# The Geneva Manifesto of Intelligent Learning Environments

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# *The Geneva ...*

At the University of Geneva (Switzerland), the School of Psychology and Educational Sciences has created a new unit in educational technology, called TECFA (for "Technologie de la Formation et Apprentissage"). The team includes about ten experienced scientists and is directed by professor Patrick Mendelsohn. Our main focus concerns the applications of artificial intelligence and cognitive science to education(AI&ED), especially to the design of intelligent learning environments.

Several academic groups and private companies, located around Geneva, are involved in the same field of research and collaborate with TECFA: the START-UP group (A. Boder, C.Gardiol), the Concept Moderne S.A. (X. Comtesse et al.),... This situation has created a very dynamic environment for research and action in educational computing. They partially share the approach of AI&ED we define in this manifesto.

# *..Manifesto...*

This document presents our major philosophical and educational choices with respect to this domain. As a "manifesto", it enumerates 8 slogans, without a lengthy argumentation.Its aim is not to present a complete theory of what learning is or what a learning environment should be. More modestly, it aims to define a broad theoretical position within the AI&ED community and to open a public debate about the presented ideas. These 8 slogans may lead you to think about the ten commandments. We hope they will be so famous but... more discussable. They do not describe the system we will implement next week, but rather long term goals which will guide our research activities.

The design of a learning environment is, at the same time, a methodology for fundamental research and a process of software development. Our research goals are fundamentally oriented towards educational innovation in a broad sense. For instance, innovation in classroom courseware could profit from the requirements of professional training systems (e.g. developing skills useful in everyday practice).

# *...of Intelligent Learning Environments.*

The concept of "intelligent learning environment" generalizes the various kinds of systems developed by researchers in AI and Education. From Intelligent Tutoring Systems (ITS) to Logo-like micro-worlds, these systems vary along a continuum. Their position is defined by the degree of student initiative, their representation of the learner's knowledge, their knowledge of the tutored domain, etc. The combination of "intelligent" (taken from ITS) and "environment" (taken from micro-worlds) points out the current shift in research towards contracting this continuum into a union point.

# The Eight Slogans.

### *- 1 -*

*"Nobody grows up by solving the tower of Hanoï problem! "*

***The rationalist view of human reasoning is inadequate for designing learning environments.***

AI & Ed has been strongly influenced by the AI paradigm of quasi-rational thinking. This paradigm has proven its usefulness for the study and the simulation of problem solving processes in well defined areas. However, this (often hyper-) rationalist view of human reasoning is inadequate for designing systems which have to handle real life behaviors! For instance, plans are a useful concept for understanding human actions, but they are seldom built for generating these actions.On the contrary, plans emerge from heuristics built out of more contextual cognitive units we call familiar schemes. These units may then be generalized, if they reappear in various domains. This position is an alternative view to the drastic opposition between domain-independent heuristics versus specific domain oriented knowledge.

### *- 2 -*

*"Jumbo pilots are not trained on helicopters"*

***Knowledge acquisition is context dependent***
***Transfer must be learned.***

A major restriction to rationalism lies in the context-dependency of human knowledge structures. The context in which knowledge is acquired determines how this knowledge is recorded and, consequently, how it may be accessed to and used. We have to ask ourselves how a piece of knowledge has been integrated within one's knowledge structure, how general these structures are and how information may be retrieved from them. As a corollary, knowledge transfer itself must be learned, mostly through context variation.

### *- 3 -*

*"The problem is that they ignore that they ignore it."*

***Metacognition and reflection are the keys for access to knowledge.***

Metacognition is a major challenge in education. Metacognitive skills don't float in the sky. They constitute some high layers in the architecture of human cognition and hence are intertwined with lower level skills. Installing metacognitive skills implies caring about the interdependency of these layers.

One aspect of metacognition, namely the use of relatively domain-independent heuristics, partially contradicts the stated context-dependency of knowledge. Another aspect of metacognition should be focused on instead: reflection. Reflection is the process which leads to self-awareness. It is the basic mechanism for context adaptation. A frequent case of meta-ignorance, of reflection failure, is indeed the overgeneralization of knowledge applicability (see slogan 2)

### *- 4 -*

***Significant learning experiences require time.***
***Learning environments must reflect the stages of development.***

High level skills can not be acquired in short periods. Learning systems aiming to develop high level skills must be designed for term long use: they have to include opportunities for numerous and various experiences, for long-term projects, and so on. Projects influence the internal consistency of microworlds and the motivation of their users.

Cognitive growth is not linear, but accelerates around some stages, piagetian or not. An isomorphic discontinuity of knowledge representation and interaction modes has to be offered by learning environments : they must mirror the qualitative jumps performed by the learner.

## *- 5 -*

*"We have spent 20 years working towards adaptive systems while the real goal is to help students to become themselves adaptive."*

***The main quality of a learning environment is to help the student to adapt herself to new situations.***

The quality of tutoring systems is often measured as its ability to adapt its behavior to the student's one. However, the system's adaptability is not the goal, it is only a means. The goal is the student's ability to adapt itself. This does not mean that we have to develop very unadaptive systems, requiringthe student to makemake major adaptations. Our point is to tell clearly that the system's adaptivity is a means subordinated for developing the student's one. In some circumstances, this subordination is important. For example, we know that system feedback is often the best way of helping the learner to assess her behavior. But, in some circumstances, giving immediate feedback may indeed prevent the student from assessing her own behavior. Student's self-feedback might then replace the feedback provided by the system. Similarly, student models are necessary for adaptive coaching, but indeed the real goal is that the learner build an accurate model of himself.

## *- 6 -*

*In microworlds, most learners do not turn their experience into learning, while in ITSs they are supposed to learn without real experience.*

***The amount of guidance needed by the learner is not a universal educational constant, but a parameter to be modified through educational actions***

In the debate between proponents of microworlds and the proponents of ITSs, the central issue concerns the learner's control of her own activities. Most people agree on the necessity of tuning the control according to the evolution of the learner's level of competence. We think this debate should be relocated within a larger educational context. The relative inefficiency of learner's control is more an artifact of several years of classroom passivity than as a intrinsic limitation of cognitive growth. Designing systems with a high level of directiveness will simply reproduce these schooling effects and kill any chance of educational innovation.

Models of classroom interaction are internalized into passive models of learning. Learning environments have to break such models by promoting a style of interaction which contradicts the habits that students acquired at school..

## *- 7 -*

*"Good design is good cognitive theory" (Eisenstadt)*

***Learning occurs through the interface.***

The basic objects and operations offered by the interface directly influence the concepts and mental operators available to the learner. The principles underlying the screen display and users operations are not just technical or aesthetic issues. They constitute essential choices. In particular, interfaces have to reify implicit aspects of the learner's cognition in order to make them more available for reflection.

## *- 8 -*

*"Travelling is learning"*

***Multiplicity is the soul of learning environments.***

Multiplicity promotes articulation of knowledge: multiple situations for training transfer; multiple viewpoints because a constructivist approach requires that the learner be allowed to use and to test its own relevant knowledge structures; multiple coaching strategies because none is universally efficient or adequate. Learning requires frequent shifts between the various situations, viewpoints or strategies.