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Constructivism: uses and prospects in education

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CONSTRUCTIVISM AND EDUCATION

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 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 meeting, 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 educationist⁴—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 of the 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, 1977, 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 physical 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 four or five, 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 seven-eight 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 to 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 six, 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 educational 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 email 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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