The adventure of knowledge in this century’s academic pursuits

Jean-Pierre Aubin
Georges Haddad
The adventure of knowledge in this century’s academic pursuits

Jean-Pierre Aubin and Georges Haddad
Contents

1. World class universities 2
2. Knowledge: assessment, fairness and equality of opportunity 22
3. The creation of knowledge 36
4. The Transfer of knowledge 58
World class universities

Jean-Pierre Aubin and Georges Haddad
I. The legacy

The weight of history, especially cultural history, seriously hampers the possibility of change and reform. We must, it seems, look briefly at the past before envisaging the possibilities for future change.

The history of universities and other learned institutions has left a legacy that constrains the future. Those exceptional moments that signal a break with the past and the emergence of new forms of organization, offer opportunities for seeking out explanations: how new avenues have been opened up, and why – if, indeed, there was a clear purpose. These ventures occurred in specific places at specific times, but then spread outwards in space and in time.

The underlying dynamic has remained the desire to know, to explore, to discover, to imagine and to invent new kinds of knowledge, and then to transmit and share them. These activities make up the two inseparable missions of education and of teaching, complementing the learning that is indispensable in helping us to adapt to the world and to change it. Not just the physical world, or even the economic and social world, but above all the cultural world that human minds have succeeded in building and extending generation after generation.

To prepare the groundwork for a new concept of the university of the twenty-first century, spanning in both time and space the East and the West of our planet, the Sumero-Greek (rather than the Judeo-Christian) and the Indo-Chinese civilizations, which eventually came into contact. To view in their historical perspective a string, far from complete, of these great landmarks is an illuminating experience.
Without going as far back as *homo sapiens sapiens* or purely oral civilizations, we could say that the story really begins in Sumer, Egypt and China, with the invention of writing. Not only could knowledge now be shared in the present, it could also be preserved for sharing at some later time and in some other place. Knowledge no longer disappeared along with the minds of men and women. It was no longer dispatched to the next world but remained on earth. This ability to store knowledge has allowed it to grow exponentially. Writing, books, new information and communication technologies (NICT), all these innovations have increased both the area over which this knowledge can be disseminated and the speed with which this can be done.

In the West, it was Classical Greece that innovated, especially after the Academy, the Lyceum and the Gymnasium were created, which have left their mark on western vocabulary. But we should not forget the Alexandrian phase and, later still, the Golden Age of Islam.

The winds that swept across this vast lake, for this is what the Mediterranean really is, were able, thanks to the science of navigation, to bring closer together the peoples and cultures on its shores and to produce a rich cross-fertilization of cultures.

On the other side of the globe, in 135 BC, Emperor Wu (“the martial”) founded the first Chinese university, “Tai Xue”, the place of “supreme knowledge”.

1. “Tai Xue”. The Taoist symbol “Tai” designates that which is supreme, ultimate, best; “Xue(3)”, used as a noun, means “study”, and, as a verb, “to study” or “to learn”. This ideogram contains the ideogram “Zi(3)”, which means “child”, the rest of it being derived from the concept “bird’s nest”, which the child flees in order to spread its wings.

Boats lining the waterways and coastlines, caravans lining the highways, such as the famous Silk Road, enabled contact between the shores of the Mediterranean and the Far East.

Although it is Asia that invests the most in higher education and research today, it does so within the framework of a system that found a natural home in Europe, a Europe that was heir to the cultures of Greece, of Rome and of Islam, before, in turn, encountering the pre-Columbian civilizations of the Americas.
These prefatory remarks do no more than touch on some of the stages of our cultural heritage and attempt to assess the socio-cultural inertia that has stood in the way of new developments, making it difficult for cultures to interact with each other. All too often, however, such interaction engagement has been of the belligerent kind: (all too) often, and ironically, knowledge and its dissemination have owed their existence to warfare. We can but hope that the road to the global village will allow more peaceful exchanges.

Two millennia of unbroken history, as enjoyed by countries with a Judeo-Christian or Islamic culture, those with a Chinese, Indian or Japanese culture and countless others, enclose these societies in a cultural cocoon generated by their long history, a history that is more inert than that of new countries, shaped by immigration (the countries of North America, Australia, New Zealand and, to a lesser extent, those of South America and Africa). These countries benefit from a lesser degree of inertia (but which is increasing all the time), which allows them to be more flexible, and thus to introduce cultural change more quickly, and to adopt and adapt new modes of production and dissemination of knowledge.

Interventionist policies and geopolitical pressure are not always enough to transplant experiences from one culture to another; a consensus has first to be reached, in order to accept them. Cultures have immune systems, just like biological organisms, but in which antibodies are replaced by anti-souls, developed to protect them from contamination by outsiders.

1.1 European universities: their ecclesiastical origins

In Europe, the Christian Church, Catholic in the West, Orthodox in the East, assumed the mantle of culture after the collapse of the Roman Empire.

The word “university” comes both from “universitas”, a term in legal Latin meaning “community” and from the Classical Latin “universus”, meaning “totality”. In the Middle Ages, the “University” included all church institutions of secondary and higher education. Meanwhile Indian discoveries (zero and negative numbers among them) travelled as far as Baghdad, then on to Cordoba, enriching the Greco-Roman heritage. The beginning of the second millennium thus witnessed the merging of two important branches of mathematics.
In the wake of Bologna and Paris, numerous other European cities would see universities spring up within their walls, universities whose prestige and reputation were developed and consolidated over the centuries to become the great institutions of today and the inspiration behind universities in the new world and in Asia and Africa.

Thanks to Latin, the lingua franca of the university world, exchanges and mobility were made easier for both teachers and their students, despite the fact that travelling was a difficult and dangerous business. Education programmes and degrees were in the main recognized between universities.

Since the value of ideas depends on their exchange, the modernization of printing technology was soon to give rise to an increase in the dissemination of and regard for knowledge, with universal and irreversible consequences. The danger posed by the dissemination of knowledge beyond an elite led the guardians of the official ideology to burn books and, where possible, their authors.

Trades were not taught at university but in the world outside, as far as the crafts and the majority of trades of the day were concerned, through apprenticeships and guilds. Finally, university research was virtually non-existent, not to say outlawed, inasmuch as it could pose a threat for the established dogma. It was rather a matter of preserving and improving those areas of knowledge that were officially recognized.

However, at the instigation of the more enlightened universities, less official forms of teaching were developed throughout Europe, aimed at the instruction of young people, albeit a small and privileged category but nonetheless a catalyst for social and cultural progress which would need several centuries of honing. Heirs to the Roman Empire and its legal system, universities in the Middle Ages were characterized by a hierarchical and centralized system of administration that survived right up to the end of the twentieth century. They taught few subjects: theology, law, medicine, and mathematics, which in those days was divided up into arithmetic, geometry, astronomy and music, the four branches of the quadrivium. The teaching of medicine and of law formed a kind of first stage of professional training, which today is undertaken in the Faculties or Schools of Medicine and of Law. However, the main role of universities was to train teachers. It was only later, at the time of the Renaissance, that science subjects (the natural sciences and
engineering) found their way into university structures, but with little observable impact on the traditional structures of governance.

1.2 The “Pride Revolution”

Innovations spring up in a particular place at a particular time, from where they gradually spread outwards. As for those we have directly inherited, the place was Europe and the time was the Renaissance, a time which gradually opened up a new pathways.

A number of causes combine to explain this break. They are not easy to unravel, but if one major cause were to be singled out, it would be *human pride*. To it were added curiosity, the lure of exploration and the taste for discovery.

Ever since the time of the Ancient Greeks, the problem had not so much been that of being original but of improving on earlier works, of perfecting the form without undermining the content, of progressing in the same direction. If by their industry people came up with new ideas, these were most often seen as having nothing more than curiosity value and not always taken up.

Except in times of war, when immediate survival requires a lower level of inertia, there was no time for wasting on the invention of new weapons, on new ways of using them or on new strategies.

![1.2. Archimedes and Marcellus. Proof of this is the vexation of the Roman General Marcellus on being informed of the death of Archimedes at the hands of a soldier enraged by his refusal to obey him, as if a scientist knew what obedience was. Well placed to gauge the potential impact of this genius’s inventions and perhaps, too, nurturing the secret hope of winning over his disciples, Marcellus organized a funeral of magnificent proportions, and had carved on his tomb a sphere circumscribed by a cylinder. Were it not for Archimedes, who would remember the victor of the Siege of Syracuse? The state funerals of scientists are too infrequent for this one not to be recalled.](image)

The Creation being a revealed creation, humanity wants nothing more than to unveil it, to uncover it, to revere it and to interpret this revelation. Creation, from the Greeks right up to the Renaissance, is not valued as such, but is simply the imitation of a perfect model, an imitation that is executed as perfectly as
possible. If someone inadvertently recreated this interpretation of creation and communicated it to others, they hid behind a “revelation”. Becoming convinced of Nature’s indifference towards them, but as yet uncertain of it, it was humans themselves who had to hide in order to un-veil it, afraid, in spite of everything, of being exposed and punished if they were ever caught out. They then ceased to respectfully question nature and appropriated it instead. To man’s desire for power over man was added the desire for mastery over nature, and to bring it about, its secrets had to be penetrated: and that was real revolution.

It is a fact that inventions did not become a frequent phenomenon in Europe until the late Middle Ages and the Renaissance. China was, then, well ahead of Europe at this time, but its progress started to falter after the fifteenth century. Taoism, which is less concerned with dominating nature than adapting to it, no doubt regarded this attitude of intellectual pride with disfavour.

Since the European Renaissance, humanity’s humility before Nature has given way to pride, to being no longer content to adapt to Nature, but wanting to transform it. It was this pride that drove the Europeans of the Renaissance to disobey, to innovate, to transgress religious taboos, that encouraged them to cross geographical as well as cultural boundaries. Regardless of whether these inventions were useful or useless, two things showed through them: abstraction and secularism. “Dare to know” was the challenge thrown down by Kant, in the midst of this revolution, at the dawn of the Enlightenment. Sapere aude, so that the individual took control of his or her own destiny.

Mathematics was given a new impetus as the language that could interpret nature. Galileo made cosmology his exclusive preserve; Pierre de Fermat did the same with physics, making his variational principle the cornerstone of a primitive account of the world from that particular standpoint; while in mechanics, Isaac Newton, in one simple formula, gave a succinct and seemingly definitive account of that discipline.

In refusing to bow to the laws of nature the better to control it, scientific curiosity, the irresistible desire to understand, could now dissociate itself from that unquenchable thirst that impels us to turn our gaze inward rather than on the world about us. Science and contemplation had now become activities that took their practitioners in opposite directions. Erudition, exegesis and hermeneutics are all about seeking truth and knowledge among the ancients. The older thought is,
the more profound it is and the more sacred it becomes. As with titles of social rank, age is all-important. In the beginning was Knowledge, which, subjected to the ravages of time, became increasingly inaccessible. Every effort had to be made, therefore, to retrieve it. The word of the ancients became sacred, and even if it lost its original meaning, a permanent, ongoing effort of exegesis still allowed it to be adapted to the social consensus of the time.

Science, for which there are no such things as sacred texts, moves in a forward direction, is based on exploration and experiment and not on revelation. Unlike dogma, the most firmly established scientific assertions are open to revision. Their life-span becomes ever shorter as their range continues to grow. The days of what we might call the “stem” sciences, in the way that we now talk of stem cells, are over, and it is difficult to go back in time, to clearly identify the big changes, to unlearn things. Doubt prevails and calls everything into question. Scientific thought dispels magical and irrational thoughts. Scientific inventions and discoveries are destined simultaneously to disappear, after first impregnating others, and to be stockpiled over the years for the purpose of tracking their gestation. It is not the same with works of art or of literature, which cannot be transcended in this way. They become the object of scholarship for those who come later, but they are never turned into objects of “constructive destruction” by researchers, to paraphrase Schumpeter (Joseph Aloïs) [1883–1950] Joseph Schumpeter.

1.3. Bruno and Vanini. Giordano Bruno, the scholar and “preserver”, looked for truth among “both the sacred and the profane men of learning, speaking in the shadow of science and in the light of faith”, by interpreting ancient texts. A few years later, Julius Caesar Vanini embodied the start of the “Pride Revolution”, by setting out on his journey to dissidence. History has only remembered the former, who preserved knowledge belonging to the past, hermeneutics and exegesis, whereas the latter, like all innovators, blazed a trail that would be obscured by the dust thrown up by the advance of science. At the dawn of the Age of the Enlightenment, they sought enlightenment from the torch of science. Bruno was burnt at the stake, in Rome in 1600, as was Vanini, in Toulouse in 1619.

It was during this period that the attendant demand was voiced to be freed from the bonds of nature and of the celestial powers, and equally from the bonds imposed by the powerful in this world. This moral and ideological upheaval gave a
World class universities

1

boost to science and with it, to democracy, economic production, the emergence of the constitutional state and what eventually came to be known as capitalism.

The pride of humanity not only incites it to claim the highest place in the Creation but also the highest place in its own creations. The industrial and computer revolutions were already in the air. This pride, which exalts people, depriving them of all sense of caution, is, by enslaving nature, in danger of alienating them a second time from their true nature; in fact, even a third time, by turning them into thinking robots that move in a virtual world.

Of course, Europe was not the only region with dissidents at that time. Contemporaneously with Bruno and Vanini, Li Zhi was expressing his views with frankness and unwonted freedom and was sent to prison, where he committed suicide in 1602.

1.4. Li Zhi. His books, among them Book To Be Burnt and Book To Be Hidden, published in 1590 and 1599 respectively, were banned by imperial decree. Jean-François Billeter quotes him in his biography [2]: “In addition, all the idiots in the area began to see me as a heretic, and I made myself become one to be worthy of the name with which these fools honoured me.” The mandarinate did not look kindly on dissidence at the time.

1.3 The industrial era and universities of the nineteenth century

It is in the eighteenth century, the century of the Enlightenment and of the great revolutions, and even more so in the nineteenth century, when the new ideas took a hold and new socio-economic relations were established, that the modern idea of a university took shape. It was, in fact, in 1806 that the university was defined for the first time as a body of schoolmasters in the public education system at its different levels (Alma Mater) and in 1809 that von Humboldt created in Berlin the first university of modern times: a higher education institution made up of a group of teaching and research units, institutes, centres and research laboratories.

Thus, for the first time, research was included among the missions officially entrusted to universities, through which was spelt out their responsibility for innovation and speculative research.
From this time onwards, the great scientific discoveries became largely the domain of university laboratories, while the major advances in knowledge, and the transmission of those advances, became the domain of teacher-researchers, a modern concept that appeared towards the end of the nineteenth century. University institutions guaranteed the independence of researchers and scientists and their freedoms, as well as the protection and dissemination of the knowledge they produced. Similarly, and quite radically, advances in production techniques and industrial revolutions spawned new trades and, with them, new needs for vocational training. It was only natural, therefore, that the so-called enterprise culture should turn to universities to meet these new needs, not only in the majority of European countries but equally in North America, where new universities sprang up, some of them now among the world’s leading institutions.

2. Anticipating key structures

The twentieth century, at one and the same time a century of the worst disasters and of the greatest advances in all areas of knowledge, saw universities become slowly but surely key partners in socio-economic development and in cultural development. There was a significant increase in discoveries and inventions, new disciplinary fields sprang up, original methods in education were established, the most recent ones being distance learning, adult learning and work-based learning. The principle of recurrent education (or lifelong learning) emerged. Recent decades have witnessed the strengthening of links between university research, teaching, industry and the world of work, as well as increased participation in development at regional and national level. Similarly, the principle of auditing a university’s objectives has become firmly established, albeit with reservations in some countries, enabling universities to progress and the public to acquire a clearer understanding of what universities actually do. Although it satisfies a natural need for accountability, this practice has experienced and is increasingly experiencing, owing to its bureaucratic and statistical approach, negative effects that are counterproductive in regard to intended aims.

By gradually widening access to education for an increasing number of age groups and opening up universities to all levels of society on the basis of merit and individual qualities, though much still needs to be done in this respect, we have set
for the present century the challenge of offering a university education to everyone while maintaining standards of relevance and quality.

The second half of the twentieth century has witnessed the end of colonialism and the emergence of new countries anxious to secure their future and the future of their young people with the help of independent but highly effective learning techniques.

New universities have been created, though in some cases haphazardly, without proper planning. Higher education will be one of the major issues for the future of these developing countries. Responsibility and solidarity at the international level are vital if we wish to avoid crises that would have unimagined consequences for these countries’ futures, which would also affect the so-called developed countries.

The key question is whether they should copy the western model inherited from the twentieth century or look ahead to the revolutions already under way to bypass or to speed up certain stages in the development of higher education and research, as well as to avoid the obstacles and the dead-ends. The question is central, for the costs of this transition, together with the limited time available for making it, are enormous.

Finally, modern communication and information technologies, and the globalization of the economy and the job market involve, for the end of this century and the next, new reciprocal responsibilities between universities and society.

The new concepts of academic freedom and autonomy, which offer universities the best chance of fulfilling their social mission, must be protected and incorporated into the framework of the new contracts and strategies that are now being put in place on a trial basis.

Contracts between universities and society at large have, then, still to be clearly defined. Failure to take account of cultural inertia could lead to the transplanting of structures of governance and subjects that are quite likely to be rejected by what could be described as our cultural immune systems. If it is to be successful, the transplantation of cultural models, such as models of education systems, must be handled with political and cultural sensitivity, over many years. It is often the case that even when they are not rejected, transplants only retain those elements the
host society finds least strange, elements that are very likely to be the least original and the least useful. There is no simple solution to these problems. But they still need to be picked up and properly identified.

3. The networking invasion

The knowledge explosion has also had an impact on higher education institutions based on the “European model”.

University institutions, bound to their location, their identity and their hierarchical structure are facing crises that will bring about a reorganization into regional and international networks of teaching and research activities. As with biological evolution, social systems complement existing institutions by adding new structures to them at times of crisis when the viability of the system is at stake.

Such networks have come into being over the last thirty years with the internationalization of publications and conferences. A number of journals that once had the name of the founding institution in their titles have given way to more specialized publications, tending more and more to be run by editorial boards drawn from international communities of subject-specialists. Similarly, the desire of most universities to be truly universal, covering the entire range of disciplines and sub-disciplines, has resulted in a dispersal of effort within specialisms and in a lower level of synergy. The subject-specialists from the international communities in question have taken to the habit of meeting up at professional conferences with increasing frequency, allowing them to collaborate with one another and to operate in networks.

It is possible to be proactive in this evolution, by devising and experimenting with other networks, and thus to speed up their emergence and their effectiveness while at the same time maintaining the looser, provisional character of their organization. That would allow less rigidly structured networks to be more responsive to scientific progress, to derive maximum benefit from information technology and to provide a stimulus to the large university institutions. These evolve naturally, in the same way as big businesses do, their size stilling discoveries and innovations, which for the most part are the preserve of small companies, the famous ‘start-up’ companies.
3.1 *Portfolios of cutting-edge education*

By their very nature, specialized discoveries and knowledge will only appeal to a minority of students. If state-of-the-art teaching and novel forms of education are all housed in a single geographical location, i.e. a single institution, such knowledge will not be disseminated throughout the “subject” community, which is dispersed over many nations. It is therefore in danger of being wasted, for want of being organized into networks that would extend its distribution to many more institutions. A preferable alternative would be for international subject-specific networks to put together “portfolios of state-of-the-art education” of courses that can only normally be offered in a very small number of institutions. For students with a genuine interest in these specialized courses to be able to access them, they would have to be moved elsewhere and compressed into a single week or at most a small number of weeks, since they would only be taught in a handful of institutions. Portfolios of state-of-the-art education would have to be compiled along subject lines and not along institutional lines, and this state-of-the-art education would be offered to networks of students from everywhere. Whenever these courses were residential, where lecturers and students lived under the same roof during a period of intensive teaching, the dissemination of knowledge would take on a different pedagogical complexion, since questions could be asked outside the traditional tutorial setting, on a personal level, and answers adapted to each individual. The fact that students from different geographical and disciplinary backgrounds would come together in this way would allow a variety of links and interdisciplinary connections to be forged and foster dialogue between cultures.

3.2 *Networks of teachers*

University institutions, especially those in the developing countries, do not have, or will not have for much longer, sufficient resources, financial or human, to offer courses in all subjects or even total coverage within a given discipline. Teacher networks could compensate for these difficulties. To this effect, a higher education institution would establish a network of teachers within a given specialism. It would invite teachers and/or researchers, who would work with the institution’s full-time staff over a period of months, *but on a recurrent basis, during the several years their contract would last*. The visitors would devote part of their time to teaching proper and would spend the rest of it engaging in research activities together with researchers or full-time staff. If the invitations to visit overlapped, this would...
result in visitors coming into contact with one another, which would supplement the contact between visitors and full-timers and would create or increase synergies in which the institution could take an active part. The prospect of collaborating with a larger number of colleagues would provide more of an incentive for teachers and researchers to leave their institutions for a fixed period of time. Conversely, the presence of a number of staff from outside would have a positive impact on teaching in the host institution, on its research, its standing and its appeal for students and future visitors, now having to compete as a result. By strengthening the fabric of traditional universities in this way, these two types of networking, one where the students uprooted themselves to follow state-of-the-art education programmes organised as “portfolios”, the other involving the teachers and researchers, would give a boost to the exchange of knowledge, and would do so more quickly and more cost-effectively. These networks could provide the blueprint for a new concept of a university in the twenty-first century, spanning in time the East and the West of our planet and the Sumero-Greek civilizations.

3.1. “Taixue” and “Thelema”. Will not the university of the future have to become an intellectual paradise on earth, bringing together and reconciling “Taixue”, supreme knowledge, and “Thelema”, that abbey of “Do what thou wilt”, since the Greek “telos” (to will) is the etymological source of the Rabelaisian maxim? The ecumenical neologism Taitel, resuming the idea “the supreme will to know” could then be used to designate it.

4. “Reversing the brain-drain”

These light, ephemeral structures are especially suited to developing countries, while also limiting the inevitable brain-drain, not only of teachers but their students too, to more prestigious institutions or wealthier countries, which benefit, at no cost to themselves, from the investment made in their education by the poorer countries. These countries should put in place a two-pronged education policy: investment in the education of their nationals and a policy of job creation in the home market, at the same time making it compulsory to reimburse the cost of their education,
should they choose to emigrate to other countries or to the private sector, which is happening today. The champions of the market economy could hardly complain about that.

Is not the brain-drain telling evidence of the deficiencies of a university system that fails in its efforts to renew its researchers and teachers, only managing to drive them into the arms of others?

Organization into networks is indispensable if developing countries or those in economic transition are to be able to access teaching and research jobs in a number of areas. For these countries, it will be a matter of making choices in order to increase the synergy of their teachers and researchers in a few carefully chosen areas where they would become experts and would be the nodes in these networks of students and teachers. The adoption of such a policy, that opts for synergies in a small number of fields, has already been tried out on a number of occasions.

One such case was Poland, rising from its own ashes after the First World War. Zygmunt Janiszewski conceived a scientific strategy for his emerging country that made it the cradle of one of the most famous schools of mathematics of the nineteenth century, a strategy that he described in a text written in 1918 called *Polish Science: Its Needs, Organization and Development*. He suggested that Polish mathematicians in no way needed to follow or imitate foreign mathematicians, that they were capable of developing a Polish position. To achieve this, he recommended that Polish mathematicians should concentrate on a very small number of themes they had already written on. He also stressed the point that mathematics needed no investment in laboratories and equipment. Even though computers have replaced the famous rubbers and pencils that were always said to be the only tools that mathematicians ever needed, the point is still relevant. Today more than ever, those mathematicians who are so inclined can slot themselves into numerous other disciplines, to which they can contribute without necessarily getting involved in costly experiments. Despite his untimely death in 1920, his suggestions were taken up: starting from nothing, Poland became a beacon for mathematicians everywhere. It has survived military occupation but may not be so successful in resisting the new, globalized ways of organizing science.

Poland’s is a strategy that could be followed by developing countries, helping them to overcome the scientific and cognitive divide which marginalizes them.
even more in the drift of cognitive continents. The problems are enormous, as we
discover in an original book [1] by Etienne Bebbé-Njoh, a doctor of mathematics
(whose supervisor was Albert Châtelet) and a doctor of philosophy, the founder
and director of the Ekoudou Education Centre in Yaoundé, covering the entire
age-range from pre-primary to baccalauréat and catering for more than 1,000
children every year. In his book, he explains with courage and candour positions
that fly in the face of received wisdom but which he has tried and tested. He takes
his cue from Lucien Lévy-Bruhl in putting forward the concept of a “primordial
mentality”, a real force of inertia, which he contrasts with scientific rationality, a
force of technological progress that propels societies into a process of constantly
modifying the environment. He refuses to make a necessary identification between
the traditional mentality and African culture or between scientific rationality and
Euro-Western culture, showing that both these components are, to varying but
not immutable degrees, present in every society.

4.1 Strategies for development. The different countries should put in place a
two-pronged education policy: investment in the education of their nationals and a
policy of job creation in the home market, at the same time making it compulsory
to reimburse the cost of their education, should they choose to emigrate to other
countries, which is not the case today.

Developing countries, might have a chance of overcoming the “scientific and
cognitive divide” which marginalizes them even more in a kind of “cognitive drift”,
a metaphor for the notion of “genetic drift” proposed by Ernst Mayr as one of the
major mechanisms in the evolution of species.

The direction of the brain-drain from one institution to another, from one country
to another, is telling evidence of the deficiencies of a university system that fails in
its efforts to renew its teaching, its research and its jobs.

Being collective, the inertia of cultural evolution is strong. It must be brought into
line with the cognitive evolution of each individual. New methods of organization
still to be devised would ensure an education programme of quality for all in a
world where it is absolutely imperative to reduce cognitive inequality. For all, from
the very first years of life right up to higher education, and, above all, a recurrent
education that continues throughout life. Nor should it be forgotten that it would
only work smoothly and effectively if all the links in the chain were developed at
the same time. One end of this chain, higher education and the training of teachers,
has not received all the attention it deserves. The other end, the training of parents
to educate their offspring from babyhood, which we now know is of the greatest
importance, does not exist at all.

**4.2 The day when the direction of the brain-drain is reversed, humanity will wake up.** Light, flexible and ephemeral structures are especially suited to
developing countries, while also limiting the inevitable brain-drain, not only of
teachers but their students as well, to more prestigious institutions or wealthier
countries, which benefit, at no cost to themselves, from the investment made to
train them in their own countries.

**5. Attaining excellence?**

Attaining excellence? Attaining excellence?

The end of the twentieth century has seen the emergence of the concept of
excellence and frantic efforts to define and attain it. Ever since, all institutions have
aspired to reap the benefits of this prestigious label.

This aspiration has gone hand in hand with the possibility of measuring excellence,
the perverse effect of which has been to take seriously statistical techniques using
numerical data that are virtually meaningless. Since knowledge has no units of
measure, it cannot be measured by numbers. This can only be done for a handful
of outcomes, but if these are too few in number, they give an unbalanced view and
distort the general picture. Unless we bear this preliminary observation in mind, we
are in danger of working against the very goals we are pursuing.

Bibliometric techniques, for example, have been invented, which, as soon as
they became available, produced perverse and damaging effects: in no time at
all, researchers adapted to these new criteria, which claimed to be objective, but
that just was not possible. The justification put forward was the duty to inform
“society”, represented by the parties involved, the “stakeholders”, or the rather
nebulous “policy-makers” behind the funding decisions.

Not to mention the trend-setters, who try to attract talent using false criteria. We
forget that originality, unlike development, often dries up once it has been socially
recognized. Celebrity fosters opportunism and conformity more than a breaking
away from the “mainstream”, which is the hallmark of genuine discoveries, before they are transformed, whenever possible, into innovations.

After all, what things can be measured? The population size of the different groups that are analysed and the funding they are allocated. Inadequately segmented populations, such as “World Class Universities”, are meaningless because they are too disparate. For instance, certain features need to be kept distinct, such as level of study (whether pre- or post-doctoral), subject-type, facilities needed, level of resource (staff-student ratio, ratio of support staff to teachers and researchers, overall budget, etc.).

Populations should, in fact, then, be first of all sorted according to population type, and resources related to population size.

Within the relatively homogeneous categories resulting from such a classification, qualitative comparisons could meaningfully and reasonably be drawn. And only then, on the basis of a whole series of criteria that it would be impossible to list exhaustively, but among which would feature:

- assessment of the quality of individual researchers (as distinct from a team project);
- contribution to economic health (measured in terms of patents, royalties, etc.);
- contribution to social and cultural quality;
- quite simply, contribution to human knowledge.

That would involve such a workload that those who have set themselves up as “rankers” (and no longer as assessors) have preferred to use raw data from the Internet on a tiny number institutions, predominant only in terms of size, that claim to be “World Class Universities”. The bigger they are, the less they have in common, and the less they have in common, the more futile it is to want to rank them.

The ever-rising costs of higher education and research institutions means that they are relying more and more on external sources of funding, especially private capital, where the main indicator is a return on investment (before the recent
salutary crisis struck). The financial factor, which is purely arithmetical, has tended to take precedence over non-arithmetical, qualitative factors, and for that very reason is based on quantitative pseudo-criteria instead of the qualitative criteria they have replaced. The latter require trust, which is difficult to promote in large organizations, which instinctively generate red tape. This is difficult to reconcile with education and research. These common-sense considerations have probably not escaped those who have an interest in exploiting them. The fact is that money can do a lot of good but it can do even more harm, if it uses quantitative criteria, which drive intellectual activities in directions that are not necessarily conducive to innovation. Such criteria, which are supposed to be transparent, are in reality distorted by the prism of profitability. The danger is scarcely visible, inasmuch as each actor in the system must look to their own survival.

The quality of an institution is measured by the excellence of those who make the judgement.

Excellence is not something that can be caught in quantitative nets: it will lose its meaning as institutions inflate their worth by claiming to be excellent. It is the inevitable fate of all superlatives that lack legitimacy.

Excellence cannot be decreed, but only be conferred.

5.1 New missions

Thus the history of universities shows that the creation of knowledge, without taking precedence over the transmission of knowledge, occupies an increasingly important place in the mission of the universities that are being established at the moment. Regardless of their structure, higher education institutions must encourage the creation of new forms of knowledge, their dissemination through aid earmarked for innovation, and the training of teachers and of students. Structures must be devised that allow all knowledge, in various subject-combinations, to be transmitted to the whole student body. Finally, to stimulate the renewal of knowledge, whether in research institutions, innovation centres or professional organizations, students need to be educated through research, to the greatest possible extent, and in the case of some students, for research.
5.1. **Learning to learn, learning to discover, learning to teach,** these are the missions of the scholarly and university institutions of tomorrow.


Knowledge: assessment, fairness and equality of opportunity

Jean-Pierre Aubin and Georges Haddad
I. The nature of knowledge

The notion of ‘knowledge’ is particularly polysemous. In the present context, it is understood as a cognitive image encoding the behaviour of an individual acting on the environment to change it. This is done with the aim of adapting to the constraints our environment imposes on our ability to survive.¹

The environment is complex, made up of physical, biological, social and, especially, as far as this analysis is concerned, cultural components.

Forms of behaviour, and therefore of knowledge, are processes that cannot be properly understood unless we simultaneously have knowledge of the input from the environment and the output on the environment. In fact, we need to begin by clearing up an ambiguity: ordinary language does not distinguish clearly between the notion of process and that of the result of a process, in other words between knowledge of the input-output relationship and that of output alone. We need therefore to observe output in its relation to each input in order to properly observe behaviour, for it would seem impossible to detect any pattern in an individual’s behaviour by observing only output, without taking input into account.

Although an environment is made up of numerous physical, social and cultural components, ordinary language tends to privilege, in the idea of knowledge, that

¹ In fact, without going into the details of cognitive systems, ‘cognitive processes’ transform, at the level of the nervous system, symbolic perceptions of input from the environment into actions on the environment producing the output, i.e. the behaviour. The above definitions are more than adequate to our purpose.
aspect of it which encodes states of the social and cultural components of the environment. This meaning can be too restricted inasmuch as the components are too tightly interwoven to be disentangled. The particular type of knowledge we focus on in the analysis below is the type that encodes behaviour acting on the cultural elements of the environment. It should not be forgotten, however, that, given that human beings live in society, knowledge also encodes behaviour involving the social components of the environment, and particularly behaviour acting on other human beings and living organisms.

Among them, the various kinds of behaviour that transmit types of knowledge, starting with the behaviour of imitation, on the one hand, of learning, on the other, are also encoded by types of knowledge, knowledge of the transmission of knowledge.

Trading in these strange commodities we call knowledge of one kind or another requires producers (researchers, innovators and entrepreneurs), consumers (pupils and students, in fact, all human beings) and distributors (parents, teachers and lecturers). Each individual plays out these different roles at different times and to different degrees.

From each of the actors, this trade demands trust, which can only be built up gradually. As soon as trust disappears, bureaucratic procedures and global rules flood in to simplify transactions in the knowledge market.

1.1 The appetite for understanding, discovery and learning

Today’s students find it increasingly difficult to see and to believe that time spent at university could be of benefit to them. Professional activities, which increasingly fall within the service and cultural sectors, no longer conjure up a vivid mental picture. And so, for many students, the effort of imagination needed for them to agree to expend their energies on studying for goals that are impossible to pin down is simply too great. The links between jobs and education have been broken, owing to the gradual disappearance of specific jobs that always stayed the same and were clearly identifiable. Without a clear picture of their future prospects, it is difficult to awaken in students that sense of calling which would make them engage with their studies.
When one’s faith in a better future is undermined, all that is left to replace it is blind obedience or the lure of gain, and that does not always produce the results hoped for.

1.2 The inertia of knowledge

Human brains can no longer cope with the body of knowledge produced and stockpiled by their predecessors. For this reason, a certain division of cognitive labour was established, giving rise to the creation of new disciplines.

The knowledge in a discipline is as inert as its history is long. The more deeply this knowledge is embedded in the collective memory and taught from early childhood, the stronger the consensus is and the more widely it is shared, then the slower will be the transition to a new consensus on subscribing to new disciplines. This transition usually takes place only when the survival of the knowledge society is at stake, in a state of crisis. It is during such periods as these that reform and the adoption of reforms become possible.

1.3 Redundancy and culturodiversity

Adaptation requires a reservoir of possibilities from which types of behaviour can be drawn and consequently the knowledge that encodes them. The dimensions of this reservoir are determined by redundancy. Paradoxically, the evolution of redundancy can be impeded by an increasingly constrained and demanding adaptation to the environment, culminating in an ecological niche. In order to specialize, we have to activate an increasing amount of knowledge, at the expense of the redundancy of the other elements of knowledge available, which diminishes over time. When the total amount of available knowledge becomes too small, the robustness of the cognitive system declines. Since our cultural environment is changing ever more rapidly, the situation could arise where there is not enough available knowledge to make the new environment viable.

The phenomenon is analogous to the totipotency of stem cells, which are not yet specialized and whose future is an open one, only gradually narrowing as they become more specialized to cope with unpredictable changes in the cultural environment in the wider sense.
Redundancy leads to a *bush-like evolution*, from which the evolution of knowledge can mushroom and life can select those elements which it validates.

Like life itself, which, as we all know, has favoured biodiversity with notable success, cultural evolution must find an equivalent in a [*culturodiversity*](#) that would lead to a “division of cognitive labour” in the processes involved in making new discoveries. Writers experience this daily, when they scribble down a thousand ideas from which they will choose just one; so does a mathematician, who makes calculation after calculation, until their aesthetic sense and the need for proof help them to choose the ‘right formula’; decision-makers, too, who meet for a brain-storming session, in the course of which the one idea emerges; and politicians, who always have several irons in the fire the better to succeed in their ambitions.

It is the redundancy in scientific and technological progress that allow human beings to increase both the production of different types of knowledge and the different types of human behaviour.

*The mechanisms that have increased redundancy by creating ever bigger reservoirs of knowledge have been (partially) selected by humanity.*

As this process of exploration of the cultural environment unfolds, we will never fully appreciate the part played by *error* in our innovating and learning.

For errors are, in fact, the source of any increase in the redundancy of knowledge, enabling an unintended exploration of the environment. Those errors, for example, and they are many, that punctuate the history of science have enabled exploration of unexpected kinds of evolution, made possible as soon as the reservoir of possibilities contains a quantity of validated knowledge. Simply because the human mind fails to understand a phenomenon – which happens when an error calls into question our confidence in the validity of a metaphor – this does not mean that we should throw out this phenomenon with the metaphorical bathwater of understanding.

*It is preferable to experiment with, to explore and to validate available knowledge.*
2. Evaluation of knowledge

The quest for excellence is a commendable objective and, if embarked on, requires procedures for assessing the knowledge exchanged between the individual assessed and the assessor. The assessment task becomes unmanageable as soon as the quantity of knowledge and the number of individuals exchanging it reach too high a level for the assessment methods peculiar to each exchange to be employed. The use of such methods becomes overcomplicated.

Like any other commercial activity, dealing in knowledge entails the exchange of items of knowledge, and ultimately their comparability, either in terms of barter or in terms of ‘marks’ that assess this knowledge, just as prices allow us to assess (measure) products and to compare them one with another.

Again like any other commercial activity, knowledge and formal qualifications are subject to inflation and devaluation. As with money, bad qualifications drive out good ones.

In any case, paper qualifications are becoming less useful in finding a job or professional opening; they have to be supplemented by a whole battery of instruments, such as job interviews, personal statements, etc. This calling into question of the educational process after it has run its course could usefully occur earlier on, at its source rather than downstream, so that the inadequacies of purely quantitative methods of assessment could be analysed and supplemented by more plausible, qualitative methods.

2.1 Marking systems

Qualifications are supposed to measure knowledge. However, knowledge cannot really be measured in terms of marks, in other words, by numbers. Unlike goods and services in economics, which can in principle be measured quantitatively using objective units of measure, ‘units of knowledge’ do not exist as such. To overcome this deficiency, human beings have invented theoretical units of knowledge that are subjective and psychological. Like prices in economics, systems for giving marks for knowledge (marking scales) have been devised, and for the same reasons: to ascribe to any body of knowledge a number that measures it and sums it up, not in terms of monetary value but in terms of ‘marks’. Used, in the final analysis, to quote the share price of
a qualification on the job market, these marks are only real to the extent that a consensus is formed to believe in them. In this shifting world, faith in these assessment methods is all the more unshakeable because it applies equally to the remuneration of jobs in the ‘intangible sector’, precisely the sector in which knowledge belongs.

Since time can be measured, the speed with which tasks can be performed is often used as a way of measuring knowledge itself: *ironically, using time in this way causes us to overlook activities that demand reflection, and so require us to ‘take our time’; one such activity is learning to learn.*

A kind of conspiracy has grown up to preserve the illusion that an ‘objective’ number can represent the assessment of an individual’s knowledge and to conceal behind an impartial exterior methods that are fundamentally subjective.

### 2.2 The perverse effects of marking systems

Every time, however, these ‘methods’ of assessment have been accompanied by perverse effects, more damaging than such a time-honoured practice might lead us to believe. The most serious, but the least advertised, is the necessity of devising or choosing the kind of knowledge that lends itself to being marked, using what pass for units of measure. The knowledge has had to be packaged and standardized, so that it can be assessed quantitatively, using a marking scheme. The ability to think, to reason and to be original, being difficult to assess, have been replaced by glib formulae learnt by rote, which can be applied automatically and are easily tested. Memory has taken over from reflection, reacting to events has taken over from reflecting on them in an attempt to anticipate them and dogma has taken over from doubt. The pleasure that rewards the effort to understand or to acquire new knowledge, satisfying one’s curiosity, is replaced by the pride of getting high marks. Admittedly, marks encourage students to compete with one another and give them status in each other’s eyes. But they also mean forgetting that the only worthwhile competition is competing against oneself, measured by one’s own objectives and with only oneself as spectator.

The use of multiple-choice questionnaires have taken this mockery of an assessment system to deplorable extremes and perverted further the knowledge they are supposedly testing. Marks and qualifications have become the main objective of
these workers in the knowledge industry that too many students are becoming in a society that expects to measure everything in units of currency.

2.3 The life-span of qualifications

The life-span of a qualification that prepares one for professions with a short life-expectancy is becoming ephemeral, because the skills learnt have an ever shorter life. The qualifications attached to these types of training should be stamped with a ‘sell-by’ date. Ironically, the training for this type of short-lived activity demands knowledge that is abstract, and so general, in nature, and therefore shared by a large number of individuals, whereas a concrete experience is unique and can only involve a small number of experts. An individual’s initial education should therefore be extended by recurrent periods of training throughout that person’s life.

Since intellectual activity, unlike physical activity, cannot be ‘measured’, society will, for a long time to come, be strongly disinclined to reward activities which have to be taken on trust, trust being an attitude not often encountered.

Trust in the “value” of qualifications is in inverse proportion to the number of people who hold them, with the result that employers have very shrewdly introduced their own methods of assessing candidates’ qualifications and knowledge, using their own criteria as the yardstick.

2.4 Keeping the roles of teacher and examiner separate

When we observe, for example, that discussions about education focus more on marks, examinations, qualifications and employment prospects than on actual educational factors, is it not time to separate the roles of teacher and examiner? Separating the functions of teaching and assessing would allow professional examiners to benefit from bigger population samples for comparison, made up of both students and their teachers. The latter would be able to judge for themselves the effectiveness of their teaching by comparing, over time, the results of their students with those from earlier years. Teachers would also be able to concentrate their efforts on the transmission and the acquisition of knowledge and skills.

Teachers, then, would concentrate their efforts on the transmission and the acquisition of knowledge and skills, and examiners would enjoy the advantage of
unbiased assessment, qualitatively and quantitatively, working on bigger population samples. Teachers, for their part, would also be able to judge the effectiveness of their teaching by analysing, over time, the results of their students and comparing them with those from earlier years. Such an arrangement would better enable examiners to advise students on changing courses, where they had embarked on unsuitable degree programmes chosen under the influence of fashion or of a perception, often erroneous, of the qualifications asked for by employers, in the public and the private sectors. It would also create the flexibility necessary for correcting the overall nature of qualifications, which is, after all, often called for at the national level, and even at European and world levels.

2.5 Individual and institution-wide evaluations

The global character of the evaluation of an institution makes it worthless, precisely because it is global. It is difficult enough to evaluate individuals; it is even more of a challenge evaluating institutions which are educating them. Over the last 40 years, the pendulum has swung in varying degrees away from the individual towards the institutional, in all countries. This system, described as modern, in the sense of contemporary, does not mean it is a better one, that is to say modern in the sense of progressive. After half a century, we have reached the following paradox: in a society that wants to become more and more individualistic, individual responsibility is being squeezed out!

Of course we should assess the players in teaching and research establishments, but individually, periodically and seriously. Evaluation of institutions themselves should only look at governance, management and the use of public funds, though individual evaluations could be available to public scrutiny.

3. Equality of opportunity in accessing knowledge

To ensure a minimum degree of fairness and improve equality of opportunity in terms of receiving an education and being equipped to adapt to the cognitive and digital revolutions, States felt it necessary to insist on all their young citizens being properly trained and to mutualize the cost by assuming it themselves. Through this redistributive pooling of public resources, States were at the same time providing
the entire population with a longer education according to their means. Unfairness appeared at two levels (at least), between States themselves and between individual citizens within States.

The “interventionist” deployment of funds to achieve these goals has been accompanied by a bureaucratic inflexibility all the more restricting because of the large numbers involved. It has proved necessary to make adjustments, either by decentralizing so as to respect the principle of subsidiarity, or else by ‘privatizing’ these institutions, thereby jeopardizing fairness and equality of opportunity.

3.1 Towards the commodification of culture

Policies for funding educational missions are essentially a matter for the State, but virtually everywhere private funding has begun to appear, initially somewhat timidly in Europe, but more boldly in North America. This has been happening since the late 1980s in particular, which experienced the silent revolution of unbridled deregulation, removing not just unnecessary restrictions but a good many others as well. It hardly needs stating that too many restrictions limit the possibilities of change, but too few lead to all manner of excesses, like those which have caused the crisis of the early twenty-first century, a crisis which affects every sector, including education and research institutions.

American universities, public as well as private, have developed an organizational structure of an entrepreneurial character, which has given rise to a strongly competitive, and often short-termist, ethos. In this context, students become customers, the university’s duty being to provide them with a service commensurate with the amount, often very considerable, of their tuition fees, for which they are personally responsible. The competition is often intense. Some institutions have no hesitation in offering higher salaries and better working conditions to attract the most famous researchers and the best teachers. Involved in the running of these institutions are financial experts in the field of economics, who are also engaged in fund-raising activities. This commercial approach produces a very wide range of institutions, varying in both reputation and effectiveness. It means that each student, providing that they have the necessary means, can choose which university to apply to on the basis of the reputation of those particular universities that match their aspirations. This management style has borrowed from business the whole range of its techniques, and has no hesitation in exploiting, over and above the institution’s
academic quality, the different media and advertising, to consolidate the institution’s prestige. In the globalization process that is under way, this system is attempting to impose itself as the universal model, with all its qualities and excesses, particularly those relating to equity.

3.2 Education rights or education dues?

Whether education is funded via the State or directly by its citizens, it is imperative that society increase its expenditure on teaching and research institutions. The number of individuals engaged in the knowledge business has gone on growing throughout human history, even though at different rates in different geographical locations, creating sharp differences both within individual countries and across countries. The rapid growth in student numbers after the Second World War had major repercussions. Society should make the education of its citizens a budgetary priority, starting with the education of parents and teachers, even though, and especially because, the effects will only be felt in the long term.

The first task would be to shore up students’ wavering faith in education and its benefits through a mechanism that was fair, motivating and allowed them to take responsibility for their own learning. A system of ‘financial credits’, properly devised, would give students increasing freedom of choice, as and when they wanted it.

These inalienable ‘dues’ (different from the inalienable rights proposed by liberal economists in the wake of Friedman (Milton) [1912–2006] Milton Friedman) would be funded from the public purse. The dues would financially compensate the institution admitting a student for the actual cost of the course they selected (which would be less for Latin than for biology or physics, for example). The amount, which would be the same for all institutions, would be calculated on a yearly basis by the relevant government department. This capital sum, representing so many years of free tuition, could be used for successive years, at least in the case of the earlier years, or could be put aside for periods of recurrent training at a later stage.

The credits would be limited to a specific number of years of free education, fixed by government, for example. The number of years in question would have to be the same for every student, in order to guarantee, as far as is humanly possible,
equality of opportunity. Attaching a time limit to the credits would require students to exercise personal responsibility, encouraging them not to waste public money.

If a student failed their course, use of the credits could be deferred, the student entering employment until they felt ready to return to their studies. As soon as this capital of free years of tuition, guaranteed for every citizen, was used up, the cost of the wasted period of study would be borne by the student, if they wished to pursue their studies. Missing out financially (expressed in terms of credits as opposed to monetary units) would be more effective than failing an examination in reinforcing a student’s sense of responsibility.

This loss of credits may well be less effective than the loss of hard cash, which is felt more keenly, but it is fairer on those penalized. It also makes students much more aware of the cost of education. The fact that the allocation of these credits can be suspended for subsequent re-use, after an early experience of the world of work, avoids the trauma of being shunted into an educational siding and keeps alive the hope, and possibility, of picking up again, at some later point, the education programme that is the due of every citizen. Above all, it allows students in their teens, a time when, for biological reasons, the pace of cognitive development is most likely to vary between individuals, to adapt at their own pace.

Such ‘dues’ should allow each student to apply to the institution of their choice, providing, of course, that the institution accepted them in accordance with its own admission criteria. They therefore promote two kinds of freedom of choice with regard to courses, the institution’s and the candidate’s. The role of the local authority would be to allocate the resources that society devoted to education and research, through taxation generally.

Education funds would thus be distributed among institutions on a pro-rata basis, depending on the number of candidates they admitted, and calculated in terms of the actual cost of the course chosen by the student and its level. The financing of institutions would thus be dependent on the number of students they attracted and admitted and on the type of education and training programmes they offered. This would give rise to a ‘market’ without cash transactions, in which the students would be the consumers, and the
teachers and examiners the producers. Each institution would then be able to
determine its own policy for recruiting its staff and students. There would be
no need for the public authorities to impose or to restrict the distribution of
students among the different institutions through bureaucratic, centralised and
blanket rules. Such a mechanism would avoid the risk of identifying distribution
(as distinct from selection) with exclusion, since everyone has a right to
education.

The threat of a financial penalty when the credits ran out, providing it could be
taken seriously by students, would replace the expectation of benefiting from a
period of education that grew ever longer.

Lastly, the mechanism would promote the principle of subsidiarity, by
delegating the management of education to institutions themselves. The
education authority would undertake the tasks of working out the cost of each
course, operating the credit system and auditing the quality of an institution’s
administration and teaching; it would also reserve the right, under government
supervision, to promote any long-term goals that fell outside the scope of this
type of market.

4. Conclusions and recommendations

The above analysis is essentially concerned with the nature of knowledge and
its evaluation, although it also touches on the subject of fairness and equality of
opportunity. The questions raised by teaching and research methods, on the one
hand, and by structural and geographical problems, on the other, will be dealt with
later.

This analysis has led to the formulation of the following proposals:

- Separation of teaching and research roles from assessment roles;
- Appraisal of individuals: occasionally, but thoroughly and universally;
- Avoidance of the worst excesses of quality assurance;
- Individual assessment of research-workers: qualitative (subject expertise, originality of research);
- Auditing of the governance of institutions;
- Reconciling equality of opportunity with student responsibility: education rights and dues.
3

The creation of knowledge

Jean-Pierre Aubin and Georges Haddad
1. Discovering: aletheia

1.1. The desire to learn

As knowledge grows in complexity and quantity and as our environment evolves, so does our understanding evolve, both at the individual level and at the level of the group. This evolution applies as much to our understanding of information, which is becoming ever more nuanced and precise, as to our validation of those metaphors that link this information to its scientific explanation: understanding is a never-ending process. The sense of satisfaction we derive from understanding a metaphor is short-lived, continually called into question by the adequacy to our environment of the behaviour patterns associated with knowledge.

The exploration of the environment and adaptation to it by living organisms, from viruses to humans, in fact, by all “gene carriers”, is a characteristic manifestation of life itself. In the cultural world that human minds have constructed, this desire for exploration is a desire to learn, which is manifested very strongly, from birth.

1.1 The desire to learn: Three ideograms, Qiu(2) Zhi(1) Yu(4), suffice, for the Chinese, to sum up in a single expression, as concise as it is marvellous, the desire to seek to know, to acquire new understanding. “Qiu”, tbf, means “to seek”, “Zhi(1)”, “to know” and “Yu(4)”, “desire”, this supreme driving force in the evolution of human beings. This expression is frequently used to reinforce what we mean by “curiosity”, but a curiosity that is both willed and never satisfied.
According to Ellenburger (Henri) [1905-1993] Henri Ellenburger, “creative illness” is found among the shamans, mystiques and some philosophers and creative artists. It follows a period of intense intellectual work, made up of long periods of reflection directed towards a goal. The illness can take the form of depression, a neurosis or a psychosomatic affection, with alternating phases of relief and aggravation. During the illness, the subject is obsessed with his or her overriding preoccupation and suffers from an acute sense of isolation. The illness ends abruptly, signalled by a period of elation; the subject has the impression of having discovered a new world, one that still has to be discovered.

The malaise that sets in causes fresh questions to be formulated, leading to a search for richer metaphors, which are more likely to be validated. But also, something has to be done to induce this malaise: scientists take risks and try to achieve it through systematic experimentation; ideologists try to avoid and take refuge in incantation. Popper (Karl) [1902-1994] Karl Popper observed in [6] in 1974, that “through the centuries there have been changes in our ideas about what qualifies as a satisfactory explanation”. Understanding is a form of desire, and like desire, once it has been satisfied, the pleasure we derive from it fades away, desire returns and the search starts all over again.

The famous line from Ovid, “Post coitum, animal triste” is worth adapting to “Post cogitum, mathematicus triste”, so intense but fleeting is the pleasure of understanding and of sharing that pleasure by trying to explain it.

The desire to explore is one thing, the desire to explain and understand is another. The etymology of the verb “explain” consists in ordering and dissecting our perceptions of our environment and then reassembling a number of them to form concepts, whereas the etymology of “comprehend” (i.e. “understand”) means they are reorganized so that new explanations can be elaborated to validate the one that appears the most satisfying, in an endless movement between explorations of the environment and the elaboration of concepts that account for them. The operations on the concepts alternate between analysis and synthesis, between perceptions and their interpretation by concepts.

1.2 Metaphors

A metaphor consists in selecting a pair of entities formed from two concepts, or else a perception of the environment and a concept, the first accepted as
known, the second as a concept to be explained. Understanding is a mechanism of validation or acceptance of a metaphor, in accordance with different criteria, depending on whether or not one is using rational or logical mechanisms of validation. Understanding allows the second concept of the metaphor to “inherit properties from the first”.

1.2 Condillac. “This manner consists in imagining something that one cannot conceive of, by using something which is more familiar to us […] ideas are easier when they are less abstract, and when they are closer to our senses […] An abstract idea therefore needs to be explained by a less abstract idea, and so on, until one arrives at a particular and tangible idea. […] nothing is more apt to explain a notion than the notion that gave rise to it”.

In order to follow this advice, we need to un-veil, to un-cover what nature, with such timid modesty, hides from us:

1.3 Alethi. Discovery is the obscure a-lethia of the poem by Parmenides. For the pre-Socratic Greeks, a-lethia had rather the meaning of a concordance, homoiosis, of adequation between two perceptions, of coherence, of idoinity in Ferdinand Gonseth’s sense, and resembles the concept of validation of a metaphor. It subsequently became synonymous with “truth” in the modern sense of the word, when the first term of the metaphor is accepted as a reference point for truth, and often, for some, as absolute truth. This truth, called ontological truth (from ontos, meaning “to be”) presupposes adequation to an ideal, even divine, knowledge.

The Latin re-velare, the origin of English revelation, means “to remove the veil”, but with a stronger connotation, since it is a question of revealing a much more mysterious message, like that of revealed religions.

To verify a metaphor, in the etymological sense, for the word comes from verus, meaning truth, comes down to demonstrating its truth, whereas a metaphor can only be validated in relation to knowledge. This point of view is similar to that of idoneism, a term coined by the philosopher Ferdinand Gonseth and expounded in his book [2], which stresses that “the categories of the verdict are neither the true nor the false of logic, but the idoin or the arbitrary”. There is room for oxymorons or oxymores (from the Greek “sharp–blunt”), those self-contradictory expressions which add spice to the insipidity of logic by trying to reconcile the irreconcilable.
1.4 Ferdinand Gonseth (1890–1975), a Swiss mathematician and philosopher, invented the concept of idoneism, which characterized his philosophy, and also the concept of dialectical synthesis through which he describes the continually suicidal process of scientific concepts that are destined to be replaced in a new system after being produced. He proposes “a continually renewable arbitration between acquired knowledge and a priori knowledge, – or between invention and intuition”. The terminology he introduced into a dozen or so works on epistemology is extremely relevant, but too abundant to be reproduced here.

To assert that a hypothesis entails a conclusion is the same as saying that the opposite of the conclusion entails the opposite of the hypothesis, which is, by definition, the converse of the original assertion. To look for the causes of an observation therefore comes down to deducing the consequences of its negation: among them will be found the negations of the hypotheses entailing its cause. It is by validating the conclusions, therefore, that we can find out whether their hypotheses are relevant.

Knowledge of theories presupposes knowledge of facts and knowledge of facts presupposes knowledge of theories. Sir Arthur Eddington wrote: “Never accept a new piece of data until it has been confirmed by theory”. The elaboration of metaphors is not causal, metaphors are an association between theories of the cultural environment and facts of that environment. The “confirmation” referred to by Eddington corresponds to the validation of a metaphor.

Idoneism is repeatedly called into question since any change of cultural regulon undermines the validity of an earlier regulon.

1.3 Comprehension

Of all the metaphors validated by a cultural regulon, a simple metaphor will always be chosen in preference to a complicated one, in accordance with the precepts of Ockham and his famous razor (“Plurality should not be posited without necessity”). This search for simplicity, for parsimony – for “good housekeeping” – is a legacy from the religious philosophy of the eighteenth century. It is not natural, since it involves resorting to abstraction, in other words the search for common denominators between different cultural regulons.
1.5 Ockham’s razor. This principle has become the mathematician’s favourite instrument in scaling the dizzy heights of abstraction, since abstraction and simplification go together: a demonstration that goes directly from an hypothesis to a conclusion is the most difficult thing for the mind to grasp, it is only discovered after forging very tortuous, involved proofs, gradually simplified, or rectified, in every sense of the word, straightened out and corrected.

There is a metaphysical temptation, or rather a metaphysical impulse, behind all “scientific” activities, which need questions to fuel their progress. Thought is that much less magical if the goals to be attained are specific and properly defined and if the questions being asked are precise and as unambiguous as possible. The process of discovery is universal and applies equally to religion and to the sciences bequeathed to us by the “pride revolution”. The differences can be detected by using, with a reasonable degree of effectiveness, our limited ability to “order our knowledge” into logical and simple (therefore abstract) chains of reasoning.

The primitive mentality [3] studied by Lucien Lévy-Bruhl in his book of the same name, remains, however, buried deep in our cognitive mechanisms, in much the same way as the reptile’s brain located beneath the cerebral cortex controls behaviour by anticipating it. This did not in any way compromise the ability to adapt, since we are the result.

The capacity to doubt, to ask questions and especially to call into question, which all fuel the drive to explore and foster an indispensable dissenting from the prevailing orthodoxy appear to be specifically human, although animals frequently hesitate in choosing their behaviour.

We can distinguish between magical and scientific thought according to the “distance” that separates the first term of a metaphor from the second, which is small for magical thought, large and complex for scientific thought. This distance, which has been measured by the creative and intellectual efforts of the human brain, generation after generation, is difficult to evaluate.

1.4 The long march towards abstraction

To simplify our analysis, the definition of a metaphor implies only two terms, a perception or a concept for the first term, a concept or an item of knowledge for
The creation of knowledge

the second one. The reality, however, is quite different, for our brains are capable of processing in parallel not just two but a number of concepts, albeit a small number, and can make connections between. Human language is not adapted to handle relations of more than two or three terms. At that point, we have to resort to mathematics to get a purchase on such concepts. It then becomes a matter of introducing a little order into this tangle of concepts, metaphors and the connections that link them together. This ordering is at the heart of the principle of abstraction, this great but unfinished conquest of the human mind.

This process of abstraction is unnatural: our nervous system is better equipped for going forward rather than backtracking, of rolling out its various cognitive processes rather than looking back at them to analyse and dissect them, a preliminary to any process of abstraction. Condillac, in his [1], explains the unfolding of this march towards abstraction through a linking together of metaphors: he writes that “abstract notions are simply ideas formed from what several individual ideas have in common”.

Abstraction is a costly process, for we have to seek out elements that are common to several perceptions and/or concepts to form the first term of a metaphor. A metaphor is all the more abstract if the number of metaphors using all or some of the common features is high. Once an abstract metaphor becomes accepted, it explains all those metaphors sharing the same first terms. Consequently, the more abstract a metaphor is, the easier it is to convey the fact or concept that constitutes the second term, thus making it useful, but the more difficult it is to manipulate and to process if one wants to exploit the metaphors associated with it. The brain appears to be subject to a kind of “algebra of metaphors”, which has not yet been elucidated.

In other words, the substance of a metaphor is easier to convey if the metaphor is abstract; there is, however, a cost, in that the abstraction is much more difficult to use and is less amenable to further development. In each situation, a compromise has to be found between ease of transmission of the abstract knowledge and the difficulty of using it. As with everything else that involves the search for a compromise, there is no clear solution.

As soon as our “tinkering” with theories associated with a set of facts is used to validate these theories by means of a given regulon, it acquires the status of an “experiment”. A scientific experiment frequently defies common sense, which is
deprived of the eye-glass supplied by science. A tinkering with theories that is not very far removed from the tinkerings of evolution itself, as François Jacob delights in pointing out to us in [4], a tinkering that nature engages in with whatever is to hand, unaided by some soothsayer supreme to conjure it _ex nihilo_. Or else, but much more rarely, a Bachelard-style revolution occurs. One need only think of the famous example of the system of Claude Ptolemy, which, for centuries, resisted all attempts to validate the movement of the planets, before it was challenged by the Copernican revolution, which paved the way for Johannes Kepler, Isaac Newton, Albert Einstein and many others.

1.6 The long march, glorious and ongoing, towards abstraction, (Chang)\(^2\) Cheng(2). From the meditative contemplation of the celestial vault to the spheres of Ptolemy (second century), to the ellipses of Kepler (seventeenth century) and Newton’s revolutionary law (eighteenth century), which stated quite simply that _force equals mass times acceleration_ and has since become the “mother of all evolutionary systems”, to …

If there is anything that can be counted as progress in the cultural history of humanity, it is surely abstraction, the culmination of many cognitive sacrifices.
The creation of knowledge

3

The etymology of “rational” is the Latin ratio: it means the relation between two numbers, which was the big issue in mathematics at a time when rational numbers, we still call them this today, were being discovered. This return to the origin of reason is precisely a turning to mathematical metaphors, and, since then, to scientific metaphors in the widest sense of the term.

The march continues, since the long march towards abstraction consists in providing metaphors that use a sufficiently small set of concepts for the brain to be able to combine them; a simple situation, then, given that these concepts, like numbers, conceal a complex system of information that is already “understood” (in the sense of “metaphors” accepted as having been “validated” by consensus of a given social group).

At the source of reason, we find mathematics. Just as human brains all share the faculty of speech, though each one of us uses this faculty in our own way, so, too, do we share the potential for doing mathematics and, providing we did not neglect putting this potentiality to work when we still had it, we can, as human beings, exploit it in a large variety of ways. As with the faculty of speech, we tend also to invent our own language and our own mathematics, inventions that are kept in check by the need to communicate with others. Creativity, indeed, but within strict limits, which education, bowing to the constraints of evaluation, has kept on a tight rein.

1.5 Reductionism and holism

It is certainly the case, and probably has been since Cro-Magnon, perhaps considerably earlier, when the Wernicke’s area was formed in the brain of hominids, that the problems in the world spur on each and every one of us to explain and understand them. However, this brain of which we are so proud can only process in parallel a small number of pieces of information in order to try to resolve them (the human brain is far from being the parallel machine that artificial intelligence specialists dream of). If it is not satisfied with the responses it receives every second in its socio-cultural world, the brain finds it necessary to make a selection, to home in on (“reduce” or narrow down) a problem, to mark out the limits of the problem in order to focus its feeble cognitive capacities on it and subsequently draw conclusions, whatever method we use to succeed, helped by metaphor. But in no case should that authorize the technique of “reduction”, which is necessary for obtaining non-trivial responses. The term reductionism
The creation of knowledge

has also become polysemous, to transform a method of investigation based on reason, which at least goes back as far as René Descartes, or to any soldier (which, incidentally, he was), to impose an approach that was, rather ironically, the exact opposite, namely to use the conclusions obtained with a scale model, if I may use such an expression, as the premise for holistic and universal conclusions.

Ironically, this holistic Eden to which our brains aspire hijacked reductionism, understood as a method of investigation, for the purpose of seeking out a single cause, ranging from the sun disk of Aton to the new Grail of (theoretical) physicists, this “theory of everything, this equation \[a=bc\] which, like \[f=mg\] or \[e=mc^2\], will be the mother of all knowledge. The monistic temptation will only be die with the brain of the last human being. The holistic virus lurks behind our neurones, ready to pounce on our synapses to open the floodgates of our neurotransmitters. For it sometimes happens that those who purport to be engaged in scientific investigation lapse into scientism, which, in some respects, is more akin to magical thought.

The tension between reductionism and holism is reflected in the names we have given to disciplines: mathematics, physics, biology, economics, history, sociology, etc., which refer both to objects of study and to techniques used for studying them, whereas others, such as management science, cognitive science, complexity theory, etc., only refer to objects of study, often far too vast, unless one restricts the coherence and specificity of the instruments used to study them. Otherwise, those who are frustrated by the paucity of explanations yielded by scientific results take the bait hidden in the polysemous traps and dream, in a rather cavalier fashion, of grand perspectives, no doubt culled from westerns. It is not enough to stick the label “science” on a field that is too vast to be made into a science in the sense of adopting a scientific approach (such as sifting out the implications of an assertion to apply them elsewhere). The activities of human beings are divided up on the basis of the tools they use, including “intellectual tools”, to extend to the methods of science the studies of André Leroi-Gourhan: human beings divide up into categories, indeed are defined, more by the kind of tools or techniques they use than by the nature of the results these instruments allow them to obtain. The scientific disciplines have fine days ahead of them, to grow and to multiply. Even so, “holistic” science has its uses nevertheless, in that it encourages interdisciplinarity.

Proving theorems, devising experiments, carrying out “scientific” activities makes us feel modest in the light of the goals pursued, especially when we know what reductionism means, what it means to home in on a problem or enclose it within
limits, and not reduce it to a utopian “ultimate cause of all things”, which only brings us back to where we started.

The long march towards abstraction remains the business of trailblazing mavericks, who patiently, often at the cost of their own lives, have had to overcome in a mediatic desert the holist temptation that haunts us all.

2. RID: research, innovation and development

2.1 Pure, applied and motivated research

Scientific activities are multifarious. It has long been customary, however, to divide them into two kinds, pure and applied research. The term applied research, used in contradistinction to pure research, suggests that there is only one distinction between the intrinsic development of scientific techniques and the use of these techniques to solve problems posed in other scientific disciplines. In fact, the term masks an essential fact about progress in science, namely the motivation that scientists can derive from the study of other sciences (the formulation of new scientific problems and the need for new scientific techniques).

We would need to have forgotten the history of science not to know that the desire to explore our environment has had the most positive and the most constant effect on the progress of science. But this crucial component of science has tended to be overlooked since the excessive dogmatization of each discipline.

To construct scientific metaphors, each discipline obviously needs to develop independently in order to provide theories to serve as metaphors for the phenomena to be explained, since “the only knowledge one does not apply is the knowledge one does not have”. This is the domain of pure or fundamental research. The construction of the scientific corpus obeys its own logic and technical constraints, as happens in the case of literature, music and painting. In all fields, aesthetic satisfaction is both a creative activity and a signal that allows us to recognize successful works.

That is not all, however: a scientific metaphor establishes a correspondence between a scientific theory and another phenomenon. This connection can be
viewed in two ways: the first, the better known one, is to look for, in the scientific corpus, a theory that will correspond as closely as possible to a given phenomenon. But the association is not always made in this direction: the other disciplines might guide scientists in their choice of problems, by creating new challenges for them, by encouraging them to exercise boldness to challenge the ideas of their predecessors, by suggesting new concepts and lines of argument to them, by causing solutions to be felt and by coming up with new modes of intuition; this is the domain of “motivated research”.

It is futile to want to draw precise borders between these three types of scientific activity, there being so much interaction between them. In any case, it may possibly lie in the intellectual and creative behaviour of the scientist rather than in the nature of the problems themselves, which must be studied from every angle.

The competition between an ever-growing number of scientists, the demand, which goes back to the Second World War, for productivity over the relatively short term, and, more recently, the excesses caused by systems of evaluation, automatically lead to a more marked division of labour and a degree of specialization that becomes increasingly pronounced. Taking time out and taking a step back from it all is becoming less and less possible, even “socially hazardous”. Moreover, not all scientists have successfully resisted the laws of psychology and of sociology, since some have found a way of transforming this distinction between different forms of intellectual behaviour into an implicit (and very often explicit) hierarchy: good pure research and bad applied research. This classification is dangerous and perpetuates itself, acquiring a higher profile and highlighting the differences in the process, since the talented new blood tends to distribute itself according to this hierarchy.

All the more so since it often has no justification. For it takes scientists so long to get a purchase on a scientific outcome that is outside their own specialism that they are not usually able to act as judge of the quality of their colleagues’ contribution (its originality in relation to what has come before, an a priori rather than a posteriori difficulty). Contrary to what one might expect, they have to delegate their judgement to a specialist and have complete confidence in him or her.

It is at this point that subjectivity replaces the objectivity that we attribute to the scientist. Opinions are based on a stream of rumours, positive and negative ones, impressions are formed and take a hold that becomes semi-permanent, through inertia. The labels are stuck on with a glue that is all the more indelible, the further
removed the specialism (for the simple reason that possible revisions to a judgment do not easily reach ears that are far away). Also, since what we find interesting is what we know intimately, and so much more interesting, the better we know it, anything new unsettles us, or at best is considered useless and at worst harmful.

2.2 Developing motivated research

Fashion and consensus contribute to the continuous evolution of these aesthetic and sociological criteria which allow subjectivity to get the upper hand over objectivity.

As in other areas of science and the arts, history secretes ideas and the sociology of intellectual creation still cannot tell us why certain subjects and certain scholars are put on a pedestal while others are consigned to oblivion, why the first are celebrated and the second despised. This history is so different from the ‘hagiographic’ official History of Ideas that is commonly taught.

In fact, scientific progress manifests itself in two ways; either it goes forward and deeper in the same direction or it clears a new pathway, no one knowing, to begin with, where it might lead. By exploring in a given direction, the researcher creates a tradition, which demands a great deal of technical virtuosity of him or her. Progress is easily assessed, with the help of well-established criteria. This is the approach favoured by scientists who like to respond to challenges laid down by others.

The other approach, which is the province of the ‘motivated scientist’, requires a fresh eye, fresh perspectives and a different attitude to risk. The naivety of new-comers, who are not yet familiar with ‘what is not done’, may, quite unintentionally have opened up these trails, which do not necessarily require any technical prowess. This is the famous Anglo-Saxon serendipity, which consists in finding what one is not looking for. It is often the young scientist who gets into this situation, which explains the idea, held in some quarters, that scientific genius appears early. But for that to have some substance, the paths embarked on must quickly lead to discoveries that can be understood the moment they are made. If these paths are traced too soon, they will not be recognized. They might not even be explored again, for chance (without necessity) never knocks twice.
The lack of a consensual benchmark that would help in evaluating a piece of research will often have the effect of fuelling the disdain of experts comfortably ensconced in their unshakable certainties.

In these value judgements, motivated scientists often inherit the opinion that some people have of applied science. This is all the more unjustified given that the work of the motivated scientist involves risk-taking, especially when the problems come from the sciences described as soft, the human social sciences and, to a lesser degree, the biological sciences. A great many hours of thought may very well lead to nothing more than what is known already or to problems that are insoluble in the short term, whereas the same amount of effort devoted to clearly structured problems in pure or applied research might reasonably be expected to yield tangible results.

The most one can do is to ask a few scientists interested in these new problems to leave the straight and narrow path, to the best of their ability, whenever available techniques are not adequate for coping with these problems. The role of “motivated scientists” is not just that of providing answers to questions put by others, it must also be to assist with reformulating these problems, which is a very different activity, and one which is not at all encouraged.

It is often thought that it is sufficient for scientists in other disciplines to explain their problems to an expert in a different discipline. This is another misconception, for it could only happen if these specialists knew from the outset those scientific techniques most likely to be useful in articulating the said problems. This is precisely the province of “motivated scientists”, who have a comprehensive knowledge of another discipline, a well-stocked arsenal of tried and tested techniques and the capacity to create new ones (of necessity, close to those they know already). They have to rediscover a degree of “cognitive totipotence” that will allow them to retrace their steps and take, or open up or clear, new paths.

Engaging in constant dialogue, a dialogue which can be difficult and frustrating, they must establish whether the problem posed is capable of resolution using the techniques within their competency and, if it is not, negotiate a reshaping of the problem, a possible restructuring which often causes one to forget (or so it appears) the original model and, finally, put together a new ad hoc theory, but one, it is felt, which will prove useful at some future date. They must also convince their colleagues in these other disciplines that a very long period of apprenticeship and
maturation is needed to understand the language of a given theory, its underlying principles and its main results, that the simplest, the most naïve and the most appealing statements, require, before they can be applied, further development which might go on for decades and fill several books, and that there is always something more to understand about a scientific theory.

These scientists would also need to invent new scientific tools and thus risk being outlawed by the scientific community to which they originally belonged. Not only because of the newness of such tools, always suspect until consecrated by use, but also because when new theories are conceived, they have little to boast in the way of results and present few technical challenges, thus provoking the scorn of the specialists themselves, masters of technique and of performance.

The difficulty is made worse by the fact that, from their early teens the scientists in question underwent a lengthy process of “brain-washing”, from a perspective dictated by the physical sciences, a perspective that will have to be discarded. It is very difficult, cognitively speaking, to unlearn, then learn afresh: when it comes to one’s cognitive past, the slate cannot be wiped completely clean.

In a century where we no longer spend decades building temples, cathedrals, mosques and castles, but a few years erecting the headquarters of banks that have usurped their role, in an era where the long term has lost out to the short term, it is easy to see why the profession of motivated scientist is attracting fewer and fewer candidates. This is all the more so because users are simply unaware of the usefulness of science in improving aspects of the matters they are dealing with. And even when they are aware, the common ground between their own interests and the preoccupations of the scientists is often small: the former are interested in the immediate impact on their problems, and not in scientific techniques that can be used or how these techniques are linked to the rest of the scientific structure.

Raising awareness of motivated research should be done through the teaching of the history of science, retracing the tortuous paths by which concepts have been brought to us. Just as ontogenesis would yield a summary of phylogenesis, so the teaching of science should, as far as possible, be structured in a way that reflects the history of science. The various stages would have to be compressed and arranged with imagination, of course, but on no account should they be omitted altogether. This plea for motivated research, therefore, is made in tandem with the case for incorporating a minimum of the history of science into the curriculum,
so as to recall the nature of the journey through the cultural world made by the human mind.

Scientific theories come in blocks of theories. To successfully apply the thousandth part of a theory, we cannot avoid having to understand the other 999 thousandths. What makes the situation even more challenging is that we cannot tell in advance which thousandth is likely to be the useful one. Disinterested curiosity is a precondition for the discovery of useful knowledge.

Furthermore, there must be a minimal threshold, that cannot be lowered any further, below which scientists cease to be “interesting”, in the sense of what is very familiar to us. Interdisciplinarity should only appear little by little, around a hard centre constituted by a discipline and to which the other knowledge would be linked in a structured manner. Simply juxtaposing at too low a level fragments of an elementary knowledge, gleaned from various disciplines, is not only useless but dangerous, since it is only beyond a certain stage of knowledge that we are aware of our ignorance.

It seems paradoxical that knowledge is all the more useful if it is abstract. The reason is very simple: the more abstract a piece of knowledge is, the more universal. It can be shared by numerous people, whereas a concrete experience, which is, in a sense, unique, holds little interest for the wider community.

More abstract forms of knowledge should therefore be more widely transmitted, at the cost, however, of a greater difficulty in acquiring it and of its maturation, a difficulty which limits its diffusion. This has resulted in an increasing trend towards teaching pure science, because of its universal nature, the underlying assumption being that there will be a time for applying these techniques later. All too often, though, this time never comes.

We have to add to all of these constraints a kind of time constant with a difference, which measures the time it takes to access a scientific theory. We can better appreciate why the slow pace and the esoteric side of a scientist’s work can exasperate and weary those who expect from scientists an instant solution to their problems.

Finally, a scientific outcome – in the same way as any other form of knowledge – is neither static nor inert; it lives, at the same pace as the scientists who produce
The creation of knowledge

3

it, exploit it and modify it. The most important innovators not only had teachers and disciples but also contemporaries, who were either partners or rivals, with whom or against whom they compared their work. These interactions, which go unrecognized, these missing links but indispensable ones, trigger buried thoughts, bringing them up to the surface, to the level of consciousness, from the depths of the unconscious. There are no ideas that are really pure and totally separate from the rest of the cultural milieu.

2.3 Research and innovation

Invention is distinguished from innovation by confining the former to the field of research as a producer of knowledge and the latter to the adoption by society of its value as measured by the demand for new goods and products. To undertake, with the underlying idea of risking, of intending, of constructing, thereby combining intention and risk, is to want to set up a venture and to create new objects, services or concepts. The innovating entrepreneur is the intermediary, the middleman (or woman), who turns inventions into marketable innovations. Incremental inventions signalling a break in terms of research translates, in this context, into incremental innovations signalling a break in terms of Schumpeterian innovation theory. Innovation depends on the creation of new needs in society, which must convince itself that the benefits that accrue to it outweigh the cognitive costs incurred by the transition from the old situation to the new. To become an innovation, the invention must, at some earlier point in the process, be the object of ergonomic research that would lessen the cost of the transition.

To perceive the importance of a technical invention, which is not necessarily a matter for its inventors, is a creative act which can work against the inventors by hijacking the object and the objective of the innovation as soon as it appears. The last example to date was the creation of microprocessors in Californian garages by electronics enthusiasts who had no application in mind, but, at the very most, were motivated by a sense of play or entertainment, when they came up with the idea of connecting a keyboard to the microprocessors they were building. They were not remotely thinking about word-processing or about spreadsheets, which were innovations in the use of these objects, or about the World Wide Web, the invention of two physicists at CERN “for the use of physicists”, and yet all of these inventions have transformed our lives as radically as the invention of computers has.
The creation of knowledge

The same invention can lead to an innovation in one society and not in another, either because there is no demand for it at the time or because there are no entrepreneurs to take it on (a rarer situation) or else because the invention is rejected as being the result of deviant behaviour. This observation also formalizes the chances of success in a cultural milieu already built around a time-honoured knowledge system: success can be measured in terms of the population size of the societies of each of these two knowledge systems.

It often takes a generation before an innovation is accepted and developed. What accounts for the difficulty of the transition from discovery to innovation is the gap between the cognitive rhythms of the community, which have evolved at the same speed as those of our ancestors, and the rhythms of scientific and technical progress, which are due to increasingly specialized individual experts and which have speeded up enormously. For example, before the use of computers by the general public could spread, the psychological fears of adults, brought on automatically by the newness of the tool, had first to be overcome. For children, on the other hand, whose innocent totipotency protected them from such fears, using this new technology was second nature. A generation has to pass before these new information and communication technologies are mastered.

2.4 Outcomes-based research?

To better understand the world in which we live, such was and still is the dynamo of what became scientific progress, a necessary pre-condition of technological progress.

We can either more or less favour this never-satisfied curiosity or curb it; we can exploit more or less intelligently the mind’s desire for exploration. They constitute the indispensable driving force behind the production of knowledge, the continuous flowering of new information and knowledge that keeps pace with that of new increasingly specific and diverse discoveries. The entire body of knowledge grows in proportion to the number of individuals producing and transmitting new knowledge, the durability of the methods of storing it, the density and speed of the means of communication and the quality of transmission.

Naturally, research results in socially useful applications or military applications that are socially destructive, and these have then to be developed. The social needs thus created in turn give rise to further research, in a complex system of actions
and retroactions between research and development. The current socio-political situation tends to privilege development over research.

And yet, in each generation, policy-makers and bureaucrats corrupt the desire to understand the world, the better to act on it, to steer it towards the mere satisfaction of needs supposed to be “useful” in the short term – without realizing that demand cannot express needs which have not yet been invented! In times of budgetary restraint, fundamental research is the first to be sacrificed by politicians who think they can manage research through an “outcomes-based approach”, or else by those who advocate the programming, or even worse, the planning of the future development of science.

3. Research crippled by inappropriate methods of assessment

The fashion for assessing researchers has taken on a new look recently: mass-produced expertise is definitely “in”. At least, that is what happens when the personal judgement of a researcher’s work by his peers is replaced by a battery of quantitative indicators, such as the number of publications, citation indices, etc. This still does not prevent subjective judgements from cropping up elsewhere though, even if they have been outlawed: journals are now to be evaluated by the yardstick of their reputation instead of by the quality of individual articles.

A blanket assessment of a journal is worthless, since it covers such a diversity of authors, just like the assessment of a laboratory or research centre, which contains a whole range of researchers. It would be preferable to focus on excellent articles published in “run-of-the-mill” journals rather than on publications of variable quality in “blue-chip” journals, which, to preserve their reputation, rarely welcome groundbreaking work which is outside the mainstream. It would be preferable to bring one's own prestige to an organization than inherit the reputation of an institution. It may be difficult to assess researchers individually, but assessing research centres or universities is an even finer art. The system of university chairs at least had the advantage of entrusting responsibility to their holders, and the system whereby publications were presented by a “peer” put that peer’s credibility on the line.
To be accurate, the assessment of the actors should be undertaken on a periodic basis, be far less frequent, be properly rewarded and cease to be anonymous so as to make the examiner more publicly accountable. A good assessment should look at past work and not bank on the future, since no one knows what inventions will shape it. It should also allow assessed teachers and researchers to appeal, if they felt they had been unfairly treated: the lamentable failure to identify discoveries outside the mainstream, for example, is a major flaw in the system of peer evaluation. Too much assessment kills assessment.

Judging research projects instead of past research activities, activities involving the development and perfecting of inventions that are already a reality, is at best totally meaningless, if not downright dishonest.

Nothing seems able to stop the commercialization of knowledge. The excessive pressure of getting short-term “results” that are immediately converted into units of currency by a “market” that is ignorant rather than invisible very often runs counter to the quality that is officially sought. This gives priority to results in the short term to the detriment of reflection over the long term, disrupts the steady maturation of serious ideas, focuses on the end result, and so is detrimental to discoveries, creation and innovation, and encourages conservatism, since, in this system, there is no salvation outside the mainstream.

Since information technology can make discoveries instantly and universally available relatively cheaply, publications as such should no longer be used as an alternative to a periodic inspection of the content of research, for the recruitment and promotion of researchers. It is time we gave some time to time, time we abandoned the order to publish or perish and time we distinguished between publishing researchers’ work and assessing the researchers. The instant availability of discoveries on the Internet will no doubt solve the problem by dissolving it.

It is impossible not to be scandalized by the waste involved in a system, used the world over, that has gone on increasing the number of its assessments, while undermining their effectiveness. Researchers become, in turn, the assessors and the assessed, involved in secret clashes that are best served by anonymity. Since the authors are not anonymous, it is a one-sided anonymity. Fairness requires that no one should be. If one must express criticism, one should have the courage to do so openly.
Researchers are now obliged to approach organizations and agencies, which are proliferating but often superfluous, taking up time and money, which is in increasingly short supply. What is left over for the actual research gets proportionately less, to the detriment of research. The functions of the assessor are squeezing out those of the researcher. In order to survive, researchers are being forced to devote more and more time to filling in application forms that ask for so much information that the assessor lacks the time to make a serious assessment. They have to cope with a degree of uncertainty and job insecurity that prevents them from giving their full attention to the only uncertainty that counts, the fleeting and unique opportunity that they must recognize and seize.

The funds devoted to research, through the tax-payer in terms of public research and through the consumer in terms of private research, are increasingly allocated to assessment activities to the detriment of research proper, which is slowing down the rate of new discoveries. The assessors who fill the funding agencies, which are mushrooming and competing with one another, short of the necessary time and money to perform their role of scientific watchdog, are bound to lose some of the expertise they claim to have, to judge their peers, a designation that is becoming less and less accurate. They are reaching the point where they are no longer able to decide whether new directions that deviate from those they have mapped out have the potential to become future inventions. Obviously, exceptions exist and some rare talents, but this “perverse” process diverts research away from the goals of quality that have been officially set, destroys from the inside and through short-term pressures, activities that require time and, finally, imposes a “profitability” that no one can define.

That does not mean that we should destroy the symbiosis between the industrial and financial world and the academic world, by inserting the job uncertainty of researchers into an unfamiliar American “model”, on the contrary. We must be careful not to dynamite research under the pretext of dynamizing it.


The creation of knowledge


The transfer of knowledge

Jean-Pierre Aubin and Georges Haddad
I. What knowledge should be transmitted?

1.1. Knowledge societies

The twentieth century has witnessed the beginnings of an exponential acceleration of revolutions in every area of science: physical, biological, cognitive, socio-economic and socio-cultural. It is on this basis that progress will continue exponentially, at least to begin with. Whether this progress will have its limits, whether the exponential curve will, in fact, behave like an S-curve, having reaching saturation point, it is too early to say.

These disciplines defended, and still do defend, their own territories, enclosing them within boundaries they have tried to make impenetrable, boundaries which are now under threat from the knowledge explosion. Discipline boundaries are collapsing on all sides, breached by the forces of interdisciplinarity, which, after bitter struggles, is staking out new territories for itself and riding roughshod over systems built around cultural and ideological codes (the paradigms of Kuhn (Thomas Samuel) [1922–1996] Thomas Samuel Kuhn).

Following in the footsteps of Duhem (Pierre) [1861–1916] Pierre Duham and Bachelard (Gaston) [1884–1962] Gaston Bachelard, in 1962, Kuhn published [5]. While teaching the history of science, Kuhn observed that science does not progress through a linear accumulation of knowledge but by sudden leaps, punctuating lengthy periods of consensus contributing to the relative perception of reality by those scientific communities subscribing to the underlying theories. These
leaps occur when a consensus on a given scientific theory has been completely eroded, because the validity of the theory has been called into question by a growing number of anomalies and inconsistencies. The difficulties posed by the fact that such a challenge and the intellectual conversion to a different theory have to be endorsed not by just a handful of individuals but by the whole of the scientific community, explains why these scientific revolutions take so long to happen and why their precursors, who were too far ahead of their time, are consigned to oblivion. The desire for validation, which is what distinguishes science from ideologies, calls the former into question more often than the latter. As with the history of ideologies, the history of science appears to obey a principle of inertia asserting that commitment to a knowledge system is subject to long periods of stagnation and can only be challenged when its very survival is in question. The explosion of new areas of knowledge and new disciplines calls into question the hierarchical structures through which knowledge is transmitted (lectures), how it is assessed (qualifications and their symbolic and economic value) and the existence of a common core in a number of specific areas.

Scientific organizations do not like ‘intellectual travellers’, those who live on the fringes of cultures, the ‘biculturals’ and the ‘polyculturals’, as it were, in the way that we talk of ‘bilinguals’ and ‘polyglots’, and are always on the move between cultures. The more they try to hide this sad fact, the louder they assert the opposite. Conflicts flare up within the same disciplinary area for ideological reasons or between disciplines for territorial reasons, in the mad scramble for funds, recognition and power by researchers who are only human like the rest of us.

Oddly, exchanges between scholars resort to the most violent of war metaphors, which occasionally leave the cultural arena and become transformed into struggles for power and recognition, for competition between disciplines is expressed in terms of conflict between the members of the knowledge societies involved. The cost of acquiring new knowledge systems explains why members of a knowledge society instinctively cling to the knowledge they have assimilated, either out of conservatism or because of the impossibility of starting their education all over again, so as not to have to abandon the knowledge they have so dearly acquired. They are the source of a kind of immune system that often rejects new bodies of knowledge. Some new knowledge does, however, find its champions, who keep the flickering flame alive until it can be turned into innovations. The prohibitive cost of persuading people intellectually encourages the use of much more violent
methods of conquest to establish these new knowledge systems, regardless of what form this takes at institutional level.

Like societies in general, knowledge societies cannot evolve any faster than the slowest of their members, if they want to hold on to their consensus. They depend partly on how quickly individuals who do not belong to the knowledge society can be won over and partly on how quickly the disciplines themselves evolve. Small knowledge societies evolve more quickly than larger ones; since they consist of fewer members, a consensus on accepting the new discipline is, by definition, easier to reach. The inertia of knowledge societies is, however, sufficient to explain the difficulties of reforming them. This accounts for the slow death of a knowledge society when the disciplines are no longer compatible with the knowledge of its members. To counter this, new bodies are frequently created to develop the system as a whole, when the cultural and economic costs of setting it up and developing it, at least in the early stages, are less than the costs of the organization that is dying. Once these institutions have been established, their inertia calls for further counter-attacks, for one cannot simply sweep away institutions, they go on evolving on their own, though very slowly, most of the time.

1.2 Towards new pathways in the curriculum

*Interdisciplinarity* must take precedence over *multidisciplinarity*. Since the brain cannot know everything, it used to be thought that this cognitive limitation could be overcome by *multidisciplinarity*, all the rage in the 1960s, but with disastrous consequences, which were, however, obvious to anyone who teaches. For what really counts is the coherence of what is learnt, how well the knowledge we store in our heads hangs together. Odd snippets of knowledge bearing little relation to the hard core of knowledge each of us possesses are forgotten that much more easily, if they are not strongly linked to the knowledge that we have already fully assimilated.

Not to mention the hidden danger of leaving students with the impression that knowing a few rudimentary facts about a theory can substitute for complete mastery of it. We have to go quite deeply into a subject to get an idea of how little we know about it and so that the knowledge thus acquired rests on a sufficiently firm base to take the weight of further knowledge.
Our cognitive capacities being limited, multidisciplinarity should give way to interdisciplinarity: we should no longer be thinking in terms of more and more elementary introductions to theories, of assembling, when we teach, a patchwork of “bits of disciplines”, but of mixing different cocktails of interdisciplinary courses. This would allow each student to progress as far as they could along these pathways, enriching their minds as they went along, integrated into their existing knowledge whatever was relevant. This would mean teaching modules arranged in networks, into which these pathways were woven. It would also involve a “Darwinian” diversification of the pathways, which would do away with the idea of “national qualifications”, even international ones, which are just more obstacles blocking a diversified education.

What should be taught and to whom? Everything, but to everybody.

As each brain is only capable of learning a minute amount of the knowledge and skills available to it, the basic problem can be formulated in the following terms: to teach the whole body of knowledge to the whole of the student population, dividing it up into a wide variety of coherent pathways of knowledge in amounts capable of being assimilated by a human brain.

Education, the central factor on which everything else more or less directly depends, must target all young people, and even the entire population within the framework of recurrent education (misleadingly labelled “permanent”).

The coherence of an individual’s knowledge must be compatible with the sum of all collective forms of knowledge.

1.3 Professionalization and professional integration

This diversification goes hand in hand with the diversification of professional activities. The proportion of individuals producing agricultural or industrial goods is declining, whereas information technology is boosting the productivity of the service industries. Jobs will increasingly be about knowledge conversion, producing knowledge and exchanging knowledge. The difficulty of setting standards and evaluating knowledge will certainly be the cause of social crises. No one can yet predict whether the tertiary sector, which, it must be said, is extremely heterogeneous, will be able to offer sufficient jobs to compensate for those in the agricultural and industrial sectors, which are immediately productive, and
whether there will be an expansion of “creative” jobs, for artists and scientists. It should be noted that these jobs are productive without ever over-producing, since demand never reaches saturation level. The constraints on the cultural world are considerably looser than those affecting material goods and services, in the narrower sense of the term.

The evolution of jobs retroacts on job offers and, from there, on the teaching methods applied to specific knowledge areas. The number of types of “specific” jobs has proliferated from the time of the industrial revolution, then after the Second World War and especially since the computer revolution. The concept of a “specific” job, understood as a stable and relatively permanent professional activity, dissolves into an infinite variety of tasks which just to list by name would be impossible and the future of which is difficult, even impossible, to imagine.

Some professional activities are relatively stable over time, and endure, while others, in danger of rapidly becoming obsolete owing to the progress of science and technology, will give rise to activities that we cannot yet imagine. The notion of vocational training depends on one constant, time, with regard to the activity for which the student is being prepared, long in the case of traditional jobs, short for jobs in high technology.

What people generally understand by vocational education is one that prepares young people for jobs that remain stable over time. In such cases, the area of knowledge is well known and clearly defined, and it is sufficient to teach and to develop a pupil’s capacity to work hard and to improve. This type of education is, in the outside world, a social qualification backed by a certificate, for as long as this certificate retains its value.

Those who argue for a form of education that is more “work-orientated”, having in mind an education that remains fixed over time, are, with the best intentions in the world, totally misreading the issues, in continuing the fight campaigners for “multidisciplinarity”, with all the damage it did.

As the speed of technological change makes jobs concerned with the production of goods increasingly subject to change, we should be encouraging more and more the acquisition of more flexible learning techniques, instead of sticking to a content-based approach (regardless of whether that content is intellectual or not). The signs are that the new century will make expertise, and therefore jobs, more
The transfer of knowledge

vulnerable. It will require that we teach children how to abstract and how to adapt, in the context of a vocational education for jobs that have a limited life-span.

2. How should knowledge be transmitted?

2.1 Teaching to learn, to teach and to be independent

Since the speed of technological change is making jobs in the producing industries increasingly short-lived and diverse, we should, as a result, facilitate the acquisition of flexible learning techniques to add to the acquisition of a well-defined body of factual knowledge (intellectual or otherwise), and often consisting of ready-made formulae that can be applied without thinking. For this particular task, computers and other mechanical aids can be deployed.

Teaching children to adapt as quickly as possible to the perpetual creation of new kinds of employment and their constantly changing nature must be the central mission of education today, for today’s research is tomorrow’s professionalization.

Learning to reflect, to doubt and to call into question part of our cultural and technical heritage, while at the same time respecting the consensus, must be the missions of all vocationally-based education of the future.

Teaching learners to learn is much more difficult than teaching them methods and techniques, bringing up the “Whys?” with them much more of a challenge than taking them through the “Hows”.

It is not, however, just a case of teaching pupils to learn; teaching children to teach should also be instilled in them from a very early age, since through the whole of their lives they will be actors in the transmission of knowledge, not only as receivers but also as transmitters. Besides, children are born teachers, who, from the earliest years, want to share their endless discoveries with their parents. We should therefore encourage students not only to be on the receiving end but actually to teach short stretches of the lesson, under the supervision of their teacher. We should further introduce, on a modest scale, peer-tutoring of younger pupils by those who are a few classes above them: we learn a lot more through teaching others.
In fact, all students should be their own best tutor, usurping as much as possible the role of their teachers. Teachers should, paradoxically, encourage students to become autodidacts, should help them to be responsible for the choice and coherence of what they learn. They should motivate students to stretch themselves more, by not just setting a list of homework topics but asking them to choose a minimum number of topics from a much more extensive list, with the suggestion that they recreate parts of the lesson they have just been listening to, instead of taking notes in class or going to books or the Internet; students should also be actively encouraged to give priority to high-quality knowledge in smaller quantities, but well integrated with the various strands of their existing knowledge, over larger quantities of knowledge that are fragmented and unstructured and which, for that very reason, will quickly outlive their usefulness. All this flies in the face of society’s demand for testing, which favours uniformity.

Teaching students to be independent is the third point in the triptych “Teaching to learn, to teach and to be independent”.

2.2 Transmitting ethological knowledge (coaching)

Language was added to the already existing communication signals, olfactory, auditory, visual and “kinaesthetic” (i.e. gestural and postural), but it did not replace them: we are all too often inclined to forget the ethological importance of these different ways of communicating, the legacy of our human ancestry, which play such a vital role in knowledge transmission.

Birdwhistell (Ray L.) [1918–1994] Ray Birdwhistell, in the 1950s, called these last two methods of communication “kinaesthetic”, and tried to place the study of body language on a scientific footing by proposing “kinemes”, by analogy with “phonemes” in linguistics.

Face-to-face communication uses all of these human devices: language and “kinaesthetic” signals, mixing thought and emotions, playing on our neurotransmitters and hormones and exploiting one’s charismatic qualities and “coach-like” status if one is a teacher, which are more often the work of nature than of nurture.

This is one good reason for not dispensing with the services of teachers in the transmission of information.
The transfer of knowledge

The new information and communication technologies (NICT) will never replace the teacher; any more than books and audio-visual methods did, quite the opposite. This role of “ethological communication” has justified the growth of transport, from travelling on foot to travelling by air, which leads to human beings communicating face to face, and businessmen and women and political leaders striking deals at copious banquets. When the knowledge belongs to the domain of the “spectacle” (theatre, sport), the part played by the theatre director or the team coach is universally recognized. But this no longer happens in the case of teachers. We urgently need to give teachers credit for this role, which the productiveness of the means of transmitting knowledge has made indispensable.

It is also the teacher’s role to question and to call into question both the information imparted to students in class and the information imparted by other media. Teaching students to be sceptical about information, just like teaching them to distrust their senses and perceptions, is a teaching objective that is seriously underestimated. Teachers tend, in any case, through the nature of the job, to make use of their authority to impose their knowledge on their students. It is not enough to teach the “Hows”, we must also reply to the “Whys?”, and to make them explicit whenever they are assumed to be implicit. Doubt is as indispensable a weapon for the citizen as it is for the researcher.

Language, memory, writing, printing and digital technology all allow us to preserve knowledge in spite of the destruction brought about by natural disasters, wars and rudimentary methods of conservation. Storing knowledge is essential, if we are to disseminate and pass it on to future generations, to compare it to the knowledge of our contemporaries or to build a consensus.

The curiosity and the desire for exploration manifested by the human mind, which are embedded in phylogensis, are the main driving force behind knowledge production, of the continuous burgeoning of new information and knowledge that keeps pace with new discoveries that become ever more specialized and diverse, which are usually seen to be more important than the short-term satisfaction of consumerist goals.
3. The tools: from the printed word to NICT

The new information and communication technologies will never, any more than books and audio-visual methods did, replace the teacher, a prospect that bureaucrats too often dream of, fixated by their budgets and totally ignorant of what goes on in schools and universities. The possibility of accessing these facilities achieves nothing unless it is preceded by the awakening of cultural curiosity.

Just as printing played its part in triggering the scientific renaissance and joined forces with it, so information technology and the Internet are contributing to another revolution, though it is difficult at this point in time to see just where it is leading. These inventions have permanently abolished time and distance, and the cost of spreading information, not to mention the consequences for science and industry. The same document, whether text, image, film or computer programme, can now be sent from the comfort of one’s own home to any number of discussion partners anywhere in the world, who will receive it within a matter of minutes, providing it does not fall foul of the digital divide between those who have access to the Internet and those who do not. This technology also allows us to avoid censorship for the most part, and to dispense with a central structure, so providing a necessary counterweight to an intellectual tradition that is becoming increasingly uniform, distilled by ever more powerful global monopolies that pose a threat to a “culturodiversity”, the latter as indispensable to cultural and social life as biodiversity is to sustaining life itself. That is why we have to invest in redundancy.

Students will be able to choose their teachers from a much wider range, from a distance, and even to go in for “zapping”, which they have grown up with.

The possibility of taking refuge in a virtual world, the proliferation of web-based contact, whose bytes filter out those ethological manifestations discussed above, anonymity making it easier to invent other existences for oneself, the “life points” of computer games giving us a feeling of immortality, imprinted on our brains from a very early age, access to a bottomless reservoir of information, neither sorted, nor interpreted nor validated, all of these things will inevitably change the social and cultural behaviour of future generations, in a way that is difficult to imagine.
These new forms of behaviour are already leading to a new way of interacting with learning, the learning schools lavish on their pupils, which may now be challenged, removing that aura of infallibility that teachers always used to enjoy.

The role of teachers will evolve to help their listeners to sort out the information required by such and such an objective, to see for themselves and to explain to others how the items of information can be combined, to check that the knowledge is organized, learnt, memorized and easily found, and, above all, to stir the curiosity of students and to inculcate the desire to explore and the pleasure of discovery. Complete freedom of choice will be given to students, who are increasingly consumer-oriented, although, as in the retail trade, the new ideologies will be on offer in supermarkets that are increasingly difficult to tell apart. Belief in dogmas will be weakened, despite the need of the human brain to believe and to obey. As for the eccentrics and the non-conformists, they will still have their boutiques and corner shops, reserved for the initiated.

4. The training and remuneration of teachers

Societies entrust to their education institutions, from primary right up to tertiary level, the teaching, at the initial stage, of descriptive knowledge and of the kind of knowledge that answers the question “How?”. Next comes the distinctly more difficult task of teaching the kind of knowledge that explains “Why?” and that which studies behaviour. This requires producing teachers who are not content to stop at transmitting information, but also want to inculcate cultural forms of behaviour, something for which they are not always prepared. The situation of teachers is complicated by other factors, notably the vertiginous growth of knowledge and the ever increasing, and ever faster increasing, numbers of students in their care. The governments in countries that are faced with this development encounter many difficulties in dealing with it. The short time in which this has happened, compared to the long time it takes to train teachers, together with curricula that are impervious to change, the difficulty of deciding what should be taught – and especially what should be left out as no longer being indispensable – of arresting the disastrous decline in the standing of teachers, who are not even adequately rewarded, all these things are the root cause of a crisis in schools which is like a gaping wound in society’s side. The challenge is to find ways of transmitting a
type of knowledge that is becoming increasingly abstract and divorced from the cultural experience prevalent in an intake that has been deliberately mixed to meet political objectives of fairness that are not necessarily compatible with the practical constraints of the classroom, without providing the necessary funding for the task. The complexity of the knowledge to be transmitted and the task of educating these children releases parents from their educational responsibilities by offloading these onto the teachers while calling the same teachers to account and blaming them for their children’s failure. This has only widened the gulf between society and its educational institutions.

The art of educators consists in playing down violence and authoritarianism by means of their charisma, transforming the learning process from a constraint imposed from the outside into an act of volition coming from within, and to achieve this through the artful deployment of motivation and rewards. We have to recognize in teachers what we demand from the managers of football teams or from generals capable of leading reluctant soldiers into making the ultimate sacrifice. The vertiginous growth of knowledge and the ever increasing numbers, growing at ever increasing rates, of pupils in their care call for a longer and more thorough period of training for teachers and classroom assistants, ironically, at the very time when their prestige has disappeared altogether and their social status is as low as their salaries.

The main challenge is to attract into teaching those individuals who have the advantage of being natural teachers, instead of letting them waste these precious gifts in more lucrative and prestigious professions. This depends on society properly valuing the jobs of teachers and researchers, together with a serious reappraisal of their skills.

The remuneration of teachers is really a problem for society at large. Restoring their prestige and their remuneration is indeed a pre-condition for persuading back into this demanding profession those who are blessed with a natural gift for teaching, something which cannot be taught, but which can be drawn out and developed to the full. At the moment, these rare talents are being wasted. The above comes at a price though and it is a price we have to pay, if we want an education system of quality. It only seems exorbitant if we fail to properly evaluate the benefits of education for the whole country, its effect on that country’s importance and the quality of life of its inhabitants.
The transfer of knowledge

Of course, bringing teachers’ salaries and their working conditions back up to an acceptable standard, both having been eroded by the recent and indispensable “democratization” of education, cannot be divorced from the quality of their training and a sensible evaluation of their job.

The fact that curricula are notoriously resistant to change, the difficulty of deciding what should be taught, and especially of weeding out what is no longer necessary, the revolution in the methods of transmitting knowledge, the increase in the number of students to be educated, the sheer diversity of pupils’ backgrounds and abilities, the abdication of responsibility by parents and a host of other factors are all to blame for the dangerous crisis in our schools. We are always being promised more investment in education and research, it is true, but what usually happens is quite the reverse.