to learn alone (goal choice, course choice, choice of the best time frame), assisted by tutors, and enjoying the educational facilities of the school (libraries, laboratories, and other logistical paraphernalia).

As for official recognition, the concept of lifelong education has broken all records. The European Union countries introduced it into the Treaty of Amsterdam. The year, 1996, was declared the "European Year of Lifelong Education". The entire education and training programme of the Communication Commission (Towards a Europe of Knowledge) for 2000-2006 is centered on the subject of lifelong learning. Following the major series of reports that introduced the concept, the recent UNESCO Delors Report (1998) ranks it first among the principles that are most likely to guide the future of education.

Despite significant conceptual progress, the situation in the field remains confused and unsatisfactory. According to the EURYDICE Survey of March 2000 (European Commission, 2000) "as in the case of other desirable social goals, there is a difference between the ideal and the reality, theory and practice, and promises and results".

Is the current situation a result of the difficulty in formulating a precise definition of lifelong education, a fact that has been pointed out by many analysts? All major concepts that influence political activity – *i.e.,* democracy, liberty, welfare – are fuzzy. There is no clear boundary, no precise beginning and end. But this fuzziness does not impede either the broad use of such concepts or their incorporation into legislation and common law.

The present state of the implementation of the concept is that of a huge basket of experiences, in which all attempts, otherwise praiseworthy, to embrace all new forms of learning pertaining to each and every social category and age are thrown in.

It is to be noted, however, that the assembled experiences have been conceived either outside the classical system or in addition to it. If they stay outside, there will be plenty

of goodwill and understanding. Jonasson's (1988) report is quite clear. Four categories of learners (some young students, some aged students, graduates, and those seeking employment diversification in new fields) make up *heterogeneous* groups that require a different, more clear-cut system. The objections of the advocates of the existing educational system, with its traditional and acknowledged discipline, rigour, and academic ethos, arise when a single lifelong education system is brought into question. Pressing the matter to the root of that resistance, one finds an element that has been badly neglected so far: the pressing need for a single methodology, for one homogeneous system, based on a new perspective on knowledge, which still appears to be dominated by the archaic schema of disciplines and their curricula. How can continuous lifelong education be introduced when the traditional curricula are designed for a discontinuous and closed education?

"Interdisciplinarity has been another cardinal idea of the past few decades. It has been the same guiding light for scientific research as lifelong learning has been for education. As in the case of education, what has blocked its coming to fruition has come from the same source: the watertight separation of disciplines or fields of knowledge."

It is only by breaking that deadlock and overcoming the contemporary impasse and confusion that it will become possible to give free rein to one of the most interesting ideas of our time.

1.2. INTERDISCIPLINARITY: AN AILING IDEA

Interdisciplinarity has been another cardinal idea of the past few decades. It has been the same guiding light for scientific research as lifelong learning has been for education. As in the case of education, what has blocked its coming to fruition has come from the same source: the watertight separation of disciplines or fields of knowledge.

Disciplines in the education system more or less coincide with the divisions in the classical schema of sciences. A given science has been conventionally defined according to its object, methods, and theories (also including its language and concepts). Astronomy, mathematics, logic, and mechanics have been recognized as such since antiquity, and their spheres are sharply delineated by the above-mentioned definition. But the progress of knowledge has created new fields of science. Thus, the social and human sciences were slowly emancipated from the embrace of philosophy. The difficulty has lain not so much in defining the objects of the new fields, but, rather, in the elaboration of their particular methodologies, basic theories, and concepts that should be comparable in rigour to those of the older sciences.

The common front of all sciences has always been the complexity of reality. Advancement has depended directly on the progress of technology or on the symbolic apparatus that has led research into areas previously inaccessible to direct observation or non-abstract repre-

sentation. The atomic era, the cosmic era, and the era of genetics that mankind has entered almost concomitantly these days are the most visible headlines of the new fields of science. In all these fields, our imagination is incapable of producing representations. The atom, the cell, or outer space require not only technical tools of access but also abstract tools, *i.e.,* mathematical models playing the part of a mental technology. The complexity of these three levels of reality has reached unprecedented levels.

The sciences need to rely on one another in their endeavour to move forward. Piaget enumerates them according to the criterion of growing complexity and decreasing generality: mathematics, mechanics, physics, chemistry, biology, and physiological psychology. Each field is connected to a less complex field: mechanics is subordinated to mathematics; physics creates a new branch (*i.e.,* mathematical physics); physical chemistry becomes a branch of chemistry; biology becomes so indebted to chemistry that it accepts a biochemical merger; and physiological psychology introduces mathematical methods and biochemical mechanisms in its effort to account for human behaviour.

Taking a cue from the historical solidarity of research branches that went so far as to create mixed fields in the natural sciences, the second half of the Twentieth Century acknowledged the primordial need for *interdisciplinarity* with renewed intensity. The concept has evolved from isolated cases to gain the status of a general organizing principle of knowledge. The disciplines are tending to break away from the stage of stark separatist defense and to accept the imperative of interdisciplinarity.

The *multidisciplinary* approach, defined as a partnership of distinct disciplines, follows logically. The same holds true in the case of a *pluridisciplinary* team made up of specialists in mathematics, physics, chemistry, astronomy, and various technologies who plan and manage a cosmic flight. *Pluridisciplinarity* adds a new touch to *multidisciplinarity,* in attempting to describe the joint efforts of two or more related disciplines to solve a common problem. *Cross-disciplinarity* means pushing back the boundaries of a classical disciplinary turf and making a daring foray into the methods of another, as in the case of "mathematical music". There is also *transdisciplinarity* in the attempt to transcend the boundaries of a discipline by moving into an area of principles or of general methods. The term has also been used when exploring visions or outlooks accessible to the general public without requiring specialist training.

The most widely used and accurate term is *interdisciplinarity,* which contains both the simple joint action or exchange of methods among disciplines and their merger. It announces the prevalence of the problem to be solved over the disciplines that might claim it for their own spheres of concern. It sets out from the existence of "academic disciplines", which it does not demolish, but rather combines into a scientific production co-operative.

The division between natural and social sciences, which became the subject of a major debate in the Nineteenth Century, is based, not so much on the specificity of the object of study – living and inanimate nature or man and society, respectively, but rather on the different methods they use. Within the experiment incorporated by the social sciences, towards

the end of their speculative age, the observer was no longer exterior to the experiment but became part of it. Objectivity received a different meaning in the approaches of the social and the natural sciences. Unlike the latter, psychology started to make use of introspection. Despite the tensions between them (see the dispute between psychology and sociology), the social sciences and the humanities, nowadays, have caught the interdisciplinary fever in an effort to define their own identities.

History has an older record of spawning connected sciences: archaeology, epigraphy, documentaristics, numismatics, museography, ethnology, ethnography, and others – all distinct disciplines.

Economics made a pact with mathematics the moment it became, prevailingly, a science of the measurable. In its quest for improved methods, it began to make use of the mathematical models employed in physics (mechanics, gas theory, thermodynamics), thus encroaching upon their privileged field of application. No sooner had the game theory been elaborated for the distinctive purposes of mathematics than it spread widely both into the social sciences (*e.g.,* the theory of conflicts) and into the natural sciences (*e.g.,* ecology).

The major cross disciplinary impact that mathematical models have had deserves special mention. The era of quantification was heralded when all the sciences, striving for rigour, resorted to measuring and quantifiable procedures. As a science of structures (and not of quantity), mathematics is actually related to structuralism, a trend with many echoes in the social and human sciences. Levi-Strauss (1949) would soon use mathematical instruments in ethnography just as Piaget (1967) did for the study of the evolution of thinking. It was linguistics that eventually confirmed the mathematical model in the humanities, the first to create a new discipline: mathematical linguistics. Then natural and artificial languages and grammars inspired the search for idioms to express nature, society, and life. The language of genes was next to be explored, and algebraic grammars attempted to decipher the underlying principle of the phenomenon of life.

Several trends influenced all disciplines more or less successfully during periods of considerable enthusiasm. We may thus mention cybernetics (the science of common mechanisms in technology and society), systems theory, semiotics, the theory of catastrophes, the theory of chaos, and later, computer science. They may be viewed as the off-spring of mathematics, the cardinal science of symbols and of abstract objects.

We should now ask ourselves whether or not this interdisciplinary impulse, born of the research function of disciplines and of the purposes assumed by science, has been followed by a similar process insofar as the pedagogical side of disciplines as subjects to be taught in schools is concerned. The answer is negative. Pedagogical disciplines have retired into a form of isolation that appears to be far tighter than academic disciplines with their penchant for symbioses and synergies.

Moreover, when schools have attempted to “update” themselves, they have only received “purist” acquisitions.

Such was the case of the Bourbaki School* and its search for fundamental structures, which inspired the idea of introducing the set as a basic concept instead of the number. The result was a broadly unsuccessful pedagogical experience (see, Kline, 1973). The prevalence of academic purists caused probability calculus to lose the weak position it once held, not to mention the disappearance of trigonometry and determinants. Had the school been inspired by mathematical models, it would have introduced finite mathematics resulting in a larger number of easily assimilated applications.

We should have expected the Humboldtian model of university, which provided universities with a research function, to better synchronize the pace of research with that of formal education. Despite the advent of that seminal idea, the gap between science and school-taught disciplines deepened. Departments and faculties became more specialized; chairs were established for increasingly narrow disciplines. One of the pioneers of spatial navigation, Hermann Oberth – whose book (*The Rocket towards Interplanetary Spaces,* 1923) was described by his student, Wernher von Braun, as "the scientific fundament of special navigation development technology" – was a high school teacher in a small town in Transylvania when he wrote it. When asked how he could possibly have acquired the information required for such an insight, he simply replied: "I graduated from Cluj University, Faculty of Sciences, where I took courses in mathematics, physics, and chemistry". Here we have an interesting example of a complex, eminently interdisciplinary, object of research based on multidisciplinary university education *avant la lettre.*

Medicine has probably benefited most from the multidisciplinary approach and acquired an impressive advantage in the process. This success is due mainly to the fact that it is a confederation of sciences or disciplines (anatomy, physiology, hematology, etc.) and that it remains open to new disciplines (such as infra-microbiology). When a physician needs to examine a patient, all disciplines compete and converge in his or her analysis and diagnosis. Another range of disciplines concerns fact-finding and treatment (radiology, balneology, chemotherapy, etc.). Today, medicine is, of course, the expression of its own evolution, but it is also the result of massive and decisive contributions from the external apparatus of cell biology, chemistry, and high technology (lasers, magnetoscopy, computers, etc.).

A less often cited scientific revolution, in the same order of magnitude as that occurring in medicine, is the *revolution of materials.* A new class of materials, with new properties, is invading the artificial human environment from house and furniture to goods of mass consumption, automobiles, etc., gradually substituting for "traditional" materials. The paternity of such materials is so interdisciplinary that their source becomes uncertain: metallurgy, inorganic chemistry, physics, industrial procedures, and others all coalesce to produce them.

These two examples also point to the difficulties and dilemmas of interdisciplinarity. Let us assume that the object of study is an unknown disease or a new composite material. An interdisciplinary team is formed. Which is the most economical, that is, the cheapest and

*"'Bourbaki' is the collective pseudonym for the authorship of thirty-six volumes of comprehensive texts, started in 1939, by an élite group of French mathematicians, designed to present mathematics in a contemporary and original way, and to illustrate its axiomatic structure" (see: http://education.guardian.co.uk/Print/0,3858,4545977,00.html)

the most efficient way to assemble the team: with persons each representing a single discipline or with persons who, by virtue of their education, possess the necessary knowledge from all these disciplines? Is it the team that has to be interdisciplinary as a group, or should interdisciplinarity apply to its individual members? In the first case, more people are called upon; therefore, the costs rise. Time is required for them to become accustomed to one another, and so the costs rise even higher.

"Almost all problems are now interdisciplinary, and they claim an adequate preparation."

The cost issue has long been a part of decision-making in the management of research and education, sometimes emerging as a decisive argument. There were people who regarded costs as irrelevant when it came to the progress of knowledge or to the shaping of personality, but their number has tended to decrease considerably. The other component of that reasoning, *efficiency,* is even more persistent. In pursuit of a goal, teamwork is crucial. Efficiency is based on communication, which, in its turn, is based on common language. It is thus better for fellow members of a team to have related interdisciplinary training.

The optimal research solution eventually depends on how learning is organized. The more interdisciplinary the latter, the better the chance for the former. The pressure on research with respect to interdisciplinarity has been passed on to education that has been in no hurry to react. The disciplines are even more obstinate and rigid in education than they are in research.

The stubbornness of the disciplines in higher education is forcing graduates to start anew at other faculties in order to be able to cope with the demands of their jobs. A young man from Germany says he is a physician, but he is now studying computer science because he has come to realize that he needs the latter as much as he needs medical information. Engineers who study economics, philologists who study management, and computer scientists who undergo training in finance represent frequent cases of costly and unnecessary duplication. What can be more inefficient than achieving interdisciplinarity by enrolling in two faculties instead of in one? The answer given by formal education to this phenomenon is very unsatisfactory. In the best cases, graduates are directed to non-formal education, parallel to but outside the system.

He that will enquire out the best books in every science, and inform himself of the most material authors of the several sects of philosophy and religion, will not find it an infinite work to acquaint himself with the sentiments of mankind concerning the most weighty and comprehensive subjects. Let him exercise the freedom of his reason and understanding in such a latitude as this, and his mind will be strengthened, his capacity enlarged, his faculties improved; and the light, which the remote and scattered parts of truth will give to one another will so assist his judgment, that he will seldom be widely out, or miss giving proof of a clear head and a comprehensive knowledge. At least, this is the only way I know to give the understanding its due improvement to the full extent of his capacity, and to distinguish the two most different things I know in this world, a logical chicaner from a man of reason (John Locke, *Of the Conduct of Understanding,* 1706).

Seven conclusions can be drawn from the above considerations:

i. The two contemporary strong trends, interdisciplinarity and continuous education, are interconnected, and they both rely on constituted, quasi-rigid bodies of knowledge, *i.e.,* the disciplines.

ii. Disciplines have begun to lose their function, much as is happening to the State in politics. They are eroded, but not abolished. Their roles change. A new criterion for the evaluation of disciplines refers to the measurement of their open valences and their readiness to combine with other disciplines rather than to their endurance in splendid isolation. It is all about achieving interdisciplinary partnerships.

iii. The transition that is now taking place is one from the pre-eminence of the disciplines to that of the problems to be solved. Almost all problems are now interdisciplinary, and they claim an adequate preparation.

iv. In order to become lifelong, education has to provide for an ability to use information in future professions that are defined according to the type of tasks, subjects, and problems to be solved.

v. Research is likely to be more open, more flexible, and more receptive to interdisciplinarity than is the more conservative educational system.

vi. Because they are joined in a common knowledge-acquisition process, the schools of research and of education rely on knowledge classification in disciplines. Both of them are obstructed by the rigidity of institutionalized disciplines and by their respective spokespersons.

vii. The liberation of the two concepts from persistent schemas for the purposes of true development demands a flexible schema of knowledge classification to replace the stiff academic or educational disciplines by smaller, easily combined units. These should be the building blocks for interdisciplinary edifices that are able to accommodate all the directions indicated by the nature and demands of the problems to be solved.

1.3. WHAT PEOPLE FOR WHAT SOCIETY?

For centuries, education has been organized and learning has been oriented according to the prevailing models or theories about what an educated person should be.

Quite influential for a long period, Plato's schema favoured the generation of an élite capable of leading a hierarchic society, while other groups, also belonging to the societal structure, such as warriors and workers, were to be trained separately. Hence the special attention that was paid to abstract and philosophical learning, in ancient Greece, and the neglect of practical or manual work. The dichotomy between liberal and vocational studies persisted. The Thomist scholastic model should also be mentioned with reference to the pre-eminence of faith and theology over reason and philosophy.

The philosophy of the Enlightenment primarily praised science, reason, and experience. John Locke, in *Some Thoughts Concerning Education* (1693), named virtue, wisdom, breed-

ing, and learning as goals of education. The focus was on individual freedom, and the role of institutions was looked upon with suspicion.

The reaction to the Enlightenment created the naturalistic school. Rousseau emphasized emotion and intuition. Marx was preoccupied with healing the alienation brought about by class division and proposed the ideal of the *communal man,* free only within his socially acknowledged needs and responsibilities.

In education, the pragmatism of Peirce, James, and Dewey led to the design of a reflexive, critical man, whose sources of knowledge were activity and experience. The behaviourists substituted control for liberty and, based on the role of the reward and punishment schema, suggested performance achievement by means of exterior conditioning that left little room for personal initiative. Programmed education is linked to this school, but it should not be entirely discarded along with its reductionist premises.

Many postwar philosophical trends influenced education by introducing new concepts, as in the case of existentialism: choice and decision in an existential situation. Hence, the growing role of responsibility and authenticity, the ideal being "to be" instead of "to seem" or "to have". The number of versions proposed as educational ideals is quite large, and the lack of agreement points to their historical character, that is, to their random emergence and dependence on the dominant vision or philosophy at a certain historical moment. This reality is an incentive or at least a justification for our generation to try and to free itself from the pressures of tradition or of common law and to formulate its own guiding principles for education.

Two major debates took place in an effort to formulate educational goals and the means to achieve them:

i. Does education serve the needs of society or those of the individual?
ii. Does education focus on the knowledge object or on its subject?

The first dichotomy points to the pre-eminence of society over the individual or the other way round. If society comes first, then education is shaped according to its needs; but as these are perceived differently by classes and groups, the debate will continue at the social and political level. As a reaction to totalitarianism that imposed the goals of society, regardless of individual destinies, the focus shifted to the rights and aspirations of individuals. Still, whenever society feels an acute need, *e.g.,* for development, education will be oriented towards the macro-social objective. In the developed countries, the emergence of an unwanted phenomenon such as unemployment introduces that general concern into the educational discourse, somewhat diminishing the attention paid to individual choices. Moreover, a certain parallelism with the content of political discourse can also be established. The more conservative part of the political spectrum with a fondness for economic liberalism will support free initiative and will focus on the individual. Social democrats will put a premium on solving social problems, thus taking their cue from the perceived interest of society.

The second dichotomy arises from the notion of how education should function. The main concern could be about the object of education, *i.e.,* the substance of the knowledge to be taught. At the opposite pole, the critical point could be the assimilation and processing

of knowledge by individual subjects. In the former category, we have the hetero-structuring processes, the actions whereby the student becomes an exterior agent, while the object of knowledge to be transmitted is seen as preeminent. Such is the case of traditional schools in which the arrow goes from knowledge to the students, the same as in behaviourism and cybernetics. In the latter category, it is the action of the individual student that matters in the first place. The fact of using the notion of *learning* more than that of *education* stands for the priority that is currently given to the subject (the individual).

In this respect, the parallelism with political discourse is no longer perfect. Despite the preference given to the individual and to personal initiative, the conservatives favour stronger control and discipline. While the social democrats emphasize the primacy of society and the role of its educational institutions, they tend to justify more lenient, loose, or permissive control systems and to show more confidence in the individual. When it comes to conveying their values, the conservatives appear to be more skeptical about the preferences of individuals or their ability to make free (and good) choices.

There are other paradoxes as well. The existentialist trend vehemently upheld the necessity of a strong relationship between learning and life. If one takes a closer look, one cannot help noting that, with its focus on the present tense, that school of thought was quite deficient in its contemplation of the future. It never provided a long-term educational solution.

In the absence of strong and clear orientations that are capable of gaining broad consensus, it becomes possible and, indeed, necessary to seek solutions outside the prevailing political, philosophical, or ideological discourse. Most of the trends in education are not mistaken when they signal the importance of either the individual or the social factor, but start sinning when they dismiss or neglect the importance of other factors, such as institutionalized education.

Intuition suggests the idea that modern societal and economic development depend not so much on achieving perfect, deterministic, and sure objectives, but rather on developing creative activities, in a world where uncertainty, probability, and risk are a given condition, providing a circumstance of real opportunities and choice.

This would not be a step backwards towards irrationality. Quite the contrary, more intelligence, more rationality, more initiative are required to cope with situations of uncertainty, which after all are the daily experience of every living being. The simplistic vision of mechanized pre-programmed robots belongs much more to a deterministic world: the attempt to achieve abstract "certainty" and "perfect information" can only lead to a dogmatic, pseudo-religious system on the one hand, or, on the other, to the annihilation of all intelligence, to the destruction of all hope for development and creativity. Hence, the prevailing atmosphere of pessimism in the world. The marrying-up of contemporary scientific thinking with social sciences, and in particular with economics, in an increasingly complex world which is interactive even beyond the limits of planet Earth, is providing a rich source of moral and intellectual stimulus for reconstructing an Image of the Future. Learning to face uncertainties and to manage risk beneath these new horizons might in turn lead to a quantum leap in the human condition (Orio Giarini and Walter R. Stahel, *The Limits to Certainty: The Facing Risks in the New Service Economy,* 1993).

A realistic approach should start, in our view, from the old and simple idea according to which education has to prepare the individual for life in society. The system has to be designed with an aim to help the individual find and play a rewarding role, in both moral and material terms, while offering him or her maximum freedom of choice. Let us start by identifying the ideas that are likely to meet general consensus.

i. *Increased societal rate of change*: Change is occurring in society at a speed unknown to previous generations that could accept the prospect of a constant or linear trajectory in the course of their lives. According to the principle that "the rate of learning should be higher than the rate of change", the primary task of education is to train people so that they can master change and not suffer from it.

– Corollary: Flexible frames of mind.

ii. *Anticipation, no more adaptation:* The ability to adapt, once considered as the privilege of an intelligent person, has become an insufficient outcome in the case of education today. Adapting oneself to a given situation means staying behind the events at all times, because at the moment of adaptation, things have moved again. Adaptation has acquired a new meaning: it is running behind the events, always trying to catch up with them. Cultivating an anticipatory attitude in conditions of uncertainty and risk in young people means equipping them with the kind of knowledge that enables them never to be taken by surprise.

– Corollary: Introducing foresight courses and techniques: probability calculus - a new Weltanschauung since the age of algebra, living with incessant change and uncertainty.

iii. *Continual renewal of knowledge:* The perishable nature of information along with the rapid pace of change lays the foundation for continuous education.

– Corollary: Adequate teaching of knowledge, including the "map of ignorance" and open problems, science museums, real and virtual experiences.

iv. *Lifelong education:* Subject's approval of continuing learning, perpetual incorporation of learning into a learning process with open perspectives.

– Corollary: Continuous curricula as possible roads into maps of knowledge.

v. *Interdisciplinarity:* De-emphasizing disciplines in favour of problem solving.

– Corollary: Introducing global problems (i.e., food, water, population, health, education, environment, habitat, etc.) requiring highly interdisciplinary approaches in growing proportions.

vi. *Distinction between identity and role*: Identities are the product of cultures (involving beliefs, values, and tradition). They have to be encouraged through a type of education that trains people in a multiple-culture society. Roles are assigned by civilization.

Civilization requires specific roles to be performed by teams made up of people with different identities. The job is a particular instance of the role.

– *Corollary: Education becomes flexible in relation to cultures building upon today's multiculturalism. The resulting variety is compensated by the improvement and transmission of universal knowledge values, the common treasure of a single civilization.*

vii. *Mobility of the individual*: This is one of the features of the society of tomorrow, one that is already noticeable in the current major trends.

– *Corollary: Education is meant to prepare people for a new kind of life, with more roles to play; this kind of life requires higher mobility, not only movement but also transfer from one role to another.*

viii. Competitiveness, an increasingly salient feature of societies based on a market economy.

– *Corollary: Education can decisively enhance the competitive edge (as it has already done so far: formal and non-formal contests, examinations, challenges, recognition of qualifications, especially by means of credits, etc.), while paying attention to equal opportunities and equitable rewards.*

ix. *Free initiative*: A cardinal requirement in today's society; it calls for educating for creativity and the encouragement of innovation.

– *Corollary: If the emphasis on innovative spirit and the exaltation of creativity have not led to nameable results, such a situation results from the fact that new methodologies have been placed outside school or learning. The capacity to create and to innovate presupposes general orientations in education, freedom and courage to take the initiative, and a highly associative and combinatorial system of knowledge.*

x. *The network* is the horizontal structure of the society of the future leading to a reduction of vertical hierarchy.

– *Corollary: Development of the ability to work in a team, to choose partners, and to maintain partnerships. The networks give a global (or at least a regional) dimension to human activities. The training of people is thus performed within a regional and global horizon.*

xi. *Communication* is already at the center of attention. It solves the dilemma of the individual versus society and is consequently elevated to the rank of a philosophical concept (Habermas, 1973).

– *Corollary: Introducing interactive communication in the current learning process in combination with the acquisition of techniques for conveying articulate and correct messages in several international languages.*

xii. *Technologies* (ICT) facilitate learning activities by providing the basic tools and tangible support for the knowledge acquisition process.

– Corollary: The subject of learning is an individual using a computer and a modem, seen above all as intellectual tools. He or she should know how to handle those tools for communication, knowledge management, reasoning, and experimentation.

The debate on the goals of education and the principles to be recommended by the philosophy of education gradually lead one to the discovery of the possible features of the future society in which the individual strives to find a place for him- or herself and to interact with it. Whether one starts with the individual or with society is irrelevant. Nor is it relevant to speak either of the flow of knowledge from society towards the individual as an object of study or of the flow from the individual, as a knowing agent, towards society as a repository of knowledge.

An analysis of the present trends from a prospective angle tends to put at rest the disputes and dilemmas of education by introducing other vital problems into the discussion. If knowing a subject becomes inseparable from computer technology, what will counterbalance one's physical solitude and what kind of face-to-face inter-human activities will have to be maintained and encouraged? If communication presupposes the mastery of widely spoken languages, what becomes of the relationship between one's mother tongue and other languages, given the fact that generalized automatic translation is not yet in the cards? If mobility is a must, how can excessive versatility be avoided? If competition is the law, what are the personal virtues or traits of character that will have to be cultivated in order to keep human interaction within peaceful and non-violent limits?

At any rate, knowledge – a fundamental concept for lifelong education and a basic concept for interdisciplinary research – also remains *the* concept when the goals of education are considered. The definition of knowledge as the *knowledge industry* is thus confirmed. An examination of the area of goals leads to the conclusion that the low efficiency of education as related to its aims is due to the use of inadequate methods for presenting, processing, assimilating, and storing knowledge in individual or social memory.

1.4. LEARNING AND WORK IN THE KNOWLEDGE ERA

The description of the new economy at the stage of globalization as the "knowledge economy" imparts a new status to education and changes the structure of labour and employment.

Education, viewed as the industry of knowledge, is assigned a central place in society. It witnesses an acknowledgement of its numerous claims for resources and attention. The classical formula defining the economic factors (*i.e.,* capital, natural resources, and labour) is modified once information has been identified as another basic economic factor. Nevertheless, a neutral piece of information is just a supporting element for a piece of knowledge.

Nowadays, knowledge is the main resource that is added to the classical triad. Still, it can only add value to natural resources and capital through the agency of the people who make up the labour force. In the past, the degree of personal qualification altered the supplementary

demand for manpower, but it pointed to the proportion of "skills" rather than to the quantity of knowledge it saved from manual work. The advent of the knowledge economy indicates a superior phase, one that accounts for the portion of universal knowledge that people bring to the process of problem solving (production, services, organization).

What is this knowledge? It is a continuous process that produces precise statements in a univocal language that is universally valid, or justifiable by means of a reproducible process, regarding the various relations that develop in the real world. These pieces of knowledge are grouped into large branches, such as physics and its disciplines that multiply through increasing specialization into a family comprising several dozens of disciplines. The treatises assembling those pieces of specialized knowledge as well as hundreds of learned magazines register their incessant progress.

From a mathematical point a view, each branch is a graph called a tree. Metaphorically speaking, the classical schema of science classification is a collection of trees, a sort of "orchard".

The schema gets complicated the moment interdisciplinarity comes into play. Arches meet and the graph becomes a lattice. In the tree of physics, there are disciplines that link to other branches and further on to the trees of other disciplines.

Rather than being a catalogue of isolated "trees", science is represented in a huge single table. It should be noted that the advance is marked by a diminishing generality of the object and by increasing complexity.

For centuries, education has copied the disciplines of science, confining itself to the main branches and several subdivisions. No subject, except for the topics of doctoral dissertations, has pushed specialization to the outer limits. Today it is physically impossible for an individual to keep pace with the latest developments. Making out what is essential and what is not from the viewpoint of knowledge and skill transmission and assimilation is a Herculean task. The current approach amounts to selection and simplification, with an occasional, *ad hoc,* chance to gain deeper insights through optional courses in various areas of the immense knowledge map.

Let us briefly examine the persisting dilemmas of education, starting from that of *generality versus specialty.* A preference for generality appeared at the time when the educational goals were set for ensuring the development of the intellect (France and Germany), of character (England), or of the citizen (USA). It still has undeniable applications in the way primary education is designed, possibly also secondary education and other compulsory courses. But for higher education, the goal of training specialists prevails.

The answer that the school keeps giving to the question, "What is a specialist?" refers to the disciplines. One may be a specialist in mathematics, chemistry, biology, or in a subdivision of those disciplines; the narrower it is, the more meaningful the specialization. Still, in the field of actual work and practical activities, the answer to that question is different. The specialist is defined according to what he or she can do, the type of problems he or she

can solve, or the roles he or she can play. The disciplines are no longer defining elements: they are parts of each specialization. A large number of specializations strives to acquire the ability to develop practical approaches to real problems or tasks. The more graduates there are, the more difficult it becomes for them to find employment. Speciality defined by activity gains in importance. Specialty is treasured, but not disciplinary specialities; rather, hands-on activity and work are treasured.

The successive paradigms that embrace all knowledge are transgressing the boundaries between disciplines. They lead to alternative knowledge segmentation based on new criteria that challenge the established fields:

> according to the type of crisis that emerges; according to the type and degree of complexity of the process; according to the way temporality is involved and to the relationship with chronological time; according to the type of symmetry or asymmetry; according to the way some metaphorical processes are employed; according to the type of logic, particularly to the degree of employing non-classical logic; according to the nature of cognitive models; according to the nature of the systems involved (the modern theory of systems); according to the nature of language structures; according to the nature of semiotic processes (Marcus, 1999).

Related to this dilemma of education is that of *theory versus applications.* It is obvious that the disciplines will encourage the theoretical trend, since theory is their real vocation. To applied education, the vocational option is provided. The preference for theory in the established disciplines turns vocational education into a secondary choice. Moreover, having opted for vocational education (producing workers, technicians, accountants, schoolteachers, etc.), an individual has fewer chances to rejoin the theoretical direction that ensures access to higher-valued and better-paid jobs. The prejudice that favours theory over practice has run so deep that the vocational option is considered worthy only of "drop-outs". "If you don't learn, you'll become an apprentice!" The most important differentiation among students would occur at the end of compulsory education (around the age of 16).

A major error was made in the confrontation of approaches: apprenticeship was left out of the inventory of methods. There was no room left for private learning in a single, unique model (the master), once the teacher of a discipline had talked to an entire class within a school. The tutorial system in the British colleges was an exception to the rule. Another exception was the German system of vocational learning. Other systems did not even include apprenticeship in Vocational education. In the arts or sports schools, apprenticeship has also been maintained as the best solution for performance learning (*i.e.,* musical instruments, skating, skiing, swimming, etc.). The tutor or the master is obviously an expression of interdisciplinarity. A new schema of education needs to reintegrate the tutorial system.

The sociology of education opened an interesting subject when, embarking upon an analysis of the *mechanism of manipulation by means of schooling,* it attempted to elaborate a theory of cultural transmissions (see Bernstein, 1972). It started from the definition of the curriculum that "entails a principle... whereby of all the possible contents of time, some con-

tents are given a special status and enter into an open or closed relation with each other". It is to be noted that this definition actually represents a constellation emerging from a system of choices (of the designers of the system). The social nature of this exercise has to be emphasized.

There are two distinct types of curriculum: *collected and integrated.* Two aiding concepts (*classification and framework*) assist in the design of a typology of educational codes. "Any organization of educational knowledge which involves strong classification gives rise to... a collection code. Any organization of educational knowledge which involves a marked attempt to reduce the strength of classification is here called an integrated code". On the other hand, the *frame* "refers to the form of the context in which knowledge is transmitted and received" to "the specific pedagogical relationship of teacher and taught" and, what is important, "to the strength of the boundary between what may be transmitted and what may not be transmitted". Based on this schema, the author considers that "the European non-specialized, subject-based form of collection involves strong classification but exceptionally strong framing"; the English version "involves strong classification, but relatively weaker framing than the European type. It is specialized, with very strong insulation between "pure" and "applied" knowledge; the course-based non-specialized USA form of the collection... has the weakest classification and framing of the collection code".

The implications of this analysis reveal that the way of designing the curriculum as well as the code and the frame are the mechanisms through which society gains control and reaches the desired goals. In case society aims at building an open structure (*i.e.,* one which accepts a variety of opinions and a diversity of categories, obtaining the solidarity of the citizens through integration processes around common projects), we shall have to consider designing the curriculum in such a way as to accommodate that democratic requirement. The new schema will be mirrored in the increasing degree of individual choice within the connection between the fields of knowledge and the ability to move from one to another, in other words embracing an integrated code with the least constraining frame.

> God alone is worthy of supreme consciousness, but man is made God's plaything, and that is the best part of him. Therefore, every man and woman should live accordingly, and play the noblest games and be of another mind from what they are at present.... For they deem war a serious thing, though in war there is neither play nor culture worthy the name..., which are the things we deem most serious. Hence all must live in peace as well as they possibly can. What, then, is the right way of living? Life must be lived as play, playing certain games, making sacrifices, singing and dancing, and then a man will be able to propitiate the gods, and defend himself against his enemies and win the contest (Plato, *Laws, vii,* 796).

The computer science revolution has brought an unexpected element into the discussion of *motivation,* which is essential to the learning process: *the play.* The passion with which children use the computer is by all means remarkable. The hours they spend punching the keyboard, the amount of concentration they put into it, unequaled by study or reading, have

been simply explained by the fact that a miraculous new game object had entered their lives. The ancient Romans, who used the same word to designate both school and play (*ludus*), inferred the main source of interest of the very young.

Through games, young people learn computer programming and virtues. The computer becomes their guide on the Internet, in their visits to museums, libraries, and sources of knowledge. It stimulates experiments: children drive cars and pilot aircraft in the virtual world at a time when simulation games become accredited learning methods for managers, financiers, investment strategists, etc.

The books by Johan Huizinga (1955) and Caillois (2001) revealed the deep meaning of games in human society, where fundamental activities (politics, economy, and culture) are reducible to ludic interpretations. Far from being an evasion of serious study ("Are you learning or playing?"), the game knocks at the door of the educational system, bringing an important amount of motivation and autonomous behaviour. It also fulfills another requirement of education, namely the development of curiosity and of the ability to ask questions and to formulate hypotheses: the mark of creativity. The child experiences invalidation or confirmation of an assumption in the same way as he or she wins or loses a game. Once introduced into the learning process, the ludic element breaks the century-old spell of the constraint (the long school years) and permanently shifts the focus onto the subject of learning.

The classical system based on the theoretical teaching of disciplines has been criticized for its neglect of *skill or aptitude* development. Here is the young subject of learning handling a machine: the computer. He or she simultaneously uses his or her hands and his or her head. From the very beginning, he or she depends on communication skills and develops them continuously: he or she types; he or she produces texts; he or she reads and answers messages and commands; he or she conceives various programmes or complies with their requirements; or he or she applies the rules for the operation and maintenance of a device that is at the same time a television screen and a telephone. All that is valued in a specific skill (*i.e.,* meticulousness, patience, continuity of effort, concentration, accepting a fixed workplace, undergoing a self-improvement process, and closely observing a sequence of commands) implicitly becomes part of the training of a young person who uses a computer. This instrument, which is nothing but a node in a network, also encourages teamwork.

Should we have to indicate the most important quality for the learning process, we would emphasize the *ability to concentrate.* It is well known that this ability is not well developed in early childhood (a maximum of twenty minutes at a time for children in kindergarten and primary school). Later on, the capacity to concentrate has to be maintained through various procedures known to educators (e.g., interrupting the discourse to engage in dialogue, standard time distribution, etc.). In contemporary society, noise, multiple simultaneous signals, and dozens of visual, written, or auditory sources that assault young individuals conspire against their ability to concentrate.

Educators have confirmed a deterioration in the ability of school children to concentrate when they are confronted with the onslaught of the multi-source information society. It is

therefore difficult to estimate the important part that the computer plays in the development of that valuable capacity. The passion with which the subject gets involved in a programme or a simulation game has caused concern about the "loneliness" awaiting him or her as a result of the curtailment of social contact and dialogue. The same suspicion was voiced in the case of distance learning as compared to the advantages of the classical "face-to-face" system. Of course, education is entitled to design compensatory methods to develop sociability and direct contact with other people.

Two decisive advantages come to mind with respect to the classical system. Knowledge is not merely streamlined through a passage of written text or an oral communication. All senses are open to capture information. First and foremost, the images are visual ones. *Multi -media,* is the type of presentation in which the text is accompanied by images (including movie sequences), graphs that modify and move, spatial representations, the voice of the presenter and, possibly, music. Can a speech and a few notes on the blackboard compete with a multi-media history lesson that includes visits to museums or the sites of past events, even with a feature movie evoking them?

Secondly, the computer has become *interactive.* Three decades ago, the early use of audiovisual teaching aids in schools caused considerable enthusiasm. It was soon proved that their main deficiency was that they encouraged passivity. The image on the screen or the voice coming from the headphones could not be questioned. The progress of artificial intelligence enables the computer to introduce reasoning and the possibility of dialogue. When the computer does not understand the question posed by the subject, it asks for additional information and produces an answer that has not existed in its inventory of possible answers. This answer could be compared to that of a competent teacher.

We shall now turn to anthropology in order to establish the advantages of a new education. Humans are weak creatures, with pulses of Renaissance force. They place themselves at the core of things to consolidate their precarious condition. Compared to the animal realm (particularly to a similar medium-sized animal), human physical abilities and instincts are puny: muscular strength, ability to run, sharp teeth, etc. It is through symbols and tools that humans make up for this deficiency. They use both to create universes that otherwise do not exist in nature.

The symbols and tools belong to two spheres in which humans nest: the *noosphere* and the *technosphere.* They are both products of human *imagination.* Knowledge is based on symbols. Humankind departs from reality to return to it armed with symbolic models. Culture is a product of symbols, and tools (that need symbols) are the basis of civilization. Both presuppose continuous effort, hard toil, and obstinate determination. According to Goethe, even if man fails, he who continues and strives shall be redeemed.

The anthropological insight prompts us to place *technology* on the same footing with symbolic activity. In doing so, we differ from the ancient Greeks who did not accept the nobility of tools. The second remark points to the development of imagination that owes more to fairy tales and science fiction than to formal school education. Finally, there is the *ethic of work* at the ludic level, introduced and developed within the learning process so that

it will then operate to the end of human life. From this point of view, leisure is nothing but a contemporary commercial myth.

> The conclusions of the Lisbon European Council confirm that the move towards lifelong learning must accompany a successful transition to a knowledge-based economy and society. Europe's education and training systems are at the heart of the coming changes. They too, must adapt.... The Commission and the Member States have defined lifelong learning, within the European Employment Strategy, as all purposeful learning activity, undertaken on an ongoing basis with the aim of improving knowledge, skills, and competence.... Lifelong learning is no longer just one aspect of education and training; it must become the guiding principle for provision and participation across the full continuum of learning contexts. The coming decade must witness the implementation of this vision. All those living in Europe, without exception, should have equal opportunities to adjust [to] the demands of social and economic change and to participate actively in the shaping of Europe's future. (European Commission. *A Memorandum on Lifelong Learning,* Staff Working Paper, Brussels, 30 October, 2000).

The conclusions of the approach outlined in this chapter are the following:

i. Education, in the era of knowledge, returns to its real vocation as a *knowledge institution.* The *Knowledge Economy* has the merit of discussing education, research, and work in the same framework. The organization of education and its effectiveness rely on the way knowledge is transmitted and assimilated. The revolution does not start from the substance that comes by itself, but from the methods.

ii. Knowledge is archaically classified in large disciplinary blocks that education assumes as teaching subjects. The first step is to reclassify knowledge into units or building blocks, modules that may be handled easily and combined within an integrated system having permeable internal boundaries. To put it in sociological terms, an integrated code and weak curricular frames are needed.

iii. The free combination of modules facilitates the coupling of natural sciences not only with the technical sciences but also with the social sciences, the humanities, and the arts, thus achieving a balance among the factors that make up individual personality.

iv. The combination of modules into a personal itinerary presupposes the autonomy of the subject, and meeting its demands means "learning to learn".

v. The dilemma, "theory versus activity", disappears the moment learning modules are able to combine with activity modules, and lifelong learning is paralleled by lifelong working.

vi. Gradual specialization for the final target of activity is achieved with the general contribution of all disciplines.

vii. Constraints are lessened through the introduction of the ludic element, essential to both learning and work.

viii. Skill acquisition is not an isolated chapter; it is integrated into the process of knowing comprising both the "what" and the "how".

ix. Imagination and concentration are some of the important faculties for this system to break fresh ground.

x. Education will be role-oriented, this concept comprising professions, work, social and political functions, and any aspiration towards creative activity.

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