

Teaching, an emergent property of eLearning environments

Nicolas BALACHEFF

CNRS, Leibniz Laboratory, IMAG Grenoble, FRANCE

This paper offers to the discussion the claim that educating function of a system is an emerging property of the interactions organised between several different types of specialised agents including human tutors. A project implementing these ideas is then quickly presented.

World-Wide Web: the full version of this paper can be found at <http://www-didactique.imag.fr/Balacheff>

1. Teaching models revisited

The evolution of the ideas in the field of learning technologies could be sketched as follows: the initial paradigm was to design Intelligent Tutoring Systems as autonomous machines with strong instructional functionalities and some sort of modelling of learners' needs and cognitive characteristics, a second paradigm, about ten years later, has been that of the development of learning environments opening to the learner a real space for the exploration and the construction of knowledge. The former has not led to clear success, while the latter has evidenced serious difficulties and the need to complement the environment by teachers input and guidance [1]. In summary, if teaching being reduced to instruction is not the more successful avenue, the absence of teaching features in a learning environment, which has been stressed during the last decade, does not guaranty either the quality of the learning output. What is the lesson? Clearly the need to search for a new paradigm which could ensure a better equilibrium between learning and teaching, between human and machines [2].

The reasons why the learner, either a child or an adult, needs "teaching inputs" are very often hidden as a corollary of the emphasis on—and possibly the misunderstanding of—the constructivist principles of design of learning environments. We claim here that these needs are especially important in the case of modern environments which are largely distributed and provide a potential access to a huge range of knowledge and information. The following questions illustrate some of the issues that learners may have to face when left on their own in the wild web on the digital resources: "How to look for something you don't know? ", "How to know that what you have found is what you were looking for? ", "How to know that you have learned?". Here are some of the issues that a teaching assistant should help to address. An other crucial question is: "How will others know that you know?" It is not enough that learners have solved problems for them to understand that they have learned. Creative problem-solving which is at the core of the constructivist approach is so rich in new intellectual constructs that it is even a problem for the learner to realise what is worth reminding. Here again is a specific task for a teaching assistant. This last issue is often forgotten although it is related to the fact that often learning is related to a search for an adequate certification. There is no general teaching model which could be implemented to equip a learning environment with the corresponding functionalities.

The nature of complex knowledge (as opposed to basic skills) is an other reason to seriously refocus the design of learning environments on teaching issues. One of the main characteristics of such knowledge is, first that to master it requires to master several different pieces of knowledge organised in the form of a system, and second that its use depends on methods which are not mere algorithms. Such *knowledge cannot be constructed spontaneously* even when learner are provided with an adequate problem-situation, and actually in some cases such situations are even still unknown (e.g. linear algebra). As a result, complex knowledge requires specific learning environments and content specific teaching strategies. The complexity of such knowledge also comes from the fact that the corresponding learners' conceptions (i.e. learners' cognitive constructs), can be very different the one from the other and rather complex to understand and to model. The current research on students' understanding of the concept of "function" in

mathematics or of the concept of "energy" in physics witnesses this complexity. The development of technological tools aiming at supporting the use of these knowledge (formal computation, simulation, etc.) even increases the difficulty by modifying within a kind of systemic loop the nature of the users' conceptions ([3], [4]).

We cannot expect one single universal agent to be able to handle the complexity of supporting the learning process in the case of complex knowledge. On the contrary, there is a need for specialised agents, either artificial or human, able to cooperate and to coordinate their actions in order to provide the best support to the learner—indeed, one could remark at this point that the situation might not be so different for the so called "basic skills"...

Our claim is that: *the educating function of a system is an emerging property of the interactions organised between its components*, and not a functionality of one of its parts.

2. The Baghera project

The project Baghera, a leading project of the Leibniz Laboratory, has the objective of shaping and experimenting radically new perspectives on the design of eLearning environments. First, by eLearning environment we mean not only the technology but the whole complex constituted by the machinery, its users and its environment. Second, it is the project basic belief that the complexity of human learning can be faced only if the design of eLearning environments takes the collaboration between artificial and human agents as a foundational principle. This requires a strong pluridisciplinary approach at every stage of the design and of the implementation.

A platform like the one we look for, is structured by several different types of interaction and cooperation: between teachers and artificial agents, between human teachers with the mediation of the technology, but also between learners mediated by the technology. Indeed we must add the interactions between learners and teachers either in an asynchronous mode or in telepresence, and between learners and the learning environment. Learning does not occur because of one specific type of interaction, but because of the availability of all of them. One type of interaction, or one type of agent, being selected depending of the needs of the learner at the time when the interaction is looked for, as well as of the specific characteristics of the knowledge at stake.

Then, the learning environment, constituted by content specific resources and conception specific resources (taking into account the variety of learners possible conceptualisations) gets its teaching power not from the property of one of its components, but the emergent property of the interactions of all the agents involved—either artificial or human, learners or teachers. In this approach the crucial issue is not that of the genericity of the technological environment (which is always obtain to the detriment of its cognitive and epistemological specificity), but of its adaptability and openness to change.

May be this is just rediscovering that education has never been the result of the action of one isolated tutor, or single intuition, but of the Society at large...

By the way, why "Baghera"? Because at the core of the system we intend to develop a society of non-human agents whose interactions will aim at the education of a human learner. But unlike the famous story, this time some human agents will take part in the adventure...

References

- [1] Hoyles C. (1993) Microworlds/Schoolworlds : The transformation of an innovation. *in* Keitel C., Ruthven K. (eds) *Learning from computers : mathematics education and technology* (pp.1-17). Berlin : Springer-Verlag.
- [2] Balacheff N. (1993) Artificial Intelligence and Real Teaching. *in* Keitel C., Ruthven K. (eds) *Learning through computers: Mathematics and Educational Tedchnology* (pp.131-158). Berlin : Springer-Verlag.
- [3] Balacheff N. (1997) Construction of meaning and teacher control of learning. *In*: Tinsley D., Johnson D. C. (eds.) *Information and communications technologies in school mathematics* (pp. 111-120). London: IFIP / Chapman & Hall.
- [4] Sutherland R., Balacheff N. (1999) Didactical complexity of learning environments. *Journal for Computers in Mathematics Learning*. 4, 1-26.