E-Learning as a tool of dynamic teaching

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Abstract

Some people believe that when it comes to disseminating information, Internet is the most significant invention since the printing press. Indeed, Internet may present a virtual classroom for teaching and learning as well as a virtual laboratory for research and engineering. For the virtual classroom (Web) to be equivalent to the real one, the virtual teacher (e-learning program) should possess more pedagogical talents than the real teacher who benefits from the direct physical contact with the students in the real classroom. Thus, while electronic learning offers the opportunity of distant education and formation, higher pedagogical performances compared to conventional education are required. In this work, we show how electronic learning can be used to offer fully dynamic courses with efficient interactivity. In function of the interaction of the student with the virtual course, the latter modifies itself automatically in real-time to match the needs of the student and his comprehension level with respect to the given subject. This course dynamism may be ensured by a neural network based algorithm. Rivalry between real and virtual teaching is discussed, challenges are identified and appropriate solutions proposed. Illustrations are given at the end.

Sommaire

Certains croient que quand il s'agit de diffuser l'information, Internet est l'invention la plus importante depuis l'invention de la presse. En effet, Internet peut offrir une salle de classe virtuelle d'enseignement et de formation aussi bien qu'un laboratoire virtuel pour la recherche et l'ingénierie. Pour que la salle de classe virtuelle (Web) équivaille à la classe réelle, le professeur virtuel (programme de formation électronique) devrait posséder plus de talents pédagogiques que le professeur réel qui bénéficie du contact physique direct avec les étudiants dans la salle de classe physique. Ainsi, alors que la formation électronique offre une éducation et une formation distantes, des performances pédagogiques plus élevées, comparées à l'éducation conventionnelle, sont exigées. Dans ce travail, nous montrons comment la formation électronique peut être employée pour assurer des cours pleinement dynamique à interactivité efficace. En fonction de l'interaction de l'étudiant avec le cours virtuel, ce dernier se modifie automatiquement en temps réel pour s'ajuster aux besoins de l'étudiant et de son niveau de compréhension en liaison avec sujet donné. Ce dynamisme dans le cours peut être assuré par un algorithme à base de réseaux de neurones. La rivalité entre les enseignements réel et virtuel est discutée, certains défis sont identifiés et des solutions appropriées proposées. Des illustrations sont données à la fin.

1.0 Introduction

The Interconnected Network (Inter-Network or merely Internet) has been described variously as "the grandest revolution in the capture and dissemination of emerging academic and professional knowledge and information since Caxton developed his printing press"[1], "the invention of the 20th century. The Internet is a world of its own where anything is possible. It has revolutionized communication and our access to information." [2] and "the end of the need to print to paper....the harbinger of an economic, social, and cultural revolution as significant as industrialization and urbanization in the 18th and 19th Centuries....people will not just work differently; they will think differently." [3].

Indisputably, Internet is an outstanding communication tool. People can communicate with anyone who is connected anywhere in the world. The connection is almost instantaneous. The connection does not have to be a one-on-one conversation; you are able to converse with many people at one time. In other words, you can be either the teacher or the student through Internet. However, direct physical contact and natural human interaction are missing. A real teacher (Figure 1) benefits from this natural interaction in the physical classroom to make his course understandable, his arguments convincing and his exercises attractive. For example, during a traditional face-to-face course, the real teacher can use his hands to explain new or difficult concepts, ask and re-ask the students whether they understood, read the faces of the students and reformulate his explanations if necessary … In a virtual classroom offered by Internet, direct physical contact is not available. Thus the virtual teacher (Figure 1 - a Web-based program, …) should compensate for this gap with the assets offered by the electronic learning (e-learning) on Internet.

In the present paper, we limit attention to world wide and publicly accessible e-learning, namely e-leaning on Internet. After providing some definitions, we discuss some potential abilities of e-learning for compensating the absence of direct physical contact between the teacher and the student, the trainer and the trained, the leader and the engineer ... We focus on teaching and learning in this work. Trainings and engineering works will be subject of future publication. In particular, we will discuss how e-learning on Internet can provide dynamism in the course by interpreting the user's actions. After identifying some strong points of face-to-face teaching in traditional classrooms, we propose alternatives offered by virtual teaching. Examples illustrating these solutions are given at the end.

2.0 E-Learning

E-learning has various but similar definitions. We limit ourselves to three of them:

Figure 1: Right: Real teacher (face-to-face learning), Left: virtual teacher (e-learning).

- E-learning is the use of network technology to design, deliver, select, administer, support and extend learning [4],
- E-learning can be defined as instructional content or learning experiences delivered or enabled by electronic technology [5], and
- E-learning is to classroom learning as cell phones are to a pay phone at the bus station [6].

We distinguish two types of e-learning methods. The Web-enhanced e-learning consists of a combination of instructor-led training (face-to-face) with e-learning. However, for the Web fully e-learning, instructions are only available on the Internet. In the present paper, we will focus on the second type, namely the Web fully e-learning.

3.0 Challenges For Virtual Teaching

As mentioned above the virtual teacher should possess more educational talents than the real one. One of the powerful tools that the virtual teacher can use is the popularization of science. This aspect will be treated in details in a future work. We content ourselves here with one example. The virtual teacher can offer a Web page including a science popularization article, for example, on the theory of relativity [7] or on the Big Bang [8]. However such articles present a classical educational tool that is used since the beginning of history of education. Internet in this case is only used as a medium for dissemination of information and not as a platform supporting popularization tools such as scientific simulations, visualization of scientific concepts, animated images, interaction, real time animation, sound clips, … In other words, these tools must be powerful enough to face the challenges resulting from the virtual character of e-learning. In this analysis, we restrict ourselves to the two following challenges.

- Firstly, in a physical classroom, the student can ask questions to understand some points that he missed or to be sure that he correctly understood the talk of the teacher. This option is missing in virtual teaching and presents a serious challenge for this new teaching method. The student appreciates seeing efficient alternatives offered by virtual teaching (next section).
- Secondly, the real teacher may deduce from the student's questions or incorrect answers to some exercises that some points in his explanation during the face-to-face course are not covered or insufficiently detailed or must be reformulated. Questions and errors may be very positive in education since they help the real teacher to pinpoint sources of confusion and therefore to get the possibility to clarify confusing aspects.

These are examples of challenges that virtual teaching through e-learning on the Web should face and provide appropriate alternatives. Let us see in the following section examples of tools that can be offered by e-learning to overcome these challenges.

4.0 Power Of Virtual Teaching

E-learning offers powerful tools that are lacking in traditional learning and formation (face-to-face learning). These tools may make up for the absence of the natural human interaction in a same physical room and at a same time since traditional teaching and learning are linked together in time and space. Indeed, e-learning offer fundamental elements for the popularization of science and engineering such as interaction and animation.

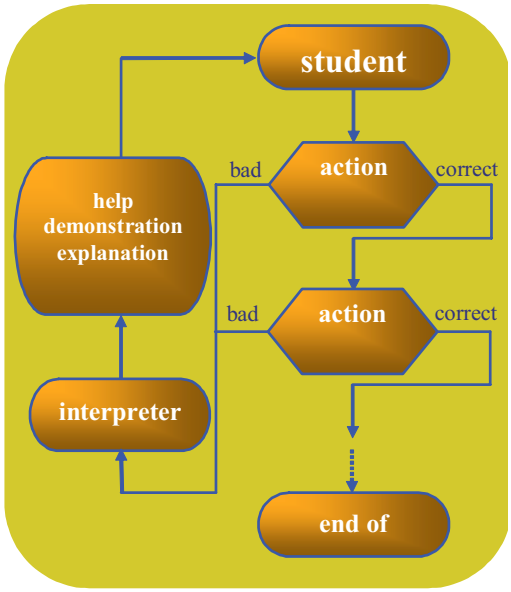

Figure 2: Electronic learning with real-time assistance: supervising the interactions of the user interpreting them to adapt the course to the user's needs and capacity.

One of the assets of e-learning is the possible implementation of multimedia and especially animation. This ability may overcome the first challenge mentioned above. Indeed, there is no doubt that animation provides a strong visual reinforcement of physics as well as engineering concepts. To be more efficient, the animated simulations of scientific phenomena must also include interaction so that the user can formulate his requirements, enter his own data or test himself. This quality may replace the possibility of asking and re-asking questions to the real teacher. All around the world, interactive Web-based animation allows people to visualize even the most difficult concepts of mathematics, computer science, physics, chemistry, telecommunications, etc, to see them and then to understand them. Interactive and especially animated scientific simulations creates real-time correlations between scientific theories and applications that help us visualize, experiment, and interact with the most complex concepts of science and engineering. Without immersing oneself in heavy mathematics, but simply by clicking or dragging a mouse, the user can visually understand difficult concepts, such as photon-atom interaction [9], optical aberrations [10], diffraction [11], fractional Talbot and Lau effects [12] or light injection into an optical fiber [13].

Concerning the second challenge, one of the solutions to meet it is to interpret the responses and the actions of the student (Figure 2). The virtual course should be based on the interaction with the student, the user of e-learning platform, to be sure that he is continuously understanding. In other words before moving to another aspect, the student is asked to interact (reply to questions, move animated elements, draw a curve, check a box, …) or to look for a demonstration. Depending on the actions of the student, the platform can identify whether or not he is understanding or estimate how much he is understanding. His actions may be interpreted by the platform to localize possible confusions or to estimate the degree of difficulty the user is facing.

First, in case of a detected confusion, the platform informs the user about the confusion and then clarifies the situation by a text or a figure or a demonstration … The platform may also change the questions addressed to the user or the kind of interaction to avoid any confusion. This might be performed by a neural network integrated in the e-learning platform.

Second, if, in the light of the user's actions, the platform realizes that the complexity degree of interaction is not presently appropriate to the student, the interaction may be revised (type, difficulty level, …) to match the comprehension level of the user with respect to the concept in question. Demonstrations and figures might be also useful in some cases. The adjustment of the interaction format in function of the user's actions may be performed by a neural network based e-learning platform.

It results that a supervision program interpreting the user's interaction with the e-learning platform is very desirable since it may replace the possibility of asking the real teacher in a face-to-face course. An example will be given in the next section.

5.0 Illustrations

One of the most interesting topologies of communications systems is the Token Ring topology. Avoiding collision and being adapted to fiber networks are two main advantages of this topology. The best way to understand the traffic of packets in a Token Ring canal is to see it (see the concept to understand it). My students provided this statement unanimously. I prepared an interactive and animated Web-based Java Applet to popularize the concept of the Token Ring [14]. The student can freely manipulate the program and build any possible case of traffic including the most complex situations. He can, for example, see what is happening to the Token or to the packet when one of the stations became out of use (Figure 3).

We provided an illustration for the principle of real-time assistance which consists of supervising the interactions of the user with the e-learning platform and interpreting them. This interpretation is used for detecting confusions or for matching the complexity degree of interaction to the estimated comprehension level of the user. We propose an interactive animated Web-based e-learning program for teaching geometrical optics. An animated audiovisual step-by-step curse is offered. The program includes numerous applets offering interaction and animation. One of these applets serves as an audiovisual interactive teaching manual for geometrical optics [15]. For example, one can easily learn

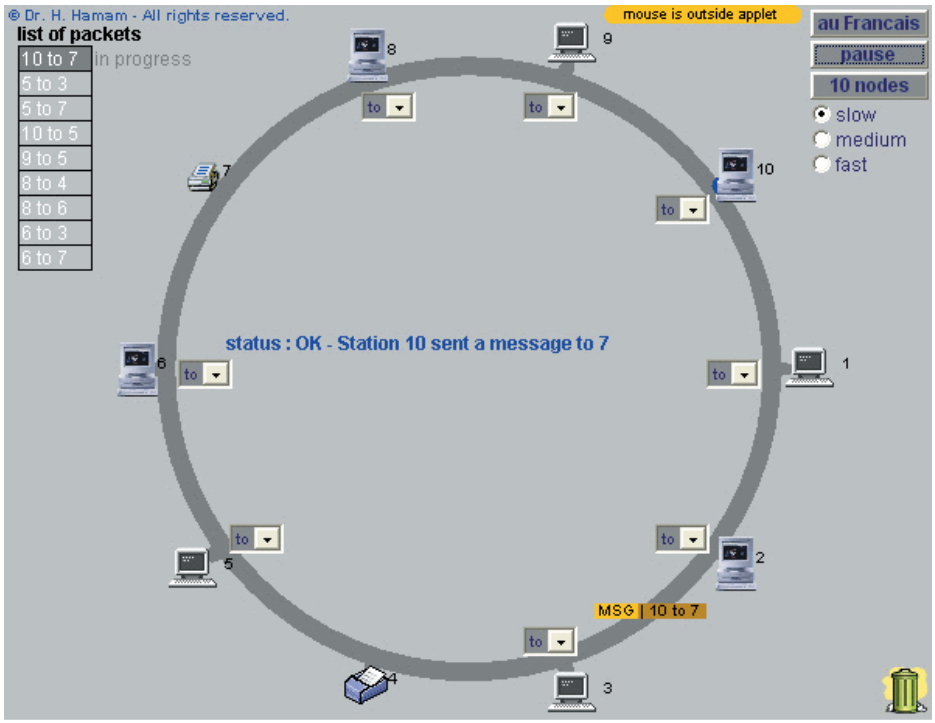

Figure 3: Interactive and animated Java Applet for the Token Ring topology

how to manipulate the three particular rays - parallel, focal and nodal rays - for various systems and for real or virtual objects and images. The applet interprets the manipulations of the user and accordingly offers to him real-time assistance. Several other applets are available [16].

6.0 Conclusion

This article treats some aspects of the rivalry between real and virtual teaching. The real teacher profits from the direct physical contact with the student to identify the needs of the latter, to answer his questions, … The real teacher, by sharing time and space with the student, may make his course dynamic according to the face-to-face interaction with the student.

The virtual course is, by nature, lifeless if the powers of e-learning are not used. We can call for an invisible teacher who should continuously supervise the scene between the Web-based e-learning platform and its user (student). This teacher, who may be a neural system, provides real-time assistance by offering demonstrations, modifying the course, clarify confusing points, asking question progressing in complexity, reminding fundamental aspects and previous explanations, …

In summary, thanks to incessant technological progress that is offering powerful tools to e-learning, the latter may enhance or efficiently replace traditional face-to-face classroom courses.

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