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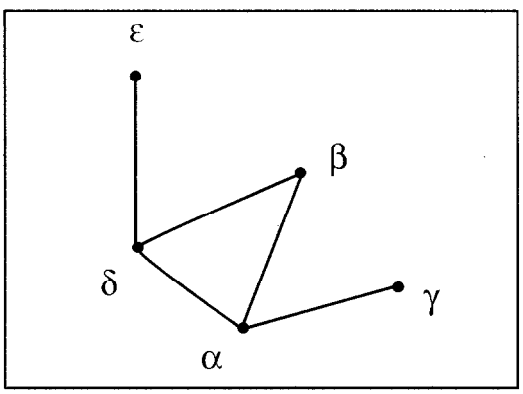
NUMBER ONE HUNDRED AND EIGHTEEN

118

OPEN FILE

CONSTRUCTIVISM



AND EDUCATION

GUEST EDITOR:
JEAN-JACQUES DUCRET

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EDITORIAL

VIEWPOINTS/CONTROVERSIES

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EDITORIAL

SOCIAL CHANGES AND CHALLENGES TO EDUCATION IN THE TWENTY-FIRST CENTURY

Cecilia Braslavsky

At the start of the twenty-first century societies are undergoing a series of transformations that are both broad, profound and closely interrelated. One of them relates to the invention and expansion of new information and communication technologies. Their emergence undoubtedly provides numerous opportunities and certain risks for education worldwide. Taking advantage of the opportunities and avoiding or reducing the pitfalls has to do with both objective and subjective issues.

The objective issues include the availability of resources for purchasing equipment, keeping it up-to-date and training the approximately 65 million teachers in the world in its intensive use.

The subjective issues include the place granted to these technologies in the new educational paradigms, the attitude towards them, the creativity and the political and business will to generate more options at lower than current costs.

The text by José Joaquín Brunner in this issue of *Prospects* analyses the characteristics of these transformations and proposes different hypotheses regarding future world scenarios depending on how these issues evolve.

But the challenges connected with the invention and expansion of the new information and communication technologies are also associated with an intense process of renewed pedagogical thinking worldwide. At the centre of this process of renewal lies the development of 'pedagogical constructivism'. Related to the theories of the New Education at the turn of the last century, constructivism investigates, on the one hand, the processes of personal construction of knowledge in general and in association with intentional and—in particular—school interventions, and on the other proposes new orientations.

The Open File prepared by Jean-Jacques Ducret offers a number of articles mostly from the colloquium on 'Constructivisms: Uses and Perspectives in Education',

organized from 4 to 8 September 2000 by the Educational Research Service of the Canton of Geneva, Switzerland, with the support of the Jean Piaget Archives Foundation. The articles are set within the overall framework of the contributions to the colloquium and combined with contributions from renowned researchers from the South who were unable to participate in such a significant meeting, but who have added their reflections.

The articles presented by Jean-Jacques Ducret include issues as varied as learning numeracy, language and science—all top priorities. They involve both children in the process of constructing their knowledge and teachers challenged by the new situations and theories. They go into universally relevant issues from the perspective of authors from such diverse contexts as France, Japan, Switzerland and Zambia.

Finally, a profile of the Indian educator J. Krishnamurti sets side by side concerns for knowledge, concerns for values and good and concerns for the new technologies and the construction of knowledge.

Therefore, the overall purpose of this number of *Prospects* is to draw attention to elements associated with the three axes of one of the triangles linked with the quality of education for all in the twenty-first century: technologies—knowledge—values. Undoubtedly the way these elements are combined (the dynamics of the triangle) will be decisive in shaping education during the coming decades. On the one hand, that shape will be influenced by the direction of whatever social changes occur outside education but, at the same time, it will be able to exert some influence on them.

GLOBALIZATION, EDUCATION AND THE TECHNOLOGICAL REVOLUTION

José Joaquín Brunner

My starting point is the assumption that we stand on the threshold of a change similar to those that gave rise first to schools, then to public education systems and, more recently, to mass education. My thesis is that a fourth revolution of the same magnitude is on the way. Of what, broadly speaking, did earlier revolutions in education consist?

Early educational revolutions

For as long as there has been symbolic communication, human societies have, without exception, felt the need to educate their members.[1] Nevertheless, as Toynbee has suggested, in most human societies in most times and places so far, education in the

Original language: Spanish

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broad sense of the transmission of a cultural heritage, has been an unselfconscious and disordered activity. People have mostly acquired their ancestral culture in the way in which they learn their mother tongue.[2]

The origin of schools, on the other hand, at least those from which our modern school systems come from, is more recent.[3] Few traces have come down to us of the first schools that existed during the Middle Ages, before the fifteenth century,[4] or of how they were run. Historians tell us that these were private institutions, dependent on the church and scattered throughout the land. There was no unified, planned, co-ordinated school system, as such. But although few in number, schools were extremely diverse, as they served a variety of groups in society (the nobility, town dwellers and country folk). An important distinction was also made between the sexes.[5] The aim of such schools was to provide a good Christian grounding and train a workforce for carrying out ecclesiastical duties. Practical training, on the other hand, was in the hands of the family and community.

That training took place essentially within an oral culture where 'you know something if you can remember it'. Hence the emphasis placed on rote learning.[6] The method of teaching consisted of repetition. Pupils were few in number and grouped together without reference to age. Generally speaking, education began late, between the ages of 7 and 9, and left off early, around age 15. It was only when universities started to appear that education was extended beyond puberty. There was no concept of a graduated curriculum. Nor did education take place in separate premises. The masters dictated their lessons in church cloisters or porches. The knowledge imparted in this way was sparse, as there was a requirement only for rudimentary education, and few records were kept. It is likely that, over a long period, cathedral schools boasted only one or two teachers. The subjects taught were the catechism and Latin, supplemented, over time, by the liberal arts. A contemporary study informs us that 'it is evident that for quite some time the children learned words and sentences in Latin without understanding their meaning'[7]—showing that some things have obviously not changed over the course of the centuries. These, then, were the medieval origins of schooling, the first revolution of which the school was the product.

The second revolution came about with the process of political concentration that occurred between the Renaissance and the Industrial Revolution, leading to the formation of the nation-state.[8] It was at this time that public education systems began to be established.[9] Initially they concentrated the intellectual energies of European nations in one or two centres. Elements of what we now know as a state system of education first made their appearance in the form of an official network of institutions devoted exclusively to teaching and providing national coverage, whose supervision and control was, in part at least, in the hands of the rising government bureaucracy. This process would be accompanied by a gradual secularization and standardization of education, helped along by the spread of printing and the development of an incipient scientific culture.[10] The first scientific journals, in fact, appear in the second half of the seventeenth century.

Oral culture was at that time giving way to the realm of the printed word. The way education was delivered became more ordered internally, by differentiating

between the various subjects and organizing them sequentially, and externally, through the imposition of a set of rules of behaviour or code of pupil discipline. Teachers broke away from the church's supervision and began to specialize and develop as a profession. Children were divided into age groups and their education—which now occupied a well-defined period of their lives—was carried out in dedicated premises, marking its physical separation within the community. The business of education was no longer simply to turn out good Christians but had widened to cover basic training—widespread literacy based on national languages—Christian ethics and the liberal arts, and also included some vocational content. A good example of this development was the Principality of Brandenburg, where elementary education became compulsory in 1717. Children had to attend school twice a week, although public education was not accessible to everyone for financial reasons or because of locality. Thus the education of the populace remained, as in the Middle Ages, in the hands of the local clergy, landowner or town authorities.[11] In the meantime, the majority were still illiterate. In 1789, if Voltaire is to be believed, only 37% of the people of France were able to write their own names.[12]

Mass education, when the third revolution originated, put an end to this state of affairs. Initially it was synonymous with mass literacy. Knowing how to read and write became the axis around which the Gutenberg Galaxy revolved.[13] Influenced by the Industrial Revolution, mass education strove to adapt the labour force to the new demands of the economy and the city. William T. Harris, a leading North American educator, set down this ideal in the most unambiguous terms:

> In modern industrial society, conformity to the time of the train, to the starting of work in the manufactory and to other characteristic activities of the city requires absolute precision and regularity. [...] The student must have his lessons ready at the appointed time, must rise at the tap of the bell, move to the line, return, in short, go through all the evolutions with equal precision.[14]

To this end, mass education adopted a series of methods that characterize it even today. First came the introduction of a standardized teaching process in the classroom, to be extended progressively to the entire youth of the nation. Second was the existence of numerous establishments, co-ordinated and supervised by a central authority whose task it was to inculcate both bodily and mental discipline on the basis of rigid organization of the timetable and educational tasks. Third was the formation of a professional teaching body within the framework of a national civil service. Fourth, education took charge of pupils' assessment and progress through a system of successive examinations. Fifth, a series of basic philosophical and scientific principles—rooted in the educational sciences—were developed, providing the conceptual and methodological basis for this most ambitious undertaking on the part of the modern State.

Over the last two centuries, the assumptions that underlie this endeavour have come to form part of schools' very structure and daily routine. Their starting point is that the knowledge transmitted is slow, limited and stable; the school is the sole infor-

mation channel with which rising generations enter into contact; the media for communicating what schools have to teach are what the teacher imparts verbally and the written word; schools' efficiency is demonstrated by the successful inculcation of certain types of knowledge and behaviour, as borne out by examination; the type of intelligence that needs cultivating is essentially of a logical-mathematical nature and schooling has the support of the family, the local community and the churches.

The contemporary educational revolution

Today, we are on the threshold of a new educational revolution. Both the context in which schools operate and the purposes of education itself are undergoing drastic and rapid transformation through the action of material and intellectual forces beyond the control of the educational community, but with inevitable consequences for the latter.

Indeed, on a world scale, education is facing an unprecedented period of change and adjustment in its progress towards an information society. As Jacques Delors points out in the Report of the International Commission on Education for the Twenty-first Century, 'Now more than ever as a world society struggles painfully to be born, education is at the heart of both personal and community development'.

While the sheer size, intensity, velocity and impact of global networks, flows and interaction are forcing all countries to re-examine education's links with politics, economy, society and culture, the establishment of a technology based on information and telecommunications systems facilitates such processes and creates new contexts in which individuals' education will in future take place. For the time being, the most characteristic outcome of this twofold change is a series of imbalances, giving rise to what the World Bank describes as a 'knowledge gap', UNDP 'networked societies with parallel communications systems', and the United States Department of Commerce 'a digital divide between those with net access and those without'.

Globalization above all means growing worldwide interconnectedness, resulting in phenomena described by various authors as accelerating interdependence,[15] unintended consequences at a distance,[16] time-space compression[17] and environments operating as real-time units on a planetary scale.[18]

In the realm of politics, it implies a weakening of the distinction between the international and domestic spheres, the emergence of new forms of sovereignty and a redefinition of the functions of the nation-State. Concerns over legitimacy in regard to national governments are gradually giving way to a preoccupation with global governance.[19]

In the realm of the economy, it implies transformation of the relationship between states and markets, an intensification and reorganization of world trade, a growing emphasis on the comparative competitiveness of nations and an increase in the number of 'systemic risks' such as environmental destruction or the spread of crises, especially financial crises, as it were by contagion.

In the social context, it implies the rise of a transnational civil society embodying growing acceptance of private sector involvement in various spheres of public action and the emergence of protest and identity movements that maintain links with one another in their attempts to counter the effects of globalization and its impact on local communities.

In the cultural domain, it implies the emergence of multiethnic, multicultural societies, the formation of global communications industries, transnationalization of symbolic flows and a proliferation of conflicts between civilizations and communities, revolving around their gods, values and traditions.

In its turn, the technological revolution in information and communications, one of the sources of global interconnectivity, is itself a force for change in virtually every field of social activity: work and production, home and consumption, trade and business, entertainment, socialization and the handing down of knowledge, the organization of industry and State, the provision of services and the dissemination of all kinds of knowledge and factual information.

So great is its effect anticipated to be that, according to the OECD, 'communications networks and interactive multimedia applications are providing the foundation for the transformation of existing social and economic relationships into an "information society". Such an information society is viewed as resulting in a paradigm shift in industrial structures and social relations, much as the industrial revolution transformed the then agrarian societies'.[20]

This emerging society is described by various authors in different ways, but they attribute to it a core of common characteristics, as follows: (i) it is in the process of formation; (ii) it is gradually acquiring a networked structure; (iii) it is based on the spread and convergence of new information and communications technologies, especially the Internet; (iv) it is giving rise to intensely knowledge-based economies; (v) in order to function effectively, it must take the form of a 'learning society'; (vi) it will bring with it organizational, commercial, social and legal innovations; (vii) it will give rise to various development models; (viii) the main differentiating element between them will be the extent to which individuals, groups or nations are integrated or excluded; (ix) it will be characterized by a greater requirement for flexibility at every level—including training opportunities, labour markets and social relations.[21]

The combination of both forces—globalization and the technological revolution—is producing a range of new imbalances internationally and within societies. Their progress, if truth were told, cannot be described as harmonious. Rather, their advance is uneven, giving rise to tensions, unintended consequences and multifarious upheavals at international, regional, national and local levels. While these are an essential condition of human activity at the start of the new millennium, they are also, nonetheless, the ingredients of what Ulrich Beck has described as a 'world risk society'.

The greatest risk is that of exclusion. Since, as Castells[22] suggests, the new global system in the process of being formed from networks of interchange and communications flows is at once highly inclusive and exclusive—inclusive of everything the

dominant codes within those flows deem to be of value and exclusive of everything that, according to them, has no value, or ceases to have any.

UNDP's 1999 *World development report* draws attention to the fact that world-scale economic, social, political and cultural imbalances have never been greater than at present. In 1960, the income of the richest 20% of the world's population was thirty times that of the poorest 20%. By 1997, the gulf had widened to seventy-four times. While, in that year, the one-fifth of the world's population living in the developed countries were the beneficiaries of 82% of the expansion in world trade and 68% of foreign direct investment, the poorest 20% saw only 1% of both. Of the total number of those infected with HIV/AIDS, 95% live in developing countries. Ten developed countries are alone responsible for 84% of the total world investment in research and development. The group of industrialized nations holds 97% of patents registered throughout the world. The United States, Europe and Japan account for more than three-quarters of the market in information technology and the rest of the world for a mere 21.4%. Of the total number of international telephone calls made in 1996 (67.5 thousand million) 50% originated from only five countries, and twenty countries—the OECD countries plus Hong Kong and China—accounted for 80% of international traffic. According to recent estimates, 80% of all information stored electronically throughout the world is in English and the more developed nations, home to only 15% of the world's population, account for 88% of Internet users.

Thus, for the moment, global networked society is more exclusive than inclusive and is tending towards concentration of power, resources and capacities rather than their decentralization.

Transformation of educational contexts

It is precisely those imbalances, and the effect of globalization and the technological revolution in widening the gap, that provides education with its main challenge. To be more specific, it is a fact that:

- Even today, in the countries of the southern hemisphere, some 900 million people of 15 years of age and over are illiterate;
- One in seven children of school age does not attend school;
- The average number of years the workforce has spent in education is currently 11.1 in the OECD countries, 8.1 in Eastern Asia (not including China) and only 5.4 in Latin America and the Caribbean;
- In developing areas, only three out of four pupils finish fourth grade and 8% on average repeat a year during the course of their primary schooling;
- Taking drop-out rates and repeat years into account, it is estimated that around 16% of public funds allocated to education by developing countries is being wasted;[23]
- Industrialized countries—which account for some 25% of the world's school population—spend six times more on human capital formation than do the developing countries, which account for the remaining 75%.

What challenges then do globalization and the technological revolution present for education? What new demands do they make of it?

KNOWLEDGE

No longer is knowledge slow, limited and stable. On the contrary, it is constantly expanding and being renewed. It is estimated that the global stock of knowledge currently doubles every five years.[24] It took almost 275 years for Harvard to collect its first 1 million books and only five years to acquire its latest million.[25] There were some 10,000 scientific journals in 1900. Nowadays there are close on 100,000.[26] One writer has noted that about 200,000 new mathematical theorems are published each year.[27] Over the last two decades alone, between 1960 and 1980, more history has been published than was written in the entire period that preceded it, from the fourth century BC onwards.[28] There has also been increasingly marked specialization, and knowledge is being 'atomized' or broken down ad infinitum. A study in the early 1990s identified 37,000 areas of active scientific research, all in a state of ferment.[29] Mathematics alone boasts 1,000 specialized publications classifying the output of the discipline into 62 major topic areas, divided in turn into 4,500 subtopics.[30]

All of the above—the abundance and seeming anarchy that characterize the world of knowledge—represent a real change in the context in which schools have traditionally operated. Neither the uniformity of the curriculum nor its claim to monopoly, nor the basic assumption behind the educational Intelligence Quotient that all forms of intelligence are equal, makes sense any more.[31] What will need to be taught in the future? Will the school curriculum be able to adapt to this change and then keep abreast of it? What shall we do to build constant change into schools? How are we to deal with the ever-greater fragmentation and specialization of knowledge? What adjustments will need to be made to convey a relatively integrated vision of knowledge? Will it suffice to introduce some 'transverse' content or will a whole new approach be necessary? And how can one escape the duality of an ever more productive, dynamic and divided scientific culture and a humanistic one seeking to preserve the wisdom of tradition and unity of values enshrined in 'great books', hallowed words or poetic utterance? It is not easy to guess what the answers to those questions might be. But one thing is clear: schools cannot survive the change unless they let go of the methods and assumptions impressed upon them by the Industrial Revolution and their even older ties with rote learning.

CHANNELS

The educational establishment is ceasing to be the sole conduit through which new generations come into contact with knowledge and information. Nowadays there are the media and alongside them, computerized networks and a veritable knowledge industry. The traditional media have grown more powerful. Hence, for example,

it is estimated that in the early years of the present decade some 900,000 books were being published, 80% more than twenty years earlier.[32] This is now supplemented by information transmitted in electronic form. In 1980, in an industrial society, the man or woman in the street was already being exposed to four times more words per day than in 1960. Over the period in question, information in electronic form expanded at a compound rate of more than 8%, doubling every ten years.[33] Therefore, while yesterday's problem was a shortage of information, or the slowness of its delivery, the danger today is an 'information overload'. With the coming of the new information and communications technologies, a revolution is in progress of comparable significance to that set in train by the printing press. 'We have discovered how to use pulses of electromagnetic energy to embody and convey messages that up to now have been sent by voice, image and text'.[34] As the director of the MIT Media Laboratories puts it, 'The slow human handling of most information in the form of books, magazines, newspapers and video cassettes is about to become the instantaneous and inexpensive transfer of electronic data that can move at the speed of light'.[35] Thus, for example, it is estimated that the World Wide Web expands daily by seven million electronic pages.[36] Consequently, the numbers of those with access to the Internet, although still in the minority throughout the world and heavily concentrated in northern countries, are growing steadily. It is estimated there could be a thousand million of them in five to ten years time. Latin America currently has thirteen million Internet subscribers,[37] a figure likely to rise to thirty million by the end of 2003.[38]

Under such circumstances, what approach should the schools of the future adopt? Will they give the new learning technologies the cold shoulder or will they make them their own? And will they be able to do so without changing or, alternatively, find themselves forced to change in order to exploit the opportunities offered to the full? People are already talking about a net generation—one that presents education with a real challenge.[39] Can the latter adapt to the more varied, less lexicographical, more iconic and less focused culture of the upcoming generations? How can schools make sure they survive in a multi-channel world, where children spend more time in front of the television than on their homework and expend more energy on their peers than on their teachers? How can they teach how to select and discriminate between information in the face of what can only be described as the rising tide around them? Can they cope or will they be sucked under without trace? Will they be able to steer their pupils along the road of 'learning to learn' or will this never be more than a slogan that fails to find practical expression? How will they manage to separate the 'noise' from the messages and contain the dissonance that inevitably tends to build up?

MEDIA

The teacher's spoken word and the written one are no longer the sole medium for the delivery of education. Even discounting the latest generation of electronic media, the stage as now set is already a veritable Tower of Babel. Television

displays 3,600 images a minute per channel. Every radio station broadcasts on average around 100 words a minute. A newspaper can contain some 100,000 words and several hundred pictures. Books and magazines account for an additional flow of similar proportions. Furthermore, individuals are exposed to some 1,600 advertisements per day[40] and are the recipients of several thousand words more in the form of telephone calls and faxes. Now add to this access to the World Wide Web and the bringing together of different forms of electronic transmission in a single—digital—mode. In light of such changes, how can the traditional functions of schools and teachers not change? What methods of instruction need to be adopted and developed? As education becomes globalized, what attitude will governments and families take? Also, can the classroom—the cornerstone of mass education—survive the changes imposed on it by the new forms of communication? The short answer is that schools, too, will have to adapt to technological change, as firms and universities are doing, and the functions of home and government. The more so if one considers that—in contrast to the Industrial Revolution—today's technological change, far from stopping short at the school gate, is altering the very structure of the educational process. Involved here are the technologies of the word, delivery of knowledge and information and the organization of educational time and space—not just factories, railways, telegraphs, production machinery and the like.

APTITUDES

Schools can no longer go on operating as though the aptitudes they are seeking to develop and the forms of learning to which they give rise, or the kind of intelligence they ascribe to their pupils, can be limited to the expectations formed during the Industrial Revolution. Technological change and liberalization leading to a knowledge-based global economy again necessarily reopen the question as to what capacities and skills societies should teach and learn.[41] Although the precise specifications vary from society to society, the underlying principles tend to converge: there is a need for greater flexibility and for attention to pupils' individual characteristics; the multiple intelligences of each one have to be developed if solutions are to be found to the problems of the real world, changing and full of uncertainty as they are. Other requirements are an ability to work co-operatively and to communicate well in increasingly technical environments, well-developed literacy and numeracy skills, personal initiative and a willingness to take on responsibility—in other words, qualities diametrically opposed to those sought through standardized mass education. In light of these new expectations, the basic teaching curriculum, teaching and learning methods and technical support to education must all be rethought. Indeed, there are those who advocate already that basic education should be structured, not around traditional subject areas, but around topics or themes and the skills necessary in a society where the very notions of work, employment and leisure are rapidly changing.[42] Just as education cannot remain detached from the workplace, the latter cannot fail to contribute to teaching and learning. Schooling as a cultural initiation rite will

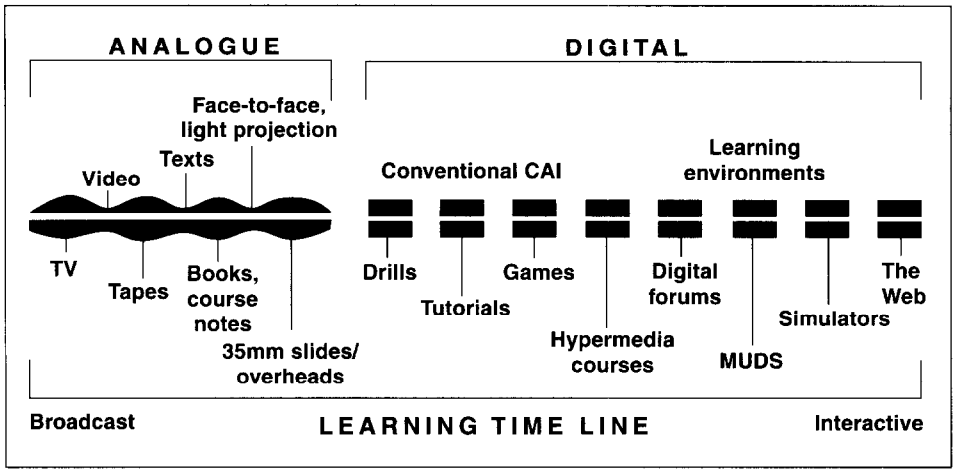
thus give way to lifelong learning. The learning society is almost with us,[43] but just when will it arrive and at what cost to the school system inherited from the Industrial Revolution, and, going even further back in time, from the cathedral schools? Will it make its appearance everywhere or simply in the more developed countries? And will it narrow or widen the knowledge and skills gap that is creating an invisible gulf between nations and individuals?

TECHNOLOGIES

The traditional technologies of the educational process are no longer necessarily the only ones available to teaching and learning. Hitherto, education has basically been a 'low tech' business, making use of talk, by the teacher—at the rate of 125 to 200 words a minute for several hours a day—pencil, chalk and the blackboard, the printed word and, on quite a large scale throughout the world, the overhead projector. As to the other technologies that have made their appearance in schools, 'the cemetery of failed experiments is large'.[44] Radio, cinema and television have not succeeded in changing teaching and learning methods, but they have given rise to various distance learning arrangements that, where these have been able to gain a firm foothold, have served to extend education, especially to more remote districts and groups in society that otherwise would not have had access to schooling.[45] However, the landscape has begun to change rapidly in recent years. Suddenly the 'immovable object' as the school has been described, has met with the 'irresistible force' of the technologies of the information society.[46] The United States aimed to have all its schools connected to the Internet by the year 2000.[47] The state of Victoria in Australia hoped that, by the year 2000, every teacher would be issued with a multimedia notebook and schools would have one personal computer to every five pupils.[48] Denmark's Committee on the Information Society by the Year 2000, set up by the Danish Government in 1994, states that 'all primary and lower secondary schools in the country will be connected by an IT network with relevant services, e.g. access to public software libraries and the possibility of communicating via national networks', a decision being backed by heavy investment in the technologies in question. IT investment in 1993 stood at 2.7% of GNP.[49] In Chile, too, a country with an emerging economy and average earnings, 100% of secondary schools are connected to the Internet, along with primary schools in urban areas, which account for the enrolment of roughly 80% of the school population at that level. However, the number of pupils to one computer is still very high (estimated at 70:1) by contrast with the developed countries (five to fifteen pupils per computer). Generally speaking, 'most Latin American countries lack a comprehensive strategy for incorporating technology into their systems—even though several are now making significant investments'.[50]

In any event, the new information and communications technologies, especially network technologies, are changing one of the basic axioms of the school order—the school's isolation—in the same way as one of the formative instruments of learning, ordinary or linear text, is starting to be replaced by hypertext. In short,

FIGURE 1. Tapscott's learning technologies continuum



we are in transit to 'high-tech' education, as illustrated by Tapscott's famous learning technologies continuum where progress from left to right along the continuum denotes the increasing degree of control over learning that those technologies afford the student.[51]

The learning technologies shown move from analogue to digital, from broadcast to interactive and from exogenous control over the process (external to the student) to autonomous control (by the student). 'Broadcast television is an example in which all the intelligence is at the point of origin'[52]—in this instance the teacher. Video recordings are a step further down the line as they allow the user more control (when and where to replay them). Books can be carried about from place to place and read in whichever order is preferred. Face-to-face lessons may have a higher interactive component. But according to Tapscott, the quantum leap really occurs with the coming of digital media, starting with the most basic computer-aided instruction: drills, pre-programmed tutorials and educational games, all of which afford the student a greater degree of control over the process as well as a variety of interactive forms. These reach a greater pitch of intensity with hypermedia courses—using a combination of media—possibly leading on to on-line forums, multi-user domains or MUDs, 'places' on the Net where users create virtual situations and take part in them in real time. As Tapscott observes, 'soon your kids studying science will be able to meet in a troubled bio-region and share data, research and solutions, or have a meeting in a space station about the results of an experiment on the impact of gravity on viruses'.[53] The next step in learning environments will be virtual reality simulators and, ultimately, the Internet as a whole.

No one knows exactly how the new information and communications technologies will transform the educational environment, but virtually no one thinks that they will pass us by without transforming the present educational structures and the way they operate. What will be the consequences of students having continuous autonomous access to information, which until now has been controlled by

teachers? How is the function of the latter likely to change once a part of their standard information presentation tasks can be done through the use of technologies more effective for the purpose than the human voice and the written word? What impact will the borderless connection accessible to pupils and teachers alike have on local cultures? What new learning experiences will become possible once the technology becomes truly interactive and how will that technology be used? Will it merely be a tool to support teaching—the computer as pencil or textbook—or, alternatively, will it give rise to new practices in new learning environments?

BORDERS

Education is already beginning to move away from being identified exclusively with a national context and is itself entering the sphere of globalization. We have already seen that the formation of global information and knowledge networks are transforming schools' immediate environment and, furthermore, the relationship between education and work. Change is also beginning to occur in the way education is delivered, with the process now reaching beyond, first, the confines of the school and then national boundaries. This, then, represents a departure from the secular movement that led education out of a world of scattered local private providers into the state sector and thence to the people at large, turning it into the principal agency of social integration within national boundaries. Education is once again becoming less focused, more decentralized, and is beginning, in many parts of the world, to admit of a much greater private input into its activities, management and finance.[54] With globalization goes greater convergence of education policies[55] and a growing emphasis on measurement, assessment and international comparison of results.[56] In this way, local and global elements are made to interface with one another and nations find themselves compelled to compete in terms of human capital and educational performance. The knowledge gap at world level is being exposed more clearly and is once more being raised as a subject for public debate,[57] finding its way on to the agenda of multilateral organizations.[58]

As we saw, the unpredictable effects of globalization raise a number of questions for the developing countries. Is the possibility of the educational process becoming transnationalized opening the way to further loss of state sovereignty? Will it threaten the cultural identity of peoples and the independence of their education systems? Is it the case that globalization is driving countries to adopt policies that subordinate educational goals to productivity at work and industrial competitiveness? Are we moving in the direction of ever-greater segmentation of labour markets, possibly causing still more acute polarization of workers between internationalized symbolic analysts and local unskilled labour? Will the search for effectiveness and efficiency in educational services end up by further emphasizing inequalities between schools and, hence, inequity in income distribution?

DIRECTIONS

The school is ceasing to be a formative institution operating in a stable socializing medium. It has to come to grips with the changes being experienced by the family, the community and the churches. As a result, inter alia, of the technological revolution currently in progress and its impact on traditional forms of social existence, we live in times that have been defined as approximating more closely to the realm of anomie than any previously by known social experience: in other words, to a state of extreme uncertainty where no one knows what kind of behaviour to expect of anyone else in any given situation.[59] And in truth, modern, contractual, atomized societies with no shared foundation of belief encounter difficulty in regulating people's behaviour normatively. Instead of moral integration and reliance on an accepted order of sanctions, uncertainty over standards tends to prevail. 'We are living at a time when traditional educational institutions—particularly the family and the school—are losing their ability effectively to transmit cultural values and standards of social cohesion. The new socialization agents, such as the mass media and in particular television, have not covered this "socialization deficit" and were not designed to take charge of the moral and cultural education of individuals'.[60] All in all, conservative thought is inclined to blame the media for such socialization deficits and television for their deleterious consequences, as does one author who contends that television has become an instrument for the dissemination of values that are 'corrupting, demoralizing and destructive', in addition to having replaced the traditional institutions for socialization and transmission of values.[61] It is not the case, however, that some institutions have replaced others. What is in fact happening is that all communications and learning media now co-exist in a multidimensional space, creating the impression that nothing is definite and everything depends on the point of view of the observer. This presents schools with a further challenge. They will need to carve out new roles for themselves in a social context whose traditional bases have grown weaker. The questions this raises are of the most pressing kind. How should education be organized in view of the changes in the family? How should we proceed faced with a pluralist culture, where different values command the loyalty of the various groups and individuals? What can education do to alleviate the effects of anomie, such as, for example, drugs and juvenile crime? And what part will it play in the development of a democratic civic culture? Science has few answers to such problems, while education, on the other hand, cannot wait.

Conclusion

To sum up, a veritable sea change is underway. Education has ceased to be coextensive with school and the latter, in turn, is forced to rethink its own foundations. If it fails, it runs the double danger of being left behind relative to other institutions that have taken the technological revolution seriously and, worse still, of contributing

to widening the gap between the information and knowledge rich and poor, as far as control over such goods is concerned. Bearing in mind these challenges, I shall conclude by pointing to a few lessons that can be learned from past educational revolutions.

First, the signs of change should not, because the change is still in its infancy, be dismissed as merely utopian, for one might easily fall then into the same trap as a certain president of the Royal Society did, in early nineteenth-century Britain, when a bill to extend basic education to the lower classes was being debated in Parliament. He opposed it as being ultimately detrimental to their morals and happiness on the grounds, as he put it, that it would teach them to despise their lot in life instead of turning them into reliable farm labourers or fitting them for such other employment as suited their station. It would, he maintained, make them factious and refractory and enable them to read seditious pamphlets and vicious books and publications that went against Christian teaching.[62] He could not have imagined that only a century later the Universal Declaration of Human Rights would proclaim everyone's right to education. What he rejected then scarcely needs justification today.

Nor should one make the mistake of imagining that educational change will be guided by the new information and communications technologies, powerful though they are. Education is much more than its technological underpinning. It enshrines a formative principle and is a social and cultural task, which, irrespective of the transformations it undergoes, will continue primarily to repose on its human, ideal and value constituents. History teaches us that the technologies of the world are cumulative, not substitutive, and are dependent on social purposes, not the other way round.

It is a mistake to suppose that some things about education are immutable, such as the present form of the school, classroom organization or the status of the written word in teaching. As we have seen, that is all a product of history. Such factors represent arrangements that have come into being and changed over time and could disappear, like certain ideas about teaching, instruments of school discipline and scientific notions, which in their day seemed set to endure.

Lastly, we must not expect the educational revolution to break upon our cities irrespective of how we, as social agents, act. Time has become compressed. We know that there are critical moments for taking action. A wasted opportunity might set us back decades. Thus, for example, a recent study points out that forty years ago Ghana and the Republic of Korea had practically the same per capita income. By contrast, at the start of the present decade, Korea's was six times higher than Ghana's, with at least half of that disparity accounted for by the former's greater success in acquiring and using knowledge.[63] Inaction, delay or procrastination could have the effect of widening the 'knowledge gap', with serious consequences for a nation's development. In an age of globalization, the threat is not of falling behind but of being left out altogether.

On the contrary, we need to sharpen our vision of the challenges the future holds and build consensus in support of progress in the desired direction. We also

need to promote innovation and not be afraid to experiment. Centralist traditions have still too much sway and the attitude that anything new in education must be handed down from on high, government defined and enacted through the usual channels is deeply ingrained. It is likely that if we go on in this way, we shall be irretrievably left behind. Without experimentation—at every level—there is no innovation, and without innovation it will be impossible to transform schools and adapt them to new requirements. There is also a need to stimulate and strengthen research and development in the educational sphere. Many support programmes for the sciences fail even to take account of applied educational research; in other cases, resources allocated are few and far between.

Lastly, it is important to act and learn together. The future of education does not belong solely to those most directly involved. Many other participants need to be brought into the debate and the experiment, and this needs to be done with a will. They include academics and the universities; representatives of industry, especially the information and communications service sector; multimedia designers and operators and the community, both local and regional. There is much to be gained from all their experience and also, since education is now 'borderless', from going out into the world to identify and exchange useful, innovative experience.

Throughout the course of history, education has given birth to an unfailing succession of changes and utopias, but only rarely is the context itself transformed to the point of transcending the utopia. At such times it is possible either to forge ahead at speed or to be left behind and slip back. At that crossroads we now stand.

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CONSTRUCTIVISM: USES AND PROSPECTS IN EDUCATION

Jean-Jacques Ducret

Most of the texts collected in this Open File come from the Conference on 'Constructivism: Uses and Prospects in Education' organized from 4 to 8 September 2000 by the Canton of Geneva's Educational Research Department (SRED), with the support of the Jean Piaget Archives Foundation and the University of Geneva's Faculty of Psychology and Educational Science.[1] The SRED's intention in organizing the conference was to pay tribute to Jean Piaget twenty years after his death. The choice of subject goes straight to the heart of the great scholar's oeuvre: it seemed to us important to explore the notion of 'constructivism' as a means of highlighting the contribution and the limitations, in educational terms, of Piaget's theory of cognitive development and the genesis of knowledge. For at least thirty years now it has been clear that his theoretical work not only continues to generate extensive research and innovative approaches to teaching and educational science, but has also allowed new theoretical currents to propose constructivist approaches intended as complementary—or even contradictory—to his thinking

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on the connection between development and learning. There was a further reason for our seeking to explore the relationship between constructivism and education: for strange as it may seem, the issue has never, in Geneva itself, been made the subject of in-depth debate. Thus, it seemed to us useful to choose a topic that has recurred in the many discussions and theoretical analyses the Jean Piaget Archives Foundation has been organizing for more than twenty years, on such core aspects of constructivism as the relationship between 'genetic psychology and the cognitive sciences' or 'genetic psychology and the history of science'. In doing so, we were simply acknowledging the fact that education is currently one of the liveliest fields of development in constructivist thinking. The final incentive to focus our examination on the relationship between 'constructivism and education' was the need to clarify certain major theoretical issues in respect of the changes in approaches to schooling that have profoundly modified contemporary teaching systems; to a considerable extent, these changes have drawn on ideas launched by Piaget himself during the many years he worked as director of the International Bureau of Education and in the period after he stepped down. To that end, then, we opted for encouraging dialogue: (a) between researchers from the different disciplines concerned, constructivism being an idea developed not only within epistemology, psychology, psychosociology, educational psychology and didactics, but also within sociology; and (b) between holders of varying conceptions of constructivism.[2] This issue of *Prospects* provides only a very partial reflection of the various constructivist conceptions outlined in the course of the conference.

Of the seventeen papers presented in plenary or semi-plenary meetings, we have been able to include in this issue only four (see the texts by *E. von Glasersfeld, J. Bideaud, A. Weil-Barais* and *M. Brossard*, below), which apply to the fields of epistemology, psychology, educational psychology and didactics. Unfortunately, it was not possible to include other contributions, notably those of G. Cellérier, F. Dubet and J. de Munck, all of whom, in raising considerations relating to biology and ethology (Cellérier), sociology (Dubet, Cellérier) and legal philosophy (de Munck), took us beyond the (incomplete) psychological, educational-psychological and didactic framework. For reasons of space, we had decided to limit our coverage. Readers interested in the papers not included here, and in the eighty or so other scientific contributions bearing on one or other of the multiple facets of the relationship between constructivism and education explored in September 2000, may refer to the proceedings of the conference published by SRED.[3] It should be added, however, that in addition to the four papers mentioned above, we also decided to include in this issue of Prospects two other texts, one by *Y. Kato* and *C. Kamii* and the other by *L. de Macedo*. Our intention here is to convey some idea of the impact of constructivist ideas in Japan and South America.

Before giving a brief presentation of the seven papers included in this volume, and since this issue is part of the conference's tribute to Piaget, let us begin with an overview of the contribution of the great Genevan scholar to education and educational science.

Piaget's contribution to education and educational science

In spite of steadfastly refusing to consider himself an educationist[4]—he had never carried out research in educational science—and although his articles on education are few in number in comparison with those on biology, psychology, epistemology and logic, Piaget maintained a close, lifelong interest in this field, as indicated not only by the many years he spent as director of the International Bureau of Education (IBE), but also by the regular publications dating from his initial research into genetic psychology in the 1920s up until his death in the late 1970s (some of these are mentioned in the bibliography at the end of this article).

Piaget's thinking and suggestions in the education field can be divided into four levels:

(a) Teaching systems (programmes and structures);
(b) Teachers and their training;
(c) Methods;
(d) Pupils and their intellectual and moral development.

As we shall see, these areas of concern are also present in the stages of development of his constructivist theory. It is natural in terms of methods and pupils that his suggestions draw most directly on the discoveries in genetic epistemology and genetic psychology, but even on the other two levels Piaget allowed himself to be guided by these discoveries. Thus, in respect of teaching systems, his role at the IBE led him to advocate changes. For example, the creation of school careers which put off selection for as long as possible was intended to allow pupils' potential to become sufficiently clear for them to choose—with their parents and with the help of their teachers and specialist psychologists—the courses of study best suited to their personal growth and the development of their individual abilities. At the same time, they were to enjoy equal status and not be 'evaluated solely in the light of future study success, that is to say, in terms of a single, ultimate—academic—goal' (1949, reprinted in Piaget, 1972, p. 71). Where programmes were concerned, Piaget's suggestion was that they should be simplified: only the basics should be taught, as a means of postponing specialization as long as possible. It is advisable to maximize development of the pupil's intelligence and all-round culture, these being assets that will enable him or her to cope with the largest number of problematical situations and make a more organic whole of 'the different practical, technical, scientific and artistic aspects of social life, while linking this whole to a conception of history bearing on civilization in the fullest sense of the term' (ibid., p. 69). In respect of the second level, that of training primary and secondary teachers, Piaget put forward the now increasingly accepted notion of a university training that presents the two-fold advantage of socially enhancing one of the most difficult of all professions and of leading future teachers to acquire and share in the spirit of research as it applies to educational science and related disciplines, including the psychology of cognitive development in children and adolescents. His recommendations in terms of systems, programmes

and teacher training take on their full significance when seen in the light of the suggestions on methods, these latter being themselves tied to an awareness of the intellectual and moral development of pupils during childhood and adolescence. It is certainly on these last two levels—methods and pupils—that Piaget's thinking is at its richest and most original.

The recommendations concerning methods being highly dependent on genetic psychology's observations regarding the moral and intellectual development of children and adolescents, let us briefly recall, at the outset, some initial discoveries that were to influence those recommendations directly. With regard to moral development, the major discovery was that there are two moral codes which—if the prerequisites for spontaneous development are met—successively guide children's behaviour. The first of these two moral codes arises out of a sort of 'social instinct' or innate social tendency that underpins the child's relationship with its parents: unilateral respect or, in other words, a fear tinged with love or admiration. The second is based on the relationships of mutual respect that children gradually build up with their same-age peers, but also with older children and with adults when the latter behave and are recognized as partners.[5] This discovery was expanded by the link Piaget was very quick to detect between psychological and psycho-social processes allowing for the transition from one moral code to the other—favoured by exchanges with others—and similar processes at work at the intellectual development level. In respect of this level the discoveries of genetic psychology were to go even deeper, guided as they were by Piaget's dominant concern with epistemological matters. Before focusing more closely on them, let us recall the recommendations regarding appropriate methods that he was to draw from the results of his research into moral development, the first of them being, naturally, that 'procedures in moral education must take account of the child itself', that is to say of acquired knowledge concerning the child (Piaget, 1930, p. 219).

The suggestions put forward in respect of moral education are basically answers to the question whether one should 'utilize indiscriminately both fundamental tendencies of childhood morality and utilize them at the same ages' or 'utilize them successively or ensure that one of them predominates' (idem., p. 192). Everything hinges on the goal set by the adult society. If that society is seeking the development of autonomous individuals capable of exchange with others based on reciprocity and mutual respect, peer exchange is to be encouraged as allowing individuals gradually to learn to recognize the value of shared, mutually arrived-at rules of conduct. This does not mean, however, that this approach is sufficient, for the existence within each individual of a stage at which moral heteronomy necessarily prevails must also be taken into account. While emphasizing relationships conducive to the shaping of mutual respect, the adult has a duty not to neglect the question of authority and the need for guidance children can display. The level-headedness of Piaget's judgement is again evident at the intellectual development level: in 1935 (p. 248), for instance, he decided that while it was vital to encourage free activity by the child in the course of its cognitive explorations, a certain degree of 'systematization coming from the adult' might not be 'entirely harmful to pupils' and that there could even be a need,

in the interests of developing the child's capacity to reason intellectually, for 'a social structure including not only co-operation among children, but also co-operation with the adult' (p. 8). To sum up, on both the moral and intellectual levels Piaget is pleased to point out that in accordance with psychological data, 'the new educational methods tend not to eliminate the social function of the teacher, but rather to reconcile co-operation among children with respect for the adult and as far as possible to reduce adult constraint and transform it into a higher form of co-operation' (p. 264). It is clear, then, that if the child is to develop morally and intellectually, he or she needs a certain level of adult intervention and support from an appropriate form of unilateral respect. However, it remains true that the ultimate factor in enabling the child to become a reasoning being is leaving her free, alone and with her peers, to pursue her own interests and questionings together with their interests and questionings. Hence, throughout his oeuvre, we see Piaget openly supporting the school and active methods. Like intellectual truths, moral rules are only fully assimilated, grasped and accepted by the subject when he himself can construct or reconstruct them, at least partially and in a context free of all submission to an elder, however much respect the latter may command. Nonetheless, there should be no mistake about the central role granted to the subject's activity. It would certainly be an error to see the Piaget child as a Robinson Crusoe capable of developing in total solitude. When the American psychologist R.I. Evans questioned him around 1970 about his sympathy with Rousseau's ideas, Piaget replied that while he shared Rousseau's concern with attentiveness to the child, he felt that the great philosopher had made a mistake in neglecting the 'collective Emile', the social dimension of development (Piaget, 1973, p. 99).

To conclude this summary of Piaget's contribution to education, we should like to mention, without being able to go into detail, the suggestions drawing most directly on certain more advanced discoveries in genetic psychology. The first of them, which thoroughly revolutionized the discipline, was that of the existence of stages of development, each of which is characterized by precisely structured, mathematically modelizable properties. Initially, Piaget thought the existence of such stages could be attributed to the transition from an egocentric to a decentred form of thinking, but his research rapidly revealed the presence of a deeper cause, linked to the dialectic of states and transformations. Gradually succeeding in linking the states among themselves via transformations—firstly at the level of sensory-motor actions (movement of objects, etc.) and then in terms of operations (addition, subtraction and multiplication of logical classes and differences, numbers, movements, etc.)—the subject constructs systems of actions, then of operations, whose transformational, explanatory, anticipatory and creative properties become increasingly rich, powerful and coherent. If this developmental model is largely true, as many experiments indicate, the educational conclusions are clear. The educationist who adopts the active school point of view finds himself on the one hand obliged to adapt what he is trying to teach the pupil to that pupil's skills, that is to say, to the level of development of his intellectual structures; but on the other hand—in as far as the process partially depends on of the interactions each subject, not only with physi-

cal reality as gradually discovered and explained by himself, but also with his peers, with adults and thus with what the latter can pass on to him—he can help slow or accelerate this intellectual development. However, given the organic character and the depth of the cognitive systems that the subject is led to construct in the course of his psychogenesis, the guidance and acceleration that the act of teaching can generate cannot be anodyne, at least in terms of everything affecting the deepest layers of individual constructions. A clear, but superficial, acceleration of the development of number skills could, for example, be prejudicial to the slower, underlying construction of an operative system, one rooted in the subject's most spontaneous practices (empirical additions, matching, etc.) and possessing a breadth of scope considerably greater than if it were the result of the learning of algorithms. Conversely, always leaving the subject to find his own solutions to the cognitive problems he encounters could hinder a development sufficiently rapid to let him attain the higher level of operations which, under the right circumstances, any non-intellectually handicapped subject can reach via such processes of construction as reflective abstraction.

However, the educational suggestions Piaget sketches on the basis of the discoveries of genetic psychology, and which we have condensed by bringing together recommendations taken from several stages of his work, do not end there. Among his observations concerning the sequence of operative skills, one that particularly drew his attention can lead to hasty conclusions regarding the educational consequences: this is the observation concerning the relationship between mastery of extensive quantities (addition of numbers, etc.) and the mastery, logically and epistemologically implicit in the first, of intensive quantities (addition of logical classes, etc.). The two develop in close interaction. Working from this observation, Piaget suggested to teachers that they should not confront pupils too quickly and exclusively with extensive quantity problems (for example, 7 + 2 = how many?) when they have not yet mastered intensive quantities (adding sub-classes of flowers to reach the class of flowers and deducing, when shown a bouquet, that there are more flowers than there are daisies in a bouquet composed of seven daisies and two tulips). Did Piaget mean here that numbers and numerical problems should not be spoken of as long as the child has not constructed logical class and relation, the synthesis of which, as we know, transforms empirical and thus still qualitative number into operative number? Knowing his prudence and his rejection of excessively clear-cut solutions, we doubt it, even if he can sometimes be a trifle rash in his assertions. And we doubt it even more in that in 1961, in his lengthy introduction to Volume XI of the 'Studies in genetic epistemology', devoted to Problems of number construction, he acknowledges that the child can be 'helped in construction of the [numerical] series by the acquisition of spoken numeration imposed by the social circle well before, as a rule, spontaneous operative constructions make complete assimilation possible' (Piaget, 1961, p. 53). Whatever our interpretation of his suggestions regarding the order to respect between the teaching of intensive (logical) quantities and extensive (numerical) ones, it should be recalled here that one of the most wide-ranging recommendations he made to educationists was that they should carry out their own experimental checks as a means of verifying the aptness of the methods

or procedures to be used in teaching, with a view not only to inducing acquisition of empirical knowledge or conventions, but also to helping pupils construct their logico-mathematical knowledge. In addition and by way of concluding with this point, we should note again that Piaget's insistence on the necessity of exercising logical thought structures has been to some extent confirmed, where teaching of mathematics is concerned, by the change entailed by incorporation of the discoveries of modern mathematics and, notably, set theory. However, Piaget was not slow to distance himself from the way this change was being effected, having quickly detected the presence of two major shortcomings: on the one hand the fact that mathematics continued to be taught using the traditional abstract, verbal methods; and on the other the fact of not teaching arithmetic on the grounds that it was not the basis of modern mathematics. This kind of deduction runs counter to the psychologist's observation that the young child spontaneously proceeds to intuitive evaluations of extensive quantities and even spontaneously constructs arithmetical (or pre-arithmetical) knowledge before construction of operative number. Several times in the course of his oeuvre—for instance, in a 1973 article on mathematics education—Piaget uses the example, paradigmatic for his constructivism, of his physicist friend Juvet who, at around age 4 or 5, discovered via pseudo-empirical abstraction that the same result is obtained by counting a line of stones from right to left or from left to right. This means that the most elementary arithmetic, like the most spontaneous geometry and children's spontaneous classifications and seriations, provides an ideal concrete basis for the shaping of knowledge which itself can later serve as the foundation for the construction of set theory.

After highlighting the main stages in the construction of intelligence structures in children and adolescents, Piaget and his colleagues were led to confirm even odder discoveries, such as that of the respective weights of the figurative (perception and mental image) and the operative (perceptual activities, motor actions and operations) in the solutions the subject can provide to problems she encounters; and also that of the respective weights of language and thought in the subject's development. The discoveries made regarding these two points enabled the genetic psychologist to counsel prudence to the educationist in the use of figurative instruments and language. In both cases there was a risk of encouraging either 'image verbalism' or language verbalism, both of which can seem definitive solutions to these problems and thus hold back, once again, construction of operative skills that transform the very nature of the solutions. (It was into this dual trap of image verbalism and a free-floating formalism that many educationists fell in their attempts at teaching modern mathematics.) Lastly, let us point out a discovery made during the 1970s research into development mechanisms. Piaget and his colleagues succeeded in verifying that finding a practical solution to a problem does not on its own give a child the ability correctly to describe how she went about doing so. Working in terms of their own goals, the didacticists took up and developed this discovery by insisting in their turn on the two phases of learning construction represented by practical problem-solving and 'institutionalization of learning'.

Although incomplete, this résumé provides an outline of Piaget's suggestions and his relationship with teaching sufficient to confirm the extent of his contribution. However, we should stress yet again that the idea probably closest to his heart was that educationists, while drawing on genetic psychology and other relevant sciences, should independently carry out research enabling them to establish both a teaching system and the methods most appropriate to the goals envisaged. He was doubtless delighted, too, to see just how fast such disciplines as educational psychology and didactics took off in the 1970s, a situation illustrated by Annick Weil-Barais' most instructive paper.

It is high time to introduce briefly the texts chosen for inclusion by situating them in relation to one of the general aims of the conference, namely, that of examining the uses of constructivism in respect of education within the relevant disciplines and the directions it may take as a result.

Constructivism under challenge

In the summary above, we tried to show just how Piaget himself had drawn on his research in genetic psychology and epistemology so as to put forward educational suggestions concerning not only pupils and methods, but also systems of teaching and teacher training. It is also particularly interesting to note that the upheavals in public education in the second half of the twentieth century have led to the use of adaptations of constructivism in almost all disciplines capable of throwing some kind of light on teaching and school learning. Piaget was not the originator of the constructivist idea and *Ernst von Glasersfeld*, while exploring the broad consequences of constructivism for education, reminds us once again in his paper that its roots can be traced back to the philosopher Vico. However, via the scope, originality and multidisciplinary character of an oeuvre embracing biology, logic, psychology and sociology, Piaget is unquestionably the central figure from whom the various constructivist currents have chosen to differ, not only in psychology, as *Jacqueline Bideaud* reminds us, but also in social psychology (the paper by Anne-Nelly Perret-Clermont, for instance), education (Seymour Papert), mathematical didactics (Guy Brousseau, Gérard Vergnaud and others), scientific didactics, linguistic didactics—and sociology, as François Dubet, Jean de Munck, Bernard Lahire and Philippe Zarifian pointed out during the conference. And so, without making any pretence of exhaustiveness, let us, in the light of Piaget's thinking, look at how constructivism has been changed by contact with different research goals and different research traditions.

The differentiation of constructivism first of all has to do with the changes in genetic psychology research. This is especially the case in respect of studies on number acquisition by children. Piaget's analyses had led to numbers being conceived of as a fusion of operations acting on logical classes and asymmetrical logical relationships (5 can be seen simultaneously as the cardinal of a set containing sets of 4, 3, 2 and 1 elements and as the successor to 4, each interpretation being dependent on the other). As *Bideaud* demonstrates, the research carried out in Geneva and elsewhere

led to a clearer understanding of how, before the age at which operative fusion is completed (usually around 7 or 8 years), the child can perceive or conceive, admittedly within narrow limits, numerical quantities and order. This has a two-fold implication for constructivism, at least in respect of the suggestions it can provide on the educational level: on the one hand, it forces constructivism to integrate better the possibility of a phylogenetic dimension into the capacities at the root of the construction of operative number; and on the other, it forces it to take greater account of the procedural (linked to such actions as counting) and contextual dimensions of the stages of construction of pre-operative number. Granted, as *von Glasersfeld* and Kamii made clear at the conference, it is imperative to allow the child actively to construct the basis of his skills and of the arithmetical and logical concepts on which all his later mathematical constructions will be founded. However, as soon as we take a close look at the numerical skills of children under 6, we cannot fail to notice the way their spontaneous constructions fit with various stimulations, deliberate or otherwise, coming from the adult world. Obviously this observation can be extended indefinitely as the child, and then the adolescent, comes to grips with the world of school, where one of the basic tasks is precisely the transmission of acquired knowledge in the mathematical sciences, with their ever-increasing charge of notation algorithm conventions. The further the child advances at school, the clearer it becomes that a substantial part of his most obvious learning acquisitions are traceable in one way or another to the teaching he is getting, even if many of these acquisitions are going to be lost through under-use or inadequate understanding. We then see how mathematical didactics, while continuing to play a fairly significant role in Piaget's constructivist scheme of things, has felt obliged to adjust the concept to incorporate that vital social component, transmission of knowledge, as it figures within the framework of a school-based teaching the didacticist often seems to over-value.

Yet the observation that one can do just as well in the case of pre-schoolers as with children attending school—something that would not have surprised Piaget in the least, although he could not take it into account in resolving his own mainly epistemological problems—naturally becomes more evident still when one turns away from the logico-mathematical sciences towards the natural and then the social and human sciences (and the study of language in particular). In terms of the thinking involved, it may just be conceivable that a child will take her spontaneous constructions as far as the rudiments of elementary arithmetic and geometry without help or explicit guidance from those around her, but in these other disciplines the situation is different. To the extent that they are not the outcome of a personal constitution of knowledge undertaken independently of the outside world and proceeding essentially by reflective abstraction, as is the case with logic and mathematics, they either demand painstaking experimentation involving going beyond particularly effective pre-scientific explanations of how things work—magical thinking, artificialism, animism, dynamism, etc.—and make clear their belated acquisition in terms of the socio-genesis of science, or they have to do with something (language, for example) in which social conventions play a vital part.[6]

Thus we are not surprised to see—as *Annick Weil-Barais* in her article and Jean-Pierre Astolfi in his paper in the conference proceedings both remind us—how the scientific didacticists insist even more than their mathematical counterparts on the social component of science teaching, which helps one distance oneself from the potently assimilatory forms of spontaneous physical thought. At the same time, this should not lead us to forget that children—at least in Western societies, as was demonstrated by the 1960s research into the development of causal explanation in children, carried out at the International Centre for Genetic Epistemology—can construct a form of operative causality related to the explanations of scientific physics, and do so before having received any scientific teaching. As to language didactics, and especially notation didactics as illustrated in *Michel Brossard*'s article, it is readily understandable that the discipline has found in Vigotsky's conception of development—as interiorization of intellectual tools and communication painstakingly constructed by adults down the generations—its favourite tool, one enabling the construction of 'didactic sequences' appropriate to language teaching. But here, too, it should be pointed out that as far as language acquisition during the child's actual development is concerned—and this is another matter entirely—we are still a long way from any certainty as to whether such acquisition takes place via a Vigotsky-, Chomsky- or Piaget-style process, or by some other complex process which itself borrows from two or three 'elementary' processes. Current knowledge in psycholinguistics makes this second possibility very plausible.

The differentiations Piaget's constructivism had to undergo to adapt to the world of teaching have found, as we can see, strong roots in the logic of constructivism itself. The more a science is taken to be objective and universal, the more its socially transmitted weight has to be reduced to allow the subject to root its values of objectivity and universality in his deepest practical experience. Conversely, the more a science is founded on a reality made up of conventions, the more its acquisition by each individual hinges on a knowledge transmission factor. Yet, even in mathematics teaching the 'knowledge transmission' component cannot be ignored, and this for at least two reasons: (a) the existence of conventions, necessary in practice if not by right; and (b) the incredible extent of the knowledge progressively accumulated by adult mathematicians since the science came into being in the great civilizations of the past. Even if this accumulation of knowledge is lightened by the process, accepted by Piaget's constructivism, of the integration of that which is surpassed by that which has surpassed it, its sheer quantity still represents a huge challenge for any would-be constructivist education. This is the very challenge today's protean constructivism is trying to take up, even as it remains advisable to keep in mind Piaget's suggestion that up until the point of choosing a profession to study for, development of the intelligence and all-round culture should take precedence over acquisition of specialized knowledge.

In closing, let us quickly consider what we can learn from the two articles complementing the five texts taken from the conference proceedings. These articles give palpable form to two of the main conclusions to be drawn regarding permeation of the education field by constructivist thinking. On the one hand,

this penetration seems relatively ineluctable, to the extent that, as is now widely accepted, the only firmly acquired conceptual knowledge is knowledge that has been assimilated by the pupil. On the other hand, such permeation is no sinecure: constructivist teaching and application of the 'new active school methods' are much harder to put into practice than the traditional approach, which cares little about assimilation of knowledge. Thus, the considerable difficulties involved in applying and disseminating constructivist education—financial cost, institutional transformations, personal commitment and various social pressures—make it easy to see how our education system succeeds in remaining broadly traditional and transmissive in terms of its methods and goals, especially at secondary level.

Notes

1. In 1994 the Montreal *Education sciences review* ran a report entitled 'Constructivism and education'. However, the stance taken was different from the one we chose for the conference, in that we opted at once for a definition of constructivism and avoided confrontation between different or supposedly different theoretical approaches.
2. In addition to allowing for this double dialogue, the conference was also intended to encourage exchanges between researchers and practising educationists, the aim being to examine the extent to which constructivist intentions might fit with the reality of existing education systems. A final assessment still remains to be made here.
3. The proceedings are available by post from the following address: Service de la recherche en éducation, 12 quai du Rhône, 1205 Geneva, Switzerland; by e-mail from: nairain.jagasia@etat.ge.ch; and by fax: + (41.22) 327.52.66.
4. However, many of the numerous students who attended his epistemology and genetic psychology courses testify to the talent that went into passing on his discoveries and concepts.
5. Although the mention of a hereditary side to child development is rare in Piaget, the notion is present at all stages of the oeuvre. A 1949 text, for example, raises the possibility of 'innate predispositions' allowing 'the human being to construct rules and moral attitudes' (Piaget, 1972, p. 51). The paper given by G. Cellérier and published in the proceedings of the September 2000 conference provides a detailed outline covering the three components—phylogenesis, psychogenesis and sociogenesis—of the evolution and development of psycho-ethological behaviours, together with a novel synthesis of the thinking of Darwin and Piaget.
6. Even if conventions also play a major role in mathematics, they do not constitute the actual being of the discipline—not, at least, if we accept the epistemological constructivism of a Piaget for whom there existed a true mathematical objectivity.

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RADICAL CONSTRUCTIVISM AND TEACHING

Ernst von Glasersfeld

Introduction

I should like to define the subject of this paper a little more broadly than is usual in articles about education. On a day-to-day basis, teachers are inevitably preoccupied by the practical problems connected with the fact that what students learn often falls far short of their expectations. Furthermore, they have little time to think about some of the fundamental problems of their profession, problems which are very numerous nowadays. In fact, there are far too many to discuss in a single paper.

I shall therefore restrict myself to examining two problems which I consider to be among the most crucial. The first concerns what we regard as the aims of education. The second is connected with a more fundamental investigation of the significance which the constructivist school gives to knowledge and the ways in which it believes that knowledge can be acquired.

What is the aim of education?

The concept of education is very broad in scope: it may include instruction and training, supervision of the development of specialized skills, facilitation of thinking, or

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Original language: French

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again, teaching good manners, good taste, culture and other aspects of life in society. Clearly, in view of this diversity, it cannot be expected that teaching and learning will always take place in the same way.

One of the fundamental differences between these types of activities is that some things that should be learned cannot be derived logically, while others may be generated by thought.

For example, if you want to obtain a driving licence in continental Europe, you have to learn to drive on the right. The question, 'Why don't we drive on the left?' is futile since you simply have to conform to a social convention for which there is no other explanation. Conversely, anyone who has learned to count can add the numbers two and two together and verify that they make four. This of course requires knowledge of the conventional names of the numbers but, once this has been acquired, it is a conceptual task: conceiving of units and conducting mental operations with them.

I shall discuss later this second type of knowledge that students can generally acquire on the basis of their own mental operations. For now, I want to stress the fact that learning whatever is considered 'correct', because society has decided it is, is essentially a political matter. I say 'political' because this refers to knowledge that an older generation wishes to instil in the young in order to ensure the continuation of society and, what is more, to maintain its status quo. In some respects it is quite sensible to accept this type of knowledge. Thus, to return to the banal example of the Highway Code, it is perfectly reasonable for everyone to agree to drive on the same side of the road, but the decision to drive on the right rather than the left is not a matter of rational thought.

In my opinion, it is indispensable for teachers to be aware of this difference with respect to all teaching contents, since it implies ways of teaching that are also different. What is conventional should be learned word for word, as it were; what is based on rational operations should be understood. Historical dates, the names of chemical elements, the months of the year and the days of the week, the names of the numbers and a multitude of other things should be learned by heart, as no amount of intellectual effort can lead to their discovery. This means that students should be trained to learn these sorts of things so that they can draw on them at any time and repeat them perfectly when necessary.

Our schools have centuries of experience in using methods that favour this type of learning, with varying degrees of success. In fact, this is the form of learning that is generally preferred, for the simple reason that its results are easy to verify. When students repeat something word for word, it is clear that they have learned it. Whether or not they have understood it is a question carefully avoided in such tests.

Teachers do not often say so clearly, but sometimes they maintain that the fundamental aim of schooling is to foster the development of independent thought. This implies the second type of learning, which I call conceptual learning since it is literally connected with the activity of conceptualization. In order to make my position as clear as possible, I will break with academic convention and talk a little about my own development.

On conceptual problems

I became aware of conceptual problems at an early age because I had the good fortune to grow up in an environment in which more than one language was used. In Switzerland you also have this marvellous opportunity. Some of you encounter situations every day in which you have to make up for the conceptual differences between French, German and Italian. Whether or not you become aware of the nature of those differences is quite another matter.

Here is an example of the conceptual difference between French and English. In the last chapter of *La construction du réel chez l'enfant,* Piaget wrote: 'L'intelligence ne débute ni par la connaissance du moi ni par celle des choses comme telles, mais par celle de leur interaction, et c'est en s'orientant simultanément vers les deux pôles de cette interaction qu'elle organise le monde en s'organisant elle-même' (1936, p. 311). ['The mind begins neither with knowledge of the self nor knowledge of things as such, but with knowledge of their interaction, and it is by simultaneously directing itself towards the two poles of this interaction that the mind organizes the world by organizing itself.']

In Margaret Cook's English translation, the end of this sentence is translated as 'intelligence organizes the world by organizing itself' (Piaget, 1954, p. 400).

I had already been teaching genetic epistemology for quite some time at an American university where English texts had to be used before I began to realize that this translation was unsatisfactory. The English word 'intelligence' does not refer to an active agent which can direct itself or organize things. Using it in this sense is at best a metaphorical usage. The word which best renders what Piaget meant is 'mind'. This word refers to the locus of activities which can be qualified as intelligent and it is strange that there is no specific word in French, or in German, to refer to it. The term exists as an adjective – for example in the expression 'les opérations mentales' [mental operations], and I shall return to this – but there is no substantive that refers to an active agent.

There is, therefore, a conceptual difference. This example, like the thousands of others that might be cited, shows that the conceptual structures underlying each language are seldom exactly the same. Several of these divergences are so subtle that one has to be immersed for years in another linguistic universe to become aware of them.

Some of you will perhaps be shocked if I now say that it is not necessary to examine a foreign language to identify such conceptual differences. Yet such differences often prevent people speaking the same language from understanding each other. For someone who takes Ferdinand de Saussure's fundamental intuition seriously this is not surprising since words do not refer to things in a real world but to concepts which are in the heads of those speaking. If, furthermore, you take into account Piaget's close analyses of the way concepts are constructed through empirical abstraction and reflective abstraction that the child accomplishes for him- or herself, it becomes clear that it would be a miracle if the conceptual structures in different heads were the same.

As soon as one embarks upon a discussion of abstract subjects, still more of philosophical problems, one observes over and over again how difficult mutual understanding is. Often, the meaning that others attribute to the words we use is not quite the same as the one we have in mind. Yet many people continue to cling to the tacit assumption that words refer to things, conditions and events that are unquestionable because they exist in a world which is independent of the experience an observer may have of them.

Such a belief leads inevitably to thinking that the problem of knowledge and, consequently, learning is a problem of correct description and representation of what things are. In other words, to understand how things work, it is sufficient to look attentively.

The media age in which we live favours the maintenance of this realist belief. Radio and television programmes popularizing science lead people to believe that the enigmas of the universe are being solved one after the other, and several books for the general public maintain that absolute reality can be known and understood. The fact that the most highly respected scientists of the last century all, in one way or another, regarded their explanatory theories as hypothetical models generally finds little echo either in the media or, unfortunately, in schools and higher education institutions which initiate students in the various scientific subjects and scientific thought in general.

Knowledge and a theory of cognition

I believe this situation provides us with a good reason for taking a look at the history of epistemology. At the very beginning of Western philosophy some thinkers already suspected that realism and its objectivist pretensions were untenable. Thus the Sceptics persistently denied such a possibility for more than two millennia. Most philosophers have recognized the irrefutability of the Sceptics' arguments; they have, nevertheless, continued to hope that they will find a path leading to indisputable truth about a real world. But the paths they have chosen always lead to the realm of metaphysics, in other words, they tacitly imply some form of mystical belief.

The famous metaphor of Plato's cave is a good example of this. In this fairy tale human beings are chained in a cave whose entrance they cannot see. In front of them, on the wall of the cave, they can see shadows on the basis of which they must guess what is in the outside world and what is happening there. But Plato added that God had instilled latent truths in the human soul and that, if human beings learned to use their intuition, they would be able to acquire truths about the real world.

This is a powerful metaphor because it is a poetic representation of a plausible situation; but it does not show clearly that this situation can only be described by a god, because only a god could know what was outside the scope of human experience.

This is precisely what the Italian philosopher Giambattista Vico said, and very elegantly, at the beginning of the eighteenth century: 'God knows the world because He created it; human beings can only know what they have made themselves'. The

treatise in which this statement appears is the first constructivist manifesto. Some seventy years later, Emmanuel Kant wrote in his famous book, *Critique of pure reason:* 'Human reason can grasp only what it has itself produced according to its own plans' (Kant, 1787).

However, neither Vico nor Kant succeeded in shaking the general belief that, one way or another, we should be able to discover what the real world is really like. The persistence of this belief is, in my opinion, due to the fact that we all have many items of knowledge that we consider reliable, i.e. which we trust when we wonder how to act. For example, when we go down a staircase we believe that the next steps will be where they should be and we show the same sort of trust in a great variety of contexts. For example, when I boarded the plane to come here, I did not doubt for a moment that it would take me to Geneva nor that the old town would be the same as the one I had known on earlier visits. Such trust in the permanence of objects and circumstances is essential in everyday life, even if things do not always turn out as we expect.

We simply need to believe that, on the whole, our experience presents us with a more or less stable world. But this belief should not lead us to suppose that this world must be similar to a reality situated beyond that experience.

The construction of concepts

As I have already emphasized, the great scientists of the last century were aware of this epistemological impasse. Physicists, for example, must of course assume that the world they experience and observe experimentally is a stable world. But this assumption, whatever its validity, does not enable us to conclude that their explanations can provide an account of a reality independent of the observer.

This agnostic position may be justified by all sorts of epistemological considerations but, as I want to focus on concepts, I shall quote what Albert Einstein wrote fifty years ago: 'Physical concepts are free creations of human thought, and are not, even if they seem to be, solely determined by the external world' (Einstein & Infeld, 1950).

From the constructivist point of view, creating concepts is a form of construction and, whatever the circumstances, construction involves reflection, i.e. a recognition of the connections that can be made by co-ordinating sensory elements or mental operations. Piaget usually talks of 'co-ordination' and this is clearly carried out by a mind. A very great number of such co-ordinations soon become habits and are then accomplished unconsciously.

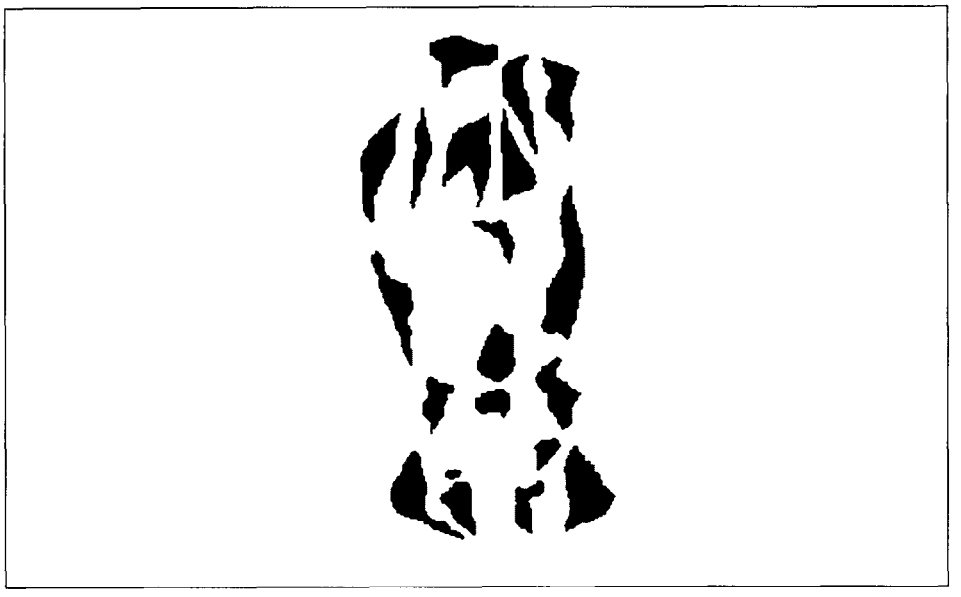
It is not possible to give a picture of mental operations since they necessarily take place inside someone's head, but here is an image that shows that it is you, and you alone, who engenders your own perception.

At first sight, Figure 1 is meaningless for many people. But, if you turn it round, you will recognize something familiar. You will probably say, 'It's a dog!', but, in fact, it is no more than a group of irregular black marks. So where is the dog?

In case anyone persists in believing that the dog is nonetheless inherent in the drawing, here is a second example. You probably know the constellation called Cassiopeia. It is a capital 'W' or, if you turn it round, an 'M'. This constellation is

near the Pole Star, opposite the Great Bear. The Greeks called it Cassiopeia's Crown. For 3,000 years the constellation has been observed without any apparent changes. It is as permanent and lasting as one could wish. But, here again, where is the constellation? You may answer that it is obviously in the sky. But, like President Clinton when he was talking about his equivocal amorous exploits, I should like to ask what is meant by the word 'is'.

FIGURE 1: Incomplete figure (from Leeper, 1935)



The constellation is composed of five stars that astronomers refer to using Greek letters.

Alpha and Delta are about forty light years from Earth. Gamma is twice as far away, Beta three times and the distance to Epsilon is 520 light years, which means that it is about twelve times more distant from Earth than the first two stars.

Now imagine that you are travelling in a space ship to Epsilon. What happens? After a few light years, the 'W' you saw from Earth has stretched so much that it is difficult for you to link the five stars. Once you have covered a tenth of the distance, Alpha and Delta are behind you. The constellation you relied upon for night navigation has disappeared. In other words, seeing a 'W' depends on two things: (a) a specific observation point, and (b) specific perceptual operations.

Piaget always maintained that perception was a form of action. Silvio Ceccato, on the other hand, has suggested that it is the shifting of the attention that generates the form and the figures we perceive (1974, p. 231). The attention, he says, is not a spotlight that illuminates objects; it is, rather, like a pulse that focuses on sensory differences and that, by moving from one point to another, produces a contour. Thus, once you have identified the stars in the night sky, focusing enables

you to connect them by passing from one to another. There are, however, several possible connections between the five stars of Cassiopeia. Here are two of them (Figure 3).

FIGURE 2: The constellation Cassiopeia

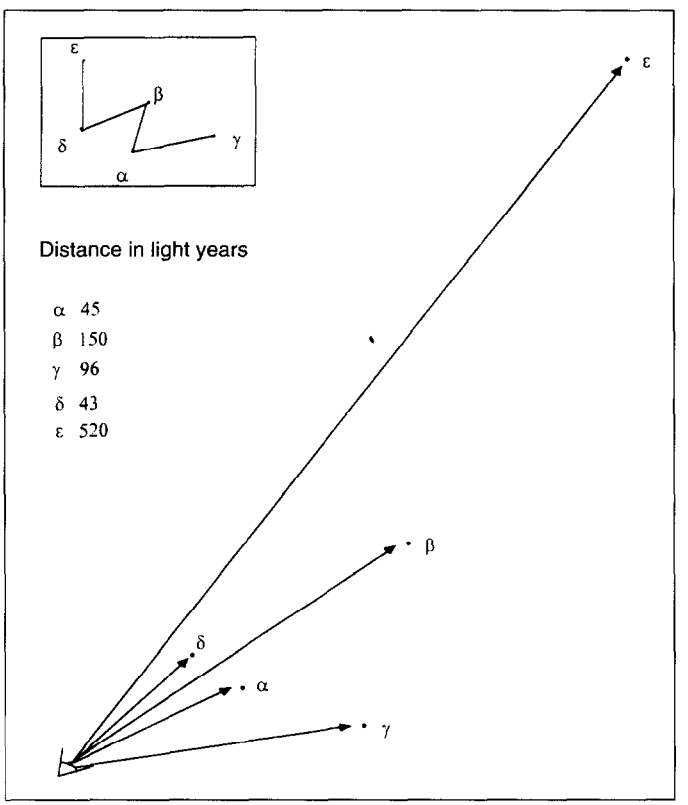
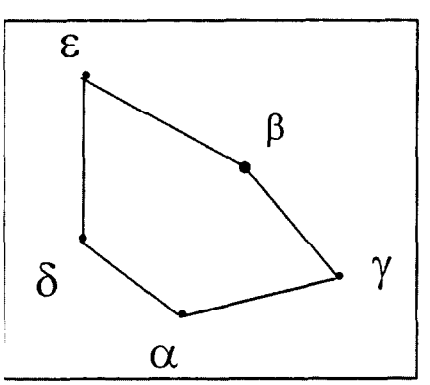
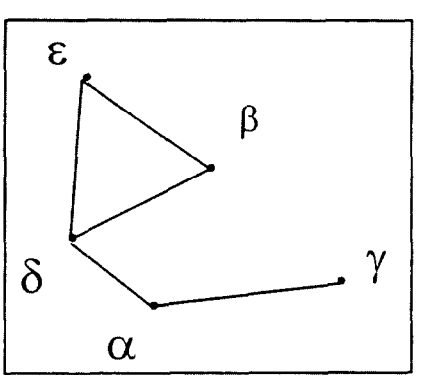


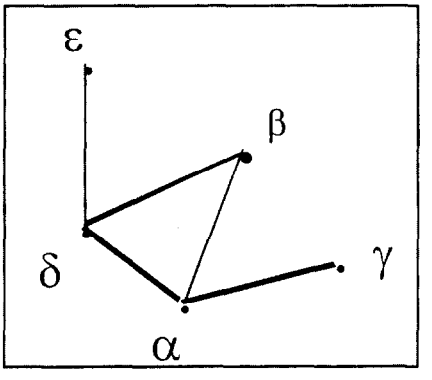
FIGURE 3. Other configurations





These configurations are produced because of the general tendency to look for something familiar, i.e. to assimilate in Piaget's sense of the term. As in the case of the dog, we tend to see what we have already seen. And in the contemporary Western world, 'W' is surely the most familiar configuration for linking these five points. The Greeks did not have 'W', but as they regularly crowned their heroes, kings and queens, they perceived the five stars as a crown (Figure 4).

FIGURE 4. Cassiopeia's Crown



You may believe that these are merely optical tricks and that the important concepts that preoccupy teachers are not simply images in people's heads. Allow me, therefore, to explain a very important concept and tell you how I think it could be constructed by children.

The concept of plurality

How does a child learn to use the plural forms of words correctly?

Imagine a little girl of 2 who has recently learned to say the word 'horse' when she sees an animal with a long mane that is taller than a dog and whinnies when she approaches it. One day she is walking in the country with her mother and they pass a meadow in which several horses are grazing. With pride, she points at one of the horses and says 'Horse'. Then she points at another and says 'Horse' again. Perhaps she says it several times more, pointing at each of the horses in turn.

'Yes, darling,' says her mother, 'there are some horses.'

It is possible that the little girl notices the difference of pronunciation for the first time. However that may be, she will hear the plural form of the word in other situations and, to general surprise, it will not be long before she uses the singular or plural according to linguistic convention.

How does the child learn this? All the horses she has seen correspond to a sort of 'recognition matrix'. The matrix is what Piaget calls the empirical abstraction, and it is with the matrix that the little girl associates the word 'horse'. But none of

the horses taken individually can tell her that it belongs to a plurality that adults call 'horses'. This difference literally has to be conceived. It is not a question of visual perception; it can only be fabricated by reflection on one's own mental operations.

Apparently, this has been regarded as so obvious that, as far back as I can remember, no researcher into psychological development has mentioned it. This does not mean, however, that it has been correctly understood.

The construction of the concept of plurality requires at least that the following operations be carried out. Once the object has been recognized, for example, an 'apple', the attention must immediately shift to at least one other object that fits into the same recognition matrix. The salient point is that one single recognition matrix can be successfully applied more than once in the same context. This repetition does not reside in the objects. Let us take the example of apples placed on a table. None of the apples on the table provides any indication as to the presence of the others. The repetition can only emerge from what is done by the person perceiving. This means that, in order to use the plural correctly, the child must, in a sense, become aware of its own recognition operations. Ceccato invented the expression '*consapevolezza operativa*' [operational consciousness] to refer to this process which is, I believe, quite similar to what Piaget called, less obviously, 'thematization'.

I have used this example of the plural many times since it is the clearest and simplest I know. Concepts such as beginning and end, duration and change, space and time, and all abstract concepts can, from my point of view, be explained in the same way. Their construction may certainly require different and sometimes complex mental operations, but it is always the attention the observer gives to his or her own operational functioning that makes them emerge.

If you find this analysis appropriate, you will perhaps agree with my conviction that it has a number of implications for teaching. Once it is clear that students have to construct their concepts on the basis of their own thoughts, the idea that concepts are transmitted by language is no longer defensible. As I tried to show at the beginning of this paper, the words someone utters are interpreted by others according to concepts they already have. It is only if their initial interpretation seems meaningless that they may try to develop a new conceptualization.

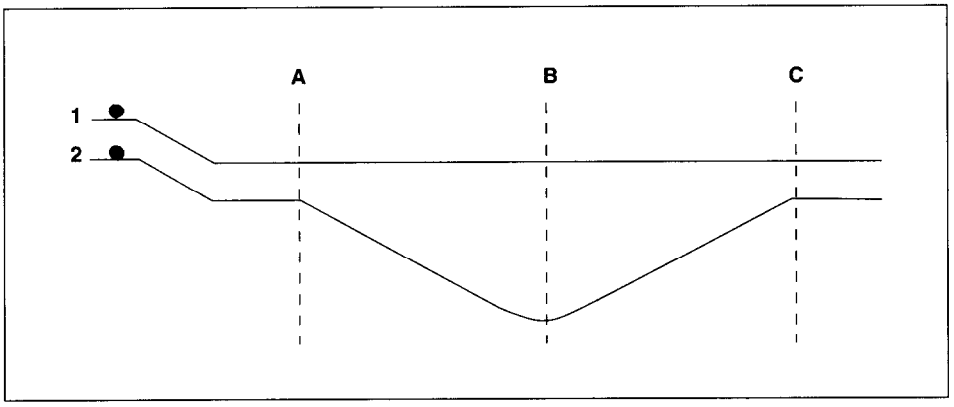
My friend Humberto Maturana has suggested that the function of language is to direct. I consider this a perspicacious proposition. Consequently, I do not entertain the illusion that my paper can give you a new conceptual framework. I shall be happy if I have been able to sow a doubt here and there which may lead you to new constructions.

Example of active learning

This leads me to raise a point of view that I believe essential for didactics. There is no infallible method of teaching conceptual thought, but one which has most success is to present to students with situations in which their usual way of thinking fails. I am going to give you an example of this method which was tried out by Leonard and Gerace (1996) in our institute at the University of Massachusetts.

Figure 5 is the diagram of an apparatus which reminds me of a game we loved playing when we were children whenever we had a big pile of sand or went to the beach. We used to make a sort of bobsleigh track and roll our marbles along it to see which was the fastest.

FIGURE 5. The example of steel balls (from Leonard & Gerace, 1996)



This figure shows two tracks on which steel balls can roll almost without loss of energy through friction. The two tracks are not identical, but the starting point and the finish are at the same height in both cases. The question is, if two balls leave at the same time, which will reach the finishing line first?

Some students who have started to learn physics answer that ball 1 will arrive first, because ball 2 has further to go. Others predict that both balls will arrive at the same time because, if ball 2 gains time going downhill, it will lose it on the upward slope. Very seldom does one of them answer that ball 2 will win the race.

So there is great surprise when the steel balls are rolled and, every time, ball 2 arrives at the finishing line first. Some students laugh and claim the apparatus has been rigged. We assure them that it has not, and ask them to describe as precisely as possible what happens in each section of the course.

At first, it is not easy to get them to speak, but when we tell them it is not a test and we simply want them to share their ideas with the others, one or two of the students begin the discussion and the others gradually join in. Usually, they soon agree on the following descriptions.

- Both balls arrive at point A at the same time and at the same speed.
- The downhill slope from A to B enables ball 2 to accelerate and reach B before ball 1.
- 'Is ball 2 in the lead?' we ask.
- 'Yes. At point B, ball 2 is in the lead, but then it has to go uphill, which makes it lose its lead.' Then we ask:
- 'And when ball 2 reaches point C, is it going faster or more slowly than ball 1?'

This question usually leads to a longer discussion, but eventually the students agree that the uphill deceleration is equal to the downhill acceleration and that both balls should therefore have the same speed at point C.

Some of the students then begin to suspect that ball 2 rolls faster than ball 1 throughout the journey from A to C. The lead it gains more than compensates for the different lengths of the two journeys and, consequently, it reaches the finishing line first.

Of course, not all the students are immediately convinced. But those who have glimpsed the solution are usually indefatigable when it comes to explaining to the others. Eventually, most of them understand how, as 'physicists', they should conceptualize the situation.

Suggestions for teachers

I regard this example as an ideal case of teaching and learning. The teacher presents a situation in which the students' conceptual framework proves inadequate. Nothing is judged 'wrong' and the teacher does not give any correct explanation. The students' thinking is simply directed from time to time by neutral questions.

The essential principles of didactic constructivism are implicit in this example. They are simple, but I should like to stress some of them.

1. Teaching should not begin with the presentation of sacred truths, but rather by creating opportunities for making the students think. For this purpose, one of the prerequisites is that teachers believe the students can think. In American schools this belief is not widespread – far from it.
2. It is not enough for teachers to be familiar with the programme content; they must also have a range of didactic situations at their disposal in which the concepts to be constructed can be implied. In addition, these situations should be developed in such a way as to stimulate the students' spontaneous interest. These two requirements are often neglected. The fact that concepts can only be formed in the individual's experiential world is often obscured by the general idea that everything conceptual is the representation of an independent reality that can therefore be passed on to students ready-made. But this type of realism is a poor basis for teaching.
3. When students show their work, it is not a good idea to say that something is 'wrong', however one may be able to justify such a judgement. Students seldom produce a solution by chance. They have worked at it and, if the result they believe to be right at a given moment is not the one the teacher is thinking of, their efforts must nevertheless be recognized. Neglecting to do so is the surest way of extinguishing any spark of motivation they may have. It is not surprising if they then lose any interest in tackling new tasks.

   I began my paper by emphasizing the relativity of the meanings of words and this is a point to which I should like to return in relation to the teaching context.
4. Several of the words teachers usually associate with specialized meanings in their particular subjects evoke very different associations among new students.

It is only when these so-called 'naive' concepts are consciously reconstructed that the understanding of the conceptual framework which is sought (especially in the sciences) becomes possible. In order to facilitate such reconstruction and the formation of new conceptual relationships, teachers should at least have some idea of the students' theories and ideas. Only if they have a model of what the students think can they begin to influence a chain of ideas and try to prevent the construction of 'inappropriate' ideas.

5. If the formation of concepts is really based on thought, teachers should have ways of stimulating it. The easiest way is to make students talk about what they think. Verbalization involves reviewing what is to be verbalized. This review is a form of thinking that often brings out inconsistencies and gaps in a chain of ideas. It is therefore crucial to initiate conversations when there is a problem to be solved. For example, the students may explain their way of thinking to the teacher or to their fellows. Both situations favour thought and constitute the beginning of what Ceccato called 'operational consciousness'. This eventually becomes a habit for the students and any opportunity to solve problems may then be transformed into a conversation with oneself.

Conclusion

Before ending this paper, I should like to respond to the objection teachers most frequently raise to the constructivist approach. That is all very fine and quite reasonable, they say, but how can we find the time for activities that stimulate individual students' thoughts when the pressure to maintain the speed imposed by curricula is already more than they can manage? My reply is simple and may seem Utopian, but there are more and more indications that it works.

Let us suppose that you devote one or even two whole lessons to an experiment such as the one I have presented using balls. This experiment has in fact been done at our institute and there can be no doubt that the students learned far more from it than simply the explanation of one surprising result. They began to realize that conscious reflection is the secret of understanding.

Furthermore, I should add that, with respect to the teaching of physics, this experiment has various possibilities for dealing with the concepts of velocity, inertia, gravity, friction and air resistance in later lessons in relation to a situation the students have experienced. If you give them one or two further such opportunities, what they realized during the first experiment will be confirmed and they will have learned to think. From that time onwards they will be able to tackle all sorts of new problems creatively and will have acquired some confidence, one of the preconditions of motivation. This kind of approach is not confined to solving physics problems. It is applicable to learning in general, is useful in all subjects, and may also enable students to make more rapid progress.

If teachers of other subjects provide students with similar opportunities for independent construction and testing of concepts, they will be surprised to see that

it becomes easier for students to understand and, therefore, deal with the whole curriculum.

Of course, I do not expect you to believe me, but I hope you will try some of the suggestions I have mentioned: then you will see for yourselves that they work.

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FORMS OF CONSTRUCTIVISM, COGNITIVE DEVELOPMENT AND NUMBER LEARNING

Jacqueline Bideaud

Summary

Genetic constructivism regards the development of cognitive structures as the product of interactions among three systems of equilibration relating to phylogenesis, sociogenesis and psychogenesis (Cellérier & Decret, 1992). From this point of view, the study of numbers is of particular interest since it reveals visible interactions between the child, his current forms of cognitive organization and his particular sociocultural environments. It is also worthy of note because the major constructivist theories (the genetic psychology of Piaget, the 'constructive' innateness of Gelman and the sociogenesis of Fuson) have taken an interest in numbers, focusing their attention in varying degrees on one of the systems in question. Our purpose here is to show the relevance of the complementarity of these approaches to research in and the teaching of elementary arithmetic.

Original language: French

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Introduction

There are several reasons for choosing the development of the concept of numbers as a means of approach to 'Constructivism: uses and prospects in education', the theme of the symposium. First, it is a field in which many fairly 'visible' interactions between the child and the various social contexts in which he or she lives are revealed. A 'software' designed in advance, with its own rules of procedure, must be internalized under the direct pressure of the family background and school environment and under the indirect pressure of a 'numerate' environment. The research on numbers has also been extended to animals and infants, which has made it possible to advance hypotheses regarding the nature of innate constraints and the temporal span of their impact on development processes. For these two reasons, the study of numbers seems to offer an insight into the processes and mechanisms of cognitive development. Another reason for this choice is that while all constructivist approaches have taken an interest in numbers, they have focused their attention in different ways on the phylogenetic, psychogenic and socio-cultural aspects of its construction. It is these aspects that we shall examine in discussing Piaget's theory of the psychogenesis of numbers, the 'constructivist innateness' position of Gelman and the neo-structuralist socio-cultural viewpoint of Fuson. We shall show how the complementarity of these positions, regardless of the real problems that arise in each case, brings out certain lines of enquiry for research into and the teaching of numbers in schools.

Numbers and Piagetian theory

Piagetian research developed over two separate periods. First, during the 1930s, the meticulous observations of Alina Szeminska provided the material for an initial article and later for a book published in 1941 in collaboration with Piaget titled *The child's conception of number* (Piaget & Szymanska, 1952). This work is somewhat disconcerting. Apart from its chapter VI, which deals with the notion of ordinal and cardinal numbers, it is devoted to a description of the logical constituents of the notion of numbers (conservation, seriation, classification) without any attempt to observe or analyse the strictly numerical skills of the child. Here numbers appear as a qualitative measure, the responses required to the various tests never being numerical (more, less, the same, as many). Indeed, the authors clearly state their objective in the foreword to the first edition: 'Beyond the child's verbal constructions, and in line with his practical activity, we now have to trace the development of the operations which give rise to number and continuous quantities' (ibid, p. vii). One-to-one matching, with conservation achieved in spite of the spatial transformations of the figure, is one of the basic *a priori* principles of arithmetic. The many observations carried out reveal that numbers (evaluated by the conservation test) are structured step by step in close association with the gradual formation of systems of class-inclusion and asymmetrical relations. Numbers develop as a seriate class. 'Obviously,

we are not suggesting that number is reduced to classes and relations; we are merely indicating their mutual relationship' (ibid., p. 157).

This is an important remark since it foreshadows further research undertaken during the fourth and fifth years of activity of the International Centre of Genetic Epistemology. Carried out by a remarkable team of psychologists, mathematicians, philosophers and logicians, it is the outcome not only of a striking degree of inventiveness in experimentation, but also of the high-level exchanges and intellectual ferment that are palpable in Piaget's reports of the symposiums that crowned these two years (Studies in genetic epistemology, XI and XVII). It is largely for this reason that it diverges from the previous work on two points: the theoretical basis is much broader and the child's numerical activities are explicitly taken into account.

If numbers cannot be reduced to classes and relations, three possibilities need to be explored: (a) classes and ordering might develop before numbers; (b) the structure of numbers might be constructed first and then spontaneously impact upon classes and relations; (c) classes, relations and numbers might develop simultaneously, with possible reciprocal interactions. Here we have a real shift in the research, whose purpose is no longer to explain the successes and failures of children in tests of conservation, seriation and inclusion, but rather to study the relations between the classes, series and numbers within the numerical chain as understood and used by children at various ages and, in particular, to examine the specificity of numerical inferences at all levels. It is this question that underlies the admirable research of Morf and Matalon on numerical connexity and recursive reasoning, as well as the research of Gréco on quotient, numerical iteration and the commutative nature of addition (SGE, XI, XIII, XVII).

There are three main conclusions to be drawn from the results of this research:

1. *The interdependence of series, class and numbers.* This interdependence appears clearly in the step-by-step construction of the connexity inherent in the sequence of numbers. At first (4–5 years old), the sequence of numbers is treated as any qualitative series in which each integer is not separated from its successor by one unit and one unit only. The number-words learned, though part of a series, remain independent and are not immediately understood as the products of repeated additions: 'At the moment when the numbers become not only "true" but acquire the quality of unique characterization of the quantity of sets of elements, they are still linked to each other by the qualitative relation "bigger than" ' (Morf, in Gréco & Morf, 1962, p. 101). It is only with the discovery of the idea of $n + 1$ that numbers become co-ordinated by a set of relations of connexity in an arithmetical sequence (about 7–8 years old). Moreover, at this stage of non-connex seriate numbers, the child does not immediately advance to a stable and general connexity. The construction process goes through a phase in which the $n+1$ iteration is initially introduced locally. The iterative inference is then acquired in steps, with the number continuing to be regarded as an isolated class until generalization of the iteration $n+1$. The numerical series then 'supercedes' the qualitative class and series. The interdependence of these structures of class and number is also attested by the existence of confu-

sion between extension and comprehension (intension) in questions of numbers, but also in questions of classification. For example, if we extract from two unequal sets, *M* and *N*, two equal subsets, *M'* and *N'*, young children between the ages of 4–5 and 6–7 years regard *N'* as being more numerous than *M'* because *N* is numerically greater than *M*. Here we have, as in the case of connexity, a sort of 'confusion' between the qualitative and the quantitative, which will only be resolved when the iteration *N+1* is introduced.

2. *The gradual construction of the structuring of the numerical chain.* The remarkable studies by Gréco (1960, 1963) reveal a slow construction of the arithmetization of the numerical series that proceeds in tandem with that of connexity. The child first of all constructs step by step a short series of successive cardinal numbers and assumes that the difference between two contiguous terms of the series remains constant (5 years old). The numbers then form a regular series up to a certain point of the known sequence, but the numerical iteration is still simply an empirical process that is only in part recursive. From the age of 8–9 years, the iteration becomes operational and 'establishes the sequence of numbers as a structure of ordered cardinal numbers' (1963, p. 268). But iteration is still only used to generalize the construction of the terms and not to reason and calculate directly. From the age of 12–13 years, iteration is no longer simply generalizable but becomes the actual instrument of generalization. Progress is due both to practice and to operational structuring 'with its usual characteristics of advances in mobility, stability and reversibility' (1960, p. 211).
3. *The specificity of numbers, which cannot be reduced to class and series.* Although the interdependence of the three ways of structuring (number, class, series) is obvious, it is equally obvious that there exists at all levels *a specificity of numerical inferences*. This is the high point of the findings. The studies of iteration and of the commutative nature of addition reveal the existence of arithmetical inferences *before* and *after* the stage of concrete operations. Gréco (1960, p. 213) writes: 'Leaving aside the configurative verbal pseudo-numbers of young children or animals, it can be assumed that the roots of operational number (as indeed the roots of the operational classes or relations themselves) are put down well before groups of classes and relations'. It should be noted that Piaget (Piaget & Szeminska, 1952) also recognizes the early use of seriation and classification, which he places at the very start of representation, towards the age of 10–12 months (at that time, apart from direct observation, there existed neither methods nor a research context that made it possible to study the behaviour of infants). The specificity of numbers may also be seen in the early use of conservation of the quantity counted, the quantity to which Gréco attributes an almost numerical cardinal status. It is here that the role of counting is introduced:

> Counting consists essentially in a one-to-one correspondence between the words learnt and the objects designated and an implicit summation of the units independently of the order [...]

But the child does not know this immediately. In learning to count [...] he is unlikely to have sufficient empirical success to reinforce the notions of cardinal number and commutation, but he learns to co-ordinate his actions [...] It is from all these individual actions of co-ordination, similar to those required by the action of matching, that number as a numerator of sets (and no longer simply as a 'denominator') and as the instrument of numerical equivalence will emerge (Gréco, 1963, p. 46).

Thus, right from the start, there would appear to exist specific pre-structures (conservation, class, relations and numbers as a qualitative measure), within which reciprocally reinforcing interactions, the driving force of their development, take root. Numbers, no longer qualitative but measuring discrete elements, are isolated as a result of the numerical iteration prompted by counting. But, isolated in this way, numbers are organized into an operational structure 'only at the same time as the logical thought which manipulates classes and relations' (Gréco, 1960, p. 211). It is odd that the abundant criticism directed at the Piagetian approach in this field is confined to the 1941 book and makes no mention of the anticipatory nature and continued relevance of his research during the 1960s.

However, attention needs to be drawn to the drawbacks of the theory, which, in spite of the advances by Gréco, Morf and Matalon, lie in an underestimation of the instigative and constraining function of cultural contexts and in the failure to link the process of learning to count, neglected by Piaget, with the structuring of the numerical chain. It should also be added that, at that time, Piaget rejected all forms of innateness, which led to certain gaps with regard to the roots of numbers. These points are more particularly covered by Gelman and Fuson.

The 'constructivist' innateness of Gelman

'As for the concepts of number', write Gelman and Meck, 'we share the positions of Piaget and Szeminska according to which very young children and older children are actively involved in the construction of their own knowledge. But, unlike Piaget and Szeminska, we believe that children possess innate elementary structures that are specific to certain fields and that help them to explore and use their environment by facilitating assimilation and accommodation' (1991). These rudimentary innate structures underlie the five principles of counting necessary for the use of numbers (stable order, term-to-term correspondence, cardinality, abstraction and the non-relevance of order).

The knowledge of numbers is based on an innate preverbal counting mechanism analogous to that which animals are believed to possess (Gallistel & Gelman, 1992). Numerous studies have shown that certain animals are naturally endowed with an elementary perception of the equality and inequality of small sets of objects; that after a relatively long period of conditioning, some become capable of perceiving the intensity of quantity in the case of higher numbers; and, lastly, that the higher primates are able to learn a symbolic representation of numerosity that does not extend beyond 6–7. In short, although an animal can easily handle numerical approx-

imations, the attempt to teach it a symbolic language of numbers would seem to be flying in the face of nature (Dehaene, 1997). These numerical approximations can be explained by the accumulator model of Meck and Church. From a particular source (pacemaker), pulses triggered by an animal's behaviour (birds tapping with their beaks, rats pressing on a lever) arrive at a constant rate in an accumulator. When the mechanism is functioning, each time that an entity is to be integrated, the closing of the valve for a brief predetermined period of time opens the way for the pulse, which then reaches the accumulator during that period. Thus, with each pulse, the accumulator steadily increases its store of equal 'beats'. The final score then shows the total quantity that can be integrated into the long-term memory and compared with other quantities previously integrated.

It is this innate mechanism of *analogical quantification*, which Gelman and Gallistel claim that infants possess, which in their view guides *the process of learning the principles of counting* by matching those principles with the subconscious preverbal process. The term-to-term constraint, necessary for the use of number-words, corresponds to the preverbal process in which the source sends pulses once and once only for each item of the set. The constraint represented by the order of number-words reproduces the order of preverbal magnitudes. The cardinal use of the final number-word corresponds to the reading, in the memory, of the final score in the accumulator. In addition, the authors advance the hypothesis that the analogical preverbal system of reasoning provides the framework—the underlying conceptual system—which makes it possible for the young child to understand and assimilate verbal numerical reasoning with regard to discrete quantities. The matching of preverbal magnitudes with figures and, conversely, of figures with preverbal magnitudes, together with the primitive capacity to work with these preverbal magnitudes, would appear to play a fundamental role in *the learning of the first algorithms*. The example given is that of an algorithm for subtraction, the main algorithm that, according to the authors, is commonly used by children. Let us take as examples the subtractions: $7 - 2 = 5$ and $7 - 5 = 2$. When children use this procedure, in the first case they count 6, 5—5: they descend in two steps from 7 to reach 5. In the second case they count 6, 7—2, rising in two steps to reach 7 from 5. Before working with number-words, the child estimates the 'magnitude' between the two terms of the operation and the outcome of this estimate determines what number-word will be used to obtain the verbal representation of the difference. Thus, since counting backwards seems to be difficult and liable to error, the child uses a preverbal subtraction and comparison to reduce to a minimum the number of steps he will have to count in the process of calculation. The acquisition of what Gallistel and Gelman call 'verbal' arithmetic is, in their view, mediated by the preverbal system of 'calculation' applied to magnitudes. The difficulties encountered in elementary arithmetic and differences between individuals are explained by the difficulty in handling with the double preverbal-verbal matching process.

The approach used by Gelman and Gallistel is interesting for several reasons. In attempting to identify what might be innate in the area of number so as better to understand the mechanisms involved in the earliest number-related learning processes,

it has highlighted two types of quantification, one approximate and the other numerical, whose interaction leads to the first skills assimilated. In doing so it has highlighted the importance of counting and of the principles by which it should be governed, which had been rather neglected in the Piagetian approach. This is clearly a constructivist approach in that, unlike associationism, the child is actively involved in the counting process on the basis of an innate system of guidance. However, the concentration on nativism leads to the neglect of socio-cultural constraints. It is very difficult to distinguish, from the time the child is able to speak and even before, what is due to innate constraints and what is due to constraints imposed by the environment (sociogenesis). The child learns to count long before it learns to use, and even more to understand, the famous principles. The psychogenesis of the general structuring of classes and relations is also not clearly apparent. From the age of 10 to 12 months, the infant is capable of aligning objects, and the analogical numerical line clearly resembles the qualitative series revealed by the Piagetian studies and which precedes and guides the strictly numerical series. The numerical preverbal-verbal and verbal-preverbal matching may be regarded as the outcome of the interactions—stressed by Piagetian studies in the 1960s—between the systems of classes, seriations and numerical inferences already suggested by Gréco as being of a very primitive nature. The understanding of cardinal numbers cannot be reduced to simply the verbal marking of the last object counted. The two-way matching process cannot on its own initiate understanding of the logical properties of the numerical series without which an efficient use of cardinal and ordinal numbers and hence of arithmetical algorithms is practically impossible. In short, the theory of Gelman and Gallistel places too much emphasis on innate guidance, the exact nature and temporal span of action of which remain to be determined more precisely, and makes no mention at all of psychogenetic and sociogenetic factors. It is on this last point that Fuson's approach is particularly interesting.

The viewpoint of Fuson and the socio-cultural origin of counting

According to Fuson, a child from earliest infancy will see and hear adults using numbers and it will itself use them in six different contexts. Three of these contexts are mathematical: The *cardinal context* (I have three children), which refers to the totality of a finite set; the *ordinal context* (Paul is my third child), which refers to a single element of a set by ranking it in relation to the other elements; and the *measurement context* (I have bought two kilos of potatoes), which refers to a quantity and indicates how many units correspond to that quantity. Two other contexts refer to cultural tools: the *sequence context*, in which the sequence of number-words refers to nothing in the absence of concrete elements; and the *counting context*, in which the number-word refers to a single element (counting the guests around a table). Lastly, there is a context of *quasi-numerical* situations, in which the cardinal and ordinal properties cannot be shown or are not linked (the number of the school bus, a postal code, a telephone number, etc.). The child is immersed in all these contexts,

which he will little by little decipher, guided by his growing mastery of the numerical chain. Unlike Gelman, Fuson considers that the counting of objects is a specifically cultural activity resulting from the learning of a culturally established list and using procedures based on culturally defined actions, the whole aimed at linking a counted object to 'a counting object', namely the number-word. The verb form 'to count' (or 'counting') should only be used to describe a socio-cultural activity that forms the subject of a learning process by the young child in a given culture. Although there exist other methods of quantification among animals or human beings that make it possible to evaluate the exact numerical content of small collections and to compare sizes, they are the result of a perceptive activity. In such cases use of the terms 'count' or 'arithmetic' (when we are talking, for example, of 1 + 1 = 2) is flying in the face of common sense. These words testify to a long history of complex human activity that extends to large numbers. Although innate processes of perception may prepare the way for certain aspects of counting, the contribution made by the socio-cultural learning process is considerable and even predominant.

The stages of this learning process are perceptively described by Fuson: the *rosary* stage, in which the grasp of small numbers of objects is based on configuration; the stage of the *unbreakable chain*, in which the child, incapable of counting from a given number, has to go back to *one* but can count up to a given number (the number-word then signifies the counting and no longer the configuration); the stage of the *breakable chain*, in which the child can count starting from any given number without going back to *one* and from any given number to any other (here the number takes on the status of symbol in an initial and gradually arithmetical sequence); the stage of the *terminal chain*, which sees the emergence of a new skill: counting n beginning from x, the difficulty of which increases according to the size of n and whether the counting is backwards. At the highest level of elaboration, from 8 years onwards, the chain becomes *interlocking, serially ordered, cardinalized and unitized*, which corresponds to what Piaget called 'proper counting'.

It is this evolution of the process of learning to count that underlies the child's grasp of the logical properties of the numerical series and cardinal numbers. The 'rule of the last number-word', spoken in response to the question 'how many?' is apparently learnt as a procedure (imitation of the adult) before being understood in its cardinal sense. A real conceptual mastery of cardinal numbers requires not only that the last number-word pronounced refers to the total number of elements counted but also that it necessarily includes all the lower numbers that are ordered and conserved. One-to-one correspondence and counting also play an important role in the inductive and deductive inferences needed for the conservation of a discrete ensemble, something that Gréco had already shown (EEG, XIII). At the same time, there exist some very clear links between the structures used by children for adding or subtracting and the ones they construct in order to establish relations of equivalence and order. Equivalence, order, inclusion and matching form a very rich network, the basis of multiple interconnections in which learning to count appears as the organizing skill. But counting cannot explain on its own

the processes by which the numerical chain is structured or the necessary linkages. In short, although Fuson describes with considerable subtlety the stages of a learning process by highlighting the socio-cultural constraint, she makes no mention of psychogenic mechanisms.

The complementarity of these approaches and its importance for education

If we take the genetic constructivist viewpoint, according to which development in a given field depends on multiple interactions among a certain innate form of guidance, socio-cultural constraints and psychogenesis (Cellérier & Ducret, 1992), the approaches described appear to be highly complementary, even though each one places more (or exclusive) emphasis on one of the three systems in question. Although the Piagetian theory emphasizes the fundamental categorical forms of structuring, it does not really explain how numbers arise from them and it neglects the learning processes triggered by the environment. Gelman and Fuson take into account the initial impetus given by the phylogenetic constraint, but in conferring for different reasons a major role on counting, their approaches largely disregard the mechanisms involved in the logical structuring of numbers. A heuristic theory of the construction of numbers in the young child would gain a lot from incorporating the most significant aspects of their respective contributions and stating more clearly the mechanisms of psychogenesis and of its interaction with innate and cultural constraints. However, it is now possible to identify certain lines of enquiry that are of relevance to education and research.

1. Evidence for the existence of early numerical knowledge, which is hinted at in the conclusions of Piagetian research, has been reinforced by the efforts to take account of an interaction, from the first months of life, between an innate guidance system (perceptive according to Fuson; pre-conceptual according to Gelman) and the indirect demands of the 'numerical' environment in which the child lives. The child acquires a certain experience of numbers and their use before the learning processes at school. The child shares out sweets, is given money, sings counting rhymes, adds elements to or takes them away from a collection of objects, and so forth. This early numerical knowledge takes place within an affective and often utilitarian context, which gives it meaning. There may be a gap between what the child already knows and what he is taught at school, in spite of the concrete situations he is faced with. The same gap exists between numerical knowledge learned at school and out of school by older children. An observation by Carraher *et al* (1985) is very instructive here: The authors cite the case of children who sell coconuts in the street. Anxious not to make mistakes in their sums in order not to lose their customers, they distrust the 'knacks' learnt at school. Thus the rule that to multiply a number by 10 you must add a zero does not seem trustworthy to them because they have not understood the reasoning behind it. So, such a child calculates the price of ten coconuts at 35 *centavos* each as follows: He has often sold three coconuts and

knows that they cost 3 x 35 =105 *centavos*. He also knows that 10 = 3 + 3 + 3 + 1. So he adds it all up: 105 + 105 + 105 + 35. This example shows that an examination of the numerical practices of young children in everyday life can provide valuable indicators regarding their real capacities and the problem-solving techniques they spontaneously resort to. Shortcomings, where they exist, could be reduced by basing the teaching process on what is already known and has been put to the test. This is the approach advocated by psychologists seeking to remedy a dysfunction.

2. From Piagetian research and the descriptions by Fuson we learn that cardinal numbers develop in conjunction with numerical order up to the age of 8 years and beyond and that an understanding of the logical properties of the sequence of numbers is essential to an understanding of the algorithms of elementary arithmetic. This seems to have been 'rediscovered' by Stern (1993), who has probably never read Piaget and who tries to understand why the problem 'John has seven eggs. He has four more than Peter. How many eggs does Peter have?' is more difficult than the problem 'John has seven eggs. Peter has four less than John. How many eggs does Peter have?' To explain these difficulties, Stern starts by noting the relative flexibility of the language describing quantities and then points to the failure to understand the reciprocity governing addition and subtraction. Does it require special insight to realize then, as she does, that 'the relations between addition and subtraction cannot themselves be understood until the numbers are represented in terms of relations between the parts and the whole'? This fully deserves the ironic response by Grégoire (1996, p. 35), who remarks upon, in this context, a hardly believable ignorance of the operational foundations of numbers and of the operations described in Geneva nearly half a century before. Jonnaert, in a splendid book *L'enfant géomètre* [The child as geometrician] (1994), emphasizes that the effective use of algorithms is impossible without a thorough understanding of the properties of numbers. The child must co-ordinate these properties with the property of the operation to be carried out. He gives as an example the terms of the subtraction of positive integers that are not permutable (4 – 3) because the second term is necessarily included in the first, whereas the converse is impossible. We see that inclusion relates directly to the cardinal dimension of numbers and, in the present case, makes it possible to understand one of the properties of subtraction. It is generally recognized that the deciphering of arithmetical errors focuses almost exclusively on procedural errors, whereas the real reason is very often an inadequate understanding of the logical properties of the numerical series. It would appear that, both in research and in education, too much attention has been paid to procedure at the expense of conceptualization.
3. The construction of numbers emerges as a long-term undertaking. Piagetian research, like the research of Fuson, has shown us the gradual nature of the arithmetization of the sequence of numbers, a given number not really being understood until the formal stage. Jonnaert, in the book mentioned above, holds that numbers are dropped too soon in the first years of schooling. It is

assumed to be *known* much earlier. The learning of its properties should be prolonged by taking account of a qualitative quantification, the analogical numerical line, whose role and importance remains to be clarified.

Here then are a few lines of enquiry, which, if they are to bear fruit, need to be explored through an essential dialogue among researchers, teachers and remedial psychologists.

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CONSTRUCTIVIST APPROACHES AND THE TEACHING OF SCIENCE

Annick Weil-Barais

Summary

The teaching methods for science that developed in France from the 1970s onwards, in conjunction with various attempts to renew science teaching, were largely inspired by constructivism. Approaching epistemology as constructivists, the physicists interested in science education found in Piaget's work a model child in tune with their own representation: a child who is active and curious, spontaneously attentive to objects and phenomena, working out concepts of the world, experimenting tirelessly, alive to contradictions, keen to be rational and intelligible, and so on. This article covers the beginnings of science-teaching theory in France, the development of research in that area and the renewed interest in constructivism by decision-makers and practitioners.

Original language: French

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A psychologist's view of science-teaching methodology

Science-teaching methodology, viewed as a field of research, is the study of the processes by which scientific knowledge is built up, transmitted and assimilated. Depending on the aspects on which it focuses, this methodology draws on a number of disciplines such as the history of science, epistemology, sociology, anthropology, pedagogy and psychology.

It was as a psychologist studying intellectual development in adolescence that I came into contact with education specialists, starting in 1975. My collaboration with them benefited from my postulation that learning processes at school should have an impact on the intellectual activities of children and adolescents. In other words, I did not believe in a 'natural' development of the psyche.[1] As I was interested in forms of reasoning[2] and intellectual approaches[3] that were particularly favoured in the sciences, I felt it would be advantageous to study them in the context of science teaching. Thanks to my membership of a laboratory specializing in teaching methods for the sciences[4] and to the studies I carried out there, I helped to improve knowledge of how and under what conditions children and adolescents were able to assimilate scientific knowledge and in what ways those learning processes had an effect on the functioning of their intellect. In so doing, I strove to win recognition for the importance of constructivism as a means of apprehending concept formation processes in the sciences and the relevance of the genetic approach to the development of systems of representation. In particular, the physicist G. Lemeignan and I devised model approaches for the construction of basic concepts in mechanics (force, energy, quantity of movement) based on 'precursors'.[5] These 'precursors' are cognitive constructions (concepts, models, procedures, etc.) generated by the educational context. They constitute the moulds for subsequent cognitive constructions, which, without their help, would be difficult, or impossible.[6] We thus demonstrated that knowledge assimilation procedures could usefully be based on constructivist approaches that allowed pupils a large measure of initiative. We also established that the construction of conceptual systems in physics requires both major changes in cognition and the assimilation of semiotic systems, both of which are long-term processes.[7] Naturally, such facts call in question the organization of physics teaching, which is based essentially on a breakdown into concepts engendered by the structure of the discipline: for what may appear as a basic concept (cell, atom, force, etc.) from the viewpoint of a conceptual system can turn out to be extremely complex from the cognitive point of view and require a long process of development before it is mastered by the individual.

Although I worked for a long time in a laboratory conducting research on the teaching of the sciences, I am not a specialist in teaching methods and have neither the pretension nor the competence to exercise scientific responsibility in that domain, which is for education specialists alone.[8] In other words, although my views are closely connected with teaching methodology for the sciences, they are not directly concerned with that subject.

The constructivism behind science-teaching methods[9]

The methodology of science teaching developed in a context of transformation of the education system, in a niche left vacant by the already established disciplines, since neither educational psychology nor the educational sciences were interested at the time in the transmission processes for particular fields of knowledge.[10] It should be remembered that technology, physics and biology became compulsory subjects for boys and girls at the beginning of the 1970–71 school year in France. In regard to the physical sciences, a group of academics (chaired by Professor Lagarrigue) was then given the task of formulating proposals for curricula founded on research. The LIRESPT (Inter-university research laboratory on the teaching of physical sciences and technology), a research unit linked to the CNRS (National Centre for Scientific Research) and established by G. Delacôte (a physicist of solids at the École Normal Supérieure in the rue d'Ulm), piloted the experiments and their evaluation. For biology curricula, research was centred at the National Institute for Pedagogical Research under V. Host, who led a team of secondary education biology teachers, which included a number of physicists.

On the whole, the scientists who helped to work out teaching methods for the experimental sciences had a constructivist approach to epistemology. Hence it was almost natural for them to come across the work of Piaget[11] and to embrace its arguments. The child physicist who emerges from the research published by the International Centre for Genetic Epistemology is so close to themselves that they will be unable to question that image until later, when confronted with lower secondary pupils for whom physics is not a natural source of pleasure or a superb and desirable intellectual construct. The constructivist theories in the Piagetian tradition serve essentially as intellectual backing for the production of documents and books.

The books designed for French lower secondary classes (age 12), belonging to the 'Libre Parcours' series published by Hachette and drafted by a group of teachers associated with the research and by researchers, provide an excellent example of the attempt to produce school textbooks based on principles derived from constructivism, in particular the importance attached to practical and intellectual activities by pupils. The textbooks for the pupils comprised documents relating to the major themes of the curricula, suggested activities andan encyclopaedic section. There was no detailed table of contents like those found in traditional school textbooks, but an index to help pupils find information in the light of their particular interests and needs. The aim was to train them to search out and structure the information needed to solve the problems encountered. Experimentation, which is used for demonstration purposes in traditional textbooks, here became the starting point for a process of questioning. An illustration of this is shown in Figure 1, where we have placed side by side parts of two approaches to the invariance of quantity in matter extracted from two textbooks for children in the first year of secondary education (one

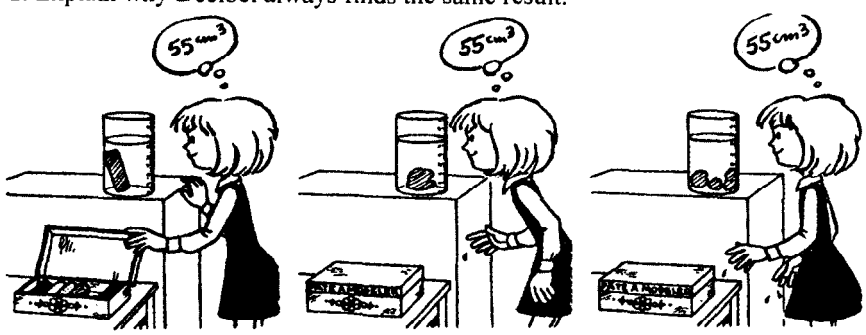
from the 1977 'Libre Parcours' series by Hachette and the other from the 1977 Lacourt-Chirouze series published by Armand Colin, a book that is typical of those in use at the time).

FIGURE 1. Learning about matter in two textbooks for the first year of secondary education (11 years old)

***Source*: 'Libre Parcours' series, Hachette, 1977**

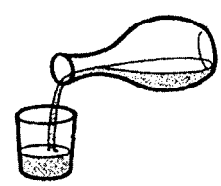
? Explain why ...

2. Explain why Décibel always finds the same result.



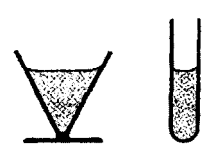
***Source*: Lacourt-Chirouze series, A. Colin, 1997**

1. THE OBJECTS AROUND US
A table, a wall, a stone, a bottle, all have a definite shape that does not change unless they are subjected to very powerful forces. Their volume hardly varies. They are solids.
Solids have a distinct shape and a practically invariable volume.



2. The glass keeps its shape but the water changes shape easily.

2. WATER FLOWS AND CAN BE POURED FROM ONE CONTAINER TO ANOTHER
Water comes out of the tap and takes the shape of the container into which it is poured.
Water has no shape of its own: it is a fluid.



3. What is the shape of the surface of the water?

Experimentation, arousal of curiosity and critical thinking, independent action by the child, the importance of consistency and methodical research, the practical usefulness of knowledge, the evolving nature of models, the comparison of ideas

with experience, scientific debate—these are the main issues at stake in science teaching, which are recognized both by the proponents of discovery methods and by the disciples of epistemological and psychological constructivism.[12]

Even when constructivism is openly displayed, its limitations quickly become clearly apparent. For example, we read in the introduction to the teacher's guide (fourth year of lower secondary education 'Libre Parcours' series in physics, Hachette, 1980, p. 14):

> The systematic use of discovery methods—which remains possible in other fields—is very difficult for the introduction of models. Resorting to a verbal explanation, however, [...] misses its mark[13] if it is not understood by each child and if each child does not fully grasp the scientific problem put to him or her by the teacher explaining the theory. In the end, the decisive factor is to heed the children,[14] which means acting in such a way that each child's questioning converges on the problem and remains focused on that problem in order to reach the solution.

In short, as soon as teaching is given the task of putting across systems of representation, it must work with the children in order to arouse their interest. This amounts to mediation in its social dimension. Such a concern results in the production of books designed for teachers (considerably thicker than those for the pupils) that offer them a great variety of information (theoretical, practical, historical, epistemological, psychological, pedagogical, and so forth) intended to help them to 'heed the children' so that the children will 'converge on the solution'.

In studying the construction of curricula, J.L. Martinand[15] apprehends another limitation of constructivism, namely, its inability to define contents geared to particular socio-economic contexts. The concept of 'social practice of reference' serves to draw attention to the fact that, alongside constraints of a psychogenetic nature, the teaching approach must take into account the social practices that determine the basic pattern of the discipline.

As a matter of fact, constructivism as it is practised by researchers and innovators is simply a preferred framework that serves as a filter for other theoretical approaches. It is legitimized by the production of situations, tools and instruments for the purpose of acting and understanding. In this sense, it appears to satisfy the researchers who base themselves on it and is occasionally misunderstood by those who support a positivist conception of teaching methodology and use questionnaires to collect data in order to identify factual, relational or structural constants.

Constructivism and research issues

Recognizing the importance of cognitive structures conducive to assimilation, educationists have begun to study them. A whole programme of research from 1975 to 1980 focused on the study of the 'concepts' of pupils regarding physical, chemical and biological phenomena.[16] Its ambition was to record pupils' knowledge prior to a systematic course of instruction on scientific models. As is stated by the authors

of a report on the study of representations and interpretations by pupils concerning the concepts of temperature, heat, gas and pressure in the first year of lower secondary education, the aim was 'to provide lower secondary teachers with a wider knowledge of children than could be obtained from their own experience and to give them an opportunity to gear their teaching more closely to the aptitudes and needs of lower secondary pupils'. In short, the project was to provide information considered to be useful to teachers.

From the earliest studies, it became apparent that the concepts used by children often constituted cognitive obstacles, and not potential foundations on which to build, because they were frequently at odds with the scientific models. So it became necessary to understand where those concepts came from, either by studying 'natural' (as opposed to 'scientific') reasoning or by studying teaching practices, with researchers then advancing the hypothesis that certain explanatory approaches might give rise to misconceptions. For example, it was discovered that basing the introduction of the concept of force on personal experience of thrust or forcing out of shape might result in its being seen as transmission rather than interaction. A return to the concept of epistemological obstacle borrowed from Bachelard helps to bring out the difficulties encountered by pupils and to regard the formation of scientific knowledge in terms of a break (and not continuity) in relation to previous knowledge. For example, a substantialist concept of heat constitutes an obstacle to the idea that the energy transferred from one system to another may take different forms (calorific, mechanical, luminous, etc.). The learning processes are thus conceived as deriving from concept transformation processes and not as a process of accumulation (as behaviourist theories would have it) or as a structuring-restructuring process (according to cognitivist theories inspired by the 'information processing' school of thought). How is the change in concept to be triggered? That was the question underlying research in the 1980s. The constructivists took up the idea of a conflict: an inner conflict resulting from inappropriate concepts, especially when the pupil was made to confront his or her predictions with experimental facts that proved them wrong, and an outer social conflict arising from disagreements among pupils as to how the phenomena should be interpreted. This approach should be distinguished from approaches that refer, for instance, to the 'master/pupil' relationship in which the aim is to lead the pupil to use the expert's knowledge to root out misconceptions.

It should be pointed out that the idea of conceptual change that emerged from the observed disparities between the conceptions of pupils (called, depending on the author, 'spontaneous', 'naive' or 'natural') and scientific models has been adopted by the majority of researchers interested in teaching-learning processes in science, whatever their theoretical views. 'Constructivist' writers, however, rather than holding that the change should lead to the replacement of misconceptions by 'true' knowledge, consider that the adoption of new concepts necessitated by the confrontation with new problems is connected with a process of mental accommodation. In brief, it is because the teacher confronts the pupils with highly specific problems quite different from the problems they come up against in their daily lives that the pupils will be induced to assimilate scientific models. Models from everyday life and scien-

tific models do not function in the same way. The two types arise from quite different processes of adaptation to experience. For example, the conception of electricity as a flow of energy that comes from a single source and can be tapped by a wire via an electric plug (the so-called 'unipolar' conception of electric current) is perfectly in keeping with a wide range of practical situations such as plugging in an electric iron, a vacuum cleaner, a fan and so on. On the other hand, if the job is to plan the electrics of a house, a conception of electricity in terms of a circuit is more practical. This boils down to the view that the essence of scientific activity resides in the modelling and problem-solving processes.[17] The study of such processes places the emphasis on the need to deal with situations in terms of the questions posed, on trial and error in seeking the most functional representation bearing in mind the question in hand, and on an awareness of the practical limitations of the models. It also pays particular attention to formalization exercises and to the mastery of mental processes. It is noteworthy, too, that the studies on problem-solving and modelling have helped to highlight the importance of the teacher's role as a mediator:[18] choice and organization of activities and of interactions between pupils, form taken by exchanges, style of tutoring, etc.[19]

One hot topic at the moment is the training of teachers: what are the professional skills needed to make effective use of approaches based on constructivism or socio-constructivism? How are we to ensure that they acquire these skills? In connection with these research issues, mention should be made of the recent thesis by J.M. Boilevin,[20] who has designed and evaluated a training model for upper and lower secondary teachers based on principles drawn from different bodies of theory such as socio-constructivism, interactionism with the emphasis on communication, and the epistemology of science. The reference to these three fields reveals the need to refer to a number of different theoretical frameworks when exploring issues connected with education in the sciences.

Constructivism and teaching

If we now turn to discourse aimed at teachers, we are struck by the omnipresence of constructivist views. Thus Françoise Balibar (1996), member of the French Physics Society, who sits on several committees dealing with the teaching of physics, writes in her preface to a book:[21]

> The uncovering of misconceptions is simply the first and entirely subordinate step in a constructivist approach [...] 'Construction' is the keyword of the book you are going to read. The pupil and the teacher must construct together the knowledge of the pupil by building on concepts the pupil already has in his or her head (and not by blocking them, as one might have feared). It is not a question of correcting misconceptions but of using them and, more particularly, of taking advantage of their own energy to inculcate lines of reasoning.

For their part, A. Dumas Carré and M. Goffard (1998)[22] also affirm, in a book for teacher trainers and teachers of the physical sciences, that

> For a pupil to learn, it is not enough to expound pre-digested information on physics and to ask her to commit it to memory and then activate this knowledge to solve a particular problem. The pupil must be placed in a situation in which she constructs and structures that knowledge for her, through selected activities designed for the purpose that are organized and presented by the teacher. The pupil learns with the knowledge that she already possesses [...] The pupil learns by being active [...] The pupil coming to her first physics lesson has already constructed for herself explanations about how the world works [...]; she is not an 'empty vessel' into which the teacher will pour a pre-digested knowledge of physics (p. 53-54).

These authors stress the need to enable pupils to express their own ways of thinking and to become aware of the limitations of those ways of thinking. These two examples show that the constructivism to which the authors refer is far removed from the constructivism of Piaget. The teacher serves as a guide; he or she is the fount of knowledge. The aim is co-construction (pupil and teacher construct together) and not just construction of the pupil.

More generally, it would seem today that constructivism is fuelling an educational doctrine that, as such, has its limits. Even if it is agreed that the knowledge involved in a construction process has a deep impact on the cognitive system of the individual, it is highly undesirable to minimize the importance of other forms of learning acquired, for example, through observation and imitation or through the study of texts. When, in our research, we have worked on constructivist approaches, the main purpose has been to pin down their implications in regard to both the organization of teaching (situations, problems, forms of study, practical role of the teacher) and the cognitive activities of pupils at the individual and group levels. The purpose was to go beyond constructivism as an end in itself and to give a detailed account of actual practices and their limitations. We have shown that these practices have a high 'cost' in terms of both teacher and pupil investment and that they require a great deal of classroom time and substantial adjustments to the curriculum. It is, therefore, to be feared that, without a thoroughgoing reform of science teaching, the constructivist doctrine will be abandoned as invalid, thus disqualifying its application to psychology or epistemology. This presentation of research into the teaching of science is influenced by the fact that we started out from constructivism and have sought to show how this theoretical current has nourished an emerging field of research and teaching practices. It should be borne in mind that the study of teaching methods in the sciences deals with other questions in addition to those relating to teaching-learning processes. Examples are research into teaching practices for the purpose of defining the skills they require and possible ways of applying them in the classroom, research into curriculum development and discipline-building processes—in technology, for instance—and research focused on relations between disciplines, all of which utilize other approaches. We still have no overall assessment of thirty years of research into science-teaching methodology in France. This contribution should therefore be regarded simply as the first step along a much broader avenue of research.

Notes

1. At the time, such a point of view owed more to intuition than to theory and subsequently enabled me to read Vygotsky and to be supported by a community of researchers in psychology who were defending the thesis of a social construction of the psyche. See: A. Dumas Carré and A. Weil-Barais, eds., *Tutelle et médiation dans l'éducation scientifique* [Tutoring and mediation in science education], Bern, Peter Lang, 1998.
2. Analogical reasoning, hypothetico-deductive reasoning. See: E. Cauzinille-Marmèche, J. Mathieu and A. Weil-Barais, *Les savants en herbe* [Scientists in the making], Bern, Peter Lang, 1983.
3. Approaches that use modelling. See: G. Lemeignan and A. Weil-Barais, *Construire des concepts en physique* [Concept-building in physics], Paris, Hachette, 1993.
4. The LIRESPT (Inter-university research laboratory on the teaching of physical sciences and technology) was founded in 1975 by G. Delacôte and transformed in 1985 into the LIREST (Inter-university research laboratory on scientific and technological education) directed by J.L. Martinand.
5. A term borrowed from Piaget.
6. We have shown that the concept of interaction (action of an object on another object) might be a good 'precursor' candidate for force. Similarly, a functional representation of physical systems—in terms of functions that each subsystem performs in relation to the ensuing system in the functional chain of objects that constitute an assemblage—is, for psychogenesis, a good precursor for the energy model.
7. This has been corroborated in a recent study by J.B. Lopes, N. Costa, A. Weil-Barais and A. Dumas Carré, Evaluation de la maîtrise des concepts de la mécanique chez des étudiants et des professeurs [Evaluation of mastery of mechanical concepts among students and professors], *Didaskalia* (Paris), vol. 14, 1999, p. 11–38.
8. In France, the majority of educationists specializing in science have joined the educational sciences. The others prefer to maintain their connection with specific scientific disciplines.
9. The views expressed in this section are based essentially on a rereading of basic texts: the proceedings, published by the *Revue française de pédagogie,* Paris, vol. 45, 1978, of a round-table held in Paris from 4 to 7 May 1977 on the initiative of G. Vergnaud (psychologist), F. Halwachs (physicist) and A. Rouchier (mathematician), entitled 'Science teaching and psychology; the proceedings', published by the CNRS (National Centre for Scientific Research) in 1984, of the first international workshop on research into the teaching of physics, held at Londe-les-Maures from 26 June to 13 July 1983 on the initiative of the Physics Education Commission of the International Union of Pure and Applied Physics, directed by G. Delacôte, A. Tiberghien and J. Schwartz; the proceedings of the first four days on science education, held at the initiative of J. Mathieu (psychologist). Our views also owe much to the rereading of some general texts: J.J. Dupin and S. Joshua, *La didactique des sciences et des mathématiques* [Science and mathematics teaching methodology], PUF, 1993; J.P. Astolfi and M. Develay, *La didactique des sciences* [Science teaching methodology], 'Que sais-je?' series, PUF, 1989, p. 248; and the Franco-Quebec journal *Didaskalia,* published by the Institut national de la recherche pédagogique (National Institute for Pedagogical Research) in Paris, a journal dealing with research on communication and learning in science and technology.
10. The present situation is now different because of the large number of educationists working in the educational sciences.

11. During my first contacts with the LIRESPT researchers, I was surprised by their familiarity with the works of Piaget. In the laboratory, study sessions were devoted to the critical discussion of works produced by Piaget and his colleagues at the International Centre for Genetic Epistemology, including *Les théories de la causalité* [Theories of causality] (Bunge et al, 1971), *Les explications causales* [Causal explanations] (Piaget and Garcia, 1971), *La direction des mobiles lors de chocs et de poussées* [How mobiles move when hit or pushed] (1972), *La formation de la notion de force* [Formation of the concept of force] (1973), *La composition des forces et le problème des vecteurs* [The composition of forces and the problem of vectors] (1973), *La prise de conscience* [The growth of awareness] (1974), *Recherches sur l'abstraction réfléchissante* [Research on reflective abstraction] (1977), *Psychogenèse et histoire des sciences* [Psychogenesis and history of science] (Piaget and Garcia, 1983).
12. The paper by V. Host, Place des procédures d'apprentissages 'spontanés' dans la formation scientifique [The place of 'spontaneous' learning procedures in scientific education] in *Revue française de pédagogie* (Paris), vol. 45, p. 103–10, 1978, gives a clear-sighted account of the convergence of the points of view.
13. Underlined in the original.
14. Underlined in the original.
15. J.L. Martinand, *Connaître et transformer la matière* [Getting to know and transforming matter], Berne, Peter Lang, 1986.
16. R. Driver, E. Guesne and A. Tiberghien, *Children's ideas in science,* Milton Keynes, United Kingdom, Open University Press, 1985; P.J. Black and A.M. Lucas, *Children's informal ideas in science,* London, Routledge,1993.
17. These two research themes had priority status at the LIREST from 1985 to 1995 and engendered several publications. See in particular: J. Colomb and J.F. Richard, eds., *Résolution de problèmes en mathématiques et en physique* [Problem-solving in mathematics and physics], Paris, INRP, 1987; J.L. Martinand et al., *Enseignement et apprentissage de la modélisation en sciences* [Teaching and learning modelling in science], Paris, INRP, 1992.
18. In the research team we set up on this question, we regarded educational mediation as a strategy aimed at preventing cognitive incompatibilities. The teacher-mediator acts as a negotiator, getting pupils to agree to enter into the spirit of science and helping them to grasp scientific models and recognize differences between forms of thought (intuitive or spontaneous, and rational or considered).
19. See: A. Dumas Carré and A. Weil-Barais, eds., *Tutelle et médiation dans l'éducation scientifique* [Tutoring and mediation in science education], Berne, Peter Lang, 1998.
20. J.M. Boilevin, *Conception et analyse du fonctionnement d'un dispositif de formation initiale d'enseignants de physique-chimie utilisant des savoirs issus de la recherche en didactique: un modèle d'activité et des cadres d'analyse des interactions en classe* [Conception and functional analysis of a system of initial training for teachers of physics and chemistry based on the findings of research in the methodology of teaching: activity model and analytical framework for classroom interactions], thesis in the methodology of teaching, University of Aix-Marseille I, 2000.
21. J. Toussaint, *Didactique appliquée à la physique-chimie* [Teaching methodology applied to physics and chemistry], Paris, Nathan, 1996.
22. A. Dumas Carré and M. Goffard, *Rénover les activités de résolution de problèmes en physique* [New ideas for problem-solving activities in physics], Paris, A. Colin., 1998.

CONSTRUCTION OF KNOWLEDGE AND WRITING PRACTICES

Michel Brossard

Introduction

In the following pages the role of writing in the teaching and learning of scientific subjects will be examined. It is generally agreed that this role is important. The justifications given for the belief remain vague.

Is writing not used solely to help to fix information, clarify it, order it and make it explicit? This instrumental (in the utilitarian sense of the word) function is undeniable. But such an assertion is a product of pure empiricism; it does not fit in with a conception of psychological functioning and cannot, in this form, be part of a didactic approach.

At what point in the teaching and learning of scientific subjects is it desirable to ask students to produce a written text? What contexts should be introduced? What aims should they be given? What results can be expected?

Following the work of Vygotsky and Goody, I put forward the hypothesis that there is a consubstantial link between writing practices and scientific knowledge.

Original language: French

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But this hypothesis needs to be tested, so an initial examination is offered. The study will be based on an example, but first a number of more general epistemological and didactic observations will be made.

A few epistemological observations

The history of science was for a long time based on the classic conception of rational subjects, individual repositories of the faculty of judgement, the innovators being those able to use their reason methodically.

According to this view, the social context—that is, all the social, technical and institutional conditions in which scientific practices are carried out—is a framework external to those practices. It does not affect the hard core of knowledge. Knowledge holds within and by itself its own coherence, its own value of truth, its own logic of development. Scientific knowledge has its own momentum, which transcends the social conditions of its emergence and formation.

A history of 'science is, therefore, possible as a history of ideas, of theoretical problems alone, concepts. The "major genre",' comments D. Pestre.

The writers I shall be referring to (Shapin, Licoppe, Pestre, Bensaude-Vincent, etc.) approach this view from the other direction. Refusing to reduce the history of a field of knowledge to the history of concepts alone, these historians of science return scientific practices to the body of social practices as a whole—instrumental, institutional and discursive practice—without any restriction. The history of science is again part of the history of humanity. The knowledge developed—its content as well as the form of its validation and exposition—is inseparable from the social context in which it is produced.

To take only one example, Licoppe has studied how, during the seventeenth century in France, a community of scientists using experimentation (*experimentum*) came to be formed.

We know that, until that time, one 'argued' in the community of the erudite according to the Aristotelian tradition on the basis of well-established or probable (*experiential*) opinions. The use of specific experimentation conducted on the basis of a hypothesis was in no way one of the accepted procedures, still less, necessary for establishing the truth. Towards the middle of the seventeenth century, an experimental community gradually formed within educated circles through correspondence, lectures and learned societies that, at the same time as it combated Aristotelian theses, succeeded in imposing new procedures for establishing the truth. This was the age in which Mersenne, but above all Petit and Pascal, and later Boyle, taking up Torricelli's work, conducted their famous experiments on atmospheric pressure (Licoppe, 1996; Shapin, 1998).

For Licoppe, writing the history of material practices for producing facts cannot be dissociated from the systems of civility through which the credibility of experiments was established. In the correspondence, people tell each other where the tubes can be obtained, how long and thick they should be; they explain how to handle them, etc.

On the basis of the various treatises on the void written by Pascal between 1647 and 1654, Licoppe shows:

- How the producer of evidence uses procedures likely to receive approval, and at the same time defines a potential readership through the text he produces;
- How in return the readers of the treatises, by putting into operation the rhetorical forms of the texts, construct themselves as a community of critical readers and at the same time ratify the evidential procedures used by the author of the treatises. Thus, a phenomenal reality and forms of rationality are simultaneously constructed. This is a dual construction, each consolidating the other.

Let me make it quite clear that such a conception should in no way be understood as an example of sociologizing reductionism, which would lead to a conventionalist attitude, one which would consist of saying: 'What is real is what a social group agrees to consider real'.

While the activities by which a researcher endeavours to know about an area of reality are not the expression of refined reason, nor are such socially rooted research activities the work of subjectivity. What makes a social agent a researcher is precisely his or her training within a community of researchers. As Bachelard put it, it is 'educated subjectivity': educated by the critical community to which the researcher belongs, educated by the knowledge he or she has inherited and is revising, and educated by the techniques he or she uses. These, in Chartier's words, 'onerous and demanding' operations[1] do not result in communities of researchers developing simple conventions, but constructing knowledge that has an objective value.

Placing knowledge activities in the social context leads to three important conclusions:

- Contrary to classical rationalism or any logical conception of knowledge, there is not 'one' but various historically constructed forms of rationality.
- These forms are initially developed in an inter-subjective configuration for the precise reason that they are the result of the construction of a phenomenal world within a communicative space, the individual functioning of a researcher (subject) being possible only after a process of internalization (internal reconstruction of an initially communicative context) of these forms of rationality. Thus, the law invoked by Vygotsky according to which complex human activities develop in two phases (first at an inter-psychological level, then at an intra-psychological level) would be valid not only at the ontogenetic level, but also at the historical level of the production of knowledge and, therefore, of forms of rationality.
- Knowledge is shot through with intentions and communicative activities that circulate in the field in which knowledge is produced. The belief in a hard core unaffected by social context is, as we have seen, abandoned. Saying this has consequences at the didactic level: if an adequate knowledge of a scientific text requires that the social context in which it was produced be taken into account (anticipated objections, the needs and questions to which a response has been

sought), learners cannot correctly appropriate a field of knowledge if they are totally ignorant about the social—i.e. communicative—context in which that knowledge was produced.

The didactic implications of this viewpoint

Let us take as an example the explanatory text.

On the basis of the concept of 'complex human activity' (Vygotsky, 1935/1994), we are led to distance ourselves from purely formal approaches to texts. We cannot dissociate the instruments from their functions. Someone who provides an explanation provides it in relation to a content, on the basis of a 'why' that arises in a field of knowledge or beliefs, when certain phenomena appear to be contradictory to one of the interlocutors or to a whole community. In short, one explains something to someone for practical or theoretical reasons (or both). This is why the speaker must simultaneously take into account two series of constraints: those that are peculiar to the content, and those that belong to the communicative context.

In the case of the production of the explanatory text, the speaker's starting point is a group of apparently irreconcilable facts. By taking into consideration and as the starting point his or her interlocutor's state of knowledge, he or she must construct a new object, by including in a new viewpoint these apparently incompatible aspects of reality and support it with arguments (Grize, 1984). From a didactic point of view, this in no way means that there are no didactic sequences devoted to work on the text for its own sake. But these sequences are a phase in the performance of a task with a social purpose. By thinking about the problems created by the production of the text, the students do not lose sight of the textual function performed by certain instruments (connectors, for example).

I tried earlier to describe scientific communities. We now turn to the classroom community and try to characterize it as a sphere of specific activities:

- New questions emerge that, for the most part, children do not ask in the sphere of daily exchanges.
- The teacher introduces new concepts developed in the sphere of academic activities. The students must appropriate these concepts by acts of thought that enable them to master an area of reality.
- New forms of activity are inaugurated in class: it is no longer sufficient to state or believe, as in the sphere of daily activities but, within the classroom community, one must argue, prove, demonstrate. In short, new forms of rationality ('cognitive practices') emerge for the students.

The work required of the students has a dual aspect. In one very real sense they must break away from the sphere of daily activities (usually expressed by the concept of decontextualization), but they must also—and as part of the same process—enter the new sphere of activities and this involves:

- A change in the speaker's position: the student no longer speaks as a particular individual, the member of a family or peer group, but as a legitimate speaker in a community of critical listeners;

- A work of construction with the aid only of the language of a new context, which, unlike the situational context, is not present;
- The students have to learn to put into practice new instruments of thought: concepts and developed procedures, graphic techniques (tables, diagrams, etc.).

By using the concept of 'recontextualization' advanced by certain authors (Mercer, 1992) that we have taken up (Brossard, 1997; Bernié, 1998; Jaubert, 2000), we endeavour to explain the work that takes place in a classroom during the teaching and learning of scientific knowledge.[2]

At the end of this discussion, I formulate the following hypothesis: the production in writing of an explanation facilitates the work required of students, work to which we have referred as 'recontextualization'. The fact of consciously and voluntarily using language, and the need to reconstruct the context with the aid of linguistic means alone—activities required by the written use of language—facilitate the process of construction of knowledge. According to this hypothesis, the usual relationship between the construction of knowledge and the practice of writing is reversed. Usually, the science teacher uses writing as a means of checking what knowledge students are able to display (the dreaded written test). Here, on the contrary, writing is an activity integrated into the very process of the construction of knowledge.

Illustration from didactic research in French

Martine Jaubert's research was conducted in a 'second year intermediate' primary school class (fifth year of formal education). It was conducted by science teachers and French teachers.[3]

The subject of the research was the construction of knowledge in the field of biology and, more specifically, the question: how and on what does a baby live inside its mother?

Three types of data were collected:

- The interactions between teacher and pupil during the learning period (about six weeks);
- The texts the pupils produced at various points in the teaching and learning period;
- The knowledge they constructed as assessed by the science teachers.

In the first phase, the teacher constructed with the pupils the classroom context connected with 'science teaching'. What they had already learned was reviewed. There was work on breathing and the exchanges between lungs and heart.

In the second phase, the teacher raised a new question: How does a baby live inside its mother? During this phase the students were invited to say what they knew and what they thought about such a question. The phase ended with the production of a text in which the pupils were invited to write down for the rest of the class how they explained the baby's life inside its mother.

Two types of spontaneous representations predominated in these initial texts:

- An autarkic representation: the baby develops of itself in its mother according to an internal growth principle;
- A representation mentioning tubes: for example, a tube that goes directly from the mother's oesophagus or stomach into the baby's mouth transmits food.

In the third phase, these texts were used as a basis for class discussion and debates carefully controlled by the teacher. Several new elements emerged:

- Some previously learned information was recalled;
- New information was brought in: observations about documents, texts, etc.;
- At the appropriate time, the teacher introduced a number of scientific concepts: the placenta; the role of blood, exchanges, CO_2, O_2, nutriments, capillaries, etc.;
- Forms of reasoning were encouraged: it was no longer enough to say, believe or state; a solution had to be suggested to a problem by putting forward reasoned arguments or observed facts.

Gradually, the classroom community was transformed: from being a motley group of individuals expressing opinions, it became a community of learners who had to put forward valid knowledge and were developing, as a community, a critical point of view about the statements put forward.

During the fourth phase, the students were asked to produce a final piece of writing that would be used as the basis for the production of an 'official' text, that is, one written to explain the phenomenon in question to another class.

The texts were analysed according to the students' ability to construct the relevant context of the scientific explanation and to make the main concepts work within it. In some texts, tensions were brought out between dialogue typical of everyday exchanges and self-generated forms typical of 'explanations in the classroom context'. It was from this viewpoint that the concept of coherence was particularly examined.

Through the texts and the discussions about them, certain states of knowledge were 'stabilized' and points identified on which further study was needed.

This research, which I believe to be essential, opens up new avenues. Does it, though, answer the question asked in the introduction about the role of writing practices in the construction of knowledge?

Up to now we have been talking about productions. These productions may be either oral or written. The specific role of writing (if, indeed, it has one) has not, however, been demonstrated.

Furthermore, the acquisition of scientific knowledge in the classroom essentially means appropriating scientific concepts. What is at the heart of the question is the particular activity of conceptualisation expected of students. I do not believe that one can ensure that this type of work has been, or is being, done by the analysis of linguistic productions alone.

In order to try to answer this question (and to close this text), I now turn to a number of Vygotsky's texts in which he helps us to think about the problem of appropriation of scientific concepts in the classroom.

Back to the question

SPONTANEOUS CONCEPTS, SCIENTIFIC CONCEPTS

In the example examined above, the teacher found it appropriate to introduce scientific concepts in a context of interaction, confrontation and even controversy.

Such concepts are not simply an extension of students' spontaneous concepts; they are 'imported' by the teacher, whose main concern is to choose the appropriate point at which to introduce them: the point at which they have the best chance of appearing to the students to provide an enlightening answer and one more powerful than the contradictions and obscurities encountered up to then, so that they are able to find the meaning and carry out for themselves the thought processes developed by their predecessors.

How, then, can the following two contradictory statements be reconciled?

- Students must appropriate already developed scientific concepts, far from their everyday concepts. In most cases, there is probably no gradual progression between the two.
- In order for this to be a genuine appropriation—and not 'routine assimilation of new information'—the work of conceptualization must be done on the basis of the students' spontaneous concepts (Vygotsky, 1934/1994).

In order to try to resolve this contradiction, I shall give an answer in two stages. In the first stage, I shall, following Vygotsky, examine what happens during the teaching and learning process. In the second stage, I shall examine what should be understood by the term 'subterranean development of concepts'.

First stage: What happens during the teaching and learning process

The teaching and learning process is in no sense the transmission to students of concepts defined only verbally. The concept of the 'zone of proximal development' must be given its full weight.

The children are invited to think in spheres in which they are not used to operating. They do not do this alone: the teacher questions them, asks them to provide explanations and guides them in their research. What the children are unable to do alone, they can do with the teacher's help. Vygotsky talks of 'collaborative activity'. In reply to our question, we can therefore talk of a collective *conceptualization* activity. Vygotsky wrote:

> When working with students on a topic, the teacher has explained, transmitted knowledge, asked questions, corrected and made the students explain themselves. *All this work on concepts, the whole process of forming them, has been carried out in detail by the children in collaboration with the adult in a learning process.* (Vygotsky, 1934/1985, p. 281. My italics.)

Application by students on their own in a certain number of situations is the final link in the teaching and learning process. This statement needs to be illustrated by an example.

In an article published in 1994, Annick Weil-Barais provides an excellent illustration. The students had to appropriate the concept of physical force. More specifically, they had to go from the spontaneous concept of force conceived of as an inherent quality of a body to a physical concept in terms of system, the state of a system and interaction.

The teacher set up a spring mechanism and asked the students to make predictions. The predictions made on the basis of the spontaneous concept of force were shown to be false, making the students move to a new conception in which it was a question of balance or imbalance within a system.

How does this example help us? According to Vygotsky's hypotheses, 'academic' concepts are acquired on the basis of spontaneous concepts. They are not substituted for such concepts, nor are they simple extensions thereof. The students' new conceptions are the result of a critical development by them, exactly in Bachelard's sense when he says that an academic concept is the sum of the corrections to which it has been subjected.

But nor is this movement of negation and extension a self-generated movement independent of the learning process. It is the teacher who sets up a mechanism according to the scientific knowledge towards which he or she wishes to lead the students. This movement is, therefore, channelled, directed, according to the developed knowledge the teacher wants to teach.

Annick Weil-Barais makes it clear that, in her research, what the students have constructed are not yet academic concepts, but their precursors. They make new constructions possible (Weil-Barais, 1994).

I believe that it is in this sense that it is possible to resolve in this first stage Vygotskian aporia and think in constructivist terms within socio-historical theory. But this is only the first stage—the teaching and learning process. The work of conceptualization continues underground.

Second stage: The subterranean development of concepts

One of Vygotsky's central theses in *Thinking and language* is that, during development and according to situations and tasks, there is a varying relationship between the content of thought (the semantic pole), linguistic forms and the relationship with the world. The type of relationship (degree of differentiation, dominance of one of the poles) established among the three poles is what he calls *meaning*. Thus, inner speech is characterized by a predominance of semantic contents and a contraction of linguistic material.

Throughout *Thinking and language*, Vygotsky explores several modes of existence of meaning: complex groups, spontaneous concepts, academic concepts, inner speech, poetic expression, etc. What are the modes of existence of meanings in the case of spontaneous concepts and scientific concepts?

SPONTANEOUS CONCEPTS

Involved in the thousand and one actions of everyday life, the child knows how to apply the meaning of the word 'brother', but at no time needs to think about the act he or she performs when applying this meaning.

When, during a family discussion, he or she uses the word 'brother', his or her attention is entirely devoted to the situation, the pragmatic target of the action undertaken. The adult, as we know, puts the child in a difficult position by asking for a definition of the word 'brother'.

Spontaneous concepts refer to immediate experience. They are, Vygotsky says, brimming with practical experience. They, therefore, have little generality and are not part of a system of relationships. Thus, in the case of spontaneous concepts, the type of existence of meaning is that of a strong fusion of the semantic pole, the phonetic forms used (an initial dissociation takes place when the child starts to learn to write) and the world of experience.

SCIENTIFIC CONCEPTS

Academic concepts do not refer to the experiential world, as do everyday concepts. They are defined by the place and relations they maintain with the other elements of the system. The relationship with the world is mediate, rather than immediate. Thinking about the semantic content—the objects conceived and their relationship with other objects—is work that is constantly controlled, in other words, it is performed with maximum awareness and voluntary control.

In the case of scientific thought, the semantic contents achieve maximum autonomy with respect to particular linguistic forms. Those who have mastered the contents of a piece of knowledge free themselves from the literal forms in which that knowledge was offered to them. They may perform the same intellectual operations, each time producing different formulations, just as they may produce an explanation, each time taking a different element of the conceptual system as a starting point.[4]

The above in no way means that, in scientific thinking, words are of little importance. The reverse is the case: The choice of signifier is of extreme importance (Vygotsky discusses this at length in *The historical meaning of the crisis in psychology*). The choice of signifier refers very precisely to a particular type of content and a particular set of operations. *Unlike what happens for spontaneous concepts, linking a semantic content and a phonetic form is conscious, deliberately performed* (Vygotsky, 1980).

While in the case of spontaneous concepts, the three poles—*semantic contents, linguistic forms and relationship with the world*—are intimately linked, in the case of scientific thinking there is maximum differentiation and conscious and deliberate movement among these three poles.

Through formulations and reformulations, the teacher, therefore, has to see that the students' thinking activities are not too distant, and are situated in the right direction with respect to the way the concepts function in the scientific community. In order to ensure this, it is not enough to produce a text. The teacher must use, and

use effectively, various activities—critical conversations, counter-suggestions, requests to reformulate—which demonstrate the ability to go through the same field of knowledge from different points of entry.

We know that Vygotsky introduced the idea—still unexplored by didacticians—of a two-way conceptualization process: from the bottom upward, and from the top downward.

Spontaneous concepts are, as we have seen, the basis on which scientific concepts will be appropriated. They will also enable scientific concepts to acquire content, the weakness of the latter being their great generality.

Spontaneous concepts will, in return, be redirected by scientific concepts. In our example, the scientific concept of 'exchange' might be used as a window and help students better understand a whole range of biological phenomena.

This internal process of conceptualisation—made of many tensions and interactions among the different levels of thinking—may last several years, or even a lifetime. It is with this thesis that Vygotsky supports theoretically his statement that learning anticipates, causes and redirects development.

Conclusion

Let us try to recapitulate the main phases through which the process I have tried to describe passes.

There are four:

- Scientific concepts exist outside the child's thinking (in the scientific community). It is on the basis of his or her own spontaneous conceptions, and therefore at the price of interpretation, that the child succeeds in giving meaning to the scientific concepts the teacher tries to introduce into classroom learning situations.
- The student is invited to solve a number of problems, provide explanations and with the teacher's assistance succeeds in applying, and using scientific concepts in a way acceptable to the latter.
- During a subsequent phase, the child succeeds in applying scientific concepts to a limited number of problems and situations (usually classroom situations) without assistance. He or she assesses their efficacy and relevance. But the concepts are still poorly assimilated. There is still a wide gap between them and spontaneous concepts. Faced with some phenomena, the child may oscillate among several explanatory registers.
- In the fourth phase, what Vygotsky calls 'the subterranean development of concepts' begins. The subterranean cognitive work in the child is characterized by a swarm of scientific concepts that develop 'rhizomes' in the flesh of spontaneous concepts (a thousand and one ways can be imagined; this work escapes the teacher's vigilance).

We may now be in a position to answer the question posed at the beginning of this article: why and under what conditions can the production by students of a written explanation facilitate the process of appropriation of knowledge?

In reply to this question and in order to support my hypothesis, I give three reasons:

- The production of a written text in the classroom context forces students to construct a new context (that of a critical community with specific intellectual operations) and become speakers in this context (this is what was described as 'recontextualization').
- The production of a written text forces students to reconstruct alone, with the aid of linguistic means alone, the context peculiar to these new activities; at the same time, this leads them to apply by and for themselves the knowledge concerning the context. This should, therefore, facilitate the transition from collective conceptualization (with the teacher's assistance) to an appropriation of concepts by themselves.
- As we know, the practice of writing presupposes a conscious, deliberate use of language (maximum differentiation between the semantic pole and the pole of linguistic forms). We have also seen that the manipulation of scientific concepts involves such conscious, deliberate activity focused on the semantic pole.

We may, therefore, suppose that, while a scientific explanation is being produced in writing, mutual reinforcement is taking place: writing facilitates the distancing and grasp of thought contents, and the distancing and grasp of thought contents facilitates the writing. However, the moment when production of a written scientific explanation will be likely to play an optimal facilitating role remains to be chosen.

Notes

1. In his last book, *Au bord de la falaise* [On the edge of the cliff], Roger Chartier conducts an epistemological examination of historical knowledge. He challenges a 'subjectivist' conception of historians' work. It is true that historians never do anything other than reconstruct a past historical period. Nevertheless, the degree of rigour with which they carry out 'the onerous and demanding operations of compiling a corpus of documents, checking data and hypotheses, constructing an interpretation' results in the construction of more or less 'objective [knowledge] of the period studied' (Chartier, 1998, p. 118).
2. Experience shows that it is difficult to think simultaneously about both aspects. The researchers (psychologists and didacticians) who have emphasized conceptualization have generally neglected the context. Conversely, the writers who have worked on the context have left the problem of conceptualization to one side.
3. See Martine Jaubert's thesis (2000) *Fonctions et fonctionnement du langage dans la construction des connaissances scientifiques* [Functions and functioning of language in the construction of scientific knowledge], 1997-2000, Université Victor Segalen, Bordeaux II.
4. Because of the maximum autonomy achieved by semantic contents, there is a delineation of knowledge. In this sense, by highlighting and focusing on the semantic pole, scientific thought approaches external language. But, in an entirely different sense: in internal speech, the meanings in a sense live 'their own lives'. In scientific thought, on the contrary, there is maximum voluntary, regulated control.

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PIAGET'S CONSTRUCTIVISM AND CHILDHOOD EDUCATION IN JAPAN

Yasuhiko Kato and Constance Kamii

Introduction

Japan came in contact with Piaget's theory for the first time in 1927, when Professor Kanji Hatano held *La representation du monde chez l'enfant* [The child's conception of the world] (Piaget, 1929) in his hands. Hatano, the foremost Piaget scholar in Japan, was then a student at Tokyo University. According to Akira Nakagaki (1990), some Japanese educators at that time valued children's freedom and individuality and viewed their thinking as being different from adults'. However, no

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one was clear about how children thought differently from adults, and Piaget provided concrete and vivid descriptions in *La representation du monde chez l'enfant.*

In 1931, Hatano published *Jidohshinrigaku* [Child psychology] (Hatano, 1931), in which he introduced Piaget's theory to Japanese readers. In this book, Hatano discussed *Le langage et la pensée chez l'enfant* [The language and thought of the child] (Piaget, 1926), *Le jugement et le raisonnement chez l'enfant* [Judgement and reasoning in the child] (Piaget, 1928), *La représentation du monde chez l'enfant* [The child's representation of the world], and *La causalité physique chez l'enfant* [The child's conception of physical causality] (Piaget, 1930). He also introduced *Le judgement moral chez l'enfant* [The moral judgement of the child] (Piaget, 1932) in a subsequent volume. Piaget's research caught the attention of Japanese psychologists, and educators in the 1930s were greatly influenced by these publications.

In the 1950s, after the Second World War, translations of Piaget's books began to appear under Hatano's leadership as well as Shigeru Ohtomo's, and twenty-five books had been translated by the 1970s. Many replication studies were undertaken in the meantime, and other research inspired by Piaget's work became popular. However, these activities took place within the framework of child psychology, and Piaget was not recognized as an epistemologist. His popularity and influence declined in the 1980s, and the only scholar still conducting research today within Piaget's paradigm is Akira Nakagaki, of the National Institute of Educational Research.

Why did Piaget's theory lose its enormous popularity? There are two reasons. First, Japanese psychologists viewed Piaget as 'Mr. Stages' and his theory only as a stage theory of child development. These researchers never noticed that Piaget's theory is an epistemological theory about the nature and development of human knowledge, and that its essence is constructivism. Japanese researchers focused on minor findings related to Piaget's stages and became critical of them. Following the fashion from the United States, Japanese psychologists began to leave Piaget's theory alone.

Second, many educators in Japan were highly impressed by Piaget's insights, but there was no one who could correct the misinterpretations of this theory. One early childhood educator in particular used Piaget's research tools as educational materials and sold these materials as well as his kindergarten programme as being based on Piaget's theory. This commercial enterprise is still flourishing today. Other people harshly criticized Piaget as having overlooked the importance of social factors in children's development. There was no one in Japan knowledgeable and influential enough to correct these misunderstandings. Unable to draw pedagogical implications from Piaget's stages, the Japanese educators who had been profoundly touched by Piaget's insights were forced to leave them alone.

Piaget's constructivism and elementary education in Japan

In general, Piaget's constructivism cannot be said to have had any direct influence on elementary education in Japan. The Japanese system of education is highly centralized, and Japanese society is competitive with a tradition of filling prestigious jobs with grad-

uates of certain universities. Every teacher, official and parent is therefore influence by the pressure of entrance examinations. Reinforced by the profound respect the Japanese feel for knowledge and know-how, Japanese educators are encouraged to follow the tradition of getting children to learn through repetition and memorization.

TOHYAMA'S WORK IN MATHEMATICS EDUCATION

The preceding statements do not imply that no one in Japan made major efforts to counteract the empiricist education that many teachers knew to be basically flawed, especially in mathematics education. The scholar who first recognized Piaget's insights and originality in *La genèse du nombre chez l'enfant* [The child's conception of number] (Piaget & Szeminska, 1952) was Hiraku Tohyama. He was already a famous mathematics educator and became convinced that the child's thinking and stages of development revealed by Piaget would help teachers in reforming arithmetic education in a fundamental way. With this conviction, he translated *La genèse du nombre* and published it in 1962.

Tohyama had been working with elementary school teachers in a new organization called the Association of Mathematical Instruction (AMI), which was founded in 1951. This is an organization mostly of teachers at the preschool, elementary, middle and high school levels, as well as professors and researchers in universities. Applying Piaget's insights, Tohyama worked with classroom teachers who agreed about the importance of children's thinking and wanted to get away from memorization and repetition.

Tohyama conceptualized a new theory of teaching arithmetic called 'Suidoh' and invented a new material called 'tiles'. Tiles are like Dienes' base-ten blocks (Dienes & Golding, 1971) but are made of cardboard. A 1 cm x 1 cm square tile represents one. A 1 cm x 10 cm rectangular tile represents 10, and a 10 cm x 10 cm square tile represents 100. These tiles are still being used in the primary grades today, and every first grader is required to have a set of tiles.

Tohyama (1969) made the following statements about these tiles:

> One of the most important contents of arithmetic education is the principle involved in place value. Our problem is how to enable children to understand the principle involved in making bundles of ten. [...] One stick for one, ten sticks bundled together with a string for ten, and 100 sticks work well but are cumbersome. Tiles were designed to overcome this shortcoming. [...] When children use these tiles, it is possible for them to master the structure of the base-ten system (p. 216–18).

Many teachers enthusiastically received Tohyama's ideas in the 1960s and 1970s and tested them in their classrooms. However, Tohyama did not succeed in going beyond his empiricist misinterpretation of Piaget's theory. He praised Piaget, but his 'Suidoh' theory as well as his tiles were in contradiction with Piaget's theory about logico-mathematical knowledge (which we will explain shortly). After Tohyama's death, his followers continued some activities of the Association of

Mathematics Instruction. However, no teacher today is trying to go beyond Tohyama by studying Piaget's constructivism.

RECENT DEVELOPMENTS IN MATHEMATICS EDUCATION

We do not wish to give the impression that nothing resembling constructivist education is now taking place in Japanese elementary schools. As can be seen in the Third International Mathematics and Science Study (NCTM, 1997) and Stigler and Hiebert (1999), teachers in Japanese schools take their profession seriously and engage in on-going professional development for years. Many of them have drastically changed their approach to mathematics education. Instead of showing children what to do, they now present children with problems and ask them to solve the problems in their own ways. The teacher circulates around the room noting how individual children are reasoning and responds to students' questions without telling them what to do. When the children have had sufficient time to solve the day's problem, the teacher conducts a whole-class discussion in which students present and defend their procedures for solving the problem.

This way of 'teaching' without teaching in the traditional sense is very similar to the constructivist approach based on Piaget's constructivism developed in the United States by Kamii (1985, 1989, 1994, 2000). This Japanese approach is the exact opposite of traditional, empiricist teaching in which the teacher shows students how to solve a problem and gives similar problems for children to practice the newly taught procedure.

It is hard to trace the origins of this new Japanese approach, but it probably grew out of teachers' organized, on-going exchanges of ideas, especially 'lesson study' (Stigler & Hiebert, 1999). In 'lesson study', teachers meet regularly over long periods of time to work on improving their teaching. They plan and implement lessons, and as many as thirty teachers may observe a lesson before meeting together for a seminar. These seminars last about two hours and involve in-depth, critical exchanges about objectives, materials, organization, pacing, appropriateness of the teacher's interventions, etc. Our description of 'lesson study' is far too brief, but we hope the reader will get the idea that Japanese teachers get together on an on-going basis for years to improve what they do in the classroom.

Teachers evaluate their own teaching by observing how children are reacting from moment to moment. Many Japanese teachers have known for years that the traditional way of teaching mathematics was not working, and their collective intuition seems to have led them to a revolutionary, better approach that resembles constructivist teaching. In the United States, the term 'constructivism' has become fashionable, and many teachers are following the so-called 'Japanese way of teaching' described above. These American teachers claim to be constructivist, but they do not know Piaget's constructivism, which is a scientific theory based on sixty years of empirical research.

We have no statistics to be able to say how widely the so-called 'Japanese way of teaching' is being practised in Japan. However, our first-hand observation leads us to believe that the great majority of teachers are continuing in the traditional way by following a textbook and workbook.

Piaget's constructivism and early childhood education in Japan

Early childhood education in Japan takes place mostly in private institutions, and kindergarten is rarely attached to a public, elementary school. There are many public day-care facilities, and these facilities are controlled by the Department of Welfare rather than by the Ministry of Education. It is, therefore, not surprising that while most preschool programmes emphasize children's play, many focus on specific skills that appeal to parents.

In August, 1980, just before Piaget's death and when his theory was on the wane in Japan, 'Piaget for early education' (Kamii & DeVries, 1977) was translated into Japanese and published as a book. To mark this event, Kamii (the second author of this article) was invited to Japan to give lectures in several cities about the contribution of Piaget's theory to early childhood education.

As a third-generation Japanese-American who had been working under Piaget for almost fifteen years, Kamii focused on two points in her lectures. First, she pointed out the unimportance of Piaget's stages and the fact that his stages are important only insofar as they support constructivism. She also pointed out that Piaget was an epistemologist interested in explaining the nature and development of human knowledge. Mathematics, physics and so on should be taught differently, she argued, based on the three kinds of knowledge Piaget distinguished. (These will be explained shortly.)

The second point Kamii made was that, for Piaget (1973), the aim of education was autonomy. Autonomy in the Piagetian sense will be clarified shortly, but suffice it to say here that no one else in Japan (or anywhere else) had pointed out this important aspect of Piaget's theory that changes almost everything a teacher does from one moment to the next.

In the audience of the lecture Kamii gave at Hiroshima University was Yasuhiko Kato, the first author of this article. Kato had been looking for a long time for a scientifically based theory of education to replace the traditional pedagogical theories based on opinions. (These opinions are commonly called 'philosophies'.) Not only researchers but also teachers and teacher educators were deeply touched by Kamii's arguments.

Kato and his colleagues immediately organized a trip to Chicago for thirty-five teachers and child-care leaders to visit Kamii to learn more about Piaget's constructivism. In 1981, they founded the Association for the Study of Constructivism consisting mostly of early childhood educators. Since then, this organization has been inviting Kamii every summer to learn more about Piaget's constructivism, to develop the curriculum, and to evaluate classroom activities.

The Association has grown during the past twenty years into a network of five organizations totalling about 500 members widely scattered around five cities—Fukuyama, Okayama, Kobe, Nagoya and Kanazawa. These organizations collaborate and now engage in the following kinds of activities.

AN ANNUAL THREE-DAY COURSE GIVEN BY KAMII AND KATO

Every summer, approximately 100 members get together over an extended weekend to discuss Piaget's theory in relation to videotaped Piagetian tasks and classroom activities. The first half of the course is reserved for those who have never taken it before, and the second half is open to those who want to come again. Since everybody from widely scattered areas stays in one building, the discussions are intense and last late into the night.

AN ANNUAL CONFERENCE SPONSORED JOINTLY BY THE FIVE ORGANIZATIONS

The five organizations jointly sponsor an annual conference in two cities. These conferences are attended by about 400 people including parents, early childhood educators, students and researchers who are unfamiliar with Piaget's theory. The conference includes a plenary lecture and many workshops in which videotaped classroom activities are presented and critically evaluated by the presenter and the audience. People attending these workshops for the first time comment that our criteria of evaluation are different from their traditional, empiricist criteria. They can see that we evaluate the teacher's interventions in light of children's process of thinking that eventually leads to autonomy.

WORKSHOPS CONDUCTED BY EACH OF THE FIVE ORGANIZATIONS

Throughout the year, each of the five organizations invites Kato and conducts a workshop every other month. (In 1993/94, Kato spent a year of study under Kamii at the University of Alabama at Birmingham as a visiting scholar.)

THE STUDY OF PIAGET'S TASKS

Whenever possible, members get together with Kamii to learn how to interview children with Piaget's tasks. In the seminars that follow, members discuss how the findings are related to children's process of constructing knowledge, and what their implications are for the classroom.

THE PUBLICATIONS OF TEACHERS' REPORTS AND OTHER REFERENCES

Eleven publications have come out so far relating theory to practice on topics such as group games, physical-knowledge activities, number, reading and writing, and moral development and the teaching of behaviours expected

by convention. The Association has also supported the translation of many of Kamii's publications (Kamii & DeVries, 1978, 1980; Kamii, 1982, 1984, 1985).

The reader must be wondering how early childhood education based on Piaget's constructivism is different from traditional, empiricist practices. This is the topic to which we now turn.

Early childhood education based on Piaget's constructivism

Traditional educators all over the world have assumed that 'to teach' is to put knowledge and moral values into the child's head, and 'to learn' means to internalize what is transmitted from the outside. As a result, teachers have valued obedience rather than children's interest and initiative, and they have used reward and punishment rather than children's exchanges of ideas to foster 'good' behaviour. In the following discussion, we begin with autonomy, the aim of education for Piaget (1948) to show that our goals are different from those of traditional education.

AUTONOMY AS THE AIM OF EDUCATION

In common parlance, autonomy means the right to make decisions. When we speak of Palestinian autonomy, we are referring to this kind of right. In Piaget's theory, however, autonomy refers to the ability to make decisions, about right and wrong in the moral realm and about what is true and untrue in the intellectual realm, by taking relevant factors into account, independently of reward and punishment. The opposite of autonomy is heteronomy. Heteronymous people are governed by someone else because they are unable to think for themselves.

Moral autonomy. An unusual example of moral autonomy is Martin Luther King's struggle for African Americans' civil rights. King was autonomous enough to take relevant factors into account and concluded that the laws discriminating against African Americans were unjust and immoral. Convinced of the need to make justice a reality, he fought to end the discriminatory laws in spite of the jails, police dogs, fire hoses and threats of assassination used to stop his efforts. Morally autonomous people are not governed by reward and punishment.

An example of moral heteronomy is the people in the cigarette industry who covered up the evidence about the harmful effects of smoking. These people did what they knew to be morally wrong because they expected to be rewarded for helping in the cover-up.

The moral judgment of the child (Piaget, 1932) gave more commonplace examples of autonomy and heteronomy. He interviewed children between the ages of 6 and 14 and asked them, for example, why it is bad to tell lies. Young, heteronymous children replied, 'Because you get punished when you tell lies'. Piaget asked, 'Would it be O.K. to tell lies if you were not punished for them'? Young children answered, 'Yes'. These children were governed by others to judge between right and wrong.

All young children are heteronymous. Ideally, they become increasingly autonomous as they grow older. As they become more able to govern themselves, they are governed less by other people. However, most human beings do not develop in this ideal way. Most people stop developing at a low level and do not have the moral courage of a Martin Luther King.

The important question for parents and teachers is: What causes certain children to become more autonomous than others? Piaget's answer was that adults reinforce children's natural heteronomy when they use rewards and punishments, thereby hindering the development of autonomy. By refraining from using rewards and punishments, and by exchanging viewpoints with children instead, we can foster the development of autonomy from the inside, he said.

For example, if a child tells a lie, an adult can punish the child by saying, 'No dessert tonight'. Alternatively, the adult can look the child straight in the eye with affection and scepticism and say: 'I really can't believe what you are saying because (state the reason). And when you tell me something next time, I am not sure I'll be able to believe you. I want you to go to your room (or seat) and think about what you might do next time to be believed'. When they are confronted with this kind of exchange of viewpoints, children are likely, over time, to come to the conclusion that it is best for people to deal honestly with each other. In other words, the adult tries to motivate the child from within to construct the value of honesty.

In general, punishment leads to three possible outcomes. The first one is a weighing of risks. Children who are punished will learn to calculate their chances of getting caught the next time and the price they might have to pay if they are caught. The second outcome is, interestingly, the opposite of the first one, namely, blind obedience. Sensitive children will do anything to avoid being punished. The third outcome derives from the second: revolt. Many 'model' children surprise everyone by beginning to cut classes, take drugs and engage in other acts that characterize delinquency. These children have decided that they are tired of living for their parents and teachers and that the time has come for them to start living for themselves.

Many behaviourists and others believe that punishment is bad because it is negative but that rewards are positive and good. However, rewards do not make children any more autonomous than punishment. Children who help their parents only to get money and those who fill out worksheets only to get a good grade are manipulated by someone else, just as much as those who behave well only to avoid being punished.

Traditional education gives ready-made rules to children and uses rewards and punishments to get children to internalise these rules. It is much better for children's construction of autonomy not to give ready-made rules and, instead, wait for a problem to come up. For example, if everybody talks at the same time, the teacher can say: 'I can't hear anybody because everybody is talking at the same time. What can we do to solve this problem'? Children invent rules when they are encouraged to, and they respect the rules they made much more than the same rules made by the teacher.

It is not possible in this brief article to discuss intellectual autonomy or to give more examples of how to foster the development of moral autonomy. The reader can find more details in Kamii (1982, 1984, 2000).

FOSTERING CHILDREN'S INTELLECTUAL DEVELOPMENT

Three kinds of knowledge (Piaget, 1971, 1951) distinguished three kinds of knowledge based on their ultimate sources: physical knowledge, social (conventional) knowledge, and logico-mathematical knowledge. Physical knowledge is knowledge of objects in external reality. The colour, shape, and weight of a banana are examples of physical properties that are in the object and can be known empirically by observation. The fact that a ball bounces and rolls is also an example of physical knowledge.

Examples of social (conventional) knowledge are holidays, written and spoken languages, and the fact that we use our right hand to shake hands. While the ultimate source of physical knowledge is partly objects, the ultimate source of social knowledge is partly conventions, which are made by people. Our reason for saying 'partly' will be clarified shortly.

Logico-mathematical knowledge consists of mental relationships, and the ultimate source of these relationships is each person's mind. For example, I used to give a test in which I asked, 'In what way are a banana and an apple alike'? Children often answered, 'An apple is red, and a banana is yellow'. I then tried to clarify the question by pointing out that the child had given a *difference* but that I wanted a *similarity*. When I repeatedly asked in what way a banana was like an apple, the child continued to reply, 'An apple is red, and a banana is yellow'. A *similarity* is not observable, and when a child cannot think of two objects as being similar in any way, they simply cannot 'see' any similarity between them.

Another example of logico-mathematical knowledge is number. A banana and an apple are both observable, but the number 'two' is not. Only when the child thinks about the objects as 'two' do they become 'two'. 'One' is not observable either. Only when we think about an apple as 'one', does the apple become 'one'.

We have spoken so far as if the three kinds of knowledge were independent of each other. Piaget made these theoretical distinctions but went on to say that, in the psychological reality of the child, the three kinds of knowledge exist together. For example, if we could not make a classificatory relationship (logico-mathematical knowledge), we could not recognize a banana as a banana (as opposed to other objects). Conversely, we could not make the relationship 'different' if all the objects in the world were identical.

Educational implications of the three kinds of knowledge. Early childhood education is generally based on empiricism, which tells us that young children learn through their senses—of vision, touch, smell, etc. Piaget opposed empiricism by pointing out that what is important is the child's actions, which are physical and mental. For example, only by shaking a rattle can babies find out that it makes a noise. The senses are necessary for hearing and seeing the rattle, but without the baby's mental and physical actions, it would be impossible for it to know a rattle or any other object.

Piaget's theory about the importance of children's actions led us to conceptualize physical-knowledge activities as can be seen in Kamii and DeVries (1978).

Examples of physical-knowledge activities are bowling and playing with a pendulum. In these activities children act on objects to produce desired effects, and the thinking they do while trying to knock many pins down, for example, contributes to their development of logico-mathematical knowledge. This is a new approach to physics in early childhood education.

Bowling is an example of a group game. Group games have traditionally been used in early-childhood programmes, but we use them differently, for children's development of autonomy. We do not give more than a few basic rules, such as the object of the game, which is to roll a ball to knock as many pins (empty plastic bottles) down as possible. Details such as who goes first and where to stand are decided by children through negotiation. We help children learn to negotiate so that they will become able to govern themselves rather than continuing to depend on the teacher's control.

Negotiations are good not only for children's socio-moral development but also for their development of logico-mathematical knowledge. Children make temporal relationships when they decide who goes first, next, and so on. They make spatial relationships and find out that everybody wants to stand close to the pins because a short distance makes their task easier. They make numerical relationships as they count the pins that were knocked down and classificatory relationships when someone argues that if a player knocks all the pins down, he or she should get another turn. The reader can find more about group games in Kamii and DeVries (1980).

Before concluding this article, we would like to return to Tohyama's tiles and explain why these tiles are in contradiction with Piaget's theory. Giving well-structured materials such as tiles and base-ten blocks is an attempt to give observable objects to children so that they will abstract the base-ten system as if numbers were physical knowledge. As stated earlier, a number is logico-mathematical knowledge, which is not observable. Therefore, neither 'ten ones' nor 'one ten' is observable and must be constructed through the child's own mental action. Dienes (Dienes & Golding, 1971) made a similar empiricist error when he gave credit to Piaget for the invention of base-ten blocks.

Conclusion

In spite of the good reputation Japanese education is enjoying, many schools at the elementary and junior-high school levels have experienced major problems during the past several years. Among them are violent behaviours, bullying, children who refuse to go to school, chaos in classrooms and suicides.

Incidents of bullying have been reported in newspapers for at least a decade and involve the singling out of specific children to torture. Ganging up on them to hit them, following them home to attack them, and taunting are some of the methods used for torture. In classrooms, some children create chaos by walking around, reading comic books, disobeying the teacher and disrupting lessons. These problems became so severe that some public schools allowed national television crews to videotape in their buildings to inform the public. Many children simply refuse to

go to school, and adults do not know what to do with them. To cope with disobedience, many teachers have turned to authoritarianism and resort to rewards and severe punishments.

In a country where tradition and conformity reign, it takes special courage for an educator to advocate autonomy as the aim of education. We strongly believe that constructivism and autonomy are ideas that can serve to reform and rebuild Japanese education in the twenty-first century. However, elementary-school teachers who come to our conferences and public lectures are still very rare. We are convinced that Piaget's scientific, revolutionary theory will eventually be accepted just as Copernicus's theory became universally accepted after 150 years of resistance and/or indifference.

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THE CURRENT STATE OF CONSTRUCTIVISM IN BRAZIL: SOME ELEMENTS FOR A DEBATE

Lino de Macedo

Introduction

This article sets out to analyse, from its author's standpoint, some considerations that shed light on the present state of constructivism in Brazil and which he sees as equally applicable—at least where the problems are concerned—to other countries of South America. We shall confine ourselves to thematic and generic comments, mentioning neither the individuals nor the institutions that may be responsible for the points raised here. Nor is it our intention to provide an overview of the subject in the customary terms.

We shall endeavour to analyse some of the data gathered by Mário Sérgio Vasconcelos in his doctoral thesis on constructivism in Brazil. He defended his thesis

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in 1995 at the Institute of Psychology of the University of São Paulo under the supervision of Professor Maria Helena Souza Patto. The thesis resulted in a book on the spread of Piaget's ideas in Brazil, which was published in 1996 under the title *A difusão das idéias de Piaget no Brasil.*

The book is based on research involving interviews with forty-two professionals from several regions of Brazil known for their association with Piagetian theory and, by extension, with constructivism. In addition to these interviews, documentary research was conducted to round out Vasconcelos's 'survey'. The author himself acknowledges (Vasconcelos, 1996, p. 3) that the work is descriptive and aims both to tell the story of Piaget in Brazil and to describe the various ways in which he has been assimilated in our country. It is the most extensive research work ever undertaken in Brazil on this theme.

The book is in two parts. In the first part, Vasconcelos presents some of the principles of the New School and criticism of it, reminding us that this movement 'created the space for Piaget's ideas to spread' (Vasconcelos, 1996, chapter 1). Also in the first part, the author provides background on Piaget, commenting on his visit to Brazil in 1949, the impact of the translation of his article 'Remarques psychologiques sur le travail par équipes' [Psychological remarks on teamwork], the influence of Aebli's book *Didactique psychologique: application à la didactique de la psychologie de Jean Piaget* [Psychological teaching: application to teaching of the psychology of Jean Piaget], and, lastly, the 'pilgrimage' of Lauro de Oliveira Lima to promote the educational use of Jean Piaget's theory in Brazil (Vasconcelos, 1996, chapter 2).

The second, more substantive part is also the book's most significant contribution (Vasconcelos, 1996, chapter 3) since it organizes the data gathered in the interviews around various focal points so as to provide a 'survey' of study centres and helps to advance the dissemination of Piaget's ideas in Brazil. The author describes six focal points (Minas Gerais, Rio de Janeiro (*carioca*), São Paulo (*paulista*), Rio Grande do Sul (*gaúcho*), Pernambuco and Paraíba, and Brasilia),[1] tells the story of their creation, presents excerpts from the interviews and names the people who took part in them. He also notes the authors (in addition to Piaget) and themes that most strongly influenced them.

Political position

Even though the issue is not analysed in the book, the context marked out by Vasconcelos allows me to raise the following political question: How can we relate in a constructivist way the interactions between an epistemological proposition and the psychological theory that provides it with empirical backing to its educational applications, which inevitably have political implications?

The first way of using an epistemological current to 'justify' an 'educational application' that is subordinate to the political forces backing it is by non-differentiation between these levels. On this subject, I consider that Vasconcelos's text permits an undifferentiated reading as between the 'liberal ambitions' of the New School, the Piagetian basis of its principles, and the criticism that it is impossible for the school to

achieve its ideals. In his text, Vasconcelos reminds us of the names of the Brazilian intellectuals who, in carrying out their political functions and motivated by the fresh opportunities offered by the proposals of the New School (as opposed to the traditional school), encouraged the dissemination and application of Piaget's work. The organization of his book—which highlights the context of the New School and the political commitments that promoted its spread in Brazil, an enumeration of the movement's educational principles and its corresponding corroboration in Piaget's propositions—makes for an undifferentiated reading of these levels. In other words, although Vasconcelos (1996, p. 259) does not consider Piaget to be a 'New Schooler', the way in which he has organized his data and structured the book's chapters permits a reading that compounds the relationship between the epistemological basis of an educational proposal, criticism of it and the political vicissitudes of its introduction.

In a constructivist perspective, an initial moment may be characterized by a combination of contents that make up a particular form or system. If these contents are diverse in nature, they have to be related to one another while emphasizing their similarities or differences. However, it often happens that the interaction between these contents takes place through juxtaposition or syncretism. Juxtaposition, since it is as if the parts were functioning while remaining independent of one another, as if the parts and the whole were not interlinked, in short, as if they could function by themselves, in isolation from the co-ordinating mechanisms that simultaneously differentiate and integrate them. Syncretism, in the sense that the elements merge together, forming a single entity, each reduced to the other. I believe that Vasconcelos's text enables the second kind of reading, not only in its first but in its second part as well. In the first because, as we have already pointed out, the 'liberal theories' that form the basis of the New School coexist alongside the constructivist principles and educational reforms aimed at improving Brazil's schools. In the second, the histories and interviews are divided into 'geographical' centres, and yet divergences between the content of the replies and the positions maintained are not analysed. The author is, of course, aware of these contradictions between Piagetians in Brazil, but remains attached to the descriptive and 'historical' criteria (a straightforward account of events) that he has adopted.

The other sort of interaction between the elements making up a system manifests itself, from a constructivist perspective, in the combined interplay between *differentiation* and *integration*: Both the whole and the parts and the parts themselves are differentiated by their structure and their function, but their functioning operates interdependently i.e. in an inseparable, complementary and irreducible way (Macedo, 1996). Inseparable, since it forms a complex system in which the elements cannot be taken apart or only to a certain extent—and then only for purposes of analysis or division (García, 2000). Complementary, since the parts complete one another other by together forming a whole that will always be 'bigger' than and different from the sum of its parts. Irreducible, since the elements do not mingle and cannot be treated as though some were the 'cause' of the others in a simple or linear sequence. The parts and their relations, the whole that includes them and its relation to its parts and to other 'wholes' (as is the case, for instance, in the subject-object relation) form elements that can only be analysed as 'divisions' of one and the same system.

Vasconcelos's text enables a reading in which the aspects described may be related according to their differentiations and integrations, but this analysis is not conducted systematically, remaining, at most, implicit.

Theoretical considerations regarding the relations between the parts and the whole that they constitute (Piaget, 1975) make it possible to characterize a system in a constructivist perspective. Such considerations were necessary to underpin the analysis set out below of the current position of constructivism in Brazil's educational policy.

Constructivism, especially in its Piagetian version, is constantly used in drawing up educational reforms in Brazil. However, in practice, all sorts of distortions, 'oversights' and political intrigues in favour of other interests can be observed. For instance, in December 1996, as in the case of other reforms, a new law on national education guidelines and bases was approved—Lei de Diretrizes e Bases da Educação Nacional (LDB)—which is based on constructivism or consistent with it. Under the LDB it is compulsory to apply the principles adopted by Brazil in 1990 in the Declaração de Direitos de uma Educação para Todos (Declaration of the Right to Education for All) and resources were provided for that purpose. As a result of the LDB, the federal Ministry of Education and the state and local education secretariats began a series of projects in 1997 to apply the measures required by this law in order to 'improve the quality' of education in Brazil.

The purposes of the present article will become clear from a list of some of the federal government projects, such as: the proposal to draw up national curriculum parameters for nursery school, primary school, secondary school, indigenous education and education for young people and adults; the formulation of references for teacher-training, and the resulting project, Parameters in Action. Mention may also be made of the institutional school assessment, pupil assessment and textbook assessment projects. This list does not claim to be exhaustive or to include all the projects carried out by the ministry and the secretariat. It is, however, intended as a simple illustration of the question underlying a more general discussion, as outlined below.

In the projects just referred to, there are indications enabling us to conclude that constructivism was an influence when the texts were being drawn up. It is enough to list here the indicators present in the official documents we have mentioned on current educational policies in Brazil:

- Many passages in which, without being explicit, the presence of constructivist principles may be noted.
- The presence in bibliographical references and suggestions for further reading of authors sharing a constructivist view of knowledge.
- The list of authors who produced the documents and the specialists (national and international) who provided assistance and advice.

So we can return to the question already posed. If, even non-explicitly, constructivism is used as the basis for education projects introduced by a government (be it federal, state or local), how can the scope of the criticism or problems arising from the political position of the government be extended to constructivism?

Discussion of the epistemological basis of an educational project taken up by a government from the standpoint of a complex system (García, 2000) is important,

since when we hold that education to the age of 18 is the duty of the state, it is highly likely (even desirable) that 'the epistemology that best explains the issues of the day' will be adopted as a reference for the state. This being so, one can readily imagine a link between the theory (which can evolve and has its own forms of validation) and the political position of the authorities and the technicians and specialists who are requested to undertake certain tasks.

The formulation of the problem of the links between epistemology and politics is not without importance and Piaget made his opinions on this subject known in 1965.

The question becomes even more important when we consider it in an international context. With the globalization of the economy, the consensus on the importance of social indicators such as the Human Development Index (HDI) and education indices (the UNESCO indicators, for example), the consensus on the drugs trade and the integration of the former colonial peoples as citizens of the countries that once dominated them—to cite but a few examples of common interest—the debate on the various ways of combining epistemology, politics and education has become fundamental. In Brazil, for instance, if constructivism was once associated with the 'liberal' practices of the New School, the trend today is to associate it more closely with the 'neo-liberal' wave of our increasingly global world. That is why I wish to stress the matter. If constructivism can through its 'globalized' aspect explain relations between countries, does this imply that we can ascribe to it the perverse or partial forms of this success? In short, does not the assumption that constructivism, in its Piagetian form at least, is 'open to all possibilities' also imply that we must look into whatever we think is 'necessary' to bring this about?

Academic position

I have only a few comments to make in this article on the academic point of view. Piaget's theory, at least with regard to the 'classic' themes (for instance, stages of development, moral judgment, operational proofs and the relationship between thought and language), continues to provide an important alternative solution in disciplines such as developmental psychology and educational psychology as practised in advanced psychology and education courses. For those who have reached the postgraduate level, Piaget's experimental psychology continues to be a major source of inspiration when conducting research for theses and dissertations. With regard to methodology, the 'clinical method' of the great Swiss scholar has become an almost compulsory reference and a term that is all too often a source of distortions and misunderstandings of all kinds, whether in relation to Piaget's original proposals, made in 1926, or to his 'revised' version of 1941 (Piaget & Inhelder, 1941). Nevertheless, a commitment to the study and application of the foundations of a constructivist vision of research (García, 2000) is noticeable on the part of those who continue to take an interest in Piaget. The pioneering work of Ferreiro and Teberosky (1979), to cite but one example, continues to be an important reference and a 'source of inspiration' in this respect.

Conceptual position

I have maintained that the descriptive criterion adopted by Vasconcelos enabled him to bring together excerpts from interviews in which the participants' positions often conflict with the content, that is to say they contain juxtapositions, syncretisms and even 'agreements' that are not analysed by the author, given the limits of the objectives of his work (to undertake a 'survey' of constructivism in Brazil). I will mention here only two themes, frequently analysed in an overly 'peripheral' way: one is the evident consistency with which Piaget is found to be a constructivist, the other relates to the place of the 'social' in his theory.

It is superficially assumed that there is a tacit equivalence between Piaget and constructivism. However, I continue to assert, especially in debates, classes and seminars, that the answer to the question, 'Is Piaget a constructivist?' is not always in the affirmative in Brazil. Why is it difficult for us—spontaneously and without 'resistance'—to regard Piaget as a constructivist, even though he identified himself as such in his opposition to empiricism and apriorism (García, 1997, p.17)? This is not a trivial problem, since in Vasconcelos's text the persons interviewed consider, for instance, Piaget, Freire, Wallon and Vygotsky as equally constructivist, despite all the differences they concurrently attribute to them (in particular with regard to Piaget and Vygotsky, or Piaget and Wallon).

The place of the 'social' in Piaget's work is a point of divergence among Vasconcelos's interviewees. In this connection, allow me to refer to García's comment (García, 2000, p. 88) on the constructive role of society in Piaget, both in relation to the development processes in children and to science itself.

Pedagogical position

A final aspect calling for comment in this text is the pedagogical position of constructivism from a general perspective, i.e. one that is not limited to initiatives generated or inferred by the public authorities. In this respect, we can note the very high level of interest today in Brazil, at least insofar as a problem is perceived, in understanding and criticizing education in its constructivist version (Macedo, 1994). The themes[2] on which didactic guidance in a constructivist perspective is proposed are: differentiated education, teaching by projects and problem-situations, the use of games and challenges, autonomy at school, educational and regulatory assessment, continuous promotion, the allocation of pupils to learning cycles, remedial classes, learning workshops, tutor-based education, inclusive education, teacher training, parameters and directives for curricula, classroom management, the desire to learn, interdependence between the acquisition of knowledge at school and the development of skills and capacities, 'external' assessment of pupils (i.e. outside the school context), education institutions and textbooks.

As an illustration, I will return to two questions, addressed above, and comment on them in the light of constructivism. The first is to do with the following prob-

lem: how should we define skills and capacities, and how can they be developed and assessed in the school context? The second refers to in-service teacher-training in a constructivist perspective.

The 1990s witnessed a new call to make primary education accessible to all, children and young people, and in addition to make it a complete course of education in itself. One of the conditions proposed to meet this demand was to require the school to provide 'meaningful learning' of the content of various disciplines and to develop the combined skills and capacities that would represent the fundamental 'knowledge' necessary for life in society. The difficulty is that skills and capacities may be just as easily 'read' from the positivist angle of mastery or control over behaviour (in the technician sense) as in the aprioristic sense of a 'gift' or a 'vocation' inherited by some and not by others who are less amenable to the learning process. How can so complex a task be accomplished in a constructivist perspective?

With regard to teacher training, one of the questions that arises is how to contribute to making teachers not just purveyors of knowledge (as recorded in books and theories), but also artisans of learning, for both their pupils and themselves. What educational strategies can be used in the classroom? How are we to create situations conducive to reflection on practice? How can we relate the study of theories (another form of reflection) to the investigation of new ways of teaching in a context in which education today is a right for all? How can we give teachers the opportunity to express their own conception of teaching, keep registers, assume responsibility for their training, learn to work in teams, and involve pupils and parents constructively in the learning process?

By way of conclusion

In the preceding pages, we have tried to raise a few questions on the current state of constructivism in Brazil and submit them for discussion. To that end, we adopted as a reference Vasconcelos's work on the spread of Piaget's ideas in Brazil, a work whose significance we readily acknowledge, but which has nevertheless been criticized on two counts. Firstly, the juxtaposed and undifferentiated way of using the context of the New School to explain the dissemination of Piaget's work in Brazil could lead to 'readings' that confuse the epistemological proposition of the author with the educational or political position of the movement. Furthermore, the survey carried out in Brazil's Piagetian study and research centres, even though they yielded good results, produced interview material whose contents were not analysed in a relational perspective.

The criticisms made of Vasconcelos's work were used as an argument to enter into a broader and more topical discussion of the relationship among politics, epistemology and education. In addition, we explained that it is difficult for us to consider Piaget a constructivist (even though he considered himself to be one) and, by extension, to be able to include certain authors (for instance, Piaget, Wallon, Freire and Vygotsky) among the upholders of this epistemological position as opposed to empiricism and apriorism.

Another question was that of relating the new educational themes to the challenges of learning to deal with them in a way consistent with constructivist principles.

Lastly, throughout this article, we have emphasized the importance in relation to the subjects under discussion of García's advocacy (García, 2000) of a vision of constructivist epistemology put into practice in the perspective of complex systems.

Notes

1. *Carioca* is the adjective relating to Rio de Janeiro, *paulista* to São Paulo and *gaucho* to Rio Grande do Sul.
2. The list was taken in slightly modified form from Macedo, Petty and Passos, 2000, p. 5.

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CONTENT-BASED TEACHER EDUCATION APPROACH VERSUS COMPETENCE-BASED TEACHER EDUCATION APPROACH

C.P. Chishimba

The content-based teacher education approach

Primary teacher training colleges in Zambia offer a two-year pre-service programme aimed at preparing teachers to teach any of the seven primary school grades. The curriculum is content- or subject-based in both outlook and organization. The division of the teacher training programme into 'background', i.e. content of the school subjects, 'methods', i.e. how to teach those subjects, and 'teaching practice' in schools is a familiar scenario to anyone who has undergone teacher training. The primary teacher training colleges have a timetable which sub-divides the programme further into a multitude of subject areas, including 'Education' (comprising developmental psychology, philosophy of education, sociology of education, history of education,

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school administration, and principles and practice of education). Over the years, increasing timetable pressures have been created by the introduction of curriculum areas such as population education and environmental education. Furthermore, a subject such as Child-to-Child and activities such as production units and station upkeep have been added to the college timetable. Under the content-based teacher education programme each subject is compartmentalized and developed as a separate entity. The artificial division of the primary teacher-education programme into more and more components has contributed to a loss of overall objectives, reduced the scope of areas of study and resulted in the loss of any element of integration. A typical primary teacher training college has forty-five 40-minute periods per week into which are crammed the centrally examined subjects. The college training programme comprises fifteen subjects, which are taught mainly through lectures and demonstrations.

The primary teacher-training colleges follow a common curriculum which was centrally designed in the 1970s and revised in 1993. It is based on the traditionally accepted subject divisions and the separation of theory and practice. Each subject syllabus was designed independently of the others. A scrutiny of the syllabuses reveals a considerable amount of overlap and repetition. The fundamental integration required in order to give direction and meaning to the diverse components does not exist.

With this overloaded primary teacher-education curriculum, there is no doubt that the student teachers are overburdened with content, learning it with very little time for independent study. Consequently, only limited development of the students' initiative and creative thinking skills can take place. In primary teacher-training colleges, teaching is based on a series of objectives which were centrally formulated by the inspectorate and curriculum workers with minimal input from college lecturers and primary school teachers. Owing to the disproportionate amount of time devoted to the restrictive curriculum objectives and primary school content, the development of problem-solving skills needed by the student teachers who are to cope with difficult and diverse classroom conditions is neglected. As a consequence, the student teachers acquire authoritarian and teacher-centred styles of teaching that place emphasis on factual knowledge and memorization. With this type of teacher training, the chances are that they will not be able to promote the flexibility, originality and ability to think independently and creatively that are required in Zambian primary schools.

The primary teacher-education curriculum is also dysfunctional in that it does not take into account the real situation in the primary schools. It does not adequately prepare the student teachers for their future roles, for example how to teach without instructional materials; managing and teaching very large classes; multigrade teaching; dealing with special pupils (that is, the gifted, the handicapped, the malnourished, the laggards, the girl child, etc); coping with the demands of teaching two or three sessions; keeping pupil records; techniques of continuous assessment; and the improvization and use of teaching and learning resources.

Teaching practice in the content-based teacher education programme consists of two six-week blocks of actual teaching experience spread over the two-year

programme. The number of lessons taught by the student teachers is determined by the availability of facilities. Some 20% of the lessons taught by the students are supervised by the college lecturers, who are expected to advise students and assess their performance. The assessment of student teaching has elements of subjectivity and the college lecturers limit their advice to lessons within their subject field.

For certification, the student teachers are assessed on the basis of results in the final examinations and teaching practice. The Examinations Council of Zambia prepares and administers examinations in a number of subjects. The students are expected to conform to set answers.

A call for change in teacher education

For the past decade educators, taxpayers, parents, employers and teachers' unions have expressed dissatisfaction with the symptoms of inadequacy in teacher training. The dissatisfaction with teacher training has, moreover, been accompanied by demands for teacher accountability. People have demanded that teachers be held responsible for the achievement, or the lack of it, of their pupils. But serving teachers have replied that their training did not equip them with the skills and strategies necessary for ensuring pupil achievement to the extent demanded by proponents of accountability.

Recognizing this discontent and the demand for reform in teacher education, the Ministry of Education has responded by organizing a workshop with donor support in order to come up with a new competence-based curriculum which should meet the needs of a changing Zambian society. Consistent with the provisions of the educational policy documents *Focus on learning* (Government of Zambia, 1992) and *Educating our future* (Government of Zambia, 1996), the reformulation of the primary teacher education curriculum is thus in order. Focus on learning underscores the need for change in teacher education by stating that the focus of concern in an effective teacher education institution is on transforming its students into competent and committed teachers. The colleges will thus be held accountable for the work they do and for the quality of the teachers they produce. In this connection, *Educating our future* upholds the notion that the quality and effectiveness of an education system depend heavily on the quality of its teachers. Indeed, they are the key persons in judging the success in attaining the education system's goals. The educational and personal well-being of the pupils in the primary schools is contingent upon the teachers' competence, commitment and resourcefulness. This is the situation, therefore, that prompts the current call for the establishment of competence criteria and a competence-based primary teacher education programme in Zambia.

The competence-based teacher education approach

The competence-based teacher education approach to programme development ensures that the competences to be learned and demonstrated by student-teach-

ers are specified in advance. It also ensures that the criteria to be utilized in making this determination are indicated. Furthermore, it holds the student-teachers accountable for mastering the particular proficiencies. The approach emphasizes that competences must always be made public. All components of the Competence-Based Teacher Education (CBTE) programme should be as close to the realities of actual classroom teaching as possible. Whatever student teachers study and practise should be similar, in respect of all situational factors, to what they will be expected to do in their subsequent teaching. In this connection, Haberman and Stinnett (1973) state that many educational administrators feel that the graduate of a content-based teacher education programme is a 'shot in the dark', while the graduate of a CBTE programme comes with a verified checklist of skills which he or she has mastered.

What are 'competences'? Perhaps there are as many conceptions of what teaching competences are as there are people who have attempted to define the term. Kay (1974) states that definitions of teaching competences have ranged from highly specific behavioural objectives delineating all the knowledge, skills, values and attitudes deemed necessary for effective teaching to more generally stated goals reflecting various functions that teachers should be able to perform. Examples of the first definition are as follows:

1. Given standardized reading test materials, a test manual and a class of Grade 4 children, the student-teacher will administer and accurately score the test for the class.
2. Given one column listing six major learning theories and one column listing ten important characteristics of their learning theories, the student-teacher will correctly match at least nine of the characteristics to the theories.

Examples of the second definition of competences, as derived from the Namibia National Institute for Educational Development for the Basic Education Teacher Diploma, are as follows:

1. *Teaching skills.* The student should be able to teach her or his subjects through a learner-centred approach.
2. *Professionalism.* The student should demonstrate professional behaviour.
3. *Responsibility.* The student should demonstrate responsible citizenship.
4. *Communication skills.* The student should be able to communicate effectively, both in general and in terms of the sharing and teaching of knowledge in basic education.
5. *Interpersonal and social skills.* The student should be able to construct meaningful relationships in order to promote efficient teaching and learning.

It should noted that these broad competence areas for the Basic Education Teacher Diploma are derived from Namibia's national education aims.

From another dimension, 'competence' is defined as the ability to integrate knowledge, skills, values and attitudes which are demonstrated by student-teachers within a context of selected professional key tasks. This sort of competence entails implicit assumptions about change and consequently about situations of unpredictability in the taking of decisions by student-teachers concerning teaching and

learning in an education milieu. It poses learning as a continuous activity for the prospective teacher, who should be an agent of change in a school system.

As teacher education programme designers, we should note that there are two dimensions to most definitions of what constitutes teaching competences, and these are:

1. the 'what' that is to be included in the new teacher-training programme; and
2. the specificity with which it is stated.

It should be noted that the 'what' dimension is critical. This may include knowledge outcomes, attitude outcomes, values outcomes, skills outcomes or any combination of them. Some designers of CBTE programmes have used all four: they identify knowledge, skills, values and attitudes for programme objectives and call them competences. The second major dimension of differing definitions of what a teaching competence is involves the level of specificity with which various functions, tasks and skills are defined.

Several approaches to specifying teacher competences have been employed by programme designers. One approach may be selected and modified, or a combination of approaches may be utilized. There are three approaches that are employed by programme designers:

1. task-analytic approach;
2. needs of school learners approach;
3. needs assessment approach.

In the task-analytic approach, the search for competences is carried out. This approach analytically examines teaching in order to discover the skills that teachers need for the purpose of performing classroom roles which bring about desired pupil outcomes. One may say that the task-analytic approach to describing teaching competences may be more theory building than theoretically derived.

In the needs of school learners approach, the programme designers study the pupils' ambitions, values and other perspectives. These needs of pupils form the basis for the school curriculum. The programme designers ask themselves the following questions:

1. In what way does the school curriculum accommodate the needs of children?
2. How should it?

When the school curriculum has been designed, the teachers' needs are specified. From these needs the teacher competences are deduced. The process used in designing learner-centred teacher education programmes according to this approach is outlined as follows:

1. Pupil outcomes desired;
2. Conditions in order to bring about the pupil outcomes desired;
3. Competences needed by teachers to provide the conditions in order to bring about the pupil outcomes desired;
4. Conditions that lead to knowledge skills and sensitivities for which teachers need to provide the conditions in order to bring about the pupil outcomes desired

Moreover, this approach to teacher education assumes that a direct relation can be derived between pupil objectives, teacher actions and teacher-training requirements.

While basic in its intent, the approach suffers from the many factors intervening between the teacher-education programmes and pupil growth and development in the school.

In the needs assessment approach, the needs of society are assessed in terms of changes desirable for it and how it will be affected by emerging trends. From this needs assessment, the specifications for a teacher-education programme are deduced. The assumption is that knowledge of the real and vital needs of society can be translated into the school curriculum for the pupils, and consequently into the teacher-education programme.

After teacher competences have been specified, using these approaches, the programme designer has to subject them to the psychological and philosophical screens. What competences are relevant and necessary for training teachers are retained while others are discarded. Thereafter, the programme designer tackles the task of sequencing competences according to the psychology of learning based on student readiness and development. One basis for such an ordering employs the structure of areas of learning as a guide, progressing from simple to complex principles. Secondly, in sequencing and clustering competences, the programme designer considers the location and facilities needed for various activities which the student teachers have to carry out. Some activities may be completed on the college campus during the first year through mediated instruction, lectures, or seminars with the active participation of the student-teachers. Others require simulation or micro-teaching and can occur either at the college or in the schools. Yet other experiences require school participation in the second or field-based year, such as teaching practice, tutorial activities involving pupils, and so on. Thirdly, the psychological needs of the student-teachers should also guide the programme designer in the sequencing of competences. In this connection, the research carried out by Fuller (1990) confirms that student-teachers are concerned initially with themselves as persons. Only after resolving conflicts resulting from such concerns do they focus on their impact on pupils and the needs of pupils.

The CBTE programme has areas of study which are derived from competences. It therefore follows that the areas of study should be consistent with the logically derived competences. The rationale for including areas of study in the CBTE programme should be articulated by the programme designer. Depending on the specified competences for the teacher-education programme, the areas of study may include education, aesthetic and creative expression, linguistic and literary studies, physical studies, natural scientific studies, social and economic studies, technological studies and mathematical studies. The CBTE programme is learner-centred and therefore has learning activities or experiences for students that are based on the areas of learning. Areas of learning and learning experiences are organized in a meaningful form through a scope and sequence chart. These aspects of the curriculum should maintain balance between depth (vertical) coverage and breadth (horizontal) coverage of areas of learning and learning experiences. Consideration has to given to how to present these aspects from one year to another. In addition, how to integrate them should be taken into account. The programme designer has also

to ask the following questions: Are the areas of learning and learning activities relevant, valid, significant or fundamental (in terms of core areas of knowledge), and suited to the age and abilities of students? Do the areas of learning and learning activities provide continuity from one year to the next? The programme designer should include compulsory and elective areas of learning in the CBTE programme.

When designing a CBTE programme we have to consider:

1. the population for which the programme will cater;
2. constraints which may impede the development of the programme;
3. assumptions on which the programme will be based.

In each case, the following questions might help us as programme designers in our efforts to design a CBTE programme.

- For which type of student-teachers is the programme designed?
- Which type of pupils are they going to teach (i.e. age range, urban or rural pupils, second-language learners)?
- Are schools involved in the training process?
- If so, are their members of staff to be retrained so that they too can demonstrate the expected competences?
- Does the programme meet government specifications in terms of educational policy and national aims of education?

As programme developers, we have to identify the following assumptions on which the CBTE programme will be based before we identify its aims and competences:

1. that student-teachers acquire skills, knowledge, values and attitudes at their own pace and in different ways;
2. that they should know the nature of learning;
3. that there are societal forces;
4. that teacher roles are defined;
5. that schools play a significant role in society, etc.

Some people might ask the reason for choosing CBTE. CBTE is a data-based system for training teachers. It precisely specifies that teachers must exhibit those competences assumed to promote pupil learning, and/or demonstrate their ability to promote desirable pupil learning. The CBTE programme is accountable and it is systematically controlled. In a CBTE programme, data are collected by means of research through a needs assessment mechanism. The data are utilized to make adjustments to and changes in what and how things are carried out. To that end, Lindsey (1976) states that CBTE is an approach to curriculum designing that is systematic, process-oriented and institutionally based. CBTE requires that we define knowledge, skills, values and attitudes, design strategies for achieving goals, evaluate achievement and feed results into the system for continuous improvement.

According to Elam (1971), the essential characteristics of CBTE are as follows:

1. Teaching competences to be demonstrated are role-derived, specified in behavioural terms and made public.

2. Assessment criteria are competence-based, specify mastery levels and are made public.
3. Assessment requires performance as prime evidence, and takes knowledge into account.
4. The students' progress rate depends on demonstrated competence.
5. The instructional programme facilitates development and evaluation of specific competences.

In designing and testing the CBTE programme, evaluation serves three functions:

1. To improve programme effectiveness;
2. To improve programme organization and management;
3. To monitor student performance.

Evaluation does not occur at the end of project, but is integral to continued programme development. Moreover, evaluation in CBTE adds the qualitative dimension to programme design—, a contextual edge to the process. In teacher education, we can measure the performance of a teacher using observation scales, rating devices or other measurement tools. Evaluation compares those measurements with objectives which imply societal criteria, change in pupil behaviour and judgements by evaluators about adequate teaching styles.

After the CBTE programme has been developed, it should be tried out with a pilot group of students in a few colleges to improve materials and procedures while the remaining colleges continue on the traditional teacher-training programme. After the trial period is finished, the CBTE programme should gradually be introduced or extended to other colleges until everyone is following the new programme.

Conclusion

From this presentation what are the areas of difference between the competence-based teacher education approach and the content-based teacher education approach (Table 1)?

TABLE 1. Comparing the competence-based and content-based approach to teacher education

	Competence-based teacher education approach		Content-based teacher education approach
1.	Competences-oriented.	1.	Objectives-oriented.
2.	Systems approach to programme designing.	2.	A shot in the dark; no system to programme designing.
3.	Integrated curriculum going beyond knowledge for its own sake.	3.	Discrete curriculum.
4.	Broad areas of learning identified.	4.	Separate subjects which are compartmentalized.
5.	What is taught to students has an empirical basis guiding programme development.	5.	What is taught to students has no empirical basis.
6.	Real research evidence guides programme development.	6.	Programme development does not emanate from research data.
7.	Follow-up of graduates' performance provides real feedback for programme revision	7.	Little evaluation of programme and follow-up of graduates.
8	The teacher-education programme is accountable for teaching students to perform programme competences.	8.	No accountability of programme to its students, their pupils or the public.
9.	Continuous assessment emphasized.	9.	Examinations emphasized.
10.	Student-centred.	10.	Teacher- or lecturer-centred.
11.	Mode of study is integrative; other study methods are stressed.	11.	Mode of study via lectures.
12.	Formative evaluation is an integral part of the programme design.	12.	No formative evaluation of the programme during the design period.
13.	Professional-content syllabuses.	13.	Subject-content syllabuses.

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PUBLISHING SCHOOL PERFORMANCE INDICATORS: SOME LESSONS

Sjoerd Karsten and Adrie Visscher

Introduction

During the 1990s, educational performance tables became features of the educational landscape in a number of countries. The intended goals of publishing these tables are to inform parents and students, support school improvement and enhance the accountability of schools. In this article, we explore the use and (negative) effects of the publication of performance tables in the United Kingdom and France.[1] We chose to focus on these countries because they both have considerable experience with the publication of school performance indicators. At the same time, the differences between them in the ways in which schools are governed, in the amount of autonomy they enjoy and in the extent to which parents have choice make them

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fruitful foci for a comparative study. We begin by examining the background and the content of the school performance indicators published in these two countries. Next, we offer a brief description of the problems associated with the publication of educational performance indicators. Finally, we discuss the effects of these indicators on parents and schools.

School-performance indicators in the United Kingdom and France

During the 1980s, the national press in the United Kingdom and in France began publishing what are known, respectively, as 'league tables' and 'palmarès'. These tables rank schools on the basis of raw data, that is, the percentages of pupils who pass the school-leaving examinations at specified levels. In both countries the governments reacted to these publications by issuing their own school performance indicators. These governmental reactions differed, however, in several essential respects.

UNITED KINGDOM

In the United Kingdom, the performance indicators played an important role in the Conservative government's efforts to transform the education system into a market. The government claimed that applying market theories and enhancing choice would encourage schools to perform better and be more responsive to their consumers. In 1992, the Office for Standards in Education (OFSTED) began to publish official school performance tables. While, unlike the unofficial league tables, these did not rank schools, they were also based on raw data—in this case, the unadjusted average achievement scores on national tests and examinations.

In England and Wales, the initial published school performance indicators were based on results from the General Certificate of Secondary Education (GCSE) examination, taken at the end of compulsory schooling (at approximately age 16). To complete the GCSE, students take tests in a range of subjects, for which they are awarded grades from A (highest) to U (lowest). The school performance indicator for each secondary school was the percentage of students achieving five or more C grades, or above. In later years, school performance indicators were also published for other educational levels, based on the percentages receiving a certain grade in a given year on the national curriculum testing regime carried out at ages 7, 11 and 14.

FRANCE

Meanwhile in France, the use of performance indicators was incorporated into the existing hierarchical administrative culture of governmental evaluation and accountability. *Le Monde de l'éducation* [The world of education] published rough passing rates for the *baccalauréat* (France's secondary school-leaving examination, generally taken at age 18) for each *lycée* (an institution where students complete the final

three years of secondary schooling). Liensol & Meuret (1987) responded to this by demonstrating that school rankings based on value-added scores were significantly different from and more instructive than those based on rough scores. From 1989 onward, value-added indicators were sent to *lycées*; since 1991, the Ministry of Education has published them more widely each year. The Ministry of Education report contains the rough success rates for the baccalauréat together with an 'expected success rate' that is crudely calculated as a weighted sum of the national rates for each age and socio-economic group. The same kind of indicators for collèges (institutions where students complete the first three years of secondary schooling) are considered confidential and are not open to the public. These are sent to schools in combination with other indicators that primarily describe student intake and staff characteristics.

LEGAL FRAMEWORK: UNITED KINGDOM AND FRANCE

Given the differences in historical background and political culture between the United Kingdom and France, the legal and institutional frameworks in which the development of public performance indicators is embedded is also different. In the United Kingdom, the right of parents to information has been more firmly entrenched in legislation and regulations since the *Education Reform Act* of 1988 and the *Parents Charter* of 1991. Conversely, in France, those who advocate the publication of performance indicators make reference to the *Loi d'Orientation* of 1989, a law that in fact does not contain any specific provisions on this subject. Indeed, schools in France do not have a specific obligation to provide data for the various performance indicators, although they all do comply, due to political and other governmental pressure. It is also worth noting that the job of gathering and processing the data has not been given to an 'independent' body in France but is carried out by a department of the Ministry of Education.

Problems concerning the publication of school-performance indicators

A scrutiny of the research literature and a discussion with experts in the United Kingdom and France brings to light a number of problems concerning the publication of performance data. These problems can be grouped into three categories: technical-analytical problems, usability problems, and political-ethical and societal problems.

TECHNICAL-ANALYTICAL PROBLEMS

This category of criticism of the publication of school performance indicators focuses on their reflectiveness of school quality:

- Raw, uncontextualised, average student achievement scores, as originally published in the United Kingdom and a number of other countries, tell more

about schools' catchment areas than about the quality of school processes and school performance. However, even when data are adjusted for student background characteristics (e.g. socio-economic status, ethnicity, gender and attainment at prior educational stages), performance indicators are imprecise because of large confidence intervals. For one, these indicators often reflect the performance of a relatively small number of students. Only when performance indicator confidence intervals do not overlap with those of other schools (as is true for 10-20% of all schools), are there grounds for assuming one institution is better or worse than another (Goldstein, 1997). But even in these exceptional cases, there are alternate explanations for school performance levels. The problem of large and overlapping confidence intervals is especially severe when assessing the performance of school departments or divisions, since they are often based on even smaller student numbers than whole-school indicators (Goldstein & Thomas, 1995). Thus, while value-added information is a precondition for comparisons between schools, it is not a sufficient one for knowing the true performance of all schools.

- Performance differences between schools cannot be accurately determined by means of a simple method even when attempting to adjust for all relevant factors. Full adjustment is simply impossible and each statistical estimation incorporates uncertainty. In the words of Rowe (1996) 'all rankings are fallible'. Assigning schools to groups and branding them as 'good', 'average', or 'poor' can have adverse effects for many institutions, especially those falling close to a borderline of arbitrary categories.
- School quality indicators are mainly based on cohort data for those students who entered the school several years earlier. In the meantime, a school may have changed considerably, meaning that the indicators do not provide reliable information on the quality of schools as they are at the time data are collected. These same factors make it even more difficult to project changes in future performance. Performance indicators may therefore be relatively unhelpful for parents interested in selecting schools for their children.
- It is difficult to assess the value added by a given school given fluctuations in the student populations. In areas where there are high levels of student mobility (i.e., dropouts, movement to other schools), so that the final cohort ends up being quite different from the intake cohort, robust value-added indicators are usually not available. In those cases, school performance indicators are only based on those students who have been in school all the time or most of the time. However, information on the students who dropped out of the school system is also clearly relevant in assessing overall quality.
- Schools performing equally well on average, based on performance indicators, may exhibit considerable internal variation. Even in good schools with many high-quality instructors, teacher effectiveness varies (cf. Goldstein & Thomas, 1995; Luyten & Snijders, 1996). A given school may be extremely effective in certain subject areas and far less so in others. Furthermore, there may be considerable variation in the degree of effectiveness for certain student groups with

respect to gender, socio-economic or ethnic backgrounds. Thus, to deal with the many facets of school effectiveness, fine-grained indicators may be called for. Parents may want more specific information, such as how appropriate a given school would be for their child, or how strong a particular subject is (e.g., mathematics or the arts). A single and simple, valid school quality measure does not exist (Goldstein & Thomas, 1995). A convincing picture of a school's quality requires multiple process and output indicators (Schagen & Morrison, 1999), which are not generally provided by published systems.

- Students from privileged socio-economic backgrounds often enter what are considered to be better schools and tend to have high levels of achievement upon enrolment. Thus, value-added adjustments for student intake features in these schools may actually lead to underestimation of their performance.
- In many education systems (including Dutch and French primary schools) there are no baseline assessments that would guarantee the option of comparing students at different schools. Where baseline assessments are conducted, they can lack validity because they do not encompass student performance in a sufficient number of subjects. The use of school-based assessments is not a good resolution to the problem because there is too much room for misconduct on the part of the schools (i.e. preparing students for tests or even fraud). There is also no way to make a real comparison between assessments provided by different schools.
- Whenever there are important differences between the public and private school sectors in terms of regulations, resources, recruitment of personnel and admission of pupils, comparisons between these types of schools can easily lead to unfair treatment of the public sector. To avoid this, all relevant factors must be taken into account.
- Although value-added school performance indicators provide information on the relative performance of schools, they do not indicate the degree to which schools meet certain absolute educational standards (TIMMS, 1999).

USABILITY PROBLEMS

This category relates to the extent to which school performance indicators can be used in various user contexts (i.e. by schools, policy makers, parents and pupils) for well-informed involvement and decision making, school improvement and to enhance accountability. The evidence is against the effectiveness of school performance indicators in keeping parents and students up to date and enabling them to make well-informed choices.

- Accessibility of public school performance publications is not equally distributed across all parents. In the United Kingdom, even after many years of publishing school league tables, a considerable percentage of parents, especially from low socio-economic groups, remain unaware of their existence. Moreover, the indicators are not readily intelligible to all parents, making careful interpretation of already questionable standards even more implausible.

- There is serious doubt regarding their real value in determining the current and future overall quality of a school, the quality of particular aspects of the school and the appropriateness of a school for a given child. For all these reasons, school performance indicators, which are unequally distributed because of the size and nature of educational supply, transportation costs, social factors and cultural differences, have not proven to be effective in providing students and parents with real freedom of choice.
- It is doubtful that the publication of performance indicators actually stimulates schools to improve their functioning. Schools that are already performing well do not need the encouragement these indicators could offer, while the schools most in need of support are more likely to find their publication discouraging, especially from non-value-added systems.
- Schools in need of support are often unable to make constructive use of the information they have been given because reports of performance indicators most often neither define the cause of problems nor outline solutions.
- Finally, it is not always viable for schools to be expected to organize themselves more effectively. To a large degree, what is possible depends on the local context (Hannaway, 1993; Hannaway & Talbert, 1993). Decentralized labour relations (as exist in the United States) or an unbalanced labour market of teachers (e.g. in the Netherlands) can influence whether schools are able to reorganize educational provisions.

POLITICAL-ETHICAL AND SOCIETAL PROBLEMS

A number of political-ethical and societal problems result from the publication of performance indicators:

- Performance indicators are flawed and may be inaccurate. Given the potential for harm to at least some institutions, it would be morally troubling to publish indicators when their accuracy is in question.
- Once data have been collected and compiled, it is paternalistic to then decide—as is done in some countries—that only certain stakeholders (for instance, schools or policy-makers) and not others can have access to them.
- The 'naming and shaming' approach, in accordance with which some schools are labeled as 'failing' to exert market-like pressures, can have negative consequences for an education system as a whole. Some schools will unavoidably receive lower ranks than others, so some will necessarily fall at the bottom. A ranking system obscures the fact that what matters most is not where schools rank but whether or not they meet the standards considered as important.
- Computing meaningful performance indicators requires spending public money on the building and maintaining of large data banks. In turn, the publication of these ratings is expensive, while the resulting revenues are uncertain.
- The publication of school performance indicators poses in especially stark form the question of the relationship between the parallel goals of evaluation and improvement. Without external pressures exerted by the market and by the

public (perhaps motivated by the availability of performance indicators), schools may be less inclined to make improvements in light of performance evaluations (though some schools do improve in response to confidential performance reviews). On the other hand, however, schools, like other public sector organizations, may react to the publication of performance indicators by focusing their efforts primarily not on the improvement of educational quality but on raising their public performance rankings.

The effects of publication on parents and schools

It is important to note that the consequences of public school performance indicators are not a function of the indicators alone, but also of the interaction between four groups of factors:

- *The nature of the information published*; for instance, raw school performance scores may have a stronger negative impact than value-added data, and publications may differ in the extent to which they define the problem or outline the remedies (global versus detailed information);
- *The way in which the information is fed back to intended users*; for instance, whether they are accompanied by explanations of what the data mean and how they may be used, or whether complicated indicators are used in combination with a 'drop and run' strategy;
- *The degree to which intended users are free to choose*. This includes both the nature of the local school market and the school alternatives available to parents and students when they determine that their schools are not performing well;
- *Actions taken by the system:* the extent to which systems take action to correct poorly performing schools, and the nature of this action.

In this article we shall mainly limit ourselves to the first two groups of factors influencing the impact of school performance indicators on parents and schools.

Parents

Broadly speaking, parents and students have two courses of action open to them if the quality of a public service is found wanting. Using Hirschmann's (1970) terms, parents have:

1. the *exit* option—that of looking for an alternative provider who can provide a better service;
2. the *voice* option—that of appealing directly to the institution providing the service.

Hirschmann's third category, the loyalty option, would apply when people are satisfied with the quality of the service, or they are especially loyal to a particular provider for reasons such as religion. Hirschmann—who focuses on the ways consumers respond to a deterioration in the quality of production of goods and services—explains that the option to which consumers appeal depends not only on the choices available to them but also on the characteristics of the consumers themselves. The exit and voice options, for instance, are determined by economies of scale, legal

opportunities, spatial barriers, information asymmetry and the income and education of consumers (Paul, 1991).

The research into the responses of parents to the publication of school performance data in the United Kingdom and France has not been thorough enough. Most research has focused on the freedom parents and students have to choose schools, as part of broader studies on increasing school choice that have been conducted in both countries since the early 1980s.

FRANCE

In France, there is currently a limited amount of school choice. In the early 1960s, the *carte scolaire* (literally 'school map') policy took away the right to choose, requiring students to attend specific schools in their districts. The policy was intended to promote better central planning and to counteract geographical differences and disparity in quality between schools. In response to major demonstrations against the socialist government's 1984 plans to abolish the specific status of private schools, experiments with limited school choice were introduced. Parents began to be given the possibility of choosing from several schools within a geographical area. This semi-experimental policy of desectorization has been systematically extended and broadened and currently covers approximately one-half of all secondary schools in France. (The Ministry of Education, however, has been unwilling to provide exact figures.)

A number of French studies (Ballion, 1986, 1989, 1991; Broccolichi & Van Zanten, 1997; Pincon & Pincon-Carlot, 1989) have shown that the behaviour of families in relation to school choice varies according to social class.

People higher on the socio-economic scale have a broader choice of 'good' schools and worthwhile curricula options than the middle (or lower) classes. This is largely a result of geographic location. In Paris, for instance, the highest concentration of very good lycées is in the wealthier fifth and sixth districts. In these kinds of areas, school selection is most often based on school selectivity indicators. School choice in more socially heterogeneous, 'middle class' areas (where there are fewer 'good' schools to choose from) is based on a wider variety of strategies. Some parents try to have their children excepted from the school map, perhaps by choosing unusual subject combinations for their studies, thus enabling them to attend schools outside of their own districts. Some try to make arrangements with school principals and some even resort to fraud, such as using false addresses. Publications dealing with school quality appear to be the most important for this segment of the population.

Survey results show that people in the lowest social classes generally make the least amount of effort to enrol their children in better schools (Ballion, 1986, 1991). This is for obvious reasons. People in this group generally have less time, energy and resources available to them. They are less likely to have the means to live in better neighbourhoods or even to transport their children to better schools farther away. Moreover, they are also less likely to be informed about the quality of schools and the possibilities for choice. Where people in this group do make efforts to avoid

certain schools, the reasons have more to do with student composition and issues such as violence at school rather than educational quality.

THE UNITED KINGDOM

Although the term 'choice' is absent from British education law (Morris, 1995), all reforms since the 1980s stress parental choice. Section 6 of the 1980 Education Act imposes a duty upon every local education authority (LEA) to make arrangements for parents to express their preferences regarding the schools their children attend. Furthermore, an LEA must honour a parental preference except when a school:

- has reached its enrolment capacity (this exception was subsequently refined in 1988 and 1998 to avoid arbitrariness in admission policies);
- is a denominational or charitable institution and the prospective student is not affiliated with the sponsoring organization;
- is selective and the applicant does not meet the selection criteria (about 5% of secondary schools are selective 'grammar schools').

In 1989, the courts ruled that parents cannot be forced to send their child to local schools within particular catchment areas (Woods, Bagley & Glatter, 1998).

Nonetheless, in the United Kingdom, schools generally admit pupils based on social selection in response to market forces in the education sector, of which league tables are a component. In response to these tables, middle-class parents, in particular, work hard to ensure that high-scoring schools admit their children. Of note, performance as measured by examination results appears to be only one of many factors parents consider when choosing schools. While a large proportion of parents find published performance indicators useful, the extent to which a school is 'child-centred' seems to be more important to parents than the extent to which it is focused on academic achievement—as evinced by examination performance data (Woods, Bagley & Glatter, 1998).

Despite the availability of opportunities for choice, many parents, especially among the lower classes, seem unaware of publications that might help them assess school performance (Foxman, 1997). Some researchers (West, Pennel & Noden, 1997, 1998) have proposed various methods to achieve more objective and fair admission procedures with equal school choice opportunities for all pupils and parents.

The ways in which parents choose schools and schools admit pupils in an educational environment with market features tend to reinforce inequalities between schools and between families (Gewirtz, Ball & Bowe, 1995). An important question is to what extent the government can (and should) use regulation to counteract the negative byproducts of an education system geared to educational consumerism.

Schools

Woods, Bagley & Glatter (1998) present a framework for analysing how schools may respond to changes in the local 'market' (that is, other schools, parents and

pupils) in which they operate. They distinguish the following responses: (a) promotional activities to present the school in the best light possible; (b) environmental scanning to gain better understanding of their own potential position within the 'market'; (c) substantive changes in the curriculum, the mission, the composition of the pupil population (through admission criteria), as well as reorganization and acquisition of new equipment; (d) structural changes in the administration or status of the school; and finally (e) changes in resource management (personnel policy). Similar responses can be expected to the publication of comparative school performance data, especially when existing relationships are affected, for example, if a school in a very competitive environment emerges as significantly better or worse than others. The pressure to respond will, therefore, vary according to the size and nature of the local market.

In addition to market incentives, a great deal also depends on the powers of the LEAs and OFSTED. If they react to the published data or make use of them in some way, schools will be more ready to respond.

FRANCE

Looking at the situation in France, we must point out, first of all, that differences between schools in France are not something new, certainly not in the big cities where for years certain *lycées* have prided themselves for their outstanding reputations and their roles as producers of France's elite. These *lycées* have practised selection for years, both in their admissions policy and in their behaviour toward students throughout the education process. What has changed is that since the 1980s, other schools have adopted strategies to 'regulate' their intake, within the limited opportunities available to them, and to satisfy parents who are increasingly behaving as consumers (Ballion, 1989). The best-known ways of doing so are the establishment of streams or 'elite' classes, offering unusual subjects (e.g. Russian), the closing of unpopular departments, focused examination preparations and the exclusion of 'difficult' pupils. The extent to which these strategies are being encouraged by the publication of performance data on schools is not easy to demonstrate. Nonetheless, it is obvious that the annual publications, including those showing the added value offered by schools, certainly do not do anything to reduce the negative processes described above.

THE UNITED KINGDOM

Research on school responses to performance indicators in the United Kingdom also shows that these are strongly dependent on local market characteristics (e.g. the degree of competitiveness between schools) and on the activities of the various parties (e.g. the LEAs and OFSTED). Observed school responses largely fall into two categories: promotional activities and substantive changes.

In order to 'inform' parents and pupils many schools are spending a good deal of money on promotional activities or marketing (Woods, Bagley & Glatter, 1998; Gewirz, Ball & Bowe, 1995), often producing expensive, glossy brochures. Schools

produce this promotional information despite common sense understanding and research results (Ball & Vincent, 1998) demonstrating that the reputations of schools depend more on social networks. Information gained socially is clearly the most valued and most crucial for consumers in their choice making.

Substantive changes made by school systems rarely focus on the curriculum and the primary process. The most important substantive changes are those geared toward influencing pupil intake. As Ball (1999, p. 93) puts it: 'it is not so much what the school can do for its students but what the students can do for their school.' Because disruptive pupils can affect the learning of a large proportion of a class, schools are more inclined to exclude them. According to Gillborn (1996), the graph of permanent exclusions shows a considerable steepening of the gradient of increase in the year the league tables were first published. Other 'improvement' strategies are denying pupils entrance to exams when they are deemed unlikely to achieve high scores. Sometimes students are even denied access to a GCSE-course, told they cannot increase the number of subjects taken, or encouraged to include subjects which are regarded as less difficult (Foxman, 1997). Based on the literature, the most frequently noted effect of league tables on secondary schools is that of targeting those pupils likely to be at the GCSE-grade C/D borderline for a particular subject (Fitz-Gibbon, 1996; Gray, 1996; Ball, 1999). Foxman (1997), however, remarks that it is not clear in how many schools this happens, and to what extent it is at the expense of other pupils.

The other possible school responses mentioned by Woods, Bagley & Glatter (1998), 'environmental scanning', 'structural changes in the administration or status of the school', and 'different personnel policy', were scarcely found if at all. Within the English context of promoting market ideology, it is striking that schools are emphasizing educational performance above all and are paying less attention to child-centredness, the very thing that appears to be more important to parents.

Conclusions

As we have shown, the publication of school performance data raises serious technical-analytical, usability, and political-ethical and societal problems. Those who defend the computation and publication of school performance indicators often argue that they enable parents and students to be better informed about educational institutions and thus help them make knowledgeable choices among schools. Research on how parents and pupils in the United Kingdom and France choose schools does not demonstrate conclusively that the publication of school performance data has a major influence for most parents on the school choices of families, for several reasons:

- A significant proportion of parents do not realize that school performance data are available or cannot readily obtain these data;
- Understanding school performance data requires a degree of training many parents may not possess;
- It is not always easy for parents to use school performance data in ways relevant to the circumstances and needs of their own children;

- Even when parents do understand school performance data, they cannot always make use of these data because alternatives are limited (due to geographical boundaries, limited provision or formal and material constraints);
- Focus is primarily on the exit option while opportunities to use the voice option remain unexploited.

Nonetheless, middle-class and upper-class parents (the ones who buy the newspapers in which school performance data are published) in France and the United Kingdom do use published performance data. These parents (especially middle-class parents living in socially mixed areas where there has traditionally been little diversity of school choice) generally invest more time, energy and resources than lower-class parents in selecting schools for their children. Their investment also extends over a longer period of time: if, for whatever reason, they do not get their first choice of school, they persist longer in trying to get around the situation.

Especially in school systems where there are significant formal and/or material limits to educational provision, the middle-class parents who seem to be the most influenced by school performance indicators may engage in a variety of inappropriate behaviours. They may use false addresses; seek to position their children as interested in unusual subjects (or subject combinations) to increase their chances of admission to higher-rated schools; demand streamed homogeneous classes for their children; and protest against allocations. It is reasonable to expect comparable behaviour on the part of similarly situated parents in other countries. We can be certain, in any case, that middle-class parents will make more use of performance data than lower-class parents and will be more equipped to take advantage of school choice options. We can also be confident that they will be more likely than lower-class parents to demand streaming or tracking in schools.

Even though there are widespread doubts about the usefulness of the published performance indicators currently available, schools do try to find strategies to improve their reputation or position in the rankings. A common strategy is to regulate student intake. Private schools and selective public schools have always been free, in general, to admit students on the basis of their academic abilities. Now, however, previously non-selective public schools are now attempting to increase the proportions of academically capable students they admit, and thus their position in the rankings, by initiating streaming or 'elite' classes. Other possibilities with similar effects include the creation of unusual subject options (as is done in France); the development of focused examination preparation programmes; the concentration of instructional time and resources on 'borderline' pupils, in a kind of academic sorting; and the exclusion of 'difficult' pupils. The short-term effects on performance levels possible through such strategies do not outweigh the more long-term negative consequences. Again, we suspect that parallel phenomena will be evident in other countries in which school performance indicators are published.

The publication of school performance indicators causes a variety of problems. It is unlikely that current performance assessment programmes will contribute positively to the improvement of school performance.

Note

1. This study was commissioned by the Dutch Advisory Council for Education, the most important body advising the Dutch government on educational matters. The publication by a number of newspapers (beginning in 1997) of data on school performance collected in the course of state inspections of primary and secondary schools served as the initial impetus for the study. In the meantime, the Office for Standards in Education has also started publishing so-called school quality cards.

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J. KRISHNAMURTI

(1895–1986)

Meenakshi Thapan

The impact of the philosopher J. Krishnamurti on the educational ethos of alternative Indian education has been of an unquantifiable quality, although this is often not visible in the formal components of secondary school education. Krishnamurti was not an educator in the narrow or formal sense of the term, as he had no formal qualifications to either propagate or promote educational goals or establish educational institutions. His concern for what he considered 'right education' was clearly not an attempt to provide temporary solutions to society's problems or seek to correct them through merely educating people to read or write. Krishnamurti has been described as a 'revolutionary teacher [...] who worked tirelessly to awaken people—to awaken their intelligence, to awaken their sense of responsibility, to awaken a flame of discontent', and this commitment to awakening the consciousness of people was undoubtedly based on a 'strong moral passion' (Herzberger & Herzberger, 1998). It is Krishnamurti's moral passion that formed the basis for his relentless pursuit of the 'good society' that was grounded in 'right values' and 'right relationships'.

Krishnamurti was a philosopher whose passionate search for the 'good society' was not grounded in any particular religious or philosophical tradition. He did not seek to follow any specific path for bringing about 'goodness' in both individuals and society. In this sense, he did not rely on an external instrument or tool for existence

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but on an inner discovery that sought to go beyond the physical body and bring about a 'mutation' in the human mind.[1] Change was therefore not possible through external means, whether these were political revolutions or social movements, but only through a complete transformation of human consciousness. This transformation did not include the use of mechanical practices, such as any form of religious ritual or attachment to a dogma. On the contrary, Krishnamurti encourages 'critical looking' or 'choiceless awareness' (Martin, 1997, p. xi), rather than the more commonly known process of 'critical thinking', as a mode of self-discovery.

In India, Krishnamurti appeared a rather forbidding philosopher who advocated no crutches of either a spiritual or an emotional nature and certainly did not allow any psychological or intellectual attachment to himself as a teacher. Moreover, he seemed to be setting a rather difficult task, especially since Hindu tradition in India allows for ritual, belief and unquestioning devotion to a teacher as instruments for psychological, spiritual and social well-being. Krishnamurti's break with tradition and all forms of authority, however, characterizes his strength as a philosopher, for he was like a breath of fresh air to those who had been trying to fathom the depths of both consciousness and existence following traditional paths of understanding.

The 'good society'

In his pursuit of the 'good society', Krishnamurti emphasized the individual's relationship to society as well as his or her responsibility for establishing the 'good' society: 'You are the repository of all humanity. You are the world, and the world is you. And, if there is a radical transformation in the very structure of an individual's psyche, it will affect the whole consciousness of man' (Krishnamurti, 1993, p. 133–34).

In his emphasis on change, Krishnamurti expressed a lifelong moral concern for the 'good' society :

> [We] are concerned with a different way of living [...] a good society. The speaker is concerned to bring about a good society where there would be order, peace, some kind of security, some kind of happiness, and go beyond all that, enquiring into that which is immeasurable. We must have [...] a society that is essentially good [...] without violence, without the contradictions of various beliefs, dogmas, rituals, gods, without national economic divisions (Krishnamurti, Ojai, 1979, quoted by Herzberger and Herzberger, 1998).

This kind of society is clearly a society in which caste, class, linguistic and regional divisions would cease to exist. Krishnamurti's emphasis on 'goodness' as the foundation of this new society underlies his plea for a society devoid of any kinds of contradictions or dichotomies. A society without 'national economic divisions' undoubtedly implies a classless society, and this aspect of Krishnamurti's thought indicates his rather obvious concern for the ending of economic and social inequalities based on material power. However, the important point is that Krishnamurti emphasized that none of this could come about without an inner renewal or change.

Krishnamurti's discomfort with the present world order stemmed from his understanding of the human condition wherein no one is truly happy but ensnared within a psychological world of sorrow, jealousy, pain, anger, envy and troubled relationships. This inner turmoil, Krishnamurti understood, could not lead to harmonious relationships or a good society. It could only create conflict and contradictions that resulted in fragmentation and chaos. These conditions in turn led to exploitation, oppression and war. This was the basis of Krishnamurti's search for a new or different kind of society that would result in harmony and well-being among individuals or groups of individuals.

The 'good society', as Krishnamurti envisaged it, certainly represented a way of 'being' and 'doing' in this world and was not some distant dream or utopian ideal that he sought to arrive at through a gradual process of change. He has often been described as an utopian idealist in his search for the good society in the midst of modern social turmoil and psychological chaos. However, he was emphatic in arguing that 'On paper we can draw a blueprint for a brilliant utopia, a brave new world but [...] our problems exist in the present and it is only in the present that they can be solved' (quoted in Martin, 1997, p. 11). It is therefore an urgent task that has to be understood and acted upon immediately. The 'urgency of change' was a constant refrain in Krishnamurti's talks given to the public and to teachers and students in the schools he established in India, England and the United States.

In his quest for the good society, Krishnamurti did not seek some kind of power, authority or legitimacy through the establishment of schools as organizations for the transformation of human beings. In fact, he abandoned formal organizations in 1929 and shunned any attempt to canonize or formalize the pursuit of the good society, which he considered possible only through an inner renewal. How, then, did Krishnamurti see education as holding the key to real change, both from an inner revolution and in society? More curiously, why did Krishnamurti seek to establish schools, as communities of people working together, as a step towards bringing about the 'enlightenment' of human beings? The answer is not as contradictory as it appears, for Krishnamurti's approach to a holistic education is essential for an inner renewal that can effect social transformation and indeed lead to societal change.

About Krishnamurti

J. Krishnamurti was born on 11 May 1895 in Madanapalle in the state of Andhra Pradesh, southern India, close to the Rishi Valley Education Centre, an institution he established in 1928. His father was an official in the Revenue Department of the colonial administration and Krishnamurti was one of five children. After his retirement from public service, Krishnamurti's father offered his services to the Theosophical Society in Chennai (then called Madras) in exchange for accommodation for his sons and himself.[2] They eventually moved to Adyar, Chennai, in 1909 (Lutyens, 1975, p. 8). In the early years of his youth, Krishnamurti and his brother, Nityananda, were adopted by Dr. Annie Besant, the President of the Theosophical Society, who saw certain spiritual qualities in him that set him apart from others. This further

resulted in Mrs. Besant and other theosophists proclaiming Krishnamurti as the vehicle for the World Teacher who was coming, in their words, to bring salvation to mankind. To prepare the world for the coming of this World Teacher, an organization called the Order of the Star in the East was formed in 1911 with Krishnamurti at its head. The role of World Teacher and spiritual leader was thrust upon Krishnamurti at a relatively young age and this daunting task must have undoubtedly influenced his own psychological development. This process did not, however, create the World Messiah and nor did it lead Krishnamurti to announce or proclaim his superiority over others. In fact, it had the contrary effect.

Although Krishnamurti underwent all the training and education befitting a budding World Teacher, he developed an independent perspective both about the nature of inquiry and about his own role in the pursuit of the good society. On 3 August 1929, in a historic and powerful speech, Krishnamurti dissolved the Order of the Star :

> I maintain that Truth is a pathless land, and you cannot approach it by any path whatsoever, by any religion, by any sect [...] Truth being limitless, unconditioned, unapproachable by any path whatsoever, cannot be organized; nor should any organization be formed to lead or coerce people along any particular path [...] My only concern is to set man absolutely, unconditionally free (Krishnamurti, 1929).

By breaking away from the Theosophical Society and its organizational trappings Krishnamurti asserted his independence, and his 'teachings', so to speak, unfolded over the remaining years of his life. Krishnamurti did not assert himself as a Teacher of Truth whose teachings had to be followed to attain Nirvana or self-understanding. He questioned whether such authority could actually initiate individual perception and change. The 'journey of understanding', therefore, has to be made by oneself, which means that one has to discard every kind of authority: 'to be a light to ourselves we must be free of all tradition, all authority, including that of the speaker, so that our own minds can look and observe and learn' (Krishnamurti, 1972, p. 52).

Krishnamurti rejected the view that the 'teaching' is something that has to be first studied and then translated into action. On being asked what his teaching was, he said that it was a matter of partaking or sharing together rather than the giving or receiving of something. There is also an emphasis on the instantaneous nature of the transformation: it is 'not something that is accomplished gradually through striving, seeking and bringing one's life, one's conduct and thought by degrees more in conformity with some ideal' (Holroyd, 1980, p. 35). The state of 'becoming' or 'being' does not exist for Krishnamurti: it is more a state of timelessness, as it were.

Krishnamurti's quest for self-knowledge or self-discovery does not take one very far from oneself. It is in this sense that, as Krishnamurti often said, 'the teachings are yourself'. There is also no culmination of this process of self-discovery: 'there is only the journey. There is no total knowing of oneself but rather an unending process of knowing oneself' (Jayakar, 1986, p. 82).

Right education

Education forms a central core of Krishnamurti's world view. In fact, Krishnamurti spent his entire life talking about education as being the agent not only of inner renewal but also of social change. Education is therefore the foundation on which the good society will build itself. Krishnamurti always asserted the individual's responsibility to the social order: 'You are the world'. One individual's action therefore affects another, since 'to be is to be related' (Krishnamurti, 1970, p. 22), and in this sense there is no individual consciousness but only a collective human consciousness, which implies that the world is not separate from the individual. Krishnamurti points to the harmonious development of the inner and outer worlds of an individual: 'what one is inwardly will eventually bring about a good society or the gradual deterioration of human relationship'. This harmony, however, 'cannot possibly come about if our eyes are fixed only on the outer'. The inner world is the 'source and continuation of the disorder', and for Krishnamurti education should be concerned with changing the source which is the individual, since it is 'human beings who create society, not some gods in heaven'(Krishnamurti, 1981, p. 93–94).

Krishnamurti asserted that the schools functioning under the auspices of the Krishnamurti Foundation India (KFI), some of which were established in his lifetime, did not exist as organizations for the indoctrination of children, but rather as places 'where students and teachers can flower, and where a future generation can be prepared because schools are meant for that' (ibid.).[3] The notion of 'flowering' here implies an unfolding of the consciousness of individuals in relationship to one another in educational praxis. The psychological development of individuals is therefore as important as acquiring academic knowledge and skills. The intention of the KFI schools is that they 'are not only to be excellent academically but [...] are to be concerned with the cultivation of the total human being' (ibid., p. 7). These schools 'fundamentally exist to help both the student and the teacher to flower in goodness. This demands excellence in behaviour, in action and in relationship. This is our intent and why these schools have come into being; not to turn out mere careerists but to bring about the excellence of spirit' (ibid., p. 14–15).

At his talks given to teachers and students at the two KFI schools in India where he made annual visits—Rishi Valley School in Andhra Pradesh and Rajghat Education Centre at Varanasi—Krishnamurti often asked the students questions about the meaning of education, the quality of education they received, the teachers' roles and attitudes, and their own contribution to the learning process. He discussed with them the purpose of education—not merely to pass examinations after learning a few facts and acquiring some skills, but to understand the complexity of life. He urged the students to appreciate their role in the creation of a 'new' world without fear, conflict or contradiction. This could only be done if there was 'right education' in an atmosphere of freedom, without fear or authority, where intelligence and goodness could be nurtured.

Talking to students, Krishnamurti reiterated that what education normally does is prepare students to fit into a 'particular frame or pattern, that is, the movement in a predetermined groove' and this is what society calls 'entering life' (Krishnamurti, 1993, p. 33). With such an education, the student meets life, which is 'like a little river meeting the vast sea' (ibid., p. 34). However, such an education does not necessarily prepare the student to meet the psychological challenges and physical vicissitudes of life.

It is important that education should in fact 'awaken intelligence' and not simply reproduce a programmed machine or trained monkey, as Krishnamurti put it. Education therefore cannot be only about reading and learning from books but about the whole of life, and should prepare students to meet the challenges of living in a complex social world. Krishnamurti's views on how to do this, however, are rather extraordinary in their very simplicity. For example, in response to a student's question about how to live happily in a competitive world, Krishnamurti observes, 'You can live happily in this competitive world only if you yourself are not competitive' (ibid.). It is possible that such a response may be contentious to the extent that it may be perceived as being unrealistic in terms of the complex nature of society, where a non-competitive member could at best only survive, not really exist. But Krishnamurti's argument is that 'competition is the very essence of violence [...] Our whole social structure is based on competition and we accept it as inevitable' (ibid.).

As an alternative to competition in everyday life, Krishnamurti emphasizes confidence—not self-confidence, but 'an entirely different kind of confidence which is without the sense of self-importance [...] confidence without the self' (quoted by Shirali, 1998). Comparison between children becomes important when their performance is judged and evaluated continuously, and this comparison is the cause of conflict, fear and a feeling of helplessness among them. Teachers in the KFI schools are therefore concerned with whether such comparison can cease in the school and in the classroom, and talent can be nurtured and allowed to grow without being captured by the self.[4]

Krishnamurti also examines the nature of human feelings and asserts that we do not really know how to 'feel' anything. It is important to experience feelings which are in fact the 'substance of life'. The role of 'right education', then, is to make the individual 'highly sensitive to everything—not just to mathematics and geography [...] because the highest form of sensitivity is the highest form of intelligence' (ibid., p. 70). For Krishnamurti, therefore, the right kind of education does not simply produce engineers, doctors or scientists, but a 'human being who is alive, fresh, eager [...] If one is a human being, one is not a specialist, but a total entity' (ibid., p. 75). An 'educated mind' is one that 'thinks, that is active, alive; it is a mind that looks, watches, listens and feels' (ibid., p. 76).

Krishnamurti's talks at the educational institutions run by the KFI included the teachers, whom he considered crucial to educational praxis. In these talks, Krishnamurti was really addressing the larger question of the human predicament in terms of the transformation of psychological consciousness that is not, however, an isolated, individualistic act. Also, this change does not rest on some kind of

psychological or spiritual 'mumbo-jumbo', as Krishnamurti used often to point out, but on the important element of 'relatedness' between human beings, whereby we are engaged with the community as well as the environment around us. This has ensured that the KFI schools focus significantly on issues relating to ecology and the community of people around them.

The KFI schools

The KFI was established originally in order to set up an educational institution—the Rishi Valley Education Centre in Andhra Pradesh. The origins of the KFI also lie in Krishnamurti's links with the Theosophical Society. Dr. Annie Besant (President of the Theosophical Society at the time) was one of the seven founder-members of the KFI, which was originally a charitable institution under the name of the Rishi Valley Trust, set up by Krishnamurti in 1928. Later, this Trust became the Foundation for New Education (in 1953) and eventually the Krishnamurti Foundation India in 1970. The work of the foundation includes education, research and environmental programmes that are conducted in an overall perspective deriving from Krishnamurti's thought. Another major KFI activity is the preservation, acquisition and publication of Krishnamurti's works and materials relating to his life. Study centres and retreats have also been set up at most of the school locations to enable people to be in places of great quietude and natural beauty for study and reflection. As part of its initiative in the field of education, the KFI has also been bringing out an annual publication, *Journal of the Krishnamurti schools*, since 1997. The volumes are unique in their attempt to document and create innovative and critical pedagogies as part of a process of educational transformation.

The KFI has focused on education to a large extent, and this resulted in the establishment of two more schools in India, in addition to the existing five, after Krishnamurti's death in 1986. A significant aspect of the schools is their location in places of great natural beauty and splendour. This is a result of Krishnamurti's emphasis on learning in natural surroundings, as well as the importance of physical space, to ensure harmony in relationships and in developing a questioning, creative mind.

It appears that in the 1920s Krishnamurti was inspired by the University of Berkeley in California, which influenced his decision to set up educational institutions in his own right (Chari, 1993, p. 3). Two hundred and twenty-five acres of land were acquired at Varanasi (originally Kashi, a holy city in Uttar Pradesh, northern India) and between 1928 and 1948, a co-educational boarding school at Rajghat—the Rajghat Besant School—was built (ibid.). Later, the Vasanta College for Women was also located at Rajghat. In its early years, this college developed an excellent reputation for being among the premier educational institutions for women in northern India that not only provided undergraduate education for women but also had a teacher-training programme for secondary school education.

At about the same time, in Chennai, the idea of developing an educational centre around Madanapalle, Krishnamurti's birthplace in Andhra Pradesh, was gath-

ering momentum. It is believed that Krishnamurti started surveying the land in and about Madanapalle in 1925 and selected what is now known as the Rishi Valley Education Centre after viewing from a rock the vast panorama of a valley stretching to the west with Rishi Konda (literally, the hill of the Rishi) at its apex. The presence of a large banyan tree in the valley, believed to be about 300 years old, is said to have influenced Krishnamurti's decision. Between 1926 and 1929, 280 acres of land were acquired for the proposed centre (Thapan, 1991, p. 30) and the Rishi Valley School (another boarding school) came into being in the early 1930s.

Two other day schools were set up in the early 1970s in Bangalore and Chennai under the auspices of the KFI, as well as an after-school care centre for underprivileged children in Mumbai (Bombay). The schools at Bangalore and Chennai are also located on large campuses of 110 acres and 14 acres respectively. Among other school subjects, environmental studies is an important focus of study in both, as in other KFI schools. There is a strong emphasis on environmental renewal through bringing together education and conservation. This element has no doubt been helped by the physical location and environment of these schools, which serve to enhance a sensitivity to nature and the environment.

At the KFI schools, there is certainly a formal curriculum affiliated to a centrally administered, or state-level, education board, with public examinations at the end of Class 10 and Class 12. In this sense, the schools are perhaps not very different from other private schools in India. There is, however, a significant difference in the manner in which learning takes place—through exploration and discovery—and in the nature and quality of interaction between teachers and students. Also, there are a variety of co-curricular activities and programmes that, in addition to their focus on the arts, engage students creatively in their immediate environment. Furthermore, there is a definite attempt to help students understand their psychological world and share their inner discoveries and problems. The focus at these schools is therefore not only on academic excellence but also on trying to develop and nurture a different quality of mind that will be in harmony with the external world.[5]

Two more schools were established by the KFI after Krishnamurti's death in February 1986. The more recent Sahyadri School near Pune, Maharashtra, is a boarding school, started in 1995. Like other KFI schools, this school caters to children from fairly upper-class backgrounds, as all these schools are fee-paying, private schools. Two other schools, however, Bal-Anand in Mumbai and the Bhagirathi Valley School in Uttar Pradesh, enrol children from underprivileged and lower middle-class backgrounds. Critics have often said that Krishnamurti was unconcerned with poverty and issues relating to economic and social inequality in Indian society. While he was not directly concerned with the practical, or indeed activist, dimension of removing socio-economic disparities or inequalities, he was deeply concerned about the problem of human relatedness that encompasses the rich and the poor alike.

In his talks given to children at the KFI schools, Krishnamurti would often ask students to experience the world around them more meaningfully and realistically. If their minds were locked in narrow grooves of bookish learning and in the trap-

pings of a privileged upbringing, Krishnamurti sought to take them out of their narrow perspectives into the larger world around them.

Clearly, there are certain limitations in implementing Krishnamurti's perspective on education in State-funded schools in India, where certain basic necessities and infrastructure such as safe drinking water, toilets and large spaces simply do not exist. A minimum structure is thus necessary before teachers and students can work together for 'right education'. The obvious implication is that KFI schools are therefore the only places where Krishnamurti's perspective can be shared and developed. It is possible, however, that there are certain universal features of the KFI schools that can easily be shared with, and developed by, other schools. These include an abiding interest in and commitment to the environment and the community in which the KFI schools are located.

Krishnamurti's legacy to education in contemporary India

From 1929, when Krishnamurti declared that his only concern was to set man totally free, 'freedom' as a state of being was central to his view of life. Evidently, he developed his 'celebrated doctrine of freedom against the background of an abiding love of nature and a firm commitment to individual responsibility in working towards a better society and protecting our natural heritage' (Herzberger, n.d.). This is reflected in the strong commitment to the habitat and the environment within the KFI schools' curricular frameworks. It has been suggested that this commitment points to 'new policy goals for education in India—goals that give priority to the Indian earth rather than to the Indian *nation*' (Herzberger, 1999, p. 10). This in turn would lead to a new curriculum in Indian schools focusing on 'sustaining the earth' (ibid., p. 11). To this end, the schools recently organized a workshop on biodiversity and conservation issues with the goal of exploring 'the possibility of modifying the existing school curriculum to reflect the concerns of an Earth-centred outlook' (Iyer, 1999, p. 76). The workshop identified certain key principles for developing an earth-centred curriculum in secondary schools and an attempt was made to actually redefine the current curriculum without compromising the conceptual frameworks of disciplines such as biology, chemistry and physics.[6] By enhancing children's understanding of the earth's vulnerability and its relationship to different subject disciplines in very concrete terms and in students' engagement with teachers in, for example, reforestation projects, the KFI schools pose a challenge to conventional pedagogy in schools across India.

Learning, therefore, in the KFI schools is not just about ideas or facts in books, but is also about feeling the earth, watching the sunset, listening to the birds, seeing the colours of the leaves change in the different seasons and observing nature in its many colours, forms and shapes, not as a romantic naturalist but in harmony with what is being observed. From this harmony, a sense of responsibility towards the earth and a commitment towards life on earth will evolve. The KFI school in Chennai has in fact developed a formal curriculum for environmental studies as an optional subject

at the senior secondary school level, which has been accepted and granted recognition by the Indian Council for Secondary Education (ICSE) for use in all schools affiliated with the ICSE.[7] This has undoubtedly been a major contribution by the KFI schools to the senior secondary school curriculum in India and has wider ramifications in terms of developing the potential for developing a perspective and lifestyle that support ecological balance and emphasize the sustenance of the biosphere.

It is true that very few schools in India have included environmental and social concerns directly in the curriculum. There is a component of 'socially useful productive work' in secondary schools that enables students to engage in a variety of activities, from gardening to community service, on a fixed and somewhat formal basis. It is here that KFI schools have made another contribution to educational processes in terms of the school's relationship with the community. Taking the cue from Krishnamurti's emphasis on an individual's relatedness to society, the KFI schools undertake projects with the local community and try to establish a wider network of relating to the community that goes beyond mere 'community service' as an aspect of the formal curriculum.

The Rural Education Centre (REC) at the Rishi Valley Education Centre in Andhra Pradesh has grown and expanded from providing quality elementary education to the children of workers and of neighbouring villages to being part of a larger network of schools spread over the surrounding villages. The REC infrastructure now includes two demonstration multi-grade schools, sixteen multi-grade satellite schools within a radius of fifteen kilometres, a teacher-training centre, a curriculum development cell and a vocational training centre. In response to the dismal learning conditions in rural classrooms, where there is high absenteeism, low motivation levels, high drop-out rates, bored and demotivated teachers and an acute shortage of funds, an alternative approach to elementary education has been planned. This approach focuses on the preparation of high-quality, individualized self-learning materials, community involvement and teacher development (Rishi Valley Education Centre, 1999). Rather than relying on formal textbooks that are often unrelated to children's lives, the focus has been on designing material and methodology that are most useful, meaningful and successful as a pedagogical tool. This has resulted in the now well-known 'School-in-a-Box' material, which is being used in elementary schools all over Andhra Pradesh. This REC project has now greatly expanded, and the REC also provides its expertise in rural elementary education to other agencies—State-funded, non-formal or international—engaged in similar work in other states in India.[8]

Krishnamurti's perspective on education seeks to bring about a more just and humane society in a world that is rapidly degenerating. Krishnamurti saw the possibilities for radical change through human transformation. He had a holistic approach that did not seek to fragment human existence into the 'personal' and the 'public', but pointed to the relationship between the personal and the public, the individual and society. In this sense, his vision encompasses both our little individual spaces and the wide world of our relatedness to the community, the natural environment and human society.

In post-colonial India, there has been a major emphasis by the State on evolving an approach to education for the economic growth and social development of society; and in this process, the intrinsic worth of education—in terms of its greater transformational potential—for individuals who are privileged to have access to it has been lost. The emphasis on the socio-economic development of society has so far included the rhetoric of a holistic approach to education, taking into consideration all sectors, public and private, primary, secondary and tertiary, and encompassing teachers as well as students, the girl child and the ubiquitous backward castes. In practice, however, the scenario for elementary and secondary education in India is rather bleak. This is borne out not only by the numerous policy documents and reports available from time to time, but also by field studies undertaken by non-governmental organizations and individuals.[9]

A recent study conducted by the research and advocacy wing of the Society for Integrated Development of the Himalayas (SIDH), a voluntary organization, concludes that the 'present education system has failed in all respects' (SIDH, 2000, p. 50). This includes the economic dimension (failure to procure jobs), that of social returns (the literate person contributes very little to society) and the personal level (where the educated person is unable to provide financial or emotional support to his or her parents or family) (ibid.). This failure is a result of wrongly identified priorities set by the State to encourage not only social and cultural reproduction of a particular kind, thus ensuring widening socio-economic disparities, but also denial of the intrinsic worth of education in itself.

The only area where the State concedes space for individual growth and development is in the inculcation of 'values' through some kind of moral education. These values are defined in terms of certain prevailing social problems and do not seek to address fundamental issues that are common to all social relationships. For example, a current discussion document, released by the National Council of Educational Research and Training (NCERT) in New Delhi for evolving a National Curriculum Framework for School Education, notes 'the erosion of essential values and an increasing cynicism in society' and advocates value education that will 'help eliminate obscurantism, religious fanaticism, violence, superstition and fatalism' (NCERT, 2000, p. 12). 'Values' such as 'regularity and punctuality, cleanliness, industriousness/diligence, sense of duty and service, equality, cooperation, sense of responsibility, truthfulness and national identity' are recommended (ibid., p. 14). Quite apart from its being patronizing and prescriptive, this focus will clearly not effect a major change in individual consciousness unless there is clarity about the nature of inner renewal which we seek through education.

It is in this context that Krishnamurti's engagement with education is of paramount significance, namely his emphasis on the relationship between education and society in terms of the transformational potential of education. This aspect of Krishnamurti's teachings is the cornerstone of his educational thought and can make a significant contribution to evolving a sensible policy that concerns itself with change through 'right' education.

Notes

1. Krishnamurti, in fact, suggested that through an inner renewal, and the insights thereof, a change would actually occur in the brain cells and there would be a renewal of those cells (Krishnamurti, 1978). His biographer, Mary Lutyens, adds that it has been argued that Krishnamurti suggested that 'through insight it is possible for the brain to change physically and act in an orderly way which leads to a healing of the damage caused by all the years of wrong-functioning' (Lutyens, 1988, p. 19). David Bohm, the well-known physicist, has extensively examined Krishnamurti's perspective on a mutation in the brain cells and has concluded that 'modern research into the brain and nervous system actually gives considerable support to Krishnamurti's statement that insight may change the brain cells [...] There are important substances in the body, the hormones and the neurotransmitters, that fundamentally affect the entire functioning of the brain and the nervous system. These substances respond [...] to what a person knows and what he thinks, and to what all this means to him' (quoted in Lutyens, 1988, p. 19); see Bohm (1986). For his celebrated work in which he propounds a revolutionary theory of physics similar to Krishnamurti's perspective on the wholeness of life, see Bohm (1986). For a more recent work, see Krishnamurti and Bohm (1999).
2. The Theosophical Society was founded in the United States of America in 1875 by Colonel Henry Steel Olcott, who was interested in 'spiritualism and mesmerism', and Madame Helena Petrovna Blavatsky, who was considered a fraud but worshipped by her admirers as being a 'seer and miracle-worker whose occult powers derived from the highest spiritual source' (Lutyens, 1975, p. 10). The Society had three primary objectives, '1. To form a nucleus of the Universal Brotherhood of Humanity without distinction of race, creed, sex, caste or colour; 2. To encourage the study of Comparative Religion, Philosophy and Science; 3. To investigate the unexplained laws of nature and the power latent in man' (ibid.).
3. As I am most familiar with the work of the Krishnamurti Foundation India, I focus on the work of this Foundation, although there are similar Foundations in the United Kingdom and the United States of America.
4. See Shirali (1998) for a discussion of some of these issues.
5. The *Journal of the Krishnamurti schools* (published by the KFI in Chennai) documents some of the innovative methods being used by teachers at the KFI schools. In my study of the Rishi Valley School, I attempted an analysis of the nature of interaction between ideas and institutions, and among people in these institutions, as well as of educational practice at the school (Thapan, 1991).
6. At another level, Mathur (1999) discusses the possibilities of evolving a global outlook through the teaching of geography at a very local, regional level in the middle school curriculum.
7. The ICSE is one of the two central educational boards governing the public examinations which mark the end of the secondary (Class 10) and senior secondary (Class 12) examinations in India.
8. The expansion of the REC and the involvement with larger bodies engaged in similar work are discussed at length in Kumaraswamy (1997) and Rishi Valley Education Centre (1999).
9. The recent PROBE report (1999) is an attempt to document the education situation in five selected states of India. In addition, the radical *Economic and political weekly of India* (published from Mumbai) regularly carries articles and reports on educational practice in India.

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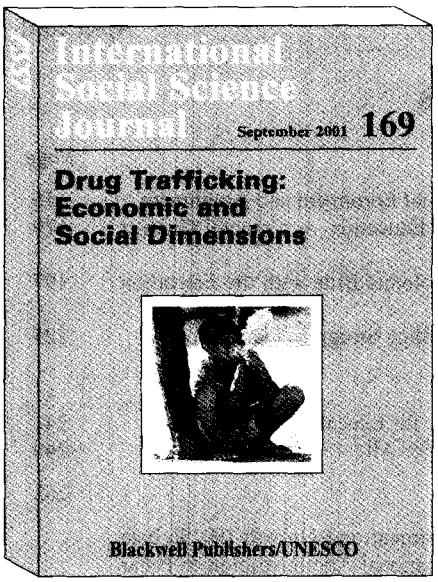

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