2

The computer: ally or alien?

Charles Duchâteau

Faculté Universitaires N-D. de la Paix
Namur, Belgium

ABSTRACT

Nearly all western educational systems are in a deep crisis; divided organisation of the school and standardised views of the teachers tasks, dating from a time when the missions of the school institution were rather different, are obviously one of the causes of this observation. It is in this context that we have been trying for many years to associate the computer (and information and communication technologies) with teaching practices. This paper aims to show why and how these tools and the related approaches bring an innovative and disturbing pedagogical model; it will also explain why and how these new modern tools could contribute to the necessary changes of educational practices.

Keywords: attitudes, classroom practice, integration, interdisciplinary, teaching methods

INTRODUCTION

Today school: long live Socrates

For about thirty years, western societies have been asking schools to welcome and to train all children between six and sixteen (or eighteen) years old. As Lafontaine states [1]:

> "In a period of twenty years, the nature and the extent of contributions and functions expected from school have deeply

D. Watson et al. (eds.), *Integrating Information Technology into Education*

> changed. From a purely quantitative point of view, school was confronted with huge number of pupils. In Belgium, between 1950 and 1965, the total number of students at secondary schools increased by 75%, and by 29.5% from 1970 to 1982. In France, the number of students at secondary schools increased fourfold between 1959 and 1985 ... we can easily understand that school was faced with the need for an urgent solution to this massive increase in the number of *different* students, different from the usual school clients."

Hence, the number of pupils as well as the number of teachers is now greater than ever before. Yet, neither teacher training nor school organisation has taken into account these transformations.

Our teaching model remains - at best - the Socratic one with masters helping chosen disciples to find their own way towards wisdom and to build their knowledge through a particular and adapted dialogue. This experience of learning, thanks to the contact with a master, is a very intense but an unusual one in the average pupil's school, and I do not aim to call this experience into question in this paper.

The absurdity, however, lies in the belief that this method can be, or even is, generalisable and that training can be organised just as if all the "teachers" were always and in any circumstances real "masters". The present organisation of educational institutions is based on a dull and absurd equation: "If one Socrates is enough for training and tutoring twenty disciples, how many Socrates do we need for the training of two million pupils?"

In the economic world, the need for mass production leads to giving up the old craftsmen model and to developing industrialisation. Today school is faced with the same need for an "industrial revolution": the task is no longer to train a small fringe of first-rate pupils but to train at best all children from 6 to 18 years old. Yet, the model of the teacher still remains the one of a craft-teacher who is able to teach in a classroom, to prepare for this teaching, and to cope with psychological and relational difficulties. Even if we tend to prefer the good old days of craft-teaching methods, school has today to undergo its own industrial revolution; to knock down all the barriers between classes, levels, subjects and to enhance the vision of what a teacher is and what a teacher does. I believe that a shift from a stereotyped and uniform view of teacher's activity during his whole career to a broader and more evolving view of this profession is essential. Unfortunately, this observation is not really new. Hyer wrote in 1974 [2]:

> "Within the next ten to fifteen years, major changes will have to be made in the training and retraining of teachers. More emphasis will need to be given to individualising instruction, operating as a member of a team, assessing pupil achievement and diagnosing learning difficulties, providing a working knowledge of technology and of man-machine relationships, and the selecting, modifying and/or producing of instructional materials."

Of course, the aim is not to transform classes into assembly lines with a mass-production of similar pupils and to introduce Taylorism into the school. To talk about industrialisation in this context means, on the contrary, to change the role and the function of teachers: sometimes they will teach in the classroom, or rather, they will assure that learning takes place; during other periods of the week, of the year, or of their professional life, they will make tools and develop environments for teaching and learning; lonely work will give way to team work and the sharing of common tools.

Nevertheless, as pointed out by Vitale [3]:

> "In spite of innovators' repetitive efforts and despite partial and limited experiments carried out in special or experimental schools, today school is dominated by the presence of notional knowledge already made up (only known by teachers at the beginning but slowly passed to students in a hard process of knowledge socialisation) and by the cutting-up of human knowledge into subjects whose frontiers are jealously watched over by experts."

As Hannafin also mentioned [4]:

> "A typical classroom, both past and present, may be described, with notable exceptions, as having one teacher who directs all activities and presents knowledge in discrete chunks to be passively ingested by students to be recalled later on in a test."

Finally, there are no simple solutions or cures to this school crisis; we have to be wary and careful about specialists making recommendations and creating fantasies. Yet, we have to go on analysing the problems and we have to find and test out solutions, even if these solutions are incomplete: the survival of school, hence of our society and our culture depends on it.

The computer

A group of specialists in education have considered for some time the computer with its range of uses as a possible means to diversify, develop

and even to improve the pedagogical relation in its teaching component as well as in its learning aspect. From obsolete teaching machines to the prophecies on the revolution linked to the generalised distribution of pocket computers, the new technologies have raised hopes. Even if achievements have probably not always lived up to expectations and to the quantity of speeches, it is important to continue considering possible ones.

In this paper I will focus on some potentialities of these new information and communication technologies by stating in what way they operate and how they are likely to intervene in pedagogy or in the routine of the trio teacher - student - subject. So I do not wish to point out all the applications and possible uses of the computer, but only to highlight some of their possible effects on teaching, learning, the organisation of the school and the perception of the role of the teacher.

THE COMPUTER: A TUTOR, A TOOL FOR THE TEACHER OR A TEMPTATION FOR THE STUDENT?

I would like here to examine three possible meanings of the acronym CAL by focusing on the position of the computer in the classical triplet subject - teacher - student.

CEL - Computer-Ensured Learning: the computer-tutor

Today this vision, fortunately out of date, of a first possible role of the computer, has perhaps been the most widespread illusion: the role of a tutorial. It involves the type of use which many people deny having done but which, however, has deeply influenced the beginning of the use of the computer for pedagogical purposes. It is the illusion of the computer tutor, that of computer-based learning and that where the software is trying to mimic as far as possible the actions and the reactions of a good teacher.

The student is placed in front of the machine-tutor and after the dialogue which is going to occur and which will be, of course, individualised, the student will learn and master, for example, the concept of the derivative or the workings of the combustion engine.

The vision of the learning conveyed by this type of approach was originated from the Skinnerian or Crowderian trends which had already widely influenced programmed teaching. The contents to be mastered are dissected and split up in small cells which will be successively proposed to the learner. According to the answers given, the learner is dragged along a more or less individualised learning track. At the end of the dialogue between the learner and his tutor, the concept is mastered and the

subject is digested. One may imagine the huge difficulty of this prior dissection of the subject to be taught which requires both a great expertise in the contents, but also a deep knowledge of the difficulties encountered during learning. It requires a complete vision of the subject to be taught and its organisation.

When we look at them from the design or analysis and programming point of view, the creation of the information technology tools is characterised by the fact that the task to computerise must be completely unfolded beforehand. No vagueness, nothing implicit is allowed, even in educational software tutorials. The designer must therefore have considered beforehand the dialogue which is going to constitute the learning but only has access to only one of the two protagonists. It is only possible to write the role of the computer with all the subsequent responses to all the predictable reactions of the learner. The problem is therefore no longer to teach but to make the machine teach; this *machine tutor* is particularly limited. Taking the main characteristic of this performer into account constitutes the second difficulty. Beyond the extreme and total dissection of the contents to be taught, there remains a detail which is at the heart of informatics; the great difficulty is that the computer is a formalist processor of information. In the word informatics, what is to be read is not information but form. The real objective of informatics is to detect the meaning under the form, to enclose the meaning in the signs and the semantics in the syntax. The domain which is the most out of reach without a doubt, is the one of the language and even more that of the dialogue. Therefore, a great deal of time has been lost and much energy spent on a problem which is, in the end, technical and marginal, that is the analysis of responses coming from the learner.

There is an additional illustration of the false importance granted to this type of use. Many proposals of evaluation of the CAL products are made by observing and judging what the computer does and not what the teacher or learner does. If one wants to judge the degree of integration of a software tool to the strategies of the teacher, it is the teacher who is to be looked at and if one wants to assess the qualities of the learning taking place, the student and not the screen, is to be watched! Yet as Crossley and Green state [5]:

> "In many educational software, the student is considered as a pitcher which has to be filled up. Some educational software designers anticipate a passive student, taking on knowledge and never tempted to switch off the computer. With their software, it is the computer which has fun."

It is possible that, in medium term and for a particularly limited universe, the progress of information technology will perhaps enable us to tackle this central problem of the CAL tutorial, that is the management of a pre-recorded dialogue. Attempts must no doubt follow but with a clear measure of the challenge. These procedures, however, which aim at changing the computer into a private tutor should no longer continue to constitute the tree which hides the forest from possible pedagogical applications : there is so much to do with a computer than to try to make it mimic a teacher. As pointed by Barchechath and Pouts-Lajus in Crossley and Green [5]:

> "it is wrong as for designing educational software ... to believe that the only way to reproduce an interpersonal communication between an interactive software designer and a user imposes to the designer that the software simulates a person (and for instance, the designer himself). Yet, the sole observation of educational software users interacting with informatics systems, could have presented a precious indication as far as the validity of the similarity necessity is concerned: none of those users claims that he thinks or that he wants the computer to behave like a human being."

CAT- Computer-Assisted Teacher: the computer set of tools

This is no doubt the domain where we could harvest a wide variety of products and ways of uses. They all have in common the fact that the teacher again assumes a role and that the computer, equipped with adequate software packages, returns the role which it should not have left, that is a tool or rather a wealth of tools. It is of course arbitrary and delicate to classify the products under the category of tools for the teacher or those for the student. Some of them can of course, be fortunately used by either of them. Without being exhaustive, I would like to point out a few typical and well known examples of this type of uses.

The computer "super-board" involves activities which the teacher decides on, prepares and carries out in the context of a traditional lesson. In front of the class, near the board or the overhead projector, the teacher uses the facilities of a spreadsheet or graphical software to illustrate a concept, to shorten repetitive and tedious calculations and to deal with the data of an experiment.

The dull drill-and-practice programmes are those which, for obvious reasons, restrict the dialogue between the student and the computer to an exchange such as 'delete as appropriate'. The dream of the tutor-computer has disappeared and handed over to a limited and patient auxiliary, just good enough to propose statements and to indicate the correction of the

stereotyped answer provided in the range of offered propositions. The initiative of the student is extremely reduced especially because of the form of the possible answers.

Everyone knows that a part of teachers' work consists of activities not requiring a great deal of grey matter, for example the acquisition test of the students' reflexes, propositions of practice exercises and their correction and checking of factual knowledge. These are typical activities where the computer equipped with little sophisticated software is irreplaceable. It is better to confine it to the role of a repetitive machine than to that of a private tutor. It does not matter here that the tools used are dull; they come to assist teachers with dull activities with which they are grappling. Then relieved with repetitive and tedious aspects of their task, teachers will perhaps find some time for remedial work which constitutes a major part of the task and for which the teacher is irreplaceable.

Even if teachers are absent, as long as learners are kept busy with the software exercise, they are the ones who decide, organise and manage the access to this type of product; in a modest way, teachers then become the managers of this particular form of learning for learners.

Bureaucratic software packages, however, are of a different type. I believe that for teachers to be assisted by a computer in the classroom, they must have perceived the advantages of these tools. Using a computer for personal purposes, material preparations, and the management of reports; these are decisive in arousing a more pedagogical curiosity. The most efficient products in this context are obviously the bureaucratic packages. At the same time, once these tools have been mastered, one can then think about their possible uses in the classroom, consider the pedagogical diversion which these packages promise and to experiment with them. These packages are, by nature, open to a wide range of uses; here too, it is the imagination and the creativity of the teacher which constitute the main motor for developing these activities.

This list of types is far from being complete; I have stressed that it is the use which is often more decisive than the characteristics of the products. Tutorials can be used by the teacher as a remedial tool; a management package as a super-board.

These uses have in common the central role of the teacher; it is the one teacher who decides where, when, how and which tools to exploit and to be used by the students. If the pitfalls of CAL mainly appeared at the design level of the products, the difficulties of this other side of CAL appear at the level of changes in the roles and attitudes of the teachers. It is obviously impossible for a trainer to integrate these new tools into

practices and make them implicit without realising it. Thus it is far less the products than the uses made of them which need to be evaluated. The question to ask is not "what does the computer do?" but rather "what does the teacher do?".

CAL - Computer-Assisted Learner: the computer-world to explore
This is no doubt the rarest type of use, but also the most promising. If I were to qualify it in a few words, I would say that as with video games, learners are found engrossed in a little world which they are going to explore gradually. The actions posed are going to cause modifications of the environment and force the students to construct hypotheses which will then be tested thanks to the interventions on their part. Little by little, with the help of their companions or the teacher, they are going to reconstruct in their heads the world on which they act and the rules which govern it; thus they are going to build themselves new knowledge. There still exist a few of these tools which allow the exploration and discovery of a particular subject. I will only quote as an example Logo or Cabri Géomètre.

If teachers still remain the managers of the learning environment, they may often also become the accomplice of the learner and the co-explorer during the discovery of the micro-world offered by this type of software. The role of the guide, in the touristic sense, should not be overlooked either: if teachers accompany the students in their discoveries, they are going to indicate and highlight the important details, make them aware of the learning taking place by analysing the route they took and show the enlightening analogies. This role of putting things into perspective has been stressed several times as crucial for allowing the transfer of acquired skills.

The real problem is once more not the technical mastery of these tools, but their integration in a global strategy and the teachers' perception of the change in the role which is required of them at certain times.

THE COMPUTER-LEARNING OPPORTUNITIES

I am tempted to state that in the triangle subject - teacher- learner, it is the vertex subject that disappears. As it is, the main goal is no longer to learn and master a traditional subject, but only to learn. The computer is the pretext or excuse for learning activities that will bring a cognitive surplus into the learner's brain.

The first and most prestigious representative of a learning opportunity through using the computer is undoubtedly Logo. It is also the more

widely used and analysed example. I would like to insist on the fact that through the Logo micro-world, learners will explore and experience algorithmic thinking. Even if it is done in a soft and unconscious way, the learner who explores the Logo universe is walking in the heart of algorithmics. Working with Logo, the problem is not to draw a circle, a house or a ship, but to have these pictures drawn by the turtle-performer, by giving it the suitable directions. The learners do not draw anything, they have it drawn by the turtle, so they program. Through Logo, you go from the usual world of 'doing' to the new and fascinating world of 'having it done by'; so you are at the heart of algorithmic thinking.

We all know that the main goal of Logo environment is not to learn geometry, even if the tool can be diverted for that learning, nor, despite the previous assertion, to learn programming. Logo activities are free; the aim is not to teach a traditional subject but to train learners to learn and to think about their learning.

Using some software as tools also brings opportunities for training some methodological competencies which would allow the pupil to do at school what is usually supposed to to be done at home.

> "Many skills have to be learnt during schooling: to be able to look for information, to process it, to communicate it, to interpret it, to be self-taught in individual or collective research activities, using recent equipment. By using intelligently a word processor, a data base or simulation, you can practice those skills." [6]

In this case too, these tools are pretexts for developing organisational, planning, and collaboration competencies.

We should also remember the field of pedagogical robotics. Giving orders to such a performing device (robot, automatic machine) even if it is very close to algorithmic thinking, has no importance by itself. What matters is not to have the task done by the robot, but rather the approach and processes leading to this result - questions, hypotheses, attempts, testing, error recognition and team working.

Although from the learner's perspective these opportunities may seem to be free, the disappearance of a precise and classical teaching about a subject may be quite disturbing for the teacher, who consequently requires a particular training to this kind of pedagogical way. This implies that, more than ever, research, experiences and exchanges have to be emphasised and communicated. We know that to put pupils in these rich learning environments is not enough for them automatically to acquire new competencies and knowledge. Teachers have to be specially trained in these new roles to become guides and accomplices of the learners.

The subject of this working conference is Integrating Information Technology into Education and not Integrating Information Technology into Existing Subjects. I believe that the computer provides a wonderful opportunity for inter- or multi-disciplinary activities, which are not limited by the existing subject frontiers [3].

The computer-mirror

In order to bring and to integrate the computer into pedagogical practice, we need some prior reflection about these practices; we could even say that the computer will give us a reflection of these practices, since it can be considered here as the mirror of actual pedagogical behaviour.

This computer-mirror asks many questions about learning processes and forces specialists to model and to formalise these processes; it also questions teachers about the ways they use it through teaching practices and it compels didactic experts to have a new look on their own subject. All these remarks were already pointed out by Bertrand [7]:

> "but it is as essential to notice that informatics highly contributes - in the learning field - to bring up to date buried problems: what is *to learn*?; how to learn complex mathematical notions more efficiently ? ... In that sense the trick of informatics fulfils its function as it forces man to wonder about himself"

Also in Jaffard [8]:

> "And finally, the presence of the intruder (computer or IT) leads the teacher to wonder about his daily pedagogical practices ... to call some of them into question, to invent new pedagogical situations".

And in Beaufils [9]:

> "In some cases, indeed, the use of computer underlined insufficiencies in the knowledge or the know-how of those subjects."

From my own experience, when working with a team of teachers, creating some educational software or thinking about the ways of how to use an existing one, you always, first of all, have to cope with present, current and usual practices. You have to be aware of your own teaching practices before deciding why and how to use the computer. But this is the usual consequence of informatisation; you have to depict and to become conscious of the present situation before using the computer. This is the mirror-effect of the computer in school as well as in business; the

computer obliges us to drive out all tacit and vague knowledge. It is a mirror reflecting what is really the reality.

The computer-lever

Insofar as the computer is a learning opportunity for the pupil, it can represent a chance for the teacher to change role and strategies. I stressed before the roles of guide, of co-explorer and of accomplice. We could add many other roles to this list, all of them sharing the same goal: a shift from loud-speaker behaviour or knowledge funnel role, to learning environment and learning scenario producer; to resource-person, to a cartographer drawing maps for exploring knowledge lands, these lands being not enclosed in the artificial barriers of subjects. Meirieu states [10]:

> "Relieved from pure informative tasks, he (the teacher) could dedicate himself to the processing of these information : he would guide the students in the multitude of diversified documents, would help him to make relevant choices and to make the most of them through efficient working, would not hesitate, if necessary, to send him back to resources from cultural, economic or social field. Because he should not fear to lose his power, convinced that he would barter the distributor role for the mediator one, to become guarantor of assimilation and no more spectator of incomprehension."

I do not intend to refer to a wait-and-see teacher; we all know that giving a bathtub to a student is not enough for him to discover naturally Archimede's principle. We also know that sending him into a library in order to establish a comparison between the US and Japan economies will not automatically lead to an answer, nor to a formative and organised behaviour. We do not have to confuse putting the stress on pupil's activity with dreaming about natural discovery methods. It is not true that the student, on his way to learning, will have sparks of genius which would be the same as those which have marked out the whole humanity evolution. The computer is only a lever which, introduced in teaching methods, can contribute to change viewpoints and roles.

Only an Archimedes could think that a lever and a fulcrum would be sufficient to lift up the world. Whatever the potential qualities of computerised environments, men and women in the educational world will have to lean on this computer-lever to try to modify school, to awaken teachers and to shake pupils.

> "If, as I think, programming and other forms of computer experiences will be able to play in the future, a catalyst role in the invention of new relationships between teachers and learners in the classroom, that will be because teachers and learners will have accepted to leave their present roles, too rigid, in order to have a more open one: curiosity, discovery, search for relevance in the building of knowledge. But the presence of computers in school and the learning of computer science won't be enough to change deeply the school landscape. In a rigid school, informatics will be considered as an additional subject, as abstract and irrelevant as others. On the other hand, the failure or the success of a social project of open and interesting school won't be due to the only presence of the computer." [3]

The computer-lever must not become a rubber repair patch computer to be put on school weakness to hide how large and deep are these rifts.

The computer-cement

The computer can also be a wonderful federative tool; I will go even further and suggest that a successful introduction of software tools in the school inevitably requires sharing and exchanges.

The school, which is a public service in our society, has to welcome new sectors, for instance, a sector whose objective would be the creation and experimentation of tools and a proposal of appropriate use of them. Teachers' teams could deal with these new fields, with the help of computer scientists, as we know that team working prevails in this kind of creation.

More widely and within the school, the need for sharing and mastering the same tools can induce exchanges. And if I could be allowed to dream, why couldn't we consider teaching as a collective work, teachers working together, in groups or teams? In a more realistic way, we can assess that the general and open character of some software tools makes easier a multidisciplinary approach.

And finally, outside the school, groups of teachers sharing the same new methods or gathered around the same tools, are emerging. In this case, telematic networks are really useful, and used as sharing opportunities, since their users have to talk together.

New roles for the teacher

This paper could have been entitled Information Technology and Changes in the Role of the Teacher, in the triangle subject - learner - teacher. I hope I have shown that many computer uses, disturbing the usual

equilibrium within a classroom, force the teacher to revise role and to modify attitudes. Some people will talk about the teacher as creator of an interactive learning environment (Oates, quoted in Hannafin [4]), underlining the designing role in a team. Others will consider the teacher as facilitator or manager of information (Berliner quoted in Hannafin [4]); these are only a few examples among many others: coach, guide, organiser, initiator or diagnostician.

Personally, I tend to use similar images, talking about a teacher as a cartographer drawing maps for exploring 'knowledge lands', co-explorer of micro-worlds, accomplice [11,12,13]. Anyway, it is important to notice that those new roles do not constituted a dissolution of the teacher's mission: to be an adult who must teach, raise and educate; to know more than the pupils; to keep defining clearly what they want needs to be learnt and to assess the extent of difficulties met by those who are learning. Mirror and cement, the computer will force teachers to re-define their position and will help them in this task.

CONCLUSIONS

For more than ten years, speeches about the computer-education duo have followed one another. Little by little, more understanding and experiences have emerged. We need to be patient and we need to have a view about these problems that is not too global and comprehensive. In the world of education, it is perhaps better to work with a lowered head, moving small stones around rather than looking at the big, still and unchanging educational mountain. If many of us move these small stones, although we may not move the mountain we may make it tremble. And the computer is such a nice shovel.

REFERENCES

1. Lafontaine, D., Grisay, A. & Orban, M. (1987) *Enseignement et enseignants: mutations et perspectives à l'heure des nouvelles technologies.* Laboratoire de Pédagogie Expérimentale, Université de Liège.

2. Hyer, A. (1974) *Effect on Teacher Role of the Introduction of Educational Technology and Media into American Schools* in The Teacher and Educational Change: A New Role, OECD, Paris, 1974 211-269.

3. Vitale, B. (1990) *L'intégration de l'informatique à la pratique pédagogique.* Volume 1. CRPP, Genève, 1990.

4. Hannafin, R. & Savenye, W. (1993) *Technology in the Classroom: theTeachers's New Role and Resistance to IT.* Educational Technology. June 93, 26-30.

5. Crossley, K. & Green, L. (1990) *Le design des didacticiels.* ACL Editions, Paris.

6. EPI (1992) *Pour une culture générale en informatique à l'école, au collège et au lycée.* Assemblée Générale de l'EPI.

7. Bertrand, I. (1991) *L'informatique pédagogique et l'apprentissage.* Informatique et apprentissages, INRP, Paris 17-27.

8. Jaffard, R. (1990) *L'EAO. Pourquoi? Pour qui? Par qui? Comment?.* Interface, Revue de la SSPCI, **1**, 35-38.

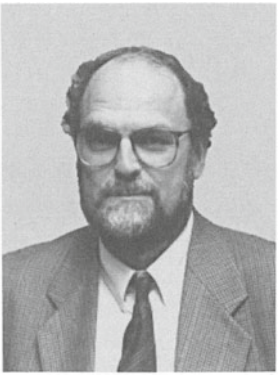
9. Beaufils, D. (1991) *L'informatique en sciences physiques au lycée.* Informatique et apprentissages, INRP, Paris, 1991 47-57.

10. Meirieu, Ph. (1989) *Enseigner, scénario pour un métier nouveau.* Editions ESF, Paris.

11. Duchâteau, C. (1990) *Images pour programmer.* De Boeck-Wersmael, Bruxelles.

12. Duchâteau, C. (1992a) *L'ordinateur et l'école! Un mariage difficile?* Publications du CeFIS, **5.28,** Namur.

13. Duchâteau, C. (1992b) *Trois visages de l'EAO.* Interface **2/92**, 5-7.



Charles Duchâteau was born in 1946 in Belgium. After studying to be a primary school teacher, he undertook a degree in Mathematics at the Catholic University of Louvain and then a PhD about incomplete information differential games at the University Notre-Dame de la Paix in Namur. It was within the Mathematics Department of this university that he founded the CeFIS - a centre for the training of teacher in informatics. He is now member of the Education and Technology Department. His research field is that of informatics didactics and the meaning of the elements constituting an Information Technology Culture.