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Some Interdisciplinary Instructional Models Used in the Primary Grades in Quebec

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Abstract: This article presents some interdisciplinary instructional models found in francophone literature on education. After a review of some basic distinctions between different types of interdisciplinary studies, a dozen instructional models are briefly presented and illustrated.

The AIM OF THIS ARTICLE is to present some of the main interdisciplinary instructional models dealing with primary education arising from the analysis of some 250 Quebec publications and about 100 from France all published between 1970 and 1990. These models are all in use, some very infrequently, others quite frequently, in primary schools in Quebec.

A brief differentiation is established among the various fields in which interdisciplinarity is practiced. Then several interdisciplinary instructional models are set out and briefly illustrated.

Various Interdisciplinary Fields

One hardly needs to be reminded of the various meanings of interdisciplinarity and the way the term is used (Lenoir, 1991b). However, as several authors have emphasized, among them Germain (1991) and Petrie (1992), the

concept of interdisciplinarity has meaning only in a disciplinary context: it presupposes the existence of at least two disciplines and a reciprocal action (Germain, 1991, p. 143). The term itself "inter-disciplinarity" points to this relationship. And Newell (1990) emphasizes the role of disciplines in interdisciplinary training: "Disciplines and not substantive facts are the raw materials of an interdisciplinary course" (73).

From that point of view, while scientific interdisciplinarity has for a long time been characterized by the tiring and often disappointing attempts to establish either a common methodology, or a common language, or common techniques or specific common objectives, or even a combination of some or all of the above, authors like Bastide (1967), Fourez (1992), Hubenthal (1994) or Vidal (1990) tend to defend the importance of maintaining disciplinary difference and of the beneficial tension between indispensable disciplinary specialization and the interdisciplinary approach which forces one to listen to the other, it understand the other's preoccupations, to grasp what is important for the other, to confront one set of knowledge with another, to share knowledge and establish bridges with a view to pursuing common goals, while maintaining as matter of principle the distinctive functions of each component, the way in which they complement each other in a spirit of exchange and collaboration which precludes the dominance of one over the other.

This reminder raises then the need to clarify the concept of discipline. Squires (1992) notes appropriately that studies on interdisciplinarity in the 1970's did not lead immediately to serious analyses of the nature of disciplines. In the field of education, the same happened in the French-speaking world with no studies on the nature and content of disciplines in school. The lack of distinction between the two types of disciplines, scientific and in schools, in addition to the absence of study of the concept of discipline itself led to simple transpositions from the scientific field to that in schools. Without getting into an extended discussion, we can no longer continue confusing the two. Numerous authors (Ball, 1990; Baron, 1989; Chervel, 1988; Cooper, 1983; Develay, 1992; Fourez, 1992; Goodlad, 1979; Goodson, 1981, 1983; Hebrard, 1988; Sachol, 1993, 1994, to name but a few), following an analysis of disciplines in primary and secondary schools, have been led to conclude that their content is quite different from that of scientific disciplines, that school disciplines follow a different internal structural logic, that they are constituted on the basis of distinct referential systems, that they rely on different modes of application and that, above all, they pursue different aims (Lenoir, 1995). In short, as far as primary teaching is concerned, interdisciplinarity deals with "school subjects," not scientific

disciplines. And school subjects, even if they are organized according to a schema which is similar or analogous without being identical to that of scientific disciplines (Sachol, 1994), and even if they borrow certain elements from scientific disciplines, are not exact copies and are not the result of a simple transposition of scientific knowledge. Several of these subjects have quite clearly separated themselves from their original discipline while others do not come from a scientific discipline at all.

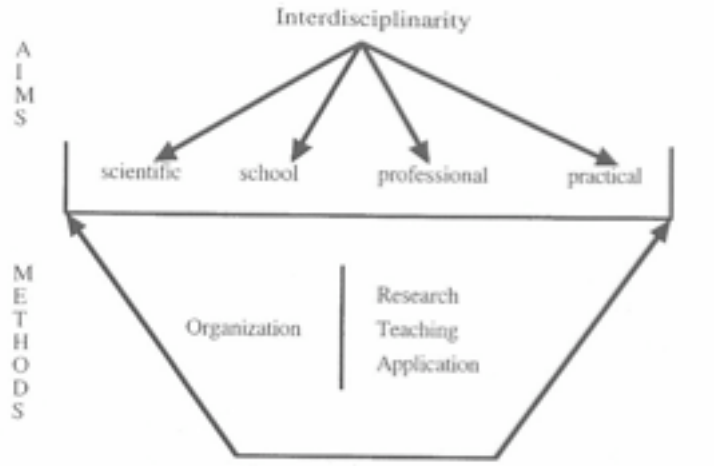

FIGURE 1. The Operational Fields of Interdisciplinarity and Their Vantage Points.

For the purposes of the present discussion, then, it is necessary to establish a basic distinction among the ways interdisciplinarity is currently defined. To this end, four major fields can be discerned: scientific, practical, professional and school. According to Hermeren (1985), these four ways of practicing interdisciplinarity may be approached according to their particular problems or preoccupations from three vantage points: organization, research and teaching. We have added a fourth; practice (Figure 1). And so, no matter what the operational field of interdisciplinarity, the latter can be investigated (research), taught (teaching) or practiced (application). In addition, as Hermeren emphasizes, organizational questions have a direct impact on teaching and research, if not on application. In the field of education, interdisciplinarity in

schools may be the object of research, may be taught and may be practiced.

Scientific Interdisciplinarity

In the realm of science, during the past four hundred years with the emergence of the concept of science in the 17th century (Bacon, Descartes, Galileo, etc.) and its institutionalization in the 18th century with the Encyclopedists and the development of explicit, systematized methods, there have been several attempts to categorize and hierarchize the relations among scientific disciplines, starling with methodological links between the objects of the disciplines concerned. Several authors have dealt with this matter (Apostel and Vanlandschoot, 1994; Berger, 1972; Fazenda, 1994; Frank, 1988; Gusdorf, 1975, 1983; Klein, 1990; Kockelmans, 1979; Lenoir, 1995; Resweber, 1981).

From these multiple and diversified attempts over the last four centuries, three distinct meanings have emerged for the possibilities of interaction between bodies of scientific knowledge. The first option considers interdisciplinarity from the point of view of the relations, exchanges, rapprochements or cooperative links woven between two or more disciplines (Bottomore, 1983); it aims at building bridges or links between disciplines (for example biochemistry, geophysics, sociolinguistics). The second option focuses on the emergence of new disciplines based on the perception of a space between already existing disciplines (for example, ecology, astrophysics, nuclear physics). The space which separates them has become problematic and unacceptable as a result of new questions. These new disciplines establish themselves by borrowing elements from existing disciplines, by restructuring them and making them interact in different ways, a procedure which may give rise to the creation of new entities. From that point of view, as Resweber (1981) notes, if every discipline sets itself up in the epistemological gap between two or more other disciplines, it does not fill the existing gap but gives the latter some shape, presenting itself as a gap which itself generates gaps, arising between gaps that have already become familiar (42). The third epistemological option questions the very nature of knowledge and promises a new restructuring or even the birth of a new conception and a new organization of scientific knowledge, as deconstructionist criticism has done (Petrie, 1992), likewise projects which counter discipline (Cohen, 1993) or see themselves as postdisciplinary (Kennedy, 1993). However, no matter which theoretical approach is adopted—the bridge (relational approach, no man's land (amplifying approach), or tabula rasa (radical approach)—scientific interdisciplinarity raises the question of scientific production activity and of the structure of advanced knowledge and, even in the third option, of the relation of scientific disciplines, sometimes the

question of the hierarchy of disciplines. And it is always defined as having as its aim the production of new knowledge in the context of scientific research, or the production of new disciplines (Lenoir, 1995).

Practical Interdisciplinarity

Practical interdisciplinarity concerns practical, technical or procedural knowledge of daily life. It is essentially based on experience acquired by individuals (experiential knowledge) in different fields or situations in order to solve problems that arise in everyday life. Its purpose is to respond in a practical way to problems that arise ordinarily in the management of individual living or life in society. And if it necessary to have recourse to scientific knowledge it is essentially in a referential way. For example, the mechanic who repairs a car, the housewife who manages household matters, the speculator who plays the market, or even the bus driver all use procedural knowledge, experiential knowledge and practices that are more or less routine and reflective, coining from various sources. Work done on teaching practices shows the place occupied by experiential knowledge and by routines in career teachers. One could say, with Petrie (1992), who takes up the Aristotelian distinction between theoretical and practical experience, that if scientific interdisciplinarity seeks that which is "true," practical interdisciplinarity seeks that which is "good." It expresses forcefully the instrumental approach to interdisciplinarity, which is as natural as M. Jourdain's prose, as Fourez (1994) notes: "When we are doing handyman chores or making health choices, for example, we bring into play elements from the natural sciences, ecological or economic questions, and ethical choices" (81).

Professional Interdisciplinarity

As for professional interdisciplinarity, it aims at training for the exercise of a professional as much as at the practice itself, i.e. it is defined within the framework of a service involving human beings (Lessard, 1990, 1991; Sockett, 1989). This aim differentiates it clearly from the first two types of interdisciplinarity, obviously from the scientific but also from the practical, especially since it does not share the instrumental rationality that is found there. As we have already emphasized,

> this distinction is similar to the one Finger (1989) established to clarify the notion of experiential training as understood in Anglo-American and German thought, which leads it to privilege training

> via life experiences based on *Lebensphilosophie,* rather than on experiential learning seen in terms of problem solving in the context of social adaptation, because it ensures that a link is maintained between a person and reality, within which individuals give meaning to the reality they construct and to their life experiences (Lenoir, 1993, p. 399).

As a result, it requires the integration of a number of procedures and knowledge aimed at the development of skills needed by the particular profession. Now this professional knowledge, needed by doctors, administrators, engineers, nurses, lawyers and other professional bodies recognized by society, including teachers, is not based solely on scientific (or theoretical) knowledge arising from established scientific disciplines. They require practical or experiential knowledge and technical or procedural knowledge interacting with theoretical knowledge in a dynamic fashion which is non-linear and not hierarchically organized in order to bring about a given professional action. Professional knowledge is therefore fundamentally interdisciplinary (Ibid.).

Interdisciplinarity in Schools

Using interdisciplinarity in schools means, of course, making major adjustments with regard to scientific interdisciplinarity. Too many attempts have been nothing more than direct transplantations from the scientific context to that of the schools. As is the case for many nomadic concepts (Stengers, 1987), the migration to other fields of application raises reinterpretations of meaning and modifications in content and scope which must be taken into account when we are dealing with interdisciplinarity. That is why, just as there is a distinction between discipline in the scientific context and discipline in the school context, it is important to make the distinction between scientific interdisciplinarity and school interdisciplinarity (Table 1).

In this way, interdisciplinarity in schools, as opposed to scientific interdisciplinarity which deals with links between branches of science and is inseparable from research and scientific productions, aims at distributing scientific knowledge in a teaching and training context. To that end it establishes the most appropriate conditions for initiating and sustaining in students the development of integrative processes and the acquisition of knowledge as cognitive products. In this sense, the concept of integration cannot be separated from interdisciplinarity. Indeed if the latter takes its meaning by association with school knowledge and the way it is treated in the

curriculum, the instructional plan and teaching strategies which are the teacher's objectives, the former is linked to the processes set in train by the teacher and student and to the cognitive results obtained.

TABLE 1.
Major Differences Between Scientific Interdisciplinarity and School Interdisciplinarity

Scientific Interdisciplinarity	School Interdisciplinarity
AIMS	
To produce a new knowledge and to answer social needs: * by establishing links between branches of science through —hierarchization (organization of scientific disciplines) —epistemological structuring * by understanding the different disciplinary perspectives through the re-establishment of communication links between disciplinary discourses (Schulert and Frank, 1994)	To spread scientific knowledge and train social agents: * by setting up the most appropriate conditions to initiate and sustain the development of integrative processes and the appropriation of knowledge as cognitive products in students, which requires arranging school knowledge in curriculum, instructional theory and teaching strategies * by establishing links between theory and practice * by establishing links between the different approaches to a segment of the reality under study
OBJECT	
Has scientific disciplines as its object	Has school disciplines as its object
APPLICATION	
Implies the notion of research: * knowledge is the system of reference	Implies the notion of teaching training: * the learning subject is the point of reference
SYSTEM OF REFERENCE	
Refers back to discipline considered as scientific professional knowledge	Refers back to disciplines as school sciences subject, and in that way to a system of reference not limited to the sciences
CONSEQUENCE	
Leads to the production of new disciplines by various means	Leads to the creation of complementary links between school subjects

Integration may be approached from three complementary points of view which favor an integrative approach: first from the point of view of training as an integrative approach, integration is, on the curricular level, a matter of joining together programs of studies and their contents, and, on the didactic and teaching level, a matter of conception and execution of the planning for integrative education. Integration in this sense is a process which is in the teacher's domain. But it is a question of putting in place the conditions, not of substitution. Secondly, from the trainee's point of view, as integrating processes, the learner is inserted into a process which calls on learning strategies which intervene in the objectifying relationship which is established between him and the objects of learning. Thirdly, as integrated knowledge, that is to say as product, integration constitutes the result of learning. Integration is therefore seen as an internal process, constructing cognitive products, a process which belongs to the subject and which requires the appropriate help of a third party acting as a temporary mediator (the teacher). The latter puts in place the most appropriate integrative instructional conditions to favor in the learner the integration of learning and knowledge. From this perspective, the curriculum must be more integrative than integrated, the integration of learning and knowledge is a matter for the subject and not the teacher. To the latter belongs the interdisciplinariy treatment.

The Implementation Levels of School Interdisciplinarity

Although in current usage the term "interdisciplinary teaching" is found in francophone scholarly literature (Cros, 1987) when we are dealing with its practice in the school context, it seems preferable to speak rather of school interdisciplinarity, so as to remove the ambiguity introduced by the term "teaching," and the strong temptation to simplify by considering interdisciplinarity only in the immediate sense of educative action solely on the level of empirical practice.

Alongside the extreme confusion in the images of interdisciplinarity and its practice which emerge from the speech of teachers at the primary level (Lenoir, 1991b, 1992a; Larose and Lenoir, 1995; Larose, Lenoir, Bacon and Ponton, 1994), the latter are generally faced by so-called interdisciplinary practices which range from "the pot-pourri" to a fusion point of view (Jacobs, 1989), to relations of dominance, to even the complete lack of links (Lenoir, 1991b). In the first case, teaching consists of transmitting, in the name of integrative practices generally based on a thematic approach, disparate

elements, unlinked and decontextualized, taken from various subjects which have been regrouped without the structure having been determined ahead of time or their pertinence ascertained. In the second case, an anti-disciplinary attitude leads to the exclusion or trivialization of any reference to conceptual structures and to a recourse to seeking answers to practices in everyday life. In the third case, teaching leans essentially on a model taken from the subject deemed to be the most important, thereby erasing the specifics of the other subjects which are then reduced to a subservient status, if not a simple pretext (the "polarization" for Jacobs, 1989). Barre de Miniac and Cros (1984) speak of predominance to qualify this type of interdisciplinary relationship. Finally, in the fourth case, pseudointerdisciplinarity, identifying a theme serves as a pretext and as a guideline for teaching selected school subjects in a vacuum. Several examples taken from Quebec teaching literature or observed in class could illustrate these four practices.

Interdisciplinarity then cannot be limited to the pedagogical domain as Tochon (1992) defined it, in conjunction with the notion of "double agenda" proposed by Leinhardt (1986) and the writings of Gillet (1987) and de Halte (1988): "Pedagogy concerns the immediate relationship with the child and the reflection-in-action of the teacher. [...] pedagogy is defined as an immediate action and bears on the relational strategies appropriate to lived states, on the synchronic plane" (Tochon, 1992, p. 29). It takes into account the situations of constraint of any kind which obtain in class. Pedagogical practice is carried out in real teaching situations, in vivo, over a short period of time, almost in the instant. Interdisciplinarity operates equally on the didactic and the curricular levels, and pedagogical interdisciplinarity is a result of the previous work done on those two levels. At the heart of school interdisciplinarity, the danger of simplification, linked among other things to the predominant empirical preoccupation (no doubt legitimate on the teacher's part), to the desire for economies in time and energy as well as to ideological positions (hierarchy of subjects, for example), has led, supported by special-pleading speeches, to an implementation of interdisciplinarity essentially on the pedagogical level, while forgetting that the latter is not independent of the didactic and the cunicular. It is, however, not one level alone but all three together which in their interactions constitute school interdisciplinarity. It is necessary then to consider school interdisciplinarity on these three levels: curricular, didactic, and pedagogical.

If we agree to recognize that the aim of school interdisciplinarity is to implement the conditions which might favor an integration of learning and knowledge on the part of students, this aim must be pursued on the curricular,

didactic and pedagogical levels, and in that order since the first determines the second, and the second the third. It is too often observed in French writing, as we have just mentioned, that interdisciplinary types of work have been carried out on the pedagogical level without dealing with the didactic and especially the curricular levels. Phenix (1964) in a work which proposes a philosophical theory for a curriculum aimed at general training based on a logical structure of disciplinary understanding observes quite rightly how frequently "the teacher teaches a particular subject or unit within a subject without any reference to its relationship to other components of the curriculum" (3). Such a qualitative leap, which aims at skipping over a systematic analysis of the programs of study which make up the curriculum for a given level of teaching leads to operational statements that are reductive and deforming, the result of hasty generalizations concerning authors noted for their professional training and activities. For example, one can read speeches and observe practices which lead to exclusion, the problem-solving strategy, the communicative strategy or the experimental strategy becoming, depending on whether the author is a mathematician, a linguist, or a physicist, the universal strategy which is applied to all programs, all learning, all situations whether they be from the realm of education or from everyday life.

Curricular Interdisciplinarity: The First Level of School Interdisciplinarity

Curricular interdisciplinarity must precede didactic and pedagogical interdisciplinarity. Palmade emphasizes this when he notes the notion of interdisciplinarity cannot be approached in a sufficiently assured manner if one is not clear about what constitutes it (Palmade, 1977, p. 78). It consists of the identification of the specifics of each program and of establishing, after a systematic analysis of the programs of study based on certain parameters (the place and function of the different subjects—the reason they are in the program—their taxonomic structure, their objects of study and of learning, their learning strategies), the links of interdependence, convergence and complementarity between the various school subjects that form the curriculum of a given level of teaching, primary education for example, so as to draw out of the school curriculum or to instill in it an interdisciplinary structure which aims at integration.

The interdisciplinary structure that we have chosen for the primary level (Lenoir, 1990, 1991b) is based on such an analysis of specifics and the

complementary links among the various programs of study which make up this level of education in Quebec as it is currently conceived. Without going beyond the fact that each program aims, at least according to policy statements, at a certain integration of aspects linked to knowledge, knowing-how and knowing-how-to-be, and that each may from then on be "officially" designated as interdisciplinary, we consider that the programs of study, taking into account their respective cognitive objectives, can be grouped together according to three types of relationship to reality, creating in that way a structure with linked brackets. Thus, two programs have as their aim the construction (or the conceptualization) of reality and give priority to the introduction of knowledge. They are the programs in social sciences, which have as their raison d'etre the construction of human reality which is socially and spatio-temporally determined (whence the base concepts of time, space and society), through the grasping of the relationships among human beings and between the latter and the physical and human elements of living milieux, and in the natural sciences which deal with the construction of natural reality (natural environment) and the relationships among the natural elements which compose it (water, earth, air, animal life, vegetable life, energy). These are indeed subjects that tone could call fundamental, since they constitute the materials which are indispensable for any apprehension of the real, any communication, and any formalization of reality, as well as any attempt to form any kind of relationship with reality.

Three other programs, forming what are generally called the basic subjects —in the sense of instrumental subjects as made clear by De Landsheere (1979)—allow the expression of this reality. These subjects, mathematics and the two vernacular languages (French as a mother tongue and English as a second language) give priority to knowing-how, since they aim above all at the development of either language skills or the formal representation of previously constructed reality. Other programs favor the establishment of relationships, from different perspectives, with reality and rely for that mainly on knowing-how-to-be. In sum, physical education aims primarily at the physical relationship of the child with his/her body, religious education at the spiritual relationship of the human being with the transcendental, moral education at the ethical relationship which governs free and responsible action of human beings in society, and finally personal and social development deals with the relationships which are created everyday with others, with the environment and with society in the areas of consumption, health, sexuality, interpersonal relationships and life in society.

In addition to bringing out one of the three dimensions of cognitive

taxonomy currently accepted, and without excluding the two other dimensions (which come into play as necessary means to assure the attainment of cognitive aims), these three regroupings of school subjects, aiming respectively at the production of reality, the expression of reality and relationship with reality, share the same scientific methodological approach. This meta-strategy (Lenoir, 1991a, 1991b) is expressed via specific learning strategies, according to the cognitive aims being pursued: the strategies of exploration (or rather of conceptualization: knowing how), experimentation (how to test. . .), communication (how to say. . .), and problem-solving (how to go about...) (Lenoir, 1990, 1991a, 1991b).

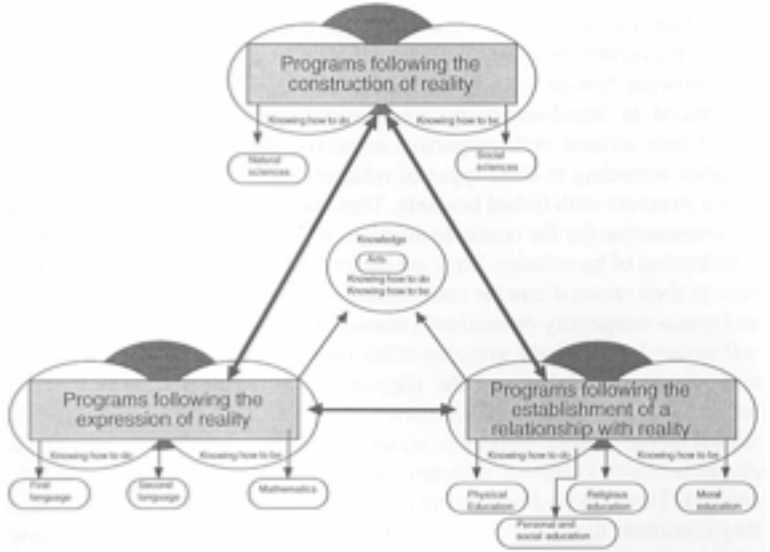

FIGURE 2. The Curricular Structure of Programs of Study at the Primary Level in Quebec from an Interdisciplinary Point of View

The fine arts, music, drama, and dance occupy a special place in our conception of the auricular structure of primary programs of study in Quebec, by reason of the importance they give to intuitive methods for apprehending the real, expressing it, and for entering it. Whereas the perception of the real is only a point of departure for the construction of reality in the social sciences and the natural sciences, from which the child must detach him/herself, it will be systematically developed and exploited in the field of the

arts following a particular strategy (Lenoir, 1990, 1991b). Figure 2 illustrates how programs in the primary curriculum are structured.

Didactic Interdisciplinarity: The Second Level of School Interdisciplinarity

At the second level of school interdisciplinarity, didactic interdisciplinarity, which is characterized first of all by its relationship to the knowledge to be taught and by its conceptual and anticipatory dimensions, bears above all on planning, organization and reflexive analysis of education. Tochon (1989) draws attention to the fact that the didactic leads to "the organization of school subjects in time in the form of preactive or positive anticipation (before or after interaction with the students), whereas pedagogy refers to the interactive management of time spent on school subjects" (31). In this sense, he notes, "it covers the temporal axis of diachrony":

> Acting as mediator between the curriculum and pedogogy, the didactic takes responsibility for the interdisciplinary structuring of the curriculum and treats it as aiming at the linking together of the knowledges to be taught and their insertion in learning situations. From this perspective, interdisciplinary didactic requires recourse to interdisciplinary models of operationalization. It is therefore through didactic interdisciplinarity that the teacher creates educational practices aimed at integration. (29)

Following the study of various proposals of formally announced operational models, among them those of d'Astolfi (1979, in Cros, 1986), Barre de Miniac and Cros (1984), D'Hainaut (1985, 1986), Legendre (1993), Phenix (1964), Rene (1983, in Cros, 1986), Serri (1977), and Tochon (1990), and a systematic and critical search of scholarly and pedagogical literature in Quebec on the question (Lenoir, 1991b), a dozen operational models have been identified. They will be briefly presented in the following section.

Pedagogical Interdisciplinarity: The Third Level of School Interdisciplinarity

As the third level of school interdisciplinarity, pedagogical interdisciplinarity refers to the actualization in class of didactic interdisciplinarity. It controls the implementation of one or more interdisciplinary didactic models inserted

into given situations, but this implementation cannot be carried out without necessarily taking account of a group of other variables which act and interact in the real dynamic of a teaching-learning situation.

Thus the didactic situation is affected by, among other things, aspects linked to classroom management and to the context in which professional teaching is carried out, routine practices, etc., but also limiting situations both inside and outside the classroom ranging from the psychological stale of the students and their personal projects to the psychological state at the time of the teacher and his or her own aims.

In short, pedagogical interdisciplinarity might easily be termed transdisciplinary and it should be, especially when teaching in the classroom demands recourse to professional knowledge which is itself transdisciplinary (Lenoir, 1993, 1995) since it calls on different types of knowledge: scientific (or theoretical) knowledge which is itself interdisciplinary, practical (or experiential) knowledge and technical (or procedural) knowledge.

The notion of transdisciplinary studies is here understood in a precise sense which differs from the meanings normally attributed to it on the epistemological level in studies of scientific interdisciplinaiity. It is not a question of understanding it in one or other of the senses of transversality between two or more disciplines (across), or of being beyond the disciplinary towards a unity of the sciences based on a number of principles, concepts, methods or unifying aims acting on some metascientific plane (beyond), nor yet of centering on behaviors (on this side), but rather in the sense of a dynamic interaction (in a non-linear, non-hierarchical, dialectic structure) brought finally into being through the professional act of teaching, between the various types of knowledge that make up professional knowledge, different from disciplinary knowledge, since it is centered on teaching in its preactive, interactive and postactive phases.

We can make the link here between pedagogical and professional interdisciplinarity, which was previously presented and which concerns the training of teachers and their professional practices. Pedagogical interdisciplinarity, which belongs to the teaching-learning relationship, may be compared with professional interdisciplinarity in that it necessitates the setting up of the most appropriate conditions in order to carry out and sustain the learning process, and that it draws on, in order to attain that, theoretical, practical and procedural knowledge specific to that profession and the personal characteristics of the practitioner, and that it constitutes in fact the final putting into practice of professional training and the realization of professional practice.

Pedagogical interdisciplinarity (or transdisciplinarity) is different from didactic and curricular interdisciplinarity in that it must be inscribed above all in disciplinary situations, a fact which is often misunderstood or ignored by those involved in education. As Tochon quite rightly pointed out in proposing an integrated taxonomy characterizing the three levels of learning, the disciplinary, the interdisciplinary and the transdisciplinary correspond to three modes of pedagogical approach (Tochon, 1990, p. 103). If discipline refers to the learning contents of each of the subjects in the curriculum, and by that to the programs of study, the interdiscipline "corresponds to a structural intersection among several branches of the knowledge taught, in the form of instrumental capabilities drawn from strategies for thinking which are transferable from one subject to another" (100), whereas the transdiscipline encompasses the content of subjects and the organizing principle of strategies for thinking, it goes beyond them since it concerns the whole person of the learner in the contextualized interaction of an expressive behavioral functioning which is at the same time cognitive, socio-affective and psychomotor, and directly aimed at reality (101).

Regardless of which terminology is employed, marked by D'Hainaut's type of behavioral inspiration, Tochon (1990) shows the necessary tension between the contents of learning conveyed by programs of study and the desire for self-realization in learning subjects. He also emphasizes the importance of not wanting to mix everything together in a pedagogical sameness which would skip over the other levels: the curricular level where the links between disciplines are determined, and the didactic level which makes sure that the curriculum is transmitted via the establishment of interdisciplinary models between the cognitive structures on the one hand and student projects on the other in which they actualize themselves within meaningful learning situations (the pedagogical level). In short, we agree with Tochon when he proposes, at the level of teaching and educational planning, nesting three levels of educational intervention which are set up not in an additive fashion, but in a dynamic and interactive way: "activities which are proper to the discipline, those which belong to the interdisciplinary domain (produced by the intersection of necessities from several branches), and those from the transdisciplinary domain which establish a contextual link with the lived experience of the students" (105). Defined in that way, the transdisciplinary makes reference to the project for functional realization of students, which has meaning only to the extent that it integrates the interdisciplinary level, which in its turn includes the disciplinary level.

In this way, the didactic level, through the models which are worked out

there, creates a sort of indispensable interface between the curricular-structure, based on disciplines, and the pedagogical actualization, based on the transdisciplinary (Figure 3). It must be seen that these three levels, treated analytically here in a way which might give the impression that there are radical breaks among them, are in fact closely interrelated and interwoven, especially the didactic and pedagogical levels. As Halté emphasizes, one must "think didactics and pedagogy as a unit in which recognizable domains, while enjoying a relative autonomy, maintain dialectical links which determine and select so that unless they are thought of as a unit they are threatened by 'didactivist' or 'pedagogist' slidings and thereby risk seeing advances made in one or the other field not producing the hoped for effect" (8).

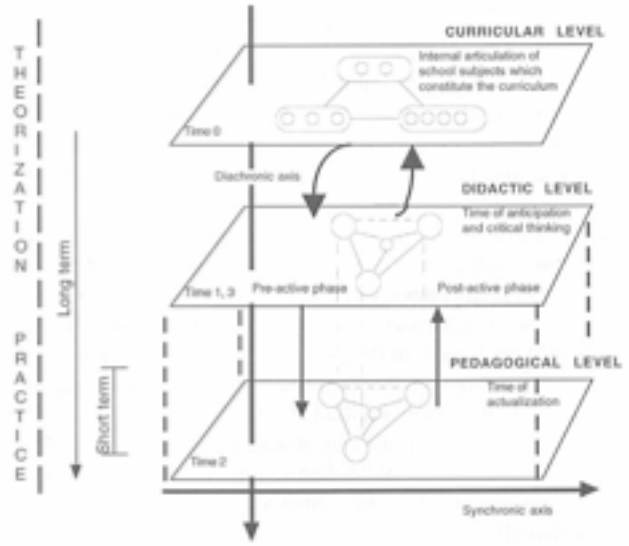

FIGURE 3. The Relationship between the Curricular, Didactic, and Pedagogical Levels

Some Interdisciplinary Didactic Models

From a didactic point of view, some interdisciplinary models may be noted which are frequently encountered in the scholarly and teaching literature as well as in the practice of primary teachers in Quebec (Lenoir, 1991b). Three

points of entry for establishing operational links may be discerned: through the object of study, through skills, and through learning strategies. In this way it is possible to identify a certain number of operational models which are based on one or the other of these parameters and which allow the creation of learning situations.

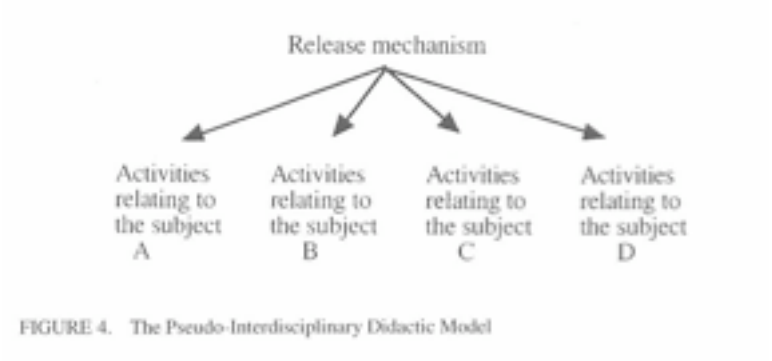

FIGURE 4. The Pseudo-Interdisciplinary Didactic Model

Entry via Objects

The Pseudo-Interdisciplinary Model—The first model, which is based on self-actualizing intentions attributed to students, is tied to a common release mechanism, also called a contextualizer or hook, which acts as the starting point for a pedagogical situation. Depending on whether the intention has been determined by the teacher or stems from the students or has been adopted by them, a theme, an idea, an event, an ordinary life situation, a project, etc., is then used as a catalyst for the students' interest. It is, however, a pseudo-interdisciplinarity to the extent that the "link," which is in no way didactic, exists only at the level of the contextualizalion, with the follow-up activities being carried out in an autonomous fashion, completely separated, according to the learning content of various programs of study (Figure 4).

As Martin emphasizes, "a learning situation in the social sciences on the Armerindians may become the release mechanism, the motive, for reading Amerindian legends (fictional texts in French)" (Martin, 1989, p. 9). This example shows the danger of believing that this approach is both interdisciplinary and integrative. The social sciences here play a walk-on part to the extent that they serve only as a release mechanism; we are dealing only with a pretext for pursuing learning objectives in French. The only integration that exists in such a case actually disintegrates the social sciences by making

them disappear from the learning plane. Only appearances remain!

It would doubtless be more precise to say that in this particular case no relationship is established between the programs of study since the release mechanism belongs essentially to the pedagogical level, that it is applied only in this moment, at the beginning of the learning situation, with a view to provoking motivation, interest, and perhaps cognitive imbalance. Nonetheless, in other cases, such as the teaching strategy of the project, recourse to a common intention may be capable of facilitating the establishment of links between programs, as well as an integrative approach to learning, but in that case it constitutes only a favorable condition, not a necessary one.

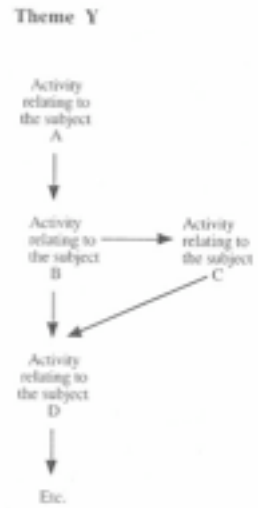

FIGURE 5. The Didactic Multidisciplinary Model

The Multidisciplinary Model—The second model is well known since it is the thematic approach. Each learning situation deals with the aims of a single program. However, the theme (e.g. the farm going back to school) serves during different learning activities as a link between different situations which are dealt with consecutively or in parallel, more or less through an associative addition of learning aims. In each of the learning activities which pursue in an isolated way aims which belong to their own program, but set as a chain or in a concomitant way around a single scenario, the teacher and his/her students

deal with the same material, speak of the same thing. The model is here multidisciplinary (Figure 5).

For example, starting from the idea of a meal (Gagne Clerk, Fallu and Allard, 1987), the first activity proposes the production in French of a song (written communication). The students then develop in music class the melody of the song. In art they create a collective mural illustrating the people who are eating, while in English oral conversation deals with various aspects of the mural. Later, two other activities, one in French, the other in English, allow the students, still starting from the mural, to read an expressive text in French on choices made in the domains of food and clothing and to work through an activity in oral communication on the personal tastes. Finally, in the last activity, students have a meal in class during which conversations take place in English and French and they perform the song they have composed against the background of the mural. The activities composing the scenario each follow learning aims which are specific to the programs of study involved.

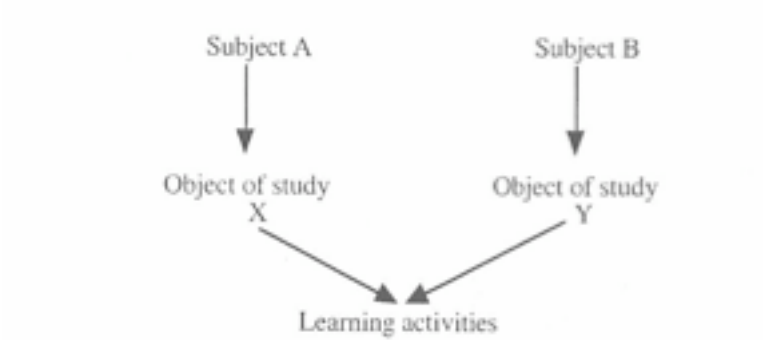

FIGURE 6. Complementary Didactic Model at the Level of the Objects of Study

The Complementary Model at the Level of the Objects of Study—A case study when a relationship is established at the level of objects of study could be the case between the natural sciences and the social sciences. Imagine learning activities which deal with questions requiring a mutual enlightenment (Figure 6). For example, one activity focusing on animal life or vegetable life in the local environment would necessitate a preliminary knowledge of this environment through the social sciences. Or, the study of water supply points in school with the aim of identifying human use of water implies the preliminary localization of these points using the social sciences. In the same way, the development of a maple grove, of electrical circuits, or of the climate are other examples of the possibilities of complementarity at the level of the

objects of study between the social sciences and the natural sciences (Gervais, Lenoir and Therien, 1989; Gadoury, Lenoir and Malette, 1990a, 1990b). This third model could be thought of as a complementary interdisciplinary approach (or as a linking) at the level of the objects of study.

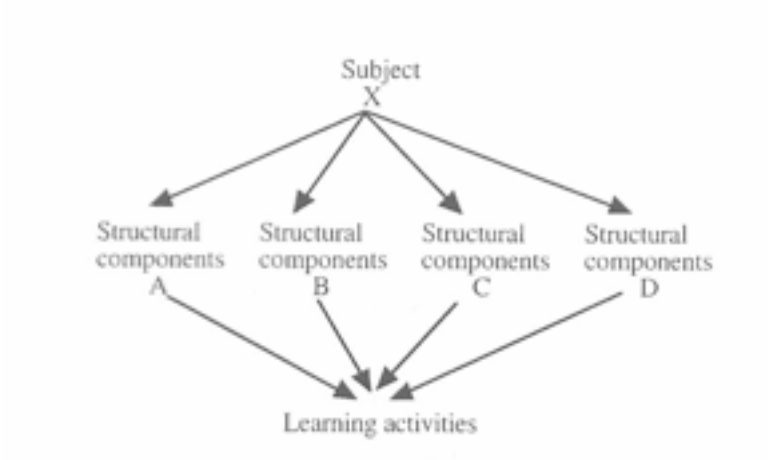

FIGURE 7. The Intradisciplinary Didactic Model

The Intradisciplinary Model—From the vantage point of the objects, the fourth model refers to the intradisciplinary approach. An appropriate application of each of the programs of study already possesses an integrative character, as we have shown (Lenoir, 1991b), since these programs were conceived through an integrative perspective (Figure 7).

For illustrative purposes, the application of the program to the social sciences requires that learning activities be designed to deal simultaneously with the three integrative concepts: time, space, and society, or at least, two of these concepts. It is not a question then of teaching history, geography, economics, sociology, etc., in the primary school, but of relying on historical, geographical, sociological (and other) perspectives, which are interrelated in order to ensure the development of retained integrative concepts. The same applies in the natural sciences (Government of Quebec, 1980b) where the integrative concepts are more numerous (Lenoir, 1991b). In fact, these two programs are more marked by an approach of the intradisciplinary type since they approach their study objects in their existential totality.

To take another example, the mathematics program necessitates the establishment of links "not only between the different elements of learning the same theme, but also between the different aspects of the program: number,

measurement, geometry" (Government of Quebec, 1980a, p. 4). Briefly, such a direction, which demands the integration of different structural components, is found in each of the programs of study.

Entry via Skills

The Limited Instrumental Model—When one takes skills into account, the interdisciplinary limited instrumental approach constitutes the fifth operational didactic model of interdisciplinarity. In a limited manner, as much in time as in its extent as far as the objects studies are concerned, this model characterizes continuation in well-defined activities which are inscribed within a strategy of learning, of development of technical or intellectual skills[1] from operational perspective (Figure 8). This approach is thus punctual, but also is limited and occasional, and a teacher should rely on it only when the need arises. However, this is not to say that activities which fall under the province of this approach should not be planned.

To illustrate, links between mathematics and social sciences can be established when, for example, third-graders are asked to measure distances on a map of the local area. In this case, the objectives of the two programs come together: the first requires the estimation and measurement of lengths (Government of Quebec, 1981a, p. 16, 25-26), the second the estimation and measurement of distances (Government of Quebec, 1981b, p. 23). The study of angles in mathematics and the reliance on adjustment in the social sciences rely on common knowledge, and the use of a theodolite can create an entirely useful tool in order to further these learning activities. As yet another example, first- or second-graders present themselves to one another by characterizing themselves through several aspects (height, sex, age, month of birth, favorite foods, etc.). They then proceed to classifications (boy classmates and girl classmates, birthdays according to months, etc.) and are asked to represent them graphically by calling upon mathematical skills (Government of Quebec, 1981a, p. 20). Or perhaps the school children are asked to write, in French, texts of an informative nature, presenting them in the form of questionnaires, observation charts, etc. There thus occurs a borrowing of the tools of observation, of fact collecting, etc.

The Generalized Instrumental Model—This fifth approach can also be generalized and thus seen as a sixth model, that of the generalized instrumental interdisciplinary model, which is of a transverse nature, insofar as the reliance on technical skills is used at the time of learning arising from other subjects (Figure 8).

If the purpose of graphs and diagrams is to express the relationships between facts, the most obvious example is doubtless the use of writing skills. Drawing skills are in wide use outside the plastic arts. However, there it is a question of all useful outcomes, of obvious facts.

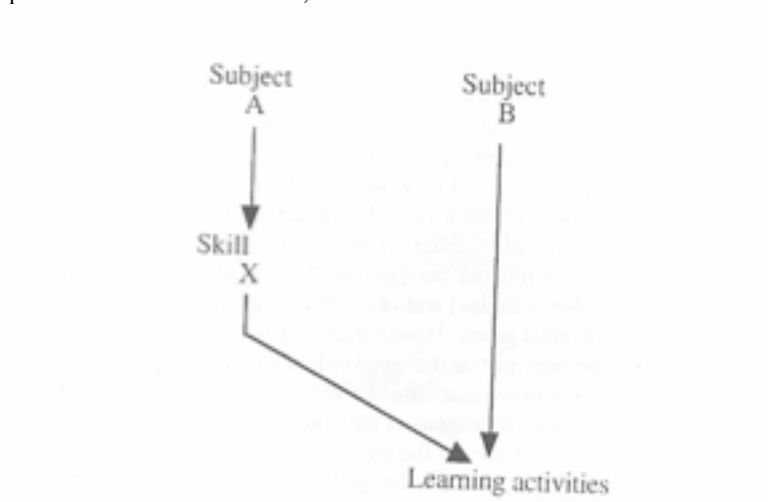

FIGURE 8. The Limited Instrumental and the Generalized Instrumental Didactic Models

Entry via Learning Strategies

Occasional, Systematic and Functional Auxiliary Models—From the viewpoint of learning strategies, auxiliary interdisciplinarity, which can be occasional, systematic or functional, and which is an "interdisciplinarity of methods" according to D'Hainaut (1986), forms the seventh, eighth, and ninth approaches. These models, which participate equally in transverse interdisciplinarity, imply the use in diverse programs of study of a learning strategy belonging to a subject with the aim of pursuing learning objectives of the subject. Thus, in the natural sciences, the child is asked to call upon the strategy of problem-solving occasionally, and in a more regular manner, to call upon the exploratory strategy (auxiliary and occasional models). As for ethics as well as personal and social development, these two programs systematically call upon the strategy of problem-solving (systematic auxiliary models) (Figure 9).

On occasion and under certain conditions, the need could also arise for one or more of the learning strategies to attain the learning objectives. Thus the

establishment of research plans in the social sciences or of a verification plan in the natural sciences could necessitate falling back upon problem-solving in order to resolve technical problems (What do you do in order to . . . ?).

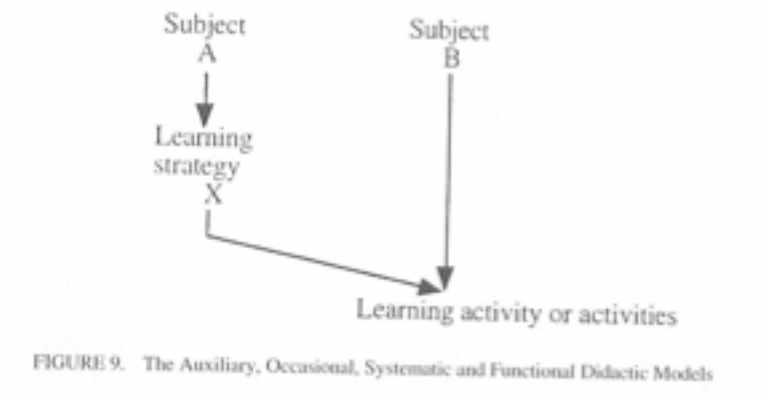

FIGURE 9. The Auxiliary, Occasional, Systematic and Functional Didactic Models

Conversely, a resolution of problems can lead to a strategy of exploration in time (for example, "Was it the same in my grandparents' time?") and in space (for example, "Is it the same somewhere else?"),[2] just as this exploratory strategy is required in the identification of the problem. In the natural sciences, the experimental strategy demands previous knowledge, which generally must be acquired by using the exploratory strategy. The auxiliary interdisciplinary model this assures a specifically functional approach which emphasizes the necessary combining of the strategies in the entire learning process.

D'Hainaut's Structural Instrumental Interdisciplinarity and Cognitive Behavioral Interdisciplinarity—In his taxonomy, D'Hainaut puts forth two of his own models which he calls instrumental transdisciplinarity and behavioral transdisciplinarity. The appeal to instrumental trnasdisciplinarity (the prefix "trans" taken here to mean "across") relies "from an epistemological point of view, upon a theory of a unifying character, the theory of systems" (D'Hainaut, 1986, p. 12) and rests upon common organizing principles, upon a "choice of concepts, methods, and strategies which possess a transdisciplinary character, that is, which can be applied to various disciplines or which are common to different disciplines" (19). For example, calling upon a concept such as "transformation" allows one "to analyze problems within different discipline or themes or situations of a pluridisciplinary nature" (12)

and more generally, aims at instilling "in the child a method that is valid across those disciplines which are not collected in one situation: the unity is in the strategy of the child, in the instrument of thought which he uses" (12). Problem-solving then becomes the privileged strategy which supports a traversal approach that the bias of the organizing principles retained. Thus, one can speak of a structural instrumental interdisciplinarity whose organizing principles, associated with a particular approach, constitute the privileged entry on the interdisciplinary level.

As for behavioral transdisciplinarity (the same prefix is retained here with a meaning of transcendence or metacognilion), it rests upon teaching which focuses at the same time on the very general strategies and operations of thought and action. One could speak of mental processes (i.e., choosing, deciding, conceiving a plan of action, putting into play a model, evaluating) which could become the object of transferences in multiple learning situations, each process being broken down "into partial strategies, such as 'reassembling elements from among which one could choose,' 'reassembling information from the criteria of choice,' ..." (13). As D'Hainaut explains,

> the behavioral transdisciplinarity approach tackles the problem of determining the content of education, not so much by the subject matters or by the themes which are the object of teaching, but more by what the child must be able to do and by the manner in which he must be able to conduct himself in the situations he is likely to encounter at the end of the teaching cycle under study. It is thus a question of determining the content of education, taking as the point of departure the very general intellectual and socio-affective strategies which the child must be able to master in those situations or for which he is being prepared. One could call this approach 'transdisciplinary' if one assigns to the prefix 'trans' the same meaning it has in 'to transcend,' that is, in the sense of the 'the beyond.' Significant intellectual activity in the child develops in contact with his cultural reality, which must be supported, treated and fed according to a certain coherent vision (D'Hainaut, 1985, p. 105— 106).

However, if "behavioral transdisciplinarity helps the student to structure and organize each of his strategies in diverse situations [...], it does not provide a structure of the whole as is the case in disciplines" (23).

If instrumental transdisciplinarity, which intends to provide the student with methods and instruments of thinking that can be transferred to new

situations, "is oriented more toward problem-solving than to the acquisition of knowledge for itself" (Ibid., p. 21), then behavioral transdisciplinarity consists essentially of an approach centered on the activity of the learner who seeks to retain situations which have meaning for her or himself. This behavioral transdisciplinarity returns to the psychological learning process which can be applied in any learning situation and it (behavioral transdisciplinarity) returns even more so, so it seems to us, to psycho-social curricula (Lenoir, 1995), which does not exactly make a didactic model.

Complementary Interdisciplinarity at the Level of Objects and Strategies— Rather than consider a single entry into knowledge (via objects, skills or stratifiers), as is generally the case for the interdisciplinary didactic models studied, the model which we have elaborated (Lenoir, 1991*b*; Lenoir and Pellerin, 1994; Lenoir and Pellerin, forthcoming; Pellerin, Lenoir, De Broin, Biron and Camirand, 1994) and experimented within the schools with primary school teachers (Larose, Lenoir, Bacon and Ponton, 1994; Larose and Lenoir, 1995; Lenoir, in press), and on which LAR1DD (Laboratory for Interdisciplinary Research in the Didactic of Disciplines) is working at the University of Sherbrooke, is a model conceived from a double entry, that of knowledge (objects) and that of the learning strategies in interaction.

This (CODA) model, complementary at the level of objects and strategies, proposes to set up on the didactic level the most favorable conditions creating and sustaining, through integrative approaches, the reliance of the learner on integrating processes aiming at the (re)construction and integration of new knowledge (integrated knowledge). The learner then operates this interaction between interdisciplinarity and integration, which was previously considered fundamental and which proved to be inseparable given that such interaction rests on epistemological foundations which are constructivist and interactive.

The CODA model is based on an interaction between different learning strategies which are particular to school disciplines, strategies that can be applied in a complementary, parallel, or consecutive manner. The strategies can also be interwoven in such a manner as to ensure that learning objects are taken into account within the context of a project of educational production (a student project) on a pedagogical level. The interaction favored by this model weaves itself among the disciplines whose object is the construction of a reality (social sciences and natural sciences) and those disciplines whose object is the expression of this reality (French as first language, mathematics, English as a second language). The model thus favors the establishment of links which forge a necessary relationship between the conceptualization of

the reality and its expression. The symbolic dimension appropriate to the different languages is absolutely necessary to this conception of human reality, social and natural. Nevertheless, this model does not exclude the establishment of links with programs which ensure the development of relationship with reality (for example, personal and social development, physical education), even less so with one or another of the divisions or the art program, more particularly with that of symbolic expression. The figure below charts this interaction between two sample disciplines: social sciences and French (Figure 10).

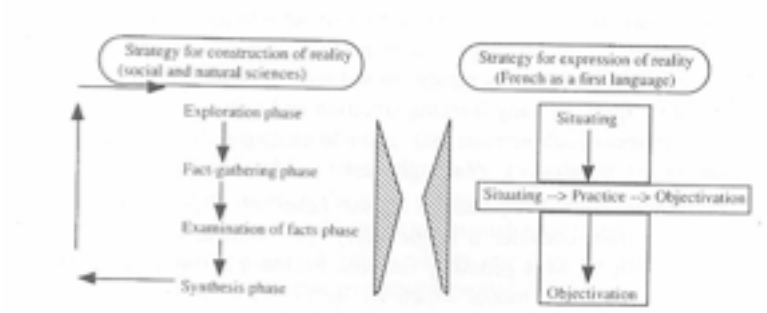

FIGURE 10. CODA Didactic Model.

The table below (Table 2) presents an overall view of these twelve didactic-models of interdisciplinary nature.

TABLE 2.
Some Operational Models of Didactic Interdisciplinarity

Entry routes	Interdisciplinary models	Characteristics
Via Objects	1. Pseudo-interdisciplinary	Exclusive reliance on a common catalyst (Examples: a story, an outing)
	2. Pluridisciplinary	Reliance on a thematic approach (Examples: the farm, New Year's)
	3. Complementary on the Level of Objects of Study	Questions treated in a complementary manner by social sciences and natural sciences (Examples: electricity, water)
	4. Intradisciplinary	Application of programs currently in use in Quebec, while respecting their principles and orientations (Examples: an activity ensuring the intersection of the three integrative concepts of social sciences)
Via skills	5. Limited Instrumental	Punctual and occasional reliance on skills arising from other disciplines (Examples: measuring length or calculating angles in mathematics and measuring distances or orientation in social sciences)
	6. Generalized Instrumental	Systematic and regular reliance on skills arising from other disciplines (Example: use of the histogram)
Via learning strategies	7. Occasional Auxiliary	Occasional reliance on a learning strategy arising from other disciplines (Example" problem-solving or conceptualization in natural sciences with the intent to pursue certain objectives)
	8. Systematic Auxiliary	Systematic reliance on a strategy arising from other disciplines (Example: problem-solving in personal and social development)
	9. Functional Auxiliary	Necessary reliance on a strategy arising from another discipline at a given moment in the process, with the intent to permit pursuit (Examples: problem-solving to establish a plan of verification or research; conceptualization preceding the experimental)

TABLE 2. continued

Entry routes	Interdisciplinary models	Characteristics
Via organizing principles	10. Structural Instrumental	Choice of concepts, methods, strategies, applicable and common to different subjects, with orientation to the process of problem-solving rather than to the acquisition of knowledge in and of itself (Examples: concepts of transformation, and space)
Via attitudes and behavior	11. Cognitive Behavioral	Reliance on very general strategies and operations of thought and action with the purpose of aiding the structuring of processes in various situations. (Examples: reliance upon mental processes)
Via objects and via learning strategies	12. Complementary at the Level of Objects and Strategies	Interaction between the strategies of learning programs constructing reality and those expressing reality, taking into account the objects of study of the first

Conclusion

Certain of the didactic models, which can be found in the pedagogical literature as well as in the practices of teachers, are used more often than others. The models which come about from the entry via objects and via skills are without a doubt more in practice than the others. If one excludes the tenth, eleventh and twelfth models, the others are characterized by the fact that they are based upon a single dimension belonging to objects, to skills or to strategies. It is just as important to emphasize that they do not all have he same relevance nor the same scope on the didactic level—which is the case for the pseudo-interdisciplinary and the pluridisciplinary models. Of course this in no way signifies that one should ignore them. On the contrary, it would seem more appropriate to recognize that they each hold a specific didactic relevance and that their pedagogical use can be justified by judicious application. Furthermore, several of the models should be introduced regularly into learning situations and the use of more than one model during an activity could prove to be completely appropriate, for these models should be considered according to their complementary contributions and not from an exclusionary perspective.

Rather than examining a single entry into knowledge, as is generally the

case for the interdisciplinary didactic models presented here, the didactic model under examination by LARIDD is conceived from a double entry, that of knowledge (objects) and that of learning strategies. This model, complementary at the level of object and strategies (CODA), is based upon an interaction among several learning strategics which are appropriate to school disciplines and which can be applied in complementarity, in parallel or in sequence to the interweaving of the objects of teaching within the context of a project of educational production (a student project) at the pedagogical level. In our opinion, such a project promotes the vital association of interdisciplinarity and integration while relying on a relational approach. Interdisciplinary practices are inseparable from integrative practices.

Finally, it is important to emphasize that a model is not, however, the practice! Didactically speaking, we visualize the didactic models presented here in the following manner. A model has no tangible reality: "it is nothing more than its function: model of, model for, it refers to something other than itself and its function is a function of delegation. The model is an intermediary to which we delegate the function of knowledge" (Bachelard, 1979, p. 3). It becomes therefore a conceptual tool. Legendre (1983) says nothing different when he writes that the raison d'être of a model is to "provide a useful representation of phenomena[...]. It is the intermediary system of reference between the reality studied and the elements of understanding which science can achieve" (147).

When a model is thus understood as a specific organization into networks of representative interrelated elements as much as an abstract representation, which Granger points out (1982, p.7), according to the narrowest definition and not in the larger sense usually employed, is practically the equivalent of a theory, it is more a functional and simplified "pattern" (pattern used in the sense of sewing) able to be modified and adapted according to the context of the situation. It rests on "principles which are more specific, more immediately revisable according to experimental results," and it does not purport "to reproduce in some manner the phenomenon" (7-8) in an analytic fashion. As a conceptual construct, it aims "to stimulate reality" (Glaserfeld and Steffe, 1991, p. 95).

Teacher training activities undertaken in the context of collaborative research and training facilities, as the work of Bru (1991, 1992) has proven, show the necessary reconstruction—and by this, the appropriation—of such a model by teachers in their contextualized practices. The reconstructions and appropriations lead to what Bru calls an intra-individual and inter-individual

variability and didactic variations, thus demonstrating the gap which exists between the model and its application by a teacher and between teachers. Furthermore, the publication of learning activities relying on the CODA model (Filion-Campeau, 1995a, 1995b; Filion-Campeau and Ramacieri, 1995; Lenoir, to be published; Pellerin, Lenoir, Biron and de Broin, 1994), as well as the results of completed experiments and of training workshops held in the school milieu, all illustrate quite well the necessary relativism and adaptation of the model.

Notes

1. The didactic, in francophone scientific literature more than in the debates which take place about it, has more to do with the relationship to teaching know-how. For Jonnaert (1991), "The object of study of the didactic of a discipline is [...] the functional solidarity of three families of variables united to accomplish a task finalized in a context which is spatio-temporally scholastic" (23), the variables linked to the students, the teacher, and to knowledge. For more explanation about the concept of didactic, see the in press issue of *Instructional Science*: *An International Journal of Learning and Cognition, 28* (1), 1997.
2. This distinction seems fundamental to making precise the steps involved in what is usually called the practical training of future teachers and to giving direction to interventions in adult education.
3. For our part, it is difficult to imagine the pursuit of intellectual skills and even technique outside of the application of learning strategies, unless it is done in an occasional manner for the purpose of practicing. It is important to be aware that the development of isolated intellectual skills by the child does not guarantee that she or he will develop the capacity to rely upon complete, structured and systematic learning strategies, nor that he will be able to appropriate the retained learning concepts.

Biographical Note: Yves Lenoir received a doctorate in the sociology of knowledge from the University of Paris VII. He holds the titles of professor and vice-dean for advanced studies and research in the education of faculty of the University of Sherbrooke in Quebec, as well as associate professor in the departments of instruction in the faculties of educational science at Laval University and the University of Montreal. Working at the interdisciplinary research laboratory for disciplinary instruction (LARIDD) which he founded in 1991, he has conducted and published research on interdisciplinarity, and on the relationships between didactics and instruction from an interdisciplinary perspective.

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