TEACHERS AS ARCHITECTS OF KNOWLEDGE IN E-LEARNING

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ABSTRACT

What teachers do when they behave as architects of knowledge and promote e-learning in order to create learning communities of students is firstly considered. Then a research project aiming at understanding the kind of physics problems that can be faced and solved through e-learning by a community of high school girls is discussed. Finally, some closing remarks are made on the roles of teachers as catalysts of learning communities.

KEY WORDS: case study, e-learning, learning community, collaborative learning

1. INTRODUCTION

Learning is a personal enterprise enriched by interpersonal exchanges. The traditional means for learning are based on presential forms of interaction with the support of written materials. Since the invention of the printing press, huge and fruitful reservoirs of knowledge to be learned have been accessible due to the successful support of technology. Nowadays, other kinds of interactions and materials are available due to technologies such as Internet, Intranet, satellite broadcast, video tape, CDROM and so on [1]. These technologies characterize a new culture by three traits: we live in the information society, of multiple knowledge and continuous learning [2]. Under these appealing conditions teaching and learning can be organized more efficiently [3]. Consequently, the creation of learning communities with the support of modern technology is giving to education a new dimension.

Learning communities have been regarded from different points of view and different kinds of experiences and guidelines have been reported showing how to form and maintain them, [4-7]. Furthermore, constructivist learning supported by modern technology has been considered as the working base for creating learning communities [8]. These authors make two kinds of assumptions about learning under those conditions:

CONCERNING KNOWLEDGE: it is constructed, not transmitted; it is a consequence of many activities, and it is context dependent. Knowledge building requires articulation, expression, or representation of what is learned.

CONCERNING MEANING: as it is in the mind of each knower there are multiple perspectives; it is prompted by a problem, question, confusion, disagreement, or dissonance; it may be shared with others but it is not created equally; also, meaning making and thinking are distributed throughout our tools, culture, and community.

It is nowadays possible that learning communities count with the support of a network of advisers and a stock of learning materials: the domain of e-learning. E-learning has two main benefits: it helps the teachers to accomplish their mission in a more efficient way, and it guides the students in their learning processes in such a way that they work at their own pace, have more equal opportunities and access materials that can be updated easily and frequently.

It is in the previous sense that teachers have been considered as architects of knowledge involved in the planning, building, evaluation and maintenance of learning spaces and structures designed in order to promote the organization of learning activities [9]. In this paper we consider a case study of a high school physics teacher working as an architect of knowledge who builds a learning community of girls through e-learning.

2. ARCHITECTURE OF KNOWLEDGE AND PHYSICS EDUCATION

Knowledge is built depending on its nature: conceptual, procedural or attitudinal. Therefore, learning of these types of knowledge will imply those teaching procedures, resources and criteria that use to manage architects of knowledge. However, what is relevant here is how e-learning transform this situation. Therefore, the aim of architects of knowledge is twofold: the creation and transformation of information and know-how by knowledge building, and the construction of a reasoning power in the students in connection with the acquisition, application and evaluation of knowledge. As described in Table I, the use of advanced technology makes these functions possible and broadens the range of its applications through e-learning projects.

TABLE I. FUNCTIONS OF TEACHERS AS ARCHITECTS OF KNOWLEDGE

FUNCTION	DESCRIPTION	RELATION TO e-LEARNING
Planning	Propose designs for promoting effective learning in the students.	Organization of learning activities in presential forms that will evolve into non-presential ones.
Building	Create diversified learning materials and effective strategies for studying.	Consideration of the cognitive requirements needed to promote collaborative work.
Evaluation	Obtain tangible results that reflect organized efficient learning, shown in different times and forms.	Continuous application of metacognitive skills in order to test what students know and what they can propose and do.
Maintenance	Define working conditions that assure personal improvement and collective success.	Fruitful navigation in order to expand or to go deeply into other topics and promote enriched communication experiences.

In order to describe the case study of a teacher-architect of knowledge that teaches physics through e-learning to a community of high school girls, in what follows we give some characteristics of physics education and then describe the educational model on which we base our project.

For different reasons and with huge differences among social and cultural settings, mathematics and science education at the high school level, particularly physics, share several characteristics in many countries [9]:

- For the great majority of students physics courses are the last ones on that subject in all their life; also remedial courses and supplementary activities are strongly needed.
- Many students had difficulties to develop reasoning and understanding, to visualize physical situations, to represent data graphically, and to express relationships in mathematical terms.
- Despite low performances in quizzes, home works and examinations, students are eager to learn and they are experiencing different ways of learning by watching TV and using computers. All our students live in a technological society and require urgently to be prepared to struggle and survive, but physics seems to them irrelevant, difficult and boring.
- Teaching methods are mostly oriented to transfer information and to solve textbook problems, but not to understand accessible real physical situations, even at a very elementary level. Very often teachers do not know or disregard the main results of education research and the resources provided by advanced technology; they also neglect the fact that concepts require time to mature in the minds of the students.

Despite these drawbacks, teaching physics is assumed to satisfy the following objectives [10]:

- To motivate the interest of the students on physical phenomena.
- To comprehend the applications of physical phenomena in technology and every day life.
- To give the students ideas about how human conditions depend on the way physics and technology are used.
- To relate with the experience and the interests of the students.
- To observe that understanding certain concepts, phenomena and fundamental relationships are preliminary conditions for understanding more complex concepts.
- To promote that students make connections among causes and effects based on their own observations of the phenomena under study.
- To lead to conclusions that provides bases for establishing universal relationships.
- To give importance to experimental work.

Furthermore, it has been proposed that education must abandon ideas such as to assign a protagonist role to the teacher, to teach subject matters separately, to encourage rote learning, to organize classrooms according to age, to encourage individual competition, to impose autocratic rules, and to separate the school from everyday life [11]. On the contrary, these authors indicate that education must be centered on explorations made by the students, working on interdisciplinary projects, promoting creativity, organizing classrooms according to knowledge, make cooperation and interdependence possible, and integrating the school to the community.

In addition, a new approach on teaching and learning science and technology has been based on the following four pragmatic pedagogical principles [12]: (1) *Making science accessible: connecting to what students want to know. (2) Making thinking visible: explaining mistakes, animating science processes, and illustrating connections. (3) Helping students learn from each other: building respectful, efficient, and effective collaborations in the classroom. (4) Promoting lifelong science learning: supporting project work, reflecting on scientific ideas, and revisiting science questions.*

Taking into account previous considerations, we propose a physics education model that is described schematically in Fig. 1. The model contains three elements: community (left side), technology (middle side), and cognition (right side).

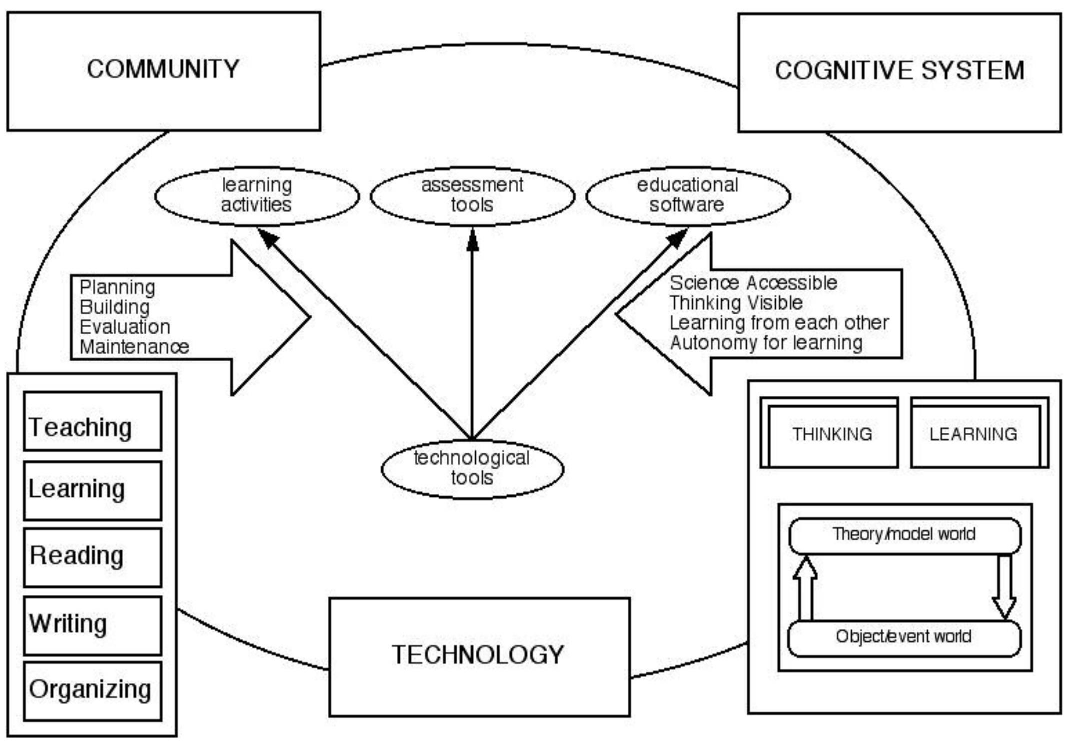

Fig. 1. Model of an integrated system of technological support for building a learning community.

3. HIGH SCHOOL PHYSICS FOR GIRLS

A research project is under development in which we study the delivery of e-learning services provided by a high school system conducted under the leadership of a teacher-architect of knowledge. In what follows we describe the context of this project, then we specify the goal, objective and methodology of the project, and finally, we comment on some expected outcomes and the most relevant findings available at this stage.

The project concerns two high school introductory physics courses at Colegio Francés del Pedregal, a private institution for girls affiliated to the incorporated system belonging to the National University (UNAM). We are working with one class of 22 students and another with 14 students. Both courses comprise 4 hours per week, during two semesters of 14 weeks each one.

In this project classroom activities were not organized in the traditional setting consisting of blackboard, chairs and tables; instead, every week the students spend three hours at the library and one hour at the laboratory. The library has been adapted in order that during class time the students have direct access to printed materials like textbooks and journals, as well as to six computers connected to the local network of the school and to Internet. Furthermore, outside class time the students have access to the computer center of the school where there are available nearly 20 computers equipped like those in the library. Each student has her own e-mail address and almost all of them have access at home to at least one computer with Internet.

The core of the courses is a web page prepared by the teacher (*www.colegio-frances.edu.mx/fisica6*). This page is traditional in the sense that it contains the table of contents of all the units of the syllabus, the schedule of learning activities, notes prepared by the teacher, supplementary lectures, links to home works and quizzes, and guides for experimental work and projects. Some activities are designed for individual work and others for teams of 3 or 4 students. The students send all their home-works through e-mail, with the exception of laboratory reports and numerical solution to problems, which are presented on paper. The goal of the project is to describe the activities and attitudes of the students during their work through the web page by looking through the kind of interactions and products in which they are involved. We are interested in understanding how the students distribute their time, organize their learning spaces and use the available resources. By studying the interactions among the students themselves as well as the interactions between the teacher and the students we hope to have an improved knowledge of two dimensions: the dimension of the students and what they are capable of doing through e-learning, and the dimension of the teacher and what makes the school system work.

The main objective of the project is to study the kind of problems and projects that the students approach and solve during a whole course. To be more specific, we concentrate on the topic of energy because it is all pervading the syllabus. In particular, we are looking at different manifestations of collaborative learning generated through the use of the web page. By collaborative learning we accept the following definition: "a learning process that emphasizes group or cooperative efforts among instructors and students, active participation and interaction on the part of both students and instructors" [13].

The methodology followed in this project is based on the analysis of categories defined and interpreted by using direct observations, personal interviews and documents generated by the students. The corresponding theoretical framework concerns publications providing foundation and perspective to the educational model depicted in Fig. 1, see for instance [14 -16].

4. CONCLUSION

In this project we want to show that e-learning used by a teacher-architect of knowledge is affordable, useful and promising, regarding collaborative work on problem solving at the high school level. We close by mentioning the main findings obtained up to now; for each finding we indicate in italics how each particular result is related to the physics education model described in Fig. 1.

(1) Although at the beginning of the course the problems are quite direct and simple, involving straightforward conceptual relationships, later on the degree of complexity and difficulty increases. Nevertheless, the students are used to solve problems without thinking, they just want to identify the required equation, determine the unknown variable, replace data on the equation, and do the calculations. Nowadays, more than half of the students are familiarized with a different approach to problem solving: they try to understand first the physical phenomena and identify the required concepts and theories, then they work a simplified model of the situation in order to propose and implement a solution, and finally they reflect on what they have been doing and on the consequences and meaning of their results. *The students are learning to explore, develop and apply their ideas and to connect the worlds of objects, events, models and theories, as indicated in the right side of Fig. 1.*

(2) The students used to study just before exams and only the contents they expected to find in the problems. Nowadays the great majority of them come to class after reading the web page, at least to be informed of the activities of the day. Nearly one third of the students are changing their attitude with respect to the importance and interest of using physics to explain different phenomena, and appreciate the usefulness and pleasure of thinking for understanding instead of memorizing. *The students are in the process of understanding the importance of thinking and learning and the practicality of building strong relationships between those aspects of the cognitive system, as indicated also in the right side of Fig. 1.*

(3) Team work present several difficulties: in some cases not all the members of the teams work together, they divide the tasks but really do not collaborate in integrated and fruitful ways. Several teams still prefer to copy and make small modifications to works presented by more advanced teams instead of working by themselves. Also

some students prefer traditional courses where the teacher present fully developed contents, although almost 90 % of the students recognize that they are learning much more and spend more time working on the course. *The students begin to work as a learning community but still they have troubles to function efficiently in the associated roles of teaching, learning, reading, writing and organizing.*

(4) Other aspect of importance is the relative mastery of the technological tools required to work through the web page, which involves the following: access to Internet, editing of texts, e-mail, discussion forums, spreadsheets, simulation software and other computer packages. *As indicated in the middle part of Fig. 1, technological tools are supporting the use of learning activities, assessment tools and educational software. A clear understanding and mastery of all these aspects must be part of the technological culture of both the teacher and the students.*

ACKNOWLEDGEMENT

The work here reported has been performed with partial support from PAPIIT Grant No. IN 305901 from UNAM.

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