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The fundamental IDs and their associated problems

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ABSTRACT

Some theoretical problems (such as taxonomies of interactivity for feedbacks or such as the measurement of the effects of learning) could hardly be addressed in a general way, independently of the ID under observation. We suggest that there are only six fundamental IDs that will be specified and illustrated. All six are based on "Natural Learning Situations", more or less "artificially" developed. Each of those six IDs have their specific characteristics and raise specific problems currently addressed by psychological and educational research and technology. ID Research should take into account this kind of distinction.

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PART I : Current constrains of I.D.

A. TOTAL QUALITY AND CYBERNETICS IN ID

Since Instructional Design "aims at the systematic choice of procedures, methods, prescriptions or advices in order to bring about effective, efficient and productive ("powerful") learning environments" (LOWIJCK, 1991, p. 4), it is also submitted to the **quality insurance** movement just as any other service. A closer look shows that ISO qualification of training systems rest mostly on refined versions of TYLER's (1949) paradigm :

1. Identify general goals and operational objectives.
2. Select learning activities and contents that will contribute to reach the objectives.
3. Organise working conditions (such as resources, timing, ways of grouping learners, instructions to guide their activities, etc.).
4. Develop assessment principles, methods and instruments.

This sequence is a typical illustration of the general process of **regulation**, i.e. the cybernetic approach : target assignments with target tracking processes and successive reductions of the existing gap between the starting point and the goal to be reached. This approach can also be called "**objectives first**".

B. EVERYDAY DESIGNING : ANOTHER PLANET ?

TYLER's paradigm constitutes a "technological" approach that leads to decomposition of problems (GALBRAITH, 1967). It has been promoted and documented by famous contributions: BLOOM (1956) in selecting objectives, MAGER (1962) in operationalizing them, ROMINSZOWSKI (1976) in media selection, SKINNER (1961) and PAPERT (1980) in implementing (contrasted) learning conditions, STUFFELBEAM (1971) in conceiving assessment procedures, HUBERMAN and MILES (1985) in studying the conditions of success for implementing innovations, etc.

In spite of all this, it is still observed that a majority of trainers and teachers, when planning teaching/learning activities do NOT start from objectives but

a) either by the selection of teaching and learning activities (Mc DONALD, 1965; CLARK & YINGER, 1979; YINGER, 1980; CHARLIER, 1989, etc.);
b) or by considering available resources (TAYLOR, 1970);
c) or by deciding the content to be covered (ZAHORIK, 1975).

To speak in terms of the NEWEL & SIMON's "General Problems Solver", it seems that in the process of filling the gap between the goal and the current situation, distance reduction proceeds more in elaborating from what is possible (the "Can do" principle) rather than from what is desirable (the "Should do" principle).

C. THE TRAINER'S DUAL NATURE

The reason of this apparent discrepancy between the normative process (the relevance of which is accepted by all trainers and teachers) and the description of actions (that any trainer and teacher will confess to actually do) may be rooted in the **trainer's dual nature**. He/she is in the same time the **conceptor** AND the **executor**, permanently involved in a "bargaining" process.

An inner dialogue is likely to contain extracts such as

-Executor : "Please do not request from me more than I can do".
-Conceptor : " - OK, what can you do ? what is reasonably at hand ?"
-Executor : "- A, B and C".
-Conceptor : "To avoid cognitive dissonance, we will fix A, B and C as our objectives".
-Executor : "Thanks, since, as you know, **I am not a machine**";

This no-deception-strategy may explain the generalised reluctance to adopt the technological approach in instructional design (LECLERCQ, 1994a), i.e. follow strictly the "regulation (or cybernetics) sequence" : Needs analysis, Objective settings (or Project conception), Activity and Environment Planning, Execution, Assessment and Regulation loops.

D. THE RISE OF TECHNOLOGY AND QUALITY CRITERIONS

With the emergence of educational technology, a process of specialisation in each step of the sequence has occurred : trainers who conceive may not be the "executors", but rely more and more on devices, on machines, the variety of which enable to overcome the "Can do" obstacle. This analytic process and this tendency to subdivide the problems in sub problems to more easily solve each of them is in the definition itself of technology (GALBRAITH, 1967).

These new "degrees of freedom" in instructional design do not help in defining which ones are optimal. Three main characteristics should be taken into account :

1. The functional relevance, i.e. the desirability of the objectives (ideally based on needs analysis and on political and ethical principles).

2. The functional coherence, i.e. a triple "concordance" between the objectives, the methods to reach them and the evaluation criterions (based on learning psychology).

3. The functional cost/effectiveness, i.e. an adequacy to the actual possibilities of the training systems, or the parallel for training to VYGOTSKY's proximal development law : training systems do best what they are ready to do (based on economics and sociology).

A closer look would reveal that we are in lack of criteria to judge of these three characteristics. For instance, even if it is answered to the third characteristics problem by a Return on Investment (R.O.I.) approach, it is still a question to assess the benefits of training since they are not all observable in a short time. **Training** is a delayed effect process, **a time-bomb**. It will blow, but it is not perfectly known when and how.

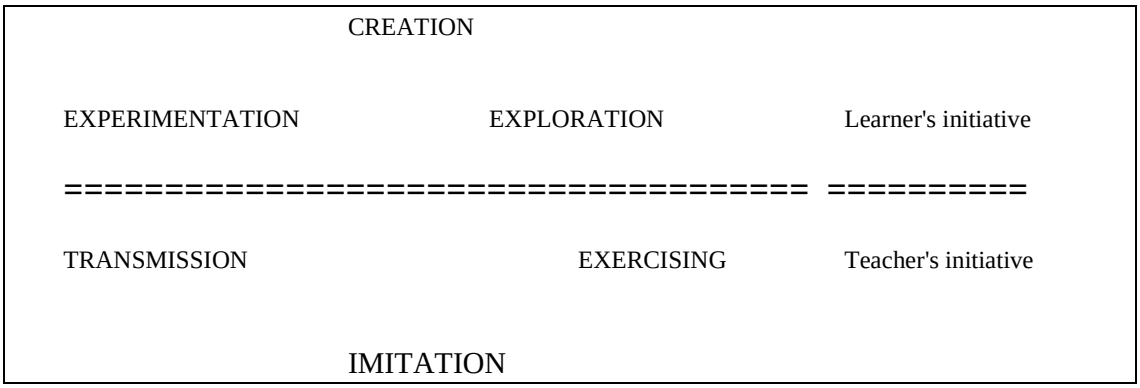
It is suggested here that significative breakthrough in this domain will be linked to the capacity of instructional designers to identify the great teaching/learning paradigms, each of them having its logic, its coherence, its relevance and its cost/effectiveness (or efficiency) parameters. To help going ahead in this direction, we suggest that there are 6 basic teaching/learning paradigms, with their typical problems, and benefiting differently (or for different reasons) from the current explosion of new information technology (NIT).

PART 2 : The six teaching/learning paradigms steering wheel

E. SIX TEACHING/LEARNING PARADIGMS

1. The upper and the lower part of the steering wheel

Six paradigms have been identified and can be grouped according to the origin of the initiative.



In the three lower paradigms, the trainer has the initiative. In the three upper ones, where the learner has the initiative refer to "situated cognition" (BROWN et al., 1989) that "rests on the assumption that the learner is an active partner" (LOWIJCK, 1991, p. 18).

2. Brief description of the six paradigms

In every day life, much is learned by **IMITATION**, resulting from immersion in social contexts. Models (BANDURA, 1971) may even not be more conscious of being "modelling" others' behaviours than the latters of being copying (technically) and identifying (symbolically) in this mostly latent process.

We learn also day after day from intentional communication, in an information **TRANSMISSION** process. Televisions, books and now NITs have already overpassed the average teachers' capacity in this function, ... in such a way that "*Technology forces humans to specialise in humanity*" (FOURASTIER).

In some domains, we need systematic **EXERCISING**, i.e. practicing with guidance, coaching and correction. The programmed learning movement deals with this paradigm.

Other domains benefit from a more free **EXPLORATING** approach, such in the free visit of a town (in opposition to a guided tour) where the learner has the initiative, wanders at will, raises the questions to the expert, etc.

In other cases, there is a need of systematically **EXPERIMENTATION**, i.e. to combine several possible modalities of a context in order to see what the effects are. The initiative of the learner lies in the conception of the hypothesis.

In a last paradigm, the learner is engaged in a **CREATION** process, i.e. builds an object, an event, a product to achieve his/her project (or a collective one). The learner is creative not only on the content side but also on the process one.

3. <u>Five facets for each paradigm</u>

Each paradigm is presented hereafter in 5 facets :

1. **The educational setting**
2. THE TEACHING/LEARNING PROCESS (type of interaction)
3. The learner's point of view
4. The teacher's main role (what he/she <u>provides</u>).
5. Typical *places* where it happens

1. **Discovery**
2. CREATION
3. "Let me build my project"
4. (Building elements)
5. *Music studio*

1. **Trials and errors**
2. EXPERIMENTATION
3. "Let me combine"
4. (Manipulation tool)
5. *Laboratory*

1. **Questioning**
2. EXPLORATION
3. "Let me wander"
4. (Browsable data)
5. *Museum, library*

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1. **Teaching**
2. TRANSMISSION
3. "Tell me"
4. (Informative sequences)
5. *School*

1. **Practice**
2. EXERCISING
3. (Correct me"
4. (Feedbacks)
5. *Stadium*

1. **Immersion**
2. IMITATION
3. "Show me"
4. (Models)
5. *Street, TV*

4. The three directions of opposition

Moreover, the paradigms are opposed in couples, according to three directions (axes).

*In the **GOAL SETTING direction**,* IMITATION of external models (or projects) is opposed to CREATION of new (personal) objects or behaviours or projects. In piagetian terms, what predominates in imitation, is accommodation, whereas in creation, it is assimilation that dominates ... especially at the level of goal definition (project, setting of objectives) as well as the level of elaboration of strategies to reach that goal.

*In the **MESSAGE STRUCTURE direction**,* The TRANSMISSION (of data structured by the transmitter) is opposed to EXPLORATION (where the primacy lies in the learner's structure or in the receptor's questions). In vygotskian terms for learners, transmission is mainly "heteroscaffolding" since the start is in the teacher's structure whereas exploration is mainly "autoscaffolding". In the first case, the exposition to stimuli is imposed from outside whereas in exploration the exposition to stimuli is the learner's choice. There is a parallel with PASK's conversation theory (1976a) that deals with the encounter of two individuals' personal views (individuals' mental maps) on the same object.

*In the **ACTION REGULATION direction**,* EXERCISING (according to an external schedule to reach an imposed level) is opposed to EXPERIMENTATION (where hypothesis and verification agenda are under the learner's responsibility). The last steps of the regulation process (LECLERCQ, 1994a), i.e. : checking of performance quality, feedback providing, interpretation and exploitation, subgoals redefinition, (re)orientation are either hetero reliant (in exercising), or self reliant (in experimentation).

F. COMMON PROBLEMS FOR THE SIX PARADIGMS

1. Mathetical ambivalence and polyvalence

When a learner has several possibilities at hand, he/she often uses them all, at will ("let me explore or try" and, a few seconds afterwards "tell me" or "correct me"), according to his/her estimated needs or his/her **mathetical competencies**[1], i.e.

- knowledge of his/her momentary readiness[2], mastery of prerequisites, i.e. VYGOTSKY's (1962) "proximal development" principle;
- momentary interest for a question, elicited by encounter of unexpected stimuli (COLIN and QUILLIAN's concept of "activity irradiation");
- degree of vigilance, fatigue, need of media variety (see the results of researches on media from LUMSDAINE to SCHRAMM);
- the estimation of the optimal degree of task difficulty (see ATKINSON's 1974 theory);
- consciousness of equilibrium disruptures (PIAGET) and need for reequilibration.

[1] A term first coined by GILBERT (1962), from the greek verb *MANTHANO* that means "to learn".

[2] See also PEARN & DOWNS, in NYHAN, 1991.

The "autonomous person in learning" is often called "autodidactician", that means "be a teacher for oneself". This wording problem could be looked upside down : considering that learning is a spontaneous process and that teaching is a prosthetic approach, teachers could be called "learnhelpers".

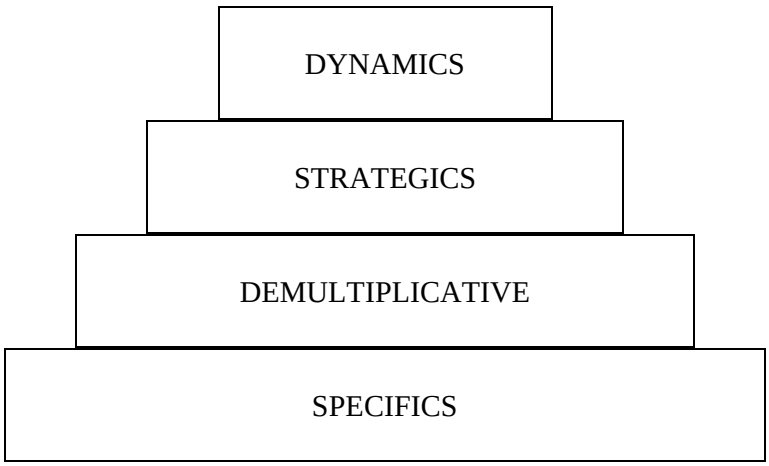
2. <u>Didactical ambivalence and polyvalence</u>

a) Didactical ambivalence

The trainer also hesitates between several paradigms. On the one hand, he/she aims to develop higher order cognitive skills in the learner (i.e. train the upper 3 paradigms), but, on the other hand he/she is conscious of the time constrains and realises how much time the learner could save thanks to the trainer's advices, models or teaching. "Self instruction might take too much time or be too expensive in other ways for an organization" (CLARK, 1991 in LOWIJCK et al., 1991, p. 105).

Actually, the trainer has to influence four levels of competencies : **specifics** (knowledge of a given vocabulary, of specific skills, of facts linked to a specific domain), **demultiplicatives** (such a reading, asking questions, note taking, data base searching, etc. that enable to learn some more specifics by oneself), **strategics** (i.e. adapt one's behavior to unique situations) and **dynamics** (i.e. the pleasure one has in doing things, in learning, etc.).

These competencies are presented (LECLERCQ, 1987) as an "Architecture of competencies" that takes the shape of a drill machine's mesh to illustrate that the "inner tool" helps penetrate new problems and new contents "dynamics first" (i.e. leaded by **motivation**, followed by **strategy**, helped by **demultiplicative** skills, and supported by already mastered **specifics**).



It often happens that a method very efficient to learn **specifics** (programmed instruction for instance), does not help in the acquisition of **strategics**, and vice versa (the LOGO environment being the opposite example).

This model largely matches LOWYCK and ELEN's (1990) one of important learners' characteristics in designing instruction : prior knowledge, cognitive strategies, metacognition, mental effort and motivation. (LOWIJCK, 1991, p. 20).

b) Didactical polyvalence

The teacher-trainer has to conceive his Method Mix (just as advertisers have to prepare a Media-Mix) that will optimise the acquisition of the best combination of parts of each of the four levels.

Since the learner can ask "Tell me" and, a few seconds afterwards "Let me explore", the trainer has to be skilled in all those functions : be a good designer, a good transmitter, a good coach, a good model, a good environment provider, a good evaluator, a good stimulator, etc. Obviously, it is less and less possible to meet all those possibilities in a person, and technology is taking an increasing place in the training strategies, leading to **SERVUCTION** (a word coined by the economists of the University of Lyon), i.e. the principle of having the learner-consumer participate more and more in the delivery of the goods or of the service, just as it happens in self banking, in self tanking and in self service in general.

3. Actual settings combine several paradigms

Traditional lessons combine mostly transmission, exercising and imitation. The LOGO approach represent almost the opposite combination. Lab work, dialogs, etc. offer other kinds of "patchwork". This can be represented in the next table.

	LESSON SEMINAR	LOGO (Microworlds)	LABORATORY	DIALOG
IMITATION	X		X	
TRANSMISSION	X		X	X
EXERCISING	X			
EXPLORATION		X	X	X
EXPERIMENTATION		X	X	
CREATION		X		

PART 3 : Problems specific to each paradigm

G. PROBLEMS SPECIFIC TO IMITATION

Context : Mental Representation researchers (ALBERTINI *et al.*, 1985) show how much our mental networks are based on our living experience. The same for the (piagetian) constructivist views on knowledge acquisition and structuration. Motivation is also a central component in this mode of acquisition. This is often expressed in a ironical way : "If a person is to become a great dancer he/she had better be born in Rio".
The problem is : **How could we provide full size live experiences, with actual human models to imitate ?**
Some unvoluntary and undesirable answers are the murders and aggressions displayed in the movies and subsequently copied by children and adults... in a vicarious (mediated) way.
Voluntary non-mediated (full size) answers are about COLLINS et al. (1989) have called "cognitive apprenticeship" where the "teacher/expert models his/her activities when trying to solve an authentic problem. After that, the learner performs autenthic activities on his or her own (situated learning), based on skills which are corrected and extended in a subsequent course of learning" (MANDL & PRENZEL, 1991, p. 77. Full size non mediated role playing is a classical answer to this question. It is assumed that the effects are more important on learning when the learners are not aware of the artificial nature of the situation. That often raises ethical problems as three famous example will show.

- In MILGRAM's (1963) experiment, the subjects discover how far their obedience would lead.
- In Jane ELIOTT's role play (the "divided class") "blue eyes children" are segregated and suffer racism during a few hours (PETERS, 1969).
- In the Dr FOX role playing (NAFTULIN *et al.*, 1973), the audience experiences how much an actor can be appreciated as a teacher whereas the content of his/her teaching is completely false.

Some mediated purposive solutions are, for instance, TV ITCOMS (situation comedies), where specific audiences (for instance adolescents) are represented, facilitating identification and the modelling process (BANDURA, 1973).

Our *caveat* for imitation is **Clear up ethical and cost/effectiveness issues.**

H. PROBLEMS SPECIFIC TO TRANSMISSION

Context : It is well known from media research that using a variety of channels (i.e. visual, audio, motor, ...) increases motivation, and that in specific contents or circumstances, it can improve comprehension and memorisation. DALE (1969) suggested a "cone" of experience where he ranks educational situations from the most multisensorial and risky one (bottom of the cone) to the most abstract and controlled one (top of the cone).
The problem is : **How could we provide the optimal variety in medias ? in channels ?**
Some answers to the problem are Multi-media presentations (CD Rom, CDI, ...). Research on iconic encoding and decoding constitutes the operative counterpart of Gestalt research. Research on media effectiveness (SCHRAMM, 1977), on media taxonomies (ALLEN, BRIGGS, etc.), on text readability (HENRY, 1981) and on icon understability (LECLERCQ, 1994) can help a lot in this respect.

Our statement about transmission is: **Continue research on iconic and decoding processes (icons readability), metaphors, schemas, scripts, ... from a cognitive perspective.**

I. PROBLEMS SPECIFIC TO EXERCISING

Context : Exercising assumes that a specific (well known) objective is to be mastered and that motivation exists. The coach has several functions. He/she micrograduates the difficulties, asks the learner to perform the actions, provides feedbacks and remedial advices. This paradigm is used in programmed instruction that can be compared to knitting ideas in a network. Linking new concepts to the previous ones are benefiting from what AUSUBEL calls the subsuming effect, helped by advance organisers.
One problem is : **How could we adapt to the learner's prerequisites ? How could we know them ?**
Some answers exist: Experienced trainers and teachers know the average difficulties. They have a "map of dangers" of their domain. They must create for themselves a hypothetical model of the learner, that constitutes a central element of an I.T.S. (Intelligent Tutoring System). It has been argued (LECLERCQ, 1992) that an ITS should have a fifth component (a monitoring system) in addition to the four classical ones (an expert system, a model of the learner, pedagogical rules and an interface).
Our with would be that : **More attention be devoted to the monitoring component (that feeds the learner's model) and its interface aspect in the "knitting" of mental webs.**

J. PROBLEMS SPECIFIC TO EXPLORATION

Context : The learner is probably in the best position to answer, due to his/her mathetical competencies. "The only way to assess objectively what a person knows is to take his/her subjectivity into account;" (adapted from de FINETTI, 1965). Exploration may be at the same time the exploration of the outer world as well as the inner one. It can be supported by appropriate methods and techniques (LECLERCQ & BRUNO, 1993).
The "Game Boy" are an illustration of that : as says a 8 years girl "I can decide whether I want to be very afraid or just a little bit".

A first problem is : **How could we know more about INTERPERSONAL differences ?**
Some answers to this problem exist : It is often advocated (e.g. CROSSLEY & GREEN, 1989) that freedom to explore increases learning motivation. Individuality expresses itself in cognitive styles : holist vs serialist approach (PASK, 1976b), deductive vs inductive approach (CARLSON, 1990), iconic vs verbal preferences (RIDING, 1981), impulsive vs reflexive (KAGAN, 1971), etc. ATI Methods show interactions between methods and outcomes :
Statement about this problem: **Study the intra personal variance in preferences, according to contents or moments.**

A second problem is : **How could we know more about INTRAINDIVIDUAL differences ?**
Some answers to this problem have been given : A more educationist trend of research stresses that those strategies vary more with external circumstances, i.e. constraints (such as imposed objectives) than with internal characteristics. ATI methods also show interactions

between methods spontaneously adopted by the learner and INTRAPERSONAL changes in objectives (LECLERCQ et PIERRET, 1989; LECLERCQ et BOSKIN, 1990). Treatment-Aptitudes Experimental design show typical interaction between methods and INTRAPERSONAL differences in learning strategies.
Statement about this problem : **Study the individual's versatility and sensitivity to circumstances**

A third problem is : **How could we offer (to the learner or the trainer) freedom in his/her approach of a domain ?**
Some answers to this problem : Hypermedia is a typical proposal to reach such a goal. Some typical hypermedias deserve mentioning.

A team from MIT recorded views from all the streets of a U.S. town (ASPEN), so that a user can travel in all the streets, turn left, right, etc. as he/she wants, stop at will, drive back, speed up, slow down, etc. This is a good practice tool to train in invading a city where you have never been before.

An other example is provided by BASSETT's idea to record interviews of Jacques LIPZIC, the famous cubic sculptor, and to put LIPZIC's answers on several videodisks driven by a computer program. The user can access those answers in asking his/her own questions (by typing them on the keyboard). Since LIPZIC is dead from 1973, almost everybody now can dialogue with a dead person. Virtual reality seems to be the most "sensory sophisticated" current way of providing exploration possibilities.
Statement about this problem: **Study the learner's capacity in (mental) travel planning, route seeking, note taking, record keeping, data structuring, etc.**

K. PROBLEMS SPECIFIC TO EXPERIMENTATION

Context : In sciences, conceiving hypotheses and testing them is often a time consuming activity. Days, months, years, have to be devoted either to set up the experiment or to observe (measure) the phenomena and to process the data. Sometimes, the subjects are inaccessible for ethical reasons (experimenting on animals or on humans), or for cost reasons (go to the moon and back) or for security reasons (plan with parameters in a nuclear power plan), etc.
The problem is : **How can we offer possibilities of manipulations, of data acquisition, of results display ?**
Some answers to this problem : Computer simulation is a typical answer to this question. A few examples will suffice :

- Analytical computer simulation : E.g. : Dr GIEZENDANNER (1993) designed MACHINA CARNIS, a simulation tool helping experiment on the human heart, with facilities to observe the phenomena (carnot cycles, the SQRT famous graphics, etc.).
- Global computer simulation : E.g. : An English nurse, Judit PORTER designed the JUNIOR software for diabetic children. In JUNIOR, a little character plays in "popping" as many balloons (as possible) (i.e. burns carbon hydrates), but in insuring that insulin injections, urine analysis and energy consumption are made on due time.
- Mixed computer simulation : E.g. : The software AIMS conceived by J. GONZALES helps understand mechanisms of epidemy, especially the sida. It

offers different possibilities, such as selecting some mundial data for some countries (statistical point of view), or simulating the diffusion of the epidemy relating to different parameters that the learner has defined.

- NONNON (1986) conceived his "cognitive spectacles" where the student can, on the one hand, observe the actual full size phenomenon (e.g. a mini train running on rails) and, on the other hand, observe its graphical transposition on the computer screen.

Statement : **Conceive working environments for experimenting, based on mental ergonomics** (cf. CROSSLEY & GREEN, 1990)

L. PROBLEMS SPECIFIC TO CREATION

Context : The learner tries to solve a problem by creating solutions. It can be a short one, such as a title for a movie or a brand name for a product. It can be a complex one, such as the conception of a whole building by an architect. In between, a handful of examples : text writing, poster designing, graphical presentation, etc.

The problem is : **How can we provide to the learner appropriate building (creative) tools as well as efficient ways of helping his/her metacognitive processes ?**

As an answer to this problem, PAPERT (1981), in his "Minstorms" book, suggested the idea of microworlds that share the following characteristics :

- they can be explored : they react to actions;
- they enable the learner to BUILD new constructions in a versatile way : conceive, make, change, test, overcome obstacles, etc.
- they help the learner to have a "mirror" of one's own thinking ("make each learner an epistemologist", in PAPERT's words).

Another famous example is the BBC Domesday Book, where thousands of numerical data, icons, maps of England not only can be explored, but are also available to BUILD new constructions, such as comparisons between one's own village statistics and an other city's ones ... resulting in an original (unique) combination.

Cooperative learning is also facilitated by some setting such as cooperative softwares (DERYCKE, 1991), grounded in psychological theories about socio-cognitive conflicts (PERRET-CLERMONT, 1979).

DENIS (1990) has proposed objectives of such micro-worlds, and has studied the conditions of actually implementing the purposed interactions.

Statement : **Conceive microworlds and the human environment (animation), study the animator's professionality (objectives, conditions, ...).**

M. CONCLUSIONS

The "systems-approach", proposed by MONTAGUE & WOLFECK, 1986 (cited by LOWICK (1991, p. 5)) should be followed : " (1) a team of experts from different disciplines bring about all necessary information and expertise accomplishing a task, (2) the task is analyzed in subtasks to reduce the task's overall complexity, (3) unique but systematic solution to the (sub)task are devised, and (4) tests are conducted to provide information for later revision and modification of the system."

We hope that the distinction into six different paradigms will help study more efficiently each of them, taking into account its own coherence, its specific conditions of relevance and efficacy, and, therefore, of the choice of one (or a combination) of them according to objectives and constrains.

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