INSTITUTO TECNOLOGICO Y DE ESTUDIOS SUPERIORES DE MONTERREY
UNIVERSIDAD VIRTUAL

DESIGN OF A PROCEDURE THAT FACILITATES THE INTEGRATION AND COMBINATION OF SEVERAL TECHNOLOGIES INTO THE TEACHING-LEARNING PROCESS

PRESENTED AS THE FINAL REQUIREMENT
FOR THE DEGREE OF:

MAESTRO EN ADMINISTRACION
DE TECNOLOGIAS DE INFORMACION

AUTHOR: ING. FRANCISCO HUERTA TAMAYO

SUPERVISOR: DRA. MONICA PORRES HERNANDEZ

MEXICO, D. F. DECEMBER, 1999

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This thesis is dedicated to:

God, for giving me the opportunity to enjoy my life.

My wife, Blanca Pérez, for her love.

My sons, Francisco and Carlos Huerta, for their happiness and patience.

To my mother, Celia Tamayo, in memory of my father, Francisco E. Huerta.

Acknowledgments

A work such as this one could not have been completed in isolation. Consequently, I wish to acknowledge a number of people who contributed to the development of this work. I am deeply grateful to the ITESM Mexico City Campus –its faculty, staff and students- for starting me down this path.

Thanks to Ariel Téllez, Damian Martínez, Oscar García and Juan Antonio Valverde for the enormous contribution in the elaboration of the product of this thesis. Also, I would like to acknowledge the assistance and support of many people who help me with their encourage during the development of this work, especially the people who I work with: Alejandra Gutiérrez, Deborah Sarky, Jaime Aguilera, Fernando Herrera, David Ramírez, Pablo Ramírez and Marco Vasquez.

I wish to recognize the contribution of all the professional people who participate with their comments. From the Innovation for Education Center of the ITESM Mexico City Campus: Cynthia and Georgina Villanueva, and Alberto Gastelú. From the Virtual University: Elizabeth Romero, Angel Ibarra, Carlos Sandoval and Juan Eligio Duarte. Tanks to all of them.

I must give special mention to Rocio Oliver and José Luis Espíndola for reading the early drafts of this work and giving me feedback and encouragement. A special thanks to Mónica Porres for her guidance and ideas, and for taking on this project.

Finally, and definitely far from least, I wish to express my gratitude to Carlos Pérez and Blanca Gómez for their unconditional help and my love for Blanca and our sons. I could not have done this without you.

ABSTRACT

DESIGN OF A PROCEDURE THAT FACILITATES THE INTEGRATION AND COMBINATION OF SEVERAL TECHNOLOGIES INTO THE TEACHING-LEARNING PROCESS

December, 1999

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Abstract

One of the reasons why many teachers are not integrating technology in their classrooms is the lack of prior experiences in using it as a productivity tool and for teaching. The teachers will not integrate technology into their practice just because they have to. Even more, if they are currently trying to use it, they may abandon an innovation (with computers and/or related

technology) just because they are unable to use it consistently and effectively. In this work, the author presents the relationship between the teaching-learning process and the technology with the intention of eliminates this problem.

The methodology used by the author to develop this work is the action research. The problem detected by him is the one defined above and then he formulates the following hypothesis: “If the teachers understand how the teaching-learning process is developed and how technology can be used to collaborate in this process, they will integrate it more efficiently”.

To deal with the problem stated, the author proposes a procedure that helps the teacher to integrate a given set of technology applications into the teaching-learning process. The procedure is used to develop a prototype that uses only the technology applications related with Internet.

The procedure and the prototype was presented to a group of experts involved in the implantation of several teaching media, and they expressed the following:

a. The procedure facilitates the work of the pedagogical advisor and the teacher on the selection of the technology tools and, helps to link successfully a pedagogical design with the use of different technology media.

b. The prototype integrates several technologies through a single interface that is user friendly. Its modularity allows to incorporate several “plug-in” Internet technologies.

Finally, the author found the following general conclusions:

a. Information Technologies allos access to a rich interactive learning experience wich can, in some cases, exceed the interactivity in a traditional classroom.

b. The procedure presented by the author provides assistance to the pedagogical advisors and the teacher to move the interactivity into the classroom toward a more student-centered approach.

c. It seems that improvements in university teaching are likely to come from multiple media.

d. With the procedure proposed, the teacher retain a key role.

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THE PROBLEM

The proliferation of computers and related technologies in schools constitutes one of the most substantive changes that have occurred in education over the last years. For example, in the ITESM Mexico City Campus, during the last two years the number of personal computers has increased from 2,000 to more than 9,000 while the population has increased only by no more of 10%. Numbers, however, do not indicate the extent to which computers and related technologies are integral to the teaching and learning process. While it appears that schools and classrooms have technology in them, evidence suggests that they are not very well integrated into teachers' practice. When it can be definitively determined that teachers are routinely using computers and related technology to accomplish their work and facilitate students' learning, then it can be said that the next step has been taken. Until that time, we must accept that technology is in schools, but many teachers still rely on traditional methods of teaching.

One of the reasons why many teachers are not integrating technology in their classrooms is the lack of prior experiences in using it as a productivity tool and for teaching. Hence, there is little in the way of a foundation to propel them to use technology to teach. Institutions responsible for preparing teachers in pedagogy fail to sufficiently prepare them to use technology to deliver academic services. The result is the perpetuation of the marriage of teachers to traditional methods of instruction.

Teachers will not abandon traditional pedagogy just because they have to. For teachers, to integrate technology into their practice, they need to believe that using technology is more efficient and effective than their usual methodologies.

There is an educational "cemetery" of innovations that never had a chance to live or lived only briefly because a vision of the impact on teaching was never conceived. When computers and related technologies are introduced in schools, a plan for why and how they are to be used needs to be in place. Its relevance to teachers, students, and the curriculum need to be clearly articulated too.

At least three problems arise in an effort to integrating technology into schools and teachers' practice. One is the difficulty associated with obtaining hardware. The second problem is that of maintaining hardware that has been purchased. The third problem, however, resides in the human realm and influences teachers' decisions about integrating technology into practice.

Of the problems related to infusing technology in schools, overcoming those emanating from human nature are imperative, if teachers are to integrate technology into their practice. Without the human, the machine (technology) cannot be used to its potential, but the human can continue to work, without the machine.

Technology is a heading for a variety of hardware, software and telecommunications available for use in schools. A list of technology includes computers, laser disc players, CD-ROM, overhead projector panels, digital cameras, local and wide area networks, and multimedia systems. Numerous applications yield computer-assisted instruction, computer managed instruction, simulation, word processing, database, spreadsheet, distance learning, desktop publishing, communication, and networking. How can a teacher productively use all the hardware, software and telecommunication applications available to him or her? It becomes useful, then, for teachers to be selective in the technology they spend time with. Also, with so much technology on the market and numerous possibilities for its use, where would teachers begin? Simplifying computer technology allowed teachers to focus their attention on a manageable configuration. The more complex an innovation is the more time it takes to master it. Teachers may also abandon an innovation because they are unable to use it consistently and effectively.

Encouraging teachers to integrate technology into their practice is a formidable task. A change agent needs to have an understanding of the psychological effect of the resistance to change, being waged by teachers undergoing the change process. Teachers have personal and professional concerns about practically any innovation introduced to them. In addition, they are also concerned about technology's impact on their students.

Teachers with concerns need specific assistance to resolve the concerns they have about an innovation. For teachers to integrate innovations (computers and related technologies) into their practice, their concerns about it need to be resolved. There are a number of interventions a change agent can use to assist teachers in overcoming their concerns. Encouraging on a one-to-one basis, providing technical assistance, and modeling how to use technology are a few examples.

Teacher educators need to revisit their practices and teach with technology so that teachers emerge able to use computers and related technology. The responsibility does not end there, however. If those responsible for training teachers incorporate technology into their preparation repertoire, then schools must extend the skills. And this is one of the main objective of these work.

In conclusion, the teachers will not integrate technology into their practice just because they have to. Even more, if they are currently trying to use it, they may abandon an innovation (with computers and/or related technology) just because they are unable to use it consistently and effectively. In this work, the author presents the relationship between the teaching-learning process and the technology with the intention of eliminate this problem.

Finally, the aim of the author is to help all those higher education's teachers that want to learn how to be more effective in the Information Age. Using most of the electronic and computer based tools available until now.

CHAPTER 1. TRENDS IN HIGHER EDUCATION

This chapter presents the changes that has to be taken in higher education as a result of the transformation that is taking place in the workplace and, in general, the hole world.

It is also stated the conclusions of some authors and researchers about:

a. The adaptation process that the learning organizations –universities and colleges- has to carry on in order to evolve according to the changes in theirs environment.

b. The paradigm shift that has to be assimilated by the teacher to play a new role.

c. The importance of the technology as one of the enablers of the new paradigm.

1.1 The world is changing

Futurists have coined a variety of phrases to describe our emerging world: “knowledge economy”, “information age”, or “digital economy”, are only a few. Regardless of the term, change is the focus, with technology increasing the pace of transformation. Oblinger & Rush (1997) explain why the society is being transformed by global competition and the power of technology. And they analyze some indicators that have been changing lately:

Volume of information. The volume of new information is increasing at such a rapid pace that the class of 2000 will be exposed to more new data in a year than their grandparents encountered in a lifetime. Knowledge doubles every seven years. Ten thousand scientific articles are published every day.

Technological Competence. Technology is now a competency that is required in the workforce; it is becoming another basic skill. Sixty-five percent of all workers use some type of information technology in their jobs. By the year 2000, this number will increase to 95%.

Telecommuting. The population that is employed in home-based business is increasing. In the US, for instance, it is expected that by year 2000, 50% of the working population will be working on this basis.

Collaboration. The capacity for individuals to use technology independently and collaboratively in their work is increasingly required. No one person has all the competencies needed in today's high performance workplace.

Reskilling. It is estimated that the shelf life of a technical degree today is only five years. Although many of the critical skills required in the high performance workplace have not changed (e.g., science, engineering, finance, and law), the pace of knowledge advancement requires constant updating.

Demographics. The changing demographics of higher education are placing new demands on institutions. Students are more diverse; they are older, must balance other life and career priorities, and prefer to attend college on a part-time basis. Individuals expect to have greater access to educational resources and alternatives, particularly from beyond the campus.

Selectivity. Students are using their purchasing power to be more selective about which institutions they attend. They expect to participate in a learning environment that fosters measurable improvement in their skill development, not just during college, but throughout their careers. Students are increasingly selecting curricula that enhance their chances for initial and sustained employment. "Today's learners are becoming increasingly impatient. Their dealing with world-class service providers in other settings have conditioned them to expect just-in-time and real-time services", Dolence & Norris, 1995. .

Government influence. Governors and other policy makers are pushing to make higher education more affordable and accessible to older, working students, and to make institutions more responsive to the changing workplace where many jobs now require continual retraining. Governors are discussing the creation of a virtual university. Accreditation is being criticized. Various boards and legislators are proposing that tenure be eliminated, or at the very least be reviewed periodically. There is a growing sense that government, not faculty senates, will dictate higher education policy.

Increasing demand. Looking slightly ahead to the year 2000, futurists estimate that just to keep even each individual in the workforce will need to accumulate learning equivalent to that currently associated with 30 credit hours of instruction, every seven years. This could equal over 20 million fulltime equivalent (FTE) learners from the workforce. Using our existing educational model, these learners would require an additional 672 campuses with an enrollment of 30,000 students each. To meet the full potential demand by the year 2010, a campus would have to be opened every eight days (Dolence & Norris, 1995).

This is not merely an issue for American higher education. With globalization, all the countries in the world are interconnected and the issues that concerns one or some of them, usually have an impact over the others.

Mexico is not the exception, it is changing with the hole world. Sometimes faster, sometimes slower, but it is changing.

Neither country can be seen as an isolated entity. All the world is being integrated as a hole and this integration is being accelerated by technology advancements. For example, now days:

a. Today a computer chip can perform electronic operations as fast as 4 billionths of a second. By the year 2000, 200 trillionths.

b. With the press of a button, in a matter of seconds, E-mail is zapped from computer to computer anywhere in the world.

c. A single hair-thin optical fiber can transmit the contents of the Encyclopedia Britannica—all twenty-nine volumes-in less than a second.

d. Satellite technology enables instant visual communication from one country to another.

e. From the comfort of your own home or office—through the Internet—you have quick and ready access to major libraries, universities, scientific journals, newspapers, magazines, and many other sources.

f. More than 50 million people in 160 countries are already on the Net with projections of 200 million devotees by the year 2000.

The author's thinking is that higher education must recognize and adapt to all these changes if it really wants to occupy the pivotal role in society of the Information Age. Lets now focus on the changes that have been taking place in the workplace to see their impact on education.

1.2 The Workplace is changing

Now days, a lot of organizations are rethinking their strategies and operating structures. Reengineering has become very common. Competition is global. Incremental change is not enough. Knowing and anticipating your customers' wants and needs is essential. Organizations are promoting more employee empowerment. Teaming and group problem solving are critical skills. Technology and the power of information are key to a competitive edge. All these changes are affecting the workplace.

The main changes that are taking place in the workplace are:

Rapid change. In this business climate, there are significant implications for workers. Consider that more than 75% of the Fortune 1,000 companies are revamping fundamental work processes and undergoing radical change. Consider too the changes brought about by the move from mainframe to client/server applications. Reskilling such a worker calls for over 350 hours of training and an investment of $50,000 per person (Panepinto, 1994 in Oblinger & Rush, 1997).

Teamwork. The ability to work effectively in teams is an important characteristic of today's high performance workplace. In our current environment, no one person has all the competencies needed to create and deliver the kind of solutions our clients require. Whether in the lab or in the office, we value people who know how to work collaboratively; people who can work with colleagues on a problem or a new product, operating in cross-functional teams of engineers, marketers, lawyers, accountants, and other skilled professionals. These teams need to be increasingly diverse-in a global sense. People from all cultures and all countries will need to be able to effectively communicate as a team in the global market.

Decision-making. Increasingly, employees are empowered to make their own decisions. The days of a parent-child like relationship between management and employees are gone from business. In business' flattened organizations, employees are expected to make decisions and to make them quickly (CMI, 1995).

Building and applying Competencies. The question "What competencies are needed here?" is constantly asked in the business environment. Employees are expected to engage in a constant quest to build their expertise, both in depth and breadth. Those with the greatest competence are expected to mentor others. The competencies of people are an important asset to business products and services (CMI, 1995), and lifelong learning is a requirement.

As organizations begin to change the way they work and the new IT enabled changes begin to take hold, there can be mayor changes in employment. Changes can occur in overall levels of employment as well as in the kinds of skills required and the rate of change of these skills.

At this point the author asks himself:

a. Does higher education teach students the new decision-making process?

b. Are students allowed to practice these skills?

c. Is lifelong learning fostered in higher education?

d. Could technology help in the develop of these skills required?

Unfortunately, there is a mismatch between traditional education and workplace requirements. Table 1.1 shows the contrast.

Table 1.1. Traditional education and workplace requirements

TRADITIONAL EDUCATION	WORKPLACE REQUIREMENTS
Facts	Problem solving
Individual effort	Team skills
Passing a test	Learning how to learn
Achieving a grade	Continuous improvement
Individual courses	Interdisciplinary knowledge
Receiving information	Interacting and processing information
Technology separate from learning	Technology integral to learning

From OBLINGER, Diana G., & RUSH, Sean C. (1997): The learning revolution. The challege of information technology in the academy (p. 7). Anker Publishing Company, Inc.

So, if higher education is expected to occupy the pivotal role in society of Information Age, it has to change and adapt to the evolution of the world and, most specifically, the workplace. Next section concerns about the present trends in higher education.

1.3 Present and future in higher education

Duderrstandt (in Katz and Associates, 1999) concludes that the next decade will represent a period of significant transformation for colleges and universities as we respond to the challenges of serving a changing society and a profoundly changed world. Perhaps the most critical challenges facing most institutions will be to develop the capacity for change; to remove the constraints that prevent institutions from responding to the needs of rapidly changing societies; to remove unnecessary processes and administrative structures; to question existing premises and arrangements; and to challenge, excite, and embolden all members of the campus community to embark on what he believes will be a great adventure.

Colleges and universities have long enjoyed a monopoly over advanced education because of geographical location and their monopoly on certification through the awarding of degrees. Today all of these market constraints are being challenged, as information technology eliminates the barriers of space and time and as new competitive forces enter the marketplace to challenge "credentialing."

In the current paradigm, the colleges and universities are faculty centered. The faculty has long been accustomed to dictating what it wishes to teach, how it will teach it, and where and when the learning will occur. Students must travel to the campus to learn.

This carefully regulated and controlled enterprise, called the university or college, could be eroded by several factors:

1. The growing demand for advanced education and training simply cannot be met by such a carefully rationed and controlled paradigm.
2. Current cost structures for higher education are simply incapable of responding to the need for high-quality yet affordable education.
3. Information technology is releasing higher education from the constraints of space and time (and possibly also reality with virtual universities).

All of these forces are driving us toward an open learning environment, in which the student will evolve into an active learner and consumer, and unleashing strong market forces (Duderrstandt, 1999).

New paradigms are being developed which address this emerging environment. In fact, some see a future where students will receive their education on three “campuses” (Oblinger & Rush, 1997). A residential college community where –for a summer or for four years– students study and receive guidance, support, evaluation, and motivation; A global electronic campus that they can enter via a computer, “commuting” from home, dormitory room, or community center; and, the continuing education and training provided at their workplace by employers and community organizations.

The new world and workplaces requires this kind of campuses, then it is better to accelerate the integration of technology in education. If not, it wont be possible to have these new kind of campuses, specially the global electronic campus.

Now days, to complete a course, students go from place to place, acquiring the resources they need. Print materials are kept in the library. Advice from a faculty member is in another place and available only at certain times. The classroom, as a resource, is in a different location and time. Lectures are presented once but are not available for later review. Laboratories are open at specified hours, based on institutional convenience rather than student needs. Although computer labs allow access to the network and external resources, the student must arrive during open hours and hope for a free terminal. The students' learning resources are fragmented.

The model of the student environment is changing. Just like the world and workplace change. The Figure 1.1* bellow depicts the current model where an institutional organization or function is at the center; students must move from place-to-place or person-to-person. The emerging model places the student at the center, with more flexible access to people and information.

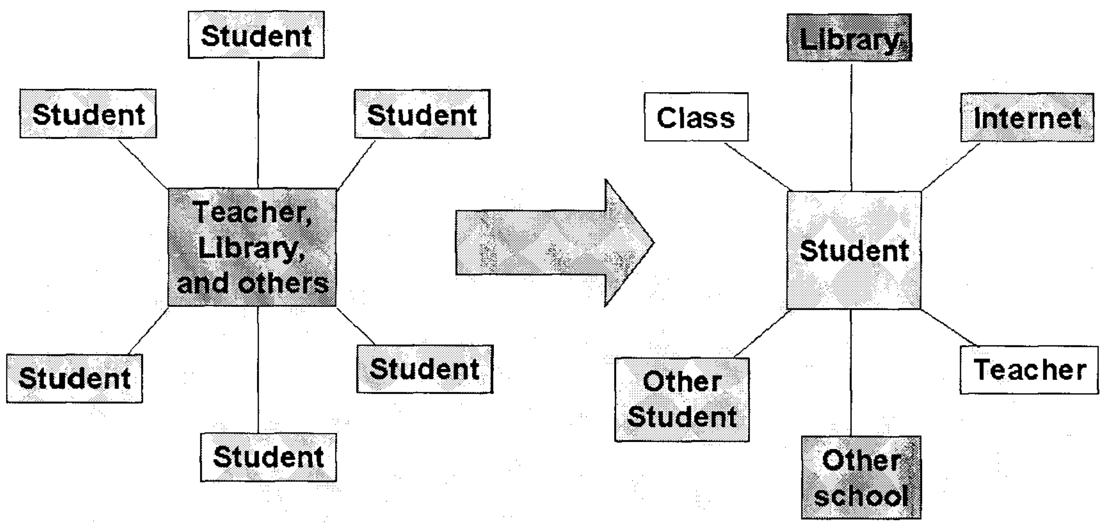


Figure 1.1. Student Environment Model

In the current model the teaching-learning process is based on the classroom lectures, that is why it is also called the lecture model. The students' learning is expected to be built through the passive absorption during the teacher

* From OBLINGER, Diana G., & RUSH, Sean C. (1997): The learning revolution. The challege of information technology in the academy (p. 15). Anker Publishing Company, Inc.

lecture, the individual work and some readings. Of course, there are some others activities, like lab practices, but they occupy just a few part of the time the student spend when he or she is learning.

On the other hand, the alternative model that is proposed, is centered in the student, not the teacher. This means that the student learns through the exploration, the experimentation and teamwork. So, the teacher is a guide and not the omniscient that used to be.

The Table 1.2 shows the comparison between the two models and the technology implications we are concern about.

Table 1.2. Alternative Educational Model

CURRENT MODEL	ALTERNATIVE MODEL	TECHNOLOGY IMPLICATIONS
Classroom lectures	Individual exploration	Networked PC's with access to information
Passive absorption	Apprenticeship	Requires skills development and simulations
Individual work	Team learning	Benefits from collaborative tools and e-mail
Omniscient teacher	Teacher as guide	Relies on access to experts over the network
Stable content	Fast-changing content	Requires networks and publishing tools
Homogeneity	Diversity	Requires a variety of access tools and methods

From BOURNE, J.R., BRODERSEN, A.J., CAMPBELL, J.O., & DAWANT, M.M. (1995). Research on asyncrhonous learning networks for engineering education. Memphis, TN. Vanderbilt University.

At the close of the twentieth century, Denning predicts that higher education is facing a series of strong, sometimes contradictory pressures that will transform the two major missions of the university- teaching and research the teaching side, he says, these pressures will be resolved by a new distinction between knowledge and information, between “knowing how” and “knowing about.” This change will be accompanied by a strong alignment of graduate educational offerings with the needs and interests of working professionals, with a special emphasis on certifying competence in selected areas. This distinction will also foster a new commitment to offering broader perspectives that enable people to deal with complexity and uncertainty, act with wisdom, build powerful social relationships, and practice the skills of entrepreneurship. Digital media and Internet communications will transform learning practices from the sequential classroom curriculum to nonlinear “hyperlearning” environments. A new kind of teacher will emerge-the teacher who is a course manager and a coach rather than an information transmitter. (Denning, 1997).

The hyperlearning is contrasted with the traditional model of school where a course is a sequence of topics covered in a series of lectures, held in classrooms at weekly intervals, with homework practice in between. It is designed to convey information in an orderly manner. All students proceed at the same pace regardless of their interests, prior experience, talents, or other demands on their time. At the end grades indicate the levels of achievement they were able to make in the fixed time period allocated for the course.

Denning (1997) explain the hyperlearning model like this:

> "... Instead of a classroom, see in your mind a large "learning room" with an entrance, an exit, and a number of learning stations (booths). You meet the teacher on entry. The teacher may place you into a small study or working group. The room's exit is guarded by a "certifier" whose job is to assess whether you have become competent at everything promised by the teacher, according to well-defined standards. You visit the stations to learn particular subjects or practices. Colored lines on the floor suggest paths among the stations. You can visit as many stations as you need to, and in any order consistent with your current knowledge, to prepare yourself for final certification. You can take trial certifications and then backtrack to the stations needed. You can take self-assessment tests at any time you like. You collaborate with other students in projects and study groups. You call on the teacher for help at any moment you are stuck. The teacher will offer guidance if you are heading in a wrong direction. In contrast to the linear model, everyone who exits gets the same "grade" (a certificate of completion or competence); the variables are the length of time and the path followed."

The digital media and networking are two driving forces who are driving teacher to a new role that will fit the new hyperlearning approach. As classrooms disappear and machines take over much of the presentations –often doing it much better than a live human lecturer– and as the machines take over testing and record keeping, the teacher most focus in some others aspects.

This does not mean that teaching is made obsolete by technologies for presentation, assessment, and record-keeping. To the contrary, the teacher will be expected to inspire, motivate, manage, and coach students. It is noticeable that just a few teachers have learned these skills because they never had to.

Learners need to develop the capacity to search, select, and synthesize vast amounts of information to create knowledge (Dolence & Norris, 1995). Yet today's students are confronted with an array of seemingly independent entities which they must navigate. Courses stand alone. Faculty speak about "their courses." Although there are prerequisites, there is little integration or coordination of content within or among departments. Courses are combined to create a curriculum or degree program –a process which the faculty own. Students have minimal choices in customizing their programs of study.

1.4 The new technologies for the new teachers

Digital media are now helping those most venerable information organizations –colleges and universities– to rethink the ways in which they serve society. Colleges and universities specialize in creating new knowledge, shifting and storing it, and then sharing it with the next generation. The new communications technologies offer higher education the opportunity to carry out its traditional missions with powerful new tools. Education has never been more important, and access to affordable higher education is increasingly a necessity rather than a privilege. The most imaginative colleges and universities will not hesitate to use the new technologies to make education more effective, more affordable, and more accessible as well.

Farrington (1999) remark that the information technology is having a great impact on programs of postgraduate education because it helps to provide lifelong learning fore mature students. He also mention that digital media is useful for liberating traditional education institutions from the constrains of their real estate and now allow them to deliver courses and programs to new and often untraditional groups of students wherever they may be in the world.

Bellow is a brief exploration of the opportunities information technologies offer for improving high education (Farrington, 1999):

a. The new media do present provocative opportunities for improving education and possibly making it less expensive. For example, digital media could be used to share faculty among different institutions and thus eliminate redundancy in teaching capacity.

b. The powerful visualization capabilities of computers can be used to present information in ways that are often more effective than print. Digital media can be used to exploit the powerful simulation capabilities of computer so it can be substituted for humans in teaching process.

c. Powerful software enables computers to interact with students more and more as humans do, to help them team skills in subjects as diverse as foreign languages mathematics, and music.

d. The digital technologies connect students and faculty so that they can discuss and debate with one another without being present in the same place at the same time.

e. The World Wide Web can be used to: deliver the notes of the teacher, promote the discussion between the students and/or the teacher, or provide a complete introductory course via this media.

It is important to remark that digital technologies are simply additional methods of communicating and certainly not the only means by which students and faculty interact.

In the next chapter the author will explain the teaching-learning process like a continuing conversation between the teacher and the students. As every part of the conversation can be realized with different media, it will be explained how different technology can be used to improve the traditional teaching-learning process.

CHAPTER 2. HOW TO USE TECHNOLOGY IN TEACHING AND LEARNING

In order to understand the way technology participates in the different steps of the teaching learning process, this chapter has the task of making a global analysis of:

a. The teaching-learning process like a continuing conversation between teachers and students.

b. How traditional teaching-learning process is improved when different media is used.

c. How technology can help in the development of the continuing conversation framework.

2.1 Understanding the teaching-learning process.

To understand better the relationship between education and technology is going to be easier if we have a reference model that explains how the teaching-learning process is taken in place. Laurillard (1993) developed one that can be useful for this purpose, but to understand it we have to inquire a little bit into her heuristic.

She based her work on the recommendations Marton and Ramden (1998) made to the teachers:

1. Present the learner with new ways of seeing.
2. Focus on a few critical issues and show how they relate.

3. Integrate substantive and syntactic structures.

4. Make the learners' conceptions explicit to them.

5. Highlight the inconsistencies within and the consequences of learners' conceptions.

6. Create situations where learners center attention on relevant aspects.

7. Test understanding of phenomena; use the results for diagnostic assessment and curriculum design.

8. Use reflective teaching strategies.

Laurillard observed that the first three and the sixth are prescriptive about what to tell students, focusing more on how to present than on how to interact. Numbers (4) and (5) work better because they assume the kind of interaction between teacher and student that gives the teacher access to what the student's conceptions are, and then prescribe how the interaction should continue thereafter. Numbers (7) and (8) prescribe different forms of interaction, allowing students' views to be represented and taken into account in the approach to teaching and assessment.

The recommendations are in the spirit of a more co-operative approach to the way both educational research and teaching should be carried out. Their discussion of each one shows how the empirical base can be used to generate the strategy they define. Implicit in this discussion are two distinct ways of linking research results to implications for teaching:

a. From descriptions of the internal structures of different conceptions, deduce how teachers and students should make their conceptions explicit so that they can be compared and contrasted.

b. From descriptions of the differences between successful and unsuccessful teaching, deduce the characteristics of successful teacher-student interactions.

She also notice that phenomenographic studies produce descriptions of the internal structures of students' and experts' conceptions, they clarify what aspects of the conceptions should be focused on in the interaction, how students relate to the ideas, and how the dialogue should be conducted. Secondly, the research prescribes not the action the teacher must do to the student, but the form of the interaction between teacher, and subject matter. This is why she believes phenomenography offers the best hope for a principled way of generating teaching strategy from research outcomes.

Finally, she concludes that co-operative style is more democratic, giving full representation to students' as well as teachers' conceptions, and if it prescribes anything, it does so at the level of how the resulting dialogue should be conducted. The best expression of an empirically-based teaching strategy so far, therefore, is as follows, and can be organized into four general categories of description. The learning process must be constituted as a dialogue between teacher and student, operating at the level of descriptions of actions in the world, and having the following characteristics:

Discursive

- teacher's and student's conceptions should each be accessible to the other
- teacher and students must agree learning goals for the topic, and task goals
- the teacher must provide an environment within which students can act on, generate and receive feedback on descriptions appropriate to the topic goal

Adaptive

- the teacher has the responsibility to use the relationship between their own and the student's conception to determine the focus of the continuing dialogue

Interactive

- the students must act to achieve the task goal
- the teacher must provide meaningful intrinsic feedback on the actions that relates to the nature of the task goal

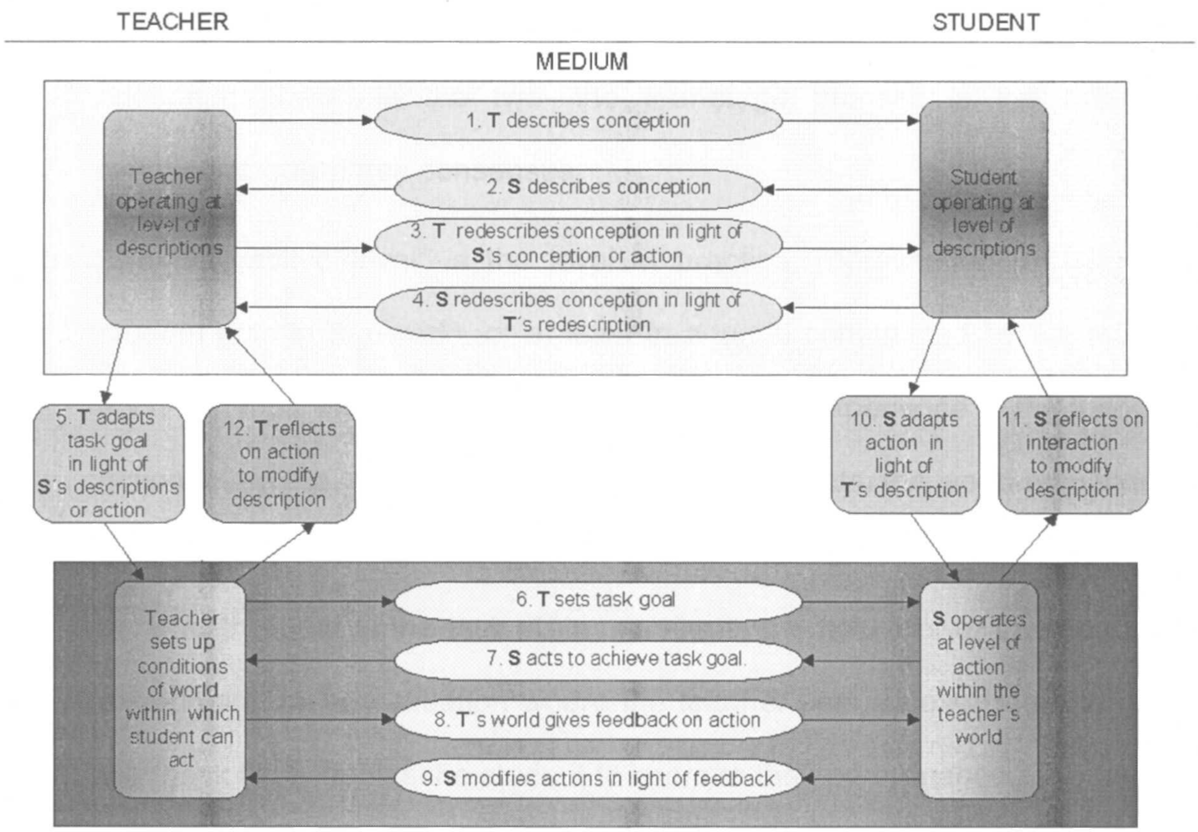
Reflective

- the teacher must support the process in which students link the feedback on their actions to the topic goal for every level of description within the topic structure

2.2 Conversational framework

The characteristics explained above, conducted Laurillard (1993) to a new model that she called the "Conversational Framework" for academic learning that is shown in Figure 2.1*.

Figure 2.1. Conversational Framework



This model describes the teaching-learning process as an interaction between teacher and student, operating at two levels:

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* Laurillard, Diana (1993). Rethinking University Teaching. A framework for the effective use of educational technology. Routledge. New York, NY, USA

a. The "discursive level" is the level of theory. This represents the way the teacher articulates the subject matter, or presents the ideas, and the student joins the dialogue, putting their point of view, asking questions, practicing the moves of language and argument, proof and representation. The teacher must then have the opportunity to re-express their point, in order to clarify or elaborate, and then the student must be able to have another attempt at representing the theory to be sure the dialogue has arrived at consensus between the two—the four-stage process is the minimum required to guarantee consensus.

b. The "interactive level" is the level of practice, representing the way the student acts in the world, or at least in a world constructed by the teacher such that their interactive activities will give them experience of the theory in action. Here the teacher sets a task, the student acts, the world responds to their action, and the student can modify their action in order to better achieve the goal of the task. This represents the field trip, or the laboratory experiment, or any situation where the teacher sets an exercise and gives feedback that enables the student to improve their performance.

Theory and practice should not remain separate, of course, and ideally, the student should be using the theoretical description to "adapt" their actions, and also to "reflect" on their experiences as they articulate their ideas at the discursive level. Therefore the student is using "reflecting" and "adapting" to link the two levels at which they are operating. Similarly, the good teacher will be using evidence of the student's understanding of theory to "adapt" the interactive activities to those appropriate to the students' needs, and will "reflect" on their performance at the interactive level in elaborating the theory.

The conversational framework highlights the iterative character of the learning process. At both levels that iteration must be able to occur: practice with feedback, and continued dialogue between student and teacher to progress towards a more accurate articulation of the theory.

The model is a complete specification of what is required during the learning situation and shows what can be offered by the combinations of different media, as it will be stated later. It also represents adaptation (activities 5 and 10) and reflection (11 and 12) as internal to both teacher and student, and characterizes the two levels of their dialogue as discursive, i.e. interactive at the level of descriptions (activities 1 to 4), and interactive at the level of actions (activities 6 to 9).

2.3 The traditional education and the conversational framework

Traditional methods of teaching and learning tend to favor the presentational aspects of the process more than the active ones. For lectures, and for reading print-based materials, which are both purely presentational in form, the students are required to do little more that "attending" a one-sided part of the discursive level. They are truly active only when they are given exercises or tasks to practice the techniques they have been taught. This is the interactive level, although it may be the case that only part of this iterative process actually occurs. Do they receive feedback on their actions? How often is the student's work checked in a problem class; does the lab experiment really give feedback or is what happens an unexpected mystery? If the teacher is supervising closely and the practice exercise is well-designed, then this kind of exercise could certainly sustain the interactive level of the learning process.

This is also the point at which students can begin to make the connection between the practice and theory, although of course while they are doing lab-work, or field-work, or problem classes, there is rarely any opportunity for the individual student to have a dialogue with the teacher. Teacher-student dialogue may be available, but in the different teaching context of the tutorial or small group (or rather large group, as is generally the case these days).

And how does the student practice the articulation of their subject, which is the other part of the discursive level? This is the stage at which they develop and generate their own ideas, their own expression of the knowledge they are learning –the point at which they make it their own. That really only occurs in the assignment tasks when they do the report and project work. And of course the feedback on the assignment will be separate again. So the essential activities in the learning process are covered in some way for the traditional modes of teaching, but they are attenuated over time.

2.4 Teaching Media

Having arrived at a perspective on teaching and learning that sees the process as a dialogue, it seems like if not other teaching methods different to the traditional face-to-face teaching could be possible. But this is not true.

The familiar methods of teaching in higher education are there to support learning as it is commonly understood to occur (Laurillard, 1993):

a. through acquisition, so we offer lectures and reading;

b. through practice, so we set exercises and problems;

c. through discussion, so we conduct seminars and tutorials;

d. through discovery, so we arrange field trips and practices.

These methods, if practiced in combination, are capable of satisfying most of the constraints imposed by the teaching strategy declared inherently in the conversational framework. Feedback on students' actions is the weakest link.

Is the author's believe that no one medium can solve the problems, as will become clear. But given the conversational character of the teaching-learning process, what kind of role can the various media possibly play? Lets explore the teaching methods and media now available to higher education, to see which are capable of delivering the complex iterative process, stated in the conversational framework. None could do it all, but all of them could do something, and a combination of them could do quite a lot.

2.5 Using multiple media to enable effective teaching and learning

A medium is in part a channel for transfer content. Just as important, however, a medium is a representational container enabling new types of messages (e.g., sometimes a picture is worth a thousand words). Since expression and communication are based on representations such as language and imagery, the process of learning is enhanced by broadening the types of instructional messages students and teachers can exchange. New forms of representation make possible a broader, more powerful repertoire of pedagogical strategies (Dede, 1999).

A mix of teaching and learning methods will be the most efficient way to support student learning, because only then it is possible to embrace all the activities of discussion, interaction, adaptation, and reflection, which are essential for academic learning. Dede (1999) confirms this thinking with his experience in distributed learning:

> "My course on learning across distance uses seven instructional media:
>
> - face-to-face interaction,
> - videoconferencing,
> - synchronous interactions in a text-based virtual world,
> - "groupware" that incorporates a shared design-space,
> - asynchronous, threaded discussions,
> - asynchronous telementoring, and
> - websites structured around an ongoing interaction or experience.
>
> The first four of these interactive media are synchronous, the next two asynchronous, and the last a mixture of both. This wide range of media enables distributed learning that incorporates the complementary strengths of face-to-face instruction, virtual synchronous interaction, and asynchronous expression and communication. Participants are able to contrast the amount of effort required to master the rhetoric of each medium, the instructional design strategies effective in each, and the ways each shapes their individual cognitive and affective experiences, as well as group interactions. With the exception of videoconferencing, the usage of these media creates no additional costs for the instructor and students."

2.6 Classification of media

There are many attempts in the literature to categorize and classify the forms of media, none of which is useful for the purpose of the author here.

Classification of forms is a notoriously difficult task, even more if we want some kind of guiding.

The following, in this chapter, each of the principal teaching media are analyzed in terms of the conversational framework to see how far they serve the needs of a principled teaching strategy. The author selected the main types of teaching media, and divided them into their unadulterated way of using each one. This allows us to focus on their essential pedagogical characteristics, and by distinguishing them from each other to identify the unique contribution made by each one. It is hard to find any of these existing in their canonical form, of course, as designers recognize the limitations and each medium is used in combination with another, to the extent that hybrids, such as Internet, acquire an identity of their own.

2.7 Audio-visual media

The audio-visual media include audio, audio-vision, broadcast one-way video system or film, and videocassette. These are distinguished from the computer-based media and the teleconferencing media discussed in the following sections of this chapter.

2.7.1 Audio-vision

Audio programming may be delivered to individuals or classrooms via radio broadcasts or through standard telephone service. In this format. The teacher speaks to distant students, who cannot respond directly in real time (during the broadcast or phone transmission). Interaction can be built into the lesson through materials delivered prior to the instruction or facilitated on-site by a third party or classroom facilitator. A teacher may ask students to respond verbally (even though the teacher can not hear the response) or in writing, and students monitor their own learning in other ways. This type of distance learning has been used extensively for student learning and teacher training in several developing countries. Besides the low cost of delivery and duplication, other benefits of one-way audio programming include ease of use, low production costs, and its requirement for little specialized training (Roblyer, Edwards and Havriluk, 1997).

2.7.2 One-way video system

Educational programming can be broadcast one way from one point (transmitter, uplink) to a single point or multiple points (receivers) via satellite, cable television, microwave, or public broadcasting systems. Broadcasts can be sent via open air or encrypted. Anyone with the necessary hardware and connections (as with a cable system) can receive open-air broadcasts, as can anyone with the coordinates to focus a satellite receiver dish. Encrypted programs require decryption devices. Anyone who has ever watched pay-per-view television at home has probably rented such a device and installed it temporarily into the cable television system (Roblyer, Edwards and Havriluk, 1997).

Instructional programs can be broadcast in real time (live), or they can be delivered via broadcast for taping and showing at a later time (tape delay). Live broadcasts permit student-teacher interaction over telephones or special response systems usually for a predetermined number of students. A later section will discuss this possibility more fully. A tape delay system can store one or more program segments for later teacher or learner control and use; this keeps delivery costs to a minimum while ensuring the timeliness of content, and it permits flexibility regarding both the time and place of instruction.

2.7.3 Video

The principal contrast between broadcast television and video is the relative controllability of the latter, making it adaptive by the student. Some researchers have referred to video-cassette plus exercises as 'interactive', but Laurillard (1993) defined it as involving intrinsic feedback on what the student does – the information in the system should change as a result of their action. Nothing in the video changes when a student rewinds it, just as nothing in a book changes when you turn a page. The epithet 'interactive' is applied to video because a cassette allows students to carry out activities in between watching sections, and to carry out analytical exercises on the video material itself. These are excellent ways of using video cassette, and of exploiting its controllability, but they are not interactive in the strong sense, and are essentially the same kind of activities as reading a book, re-reading it, analyzing passages, doing activities between reading, etc. The medium cannot itself provide intrinsic feedback on what the student is doing. It is 'active video' perhaps but not 'interactive video'.

Video has the same ability as television, however, to bring together experience and description of that experience, and being self-paced, can enhance this further with the opportunity for students to reflect on what they are doing. Nicola Durbridge, in an evaluation of video use at the British Open University, observed this in the way a set of videos of children doing mathematics were used in a course for teachers:

> "Thus, the video can be described as having two aspects to its full meaning. One is the sense of the problems of doing mathematics, the other involves a critical appreciation of these problems. Students need to respond in two ways to understand the whole; they need to be receptive to the stimulus of the 'real-life' sound plus vision and to show a sympathetic but instinctive understanding of it; they also need to pursue a rational enquiry into its fuller meaning along the lines prompted by the notes and voice-over elements."
>
> (Durbridge 1984b)

She also found in the students some frustration an anxious about the quality of their learning. However, Durbridge does suggest ways in which 'pre-emptive' extrinsic feedback can be offered, e.g. where the academic's version of the answer, or their comment on an expected wrong answer, is written at the end of the notes, or summarized at the beginning of the next video section, in much presumed to have done in an activity. Students need to know what they are meant to be learning, and need to have a sense of when they have achieved what is expected. The non-interactive media must attend to this aspect of the learning process, even though they cannot support it fully.

The only advantage of video over television is in the self-pacing provided by greater learner control, which at least allows students to reflect on the interaction they have witnessed, making this available to the activity of modifying their description, should they be invited to do this by additional instructions or notes.

2.8.1 Hypertext

The basic concept of nonsequential, Computer-based text was first envisioned more than 40 years ago by Vannevar Bush. Today, Tripp and Roby (1990) define hypertext as a "nonlinear, multidimensional, semantic structure in which words are linked by associations." These links resemble connections in a concept map in contrast to a traditional page-by-page progression through a textbook. For example, an electronic encyclopedia might link certain words with sections of text in another part of the encyclopedia. When the user clicks the mouse pointer on a word, let' s say Boston, the screen then displays information from another part of the program about that Rome. The hypertext model has no real ending point; the section on Boston may allude to the Revolutionary War, and these words could also be a "hot spot" with links to another section about that war, and so on. Some have broadened the definition of hypertext to include sound, video, animation, and pictures (Landow, 1990; Foss, 1989; Megarry, 1988). Tolhurst (1995) suggests that references to video, audio, and animation displays as text are inaccurate; she assets that textual information can include diagrams, pictures, and tables. Generally speaking, static media are acceptable in the hypertext format: photographs, sketches, tables and diagrams.

2.8.2 Hypermedia

Current literature reflects a great deal of overlap between the definitions of hypertext and hypermedia. A useful interpretation of hypermedia includes all the characteristics of hypertext plus the capabilities of video, audio, and animation displays.

2.8.3 Multimedia resources

Multimedia has become such a common term in commercial usage that its definition has become particularly vague. Many tailor its definition to suit their own particular needs (Blattner and Dannenburg, 1990). Kozma (1991) suggests that the term has actually been in use for several decades, only recently being linked to the use of computers. Since some definitions of multimedia do not include nonlinear links between information, a suggested definition would specify the use of multiple media formats to present information.

Tolhurst (1995) offers a useful diagrammatic view of the distinctions between hypertext, hypermedia, and multimedia. See Figure 2.2*. As we can notice, hypertext is a subset of hypermedia and, at the same time, hypermedia is a subset of Multimedia.

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* Roblyer, M.D.; Edwards, Jack; Havriluk, Mary Anne, (1997). Integrating educational technology into teaching. Prentice Hall. United States of America

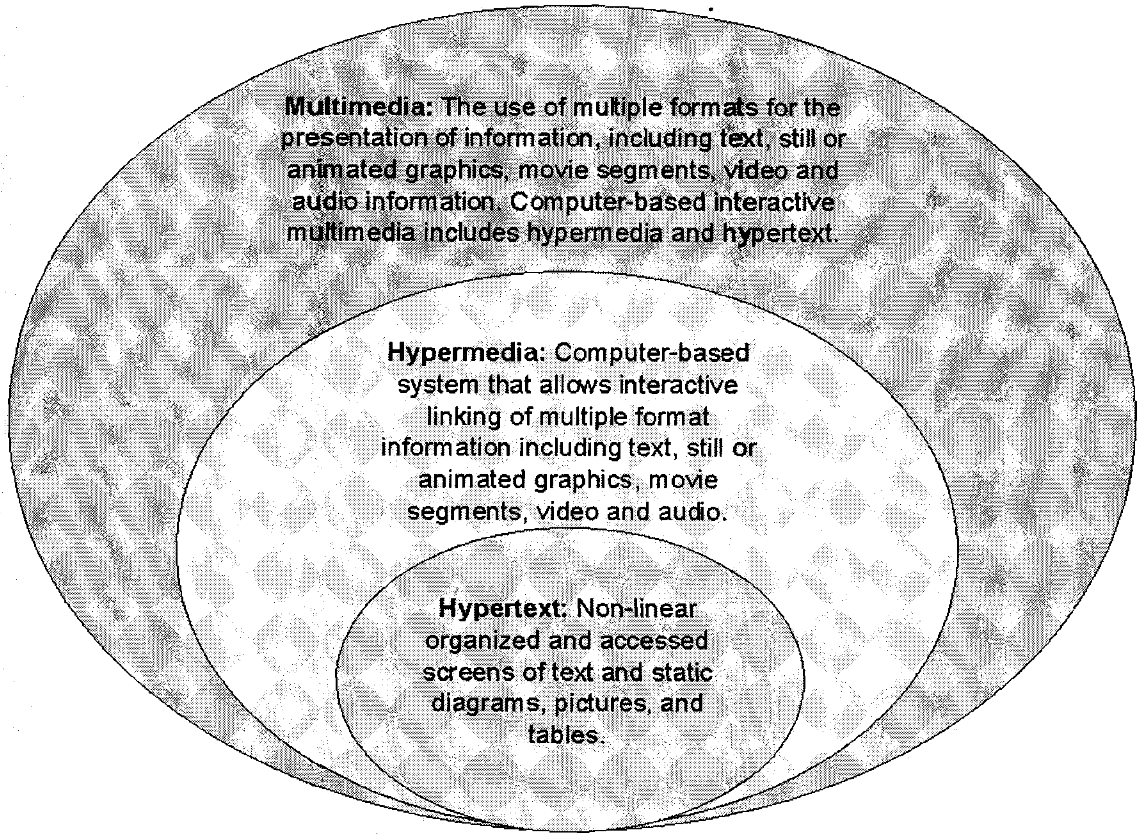

Figure 2.2. Overlapping domains of Hypertext, Hypermedia, and Multimedia

2.8.4 Overview of Hypermedia, Options

As hypermedia programs have evolved, they have become more powerful and more user friendly. Consequently, authors can now draw on wide variety of resources. This section describes some common features that are available in hypermedia authoring programs (Roblyer, Edwards and Havriluk; 1997):

1. **Audio resources.** Hypermedia authoring programs offer the user a number of ways to incorporate audio clips:

   a. CD Audio

   b. Videodiscs

   c. Recorded sounds

   d. Prerecorded sounds

2. **Video resources.** Video clips can add a whole new dimension to a program and provide authors with many new communication possibilities. As with audio, authors can incorporate video displays into a program in many ways:

   a. Digitized videos

   b. Videodiscs

   c. Prerecorded videos on CD-ROMs

3. **Photographs.** "A picture is worth a thousand words" in hypermedia, as much as elsewhere. Photographs provide a powerful resource for authors in all subject areas.

   d. Scanned photos

   e. Captured from video sources

   f. Digital cameras

   g. Imported from CD-ROMs

4. **Graphics.** Graphics or drawings offer another tool for authors to communicate their ideas. Often an illustration will make a point that is very

difficult to get across with words. This aspect of hypermedia authoring is particularly appealing to artistically inclined users.

a. Created by authors

b. Imported from clip art collections

c. Scanned images

5. **Animation.** Animation can be a highly effective tool for illustrating a concept; for example, a student might create an animation of a seed germinating as part of a project on plants. The sources of these displays are familiar:

a. Imported from CD-ROMs

b. Created using animation tools

6. **Text.** In spite of the attention paid to all the other components of hypermedia, text still remains one of the most powerful ways of communicating ideas.

c. Writing as project develops

d. Importing from word processing files

2.8.5 Impact of Hypermedia in Education

Capabilities and strengths of hypermedia include (Roblyer, Edwards and Havriluk; 1997):

1. **Motivation.** Hypermedia programs offer such varied options that most people seem to enjoy using them. Students who usually struggle to

complete a project or term paper will often tackle a hypermedia project enthusiastically. McCarthy (1989) expressed the belief that the most important characteristic of hypermedia is its ability to encourage students to be proactive learners.

2. **Flexibility.** The user of a hypermedia program can draw on such diverse tools that the technology truly offers something for everybody. For example, a student who may not excel at expressing ideas in writing can record what he/she wants to say orally.

3. **Development of creative and critical-thinking skills.** The tremendous access to hypertext and hypermedia tools opens up a multitude of creative avenues for both students and teachers. Marchionini (1988) referred to hypermedia as a "fluid" environment that constantly requires the learner to make decisions and evaluate progress. He asserted that this process forces students to apply higher-order thinking skills. Turner and Dipinto (1992) reported that the hypermedia environment seems to encourage students to think in terms of metaphors, to be introspective, and to give free rein to their imaginations.

4. **Improved writing and process skills.** Turner and Dipinto (1992) also found that exposure to hypermedia authoring tools helps students in the following areas:

    a. It gives students a new and different perspective on how to organize and present information.

b. It gives students a new insight into writing; instead of viewing their writing as one long stream of text, they now see it as “chunks” of information to be linked together.

5. **Forward thinking.** The hypertext/hypermedia seems likely to persist. A review of the number of World Wide Web pages on the Internet gives ample evidence that linking information together via hypertext and hypermedia is indeed an effective way to present and add value to large bodies of information. In time, millions of people may publish multimedia documents on the information highway in the hope of attracting viewers, readers, and listeners (Gates, 1995).

2.9.1 Interactive Media: Microworlds

Microworlds made their biggest impact in education in the form of Logo, Seymour Papert's programming language for geometry. In his book ‘Mindstorms’, Papert describes the reasoning behind the development of a Newtonian microworld, and in doing so, expresses exactly the difference between a microworld and a simulation. What makes microworlds interesting is that they appear to address explicit description of the student's point of view (Papert, 1980).

The formalism provided as an essential feature of a microworld allows the student to express their description of some aspect of the world in a form understandable by, and therefore scanned by, the program.

Microworlds are very similar to simulations (as we will see in the next part of this chapter) in the sense that they allow the user to act in a simulated world, and experience that world from the perspective of the one who defined the concept to be understood.

The student interact with the microworld through a mediating mechanism for acting, called the programming language. This provides a level of description of what is happening in that world. To use Papert's physics microworld, a student has to describe their actions in the form of a set of commands, then run them as one would a program, and the result is either the intended behavior or something unexpected. The feedback operates at the level of the description.

The students creating the program clearly have a different kind of learning experience from anyone who only uses what they have created. The difference lies in whether the action exists as a description, and can be 'captured' for inspection, reflection and revision resulting from feedback, as in a microworld, or whether it remains a fleeting thought captured only as part of the memory of the action, as in a simulation.

The feedback at the level of description is important if we want a teaching medium to address all aspects of the learning process, and the microworld is the only medium discussed so far that attempts to do this in any way. The way it does it is problematic, however. The form of description is peculiar. A program is a formalism, designed to overcome the barrier to understanding of a mathematical formalism (Papert, 1980).

A microworld permits the student to express their concept as a sequence of commands, and to check this against feedback from the interaction. It supports a special and limited form of description of their conception, therefore, which is important because it encourages them to reflect upon the interaction.

2.9.2 Interactive Media: Modeling

A modeling program invites the learner to create their own model of a system, defined mathematically, which it then runs, allowing the output to be compared with stored data of a real world system, or the program's own model. It contrasts with a simulation because the student manipulates the model itself, not just parameters within a given model. For example, the program where students define the equation to be plotted in order to find the best fit to a given set of case study data.

A modeling program contrasts with a microworld because the student defines a mathematical model directly, it is not buried within the design of objects. In a modeling program the program merely interprets formulate (or rules), it knows nothing about any subject matter, unlike the microworld. A physics microworld can only be used for physics; a modeling program can be used for anything that can be modeled. There is a considerable interface design problem in getting the program to interpret the learner's description of the model, and this is the clever part of designing such a program.

The structural form of a modeling system is the same as a microworld. The only difference is in how the student's conception is expressed : in a microworld as a code describing actions in the world; in a modeling system as a mathematical representation of those actions. Here there would be no doubt in the teacher's mind that this is 'doing physics', and that is because the focus of the students' talk is on how to express the already known behavior of a system mathematically. If the aim is not to merely experience the world but also to explain it, then the modeling program is the closest so far to supporting the learning of academic knowledge.

2.10.1 Adaptive media: Instructional software

From the time that people began to recognize the potential power of the computer to do tasks quickly and systematically, they also began exploring and experimenting with its capability to emulate (and improve on) the functions of a human teacher. If computer programs could be written to do essentially anything, why could computers not be programmed to teach? Many educators and developers pursued this goal of the computer as teacher during the 1960s and 1970s (Norris, 1977). Today, after about 30 years of development and experimentation, teachers hear less talk about computers taking their places, but programs are still available to perform various teaching functions. While these programs are not the alternatives to human teachers envisioned by Norris, they can enhance teaching and team envisioned by Norris, they can enhance teaching and learning in many ways.

Instructional software differ from all the previous media forms because they embody an explicit teaching strategy. This kind of software is premised on the assumption that it is possible for a computer program to emulate a teacher. In the previous chapter, we conclude that the ideal teaching system was a one-to-one teacher-student dialogue. We now begin to consider whether it is possible to achieve that ideal without very high staff-student ratios, with a computer program acting as 'teacher'. Given the aspirations of this type of medium, we must expect it to come close to covering all aspects of the learning process earlier identified as being essential. The basic design of such a program is to:

a. specify a learning objective
b. offer a brief introduction to the topic
c. set a task according to a strategy for achieving that objective
d. set a task according to a strategy for achieving that task
e. use this to select the appropriate feedback
f. use the student's performance so far to select the next task

> "At the very minimum, therefore, the tutoring program offers extrinsic feedback on the student's actions, and an adaptive task focus related to previous actions and the overall goal."
>
> (Laurillard, 1993)

Instructional software (or courseware) delivers all or part of a student's instruction on a given topic or assists with learning in some key way. Although software such as word processing, database, and spreadsheet programs also can enhance educational activities, this work differentiates between such tools and instructional software. Software tools can serve a variety of purposes other than teaching; this software includes programs developed for the sole purpose of delivering instruction or supporting learning activities.

Teachers may hear instructional software called by names like *computer-based instruction* (CBI), *Computer-assisted instruction* (CAI), *computer-based learning* (CBL), and computer-assisted learning along with more generic terms such as software learning tools. Names for the types of instructional software also vary, but they are usually identified as (Roblyer, Eduards and Havriluk, 1997):

a. Tutorial software. Programs that act like tutors by providing all the information and instructional activities that a learner needs to master a given topic (e.g., information summaries, explanation, practice routines, feedback, and assessment).

b. Simulation software. Programs that model real or an imagined systems to show how those systems or similar ones work.

c. Problem solving software. (1) Programs that teach directly (through explanation and/or practice) the steps involved in solving problems, or (2) programs that help learners acquire problem-solving skills by giving them opportunities to solve problems.

2.10.2 Adaptive Media: Tutorials

Tutorial courseware uses the computer to deliver an entire instructional sequence similar to a teacher's classroom instruction on the topics. This instruction is usually expected to be complete enough in itself to stand alone; the student should be able to learn the topic without any help or other materials from outside the courseware. Unlike other courseware activities, tutorials are true teaching courseware. Gagne, Wager, and Rojas (1981) stated that tutorial courseware should address all instructional events. Gagne et al. Show how a tutorial may vary its strategies to accomplish events for different kinds of learning ranging from verbal information to complex applications of rules and problem solving.

2.10.3 How to Use Tutorials in Teaching

Tutorials offer benefit of self-contained, self-paced substitutes for teacher presentations. This should in no way threaten teachers, since few conceivable situations make a computer preferable to an expert teacher. However, the tutorial's unique capability of presenting an entire interactive instructional sequence can assist in several classroom situations (Roblyer, Eduards and Havriluk, 1997):

a. For self-paced reviews of instruction

b. As an alternative presenting material to support different learning strategies

c. To allow instruction when teachers are unavailable

2.10.4 Simulations Software

A simulation is a computerized model of a real or imagined system designed to teach how a certain system or a similar one works. Simulations differ from tutorial activities by providing less structured and more learner-directed learning activities. The person using the courseware usually chooses tasks and the order in which to do them. Alessi and Trollip (1991) identify two main types of simulations: "those that teach about something and those that teach how to do something". They further divide the "about" simulations into physical and process types, and they divide the "how to" simulations into procedural and situational types:

a. Physical simulations. Users manipulate objects or phenomena represented on the screen. For example, students see selections of chemicals with instructions to combine them to see the result, or they may see how various electrical circuits operate.

b. Process simulations. These speed up or slow down processes that usually either take so long or happen so quickly that students could not ordinadly see the events unfold. For example, courseware may show the effects of changes in demographic variables on population growth or the effects of environmental factors on ecosystems. Biological simulations like those on genetics are popular, since they help students experiment with natural laws like the laws of genetics by pairing animals with given characteristics and showing the resulting offspring.

c. Procedural simulations. These activities teach the appropriate sequences of steps to perform certain procedures. They include diagnostic programs, in which students try to identify the sources of medical or mechanical problems, and flight simulators, in which students simulate piloting an airplane or other vehicle.

d. Situational simulations. These programs give students hypothetical problem situations and ask them to react. Some simulations allow for various successful strategies, such as letting students play the stock market or operate businesses. Others have most desirable and least desirable options, such as choices when encountering a potentially volatile classroom situation.

2.10.5 How to Use Simulations in Teaching

Simulations have long been recognized for their unique teaching capabilities. Depending on the topic it addresses, a simulation can provide one or more of the following benefits (Alessi and Trollip, 1991):

a. Compress time

b. Slow down the process, so it can be visible to the human eye

c. Get students involved asking constantly "What would you do?"

d. Make experimentation safe

e. Save money and other resources

f. Repeat with variation

g. Make situations controllable

2.10.6 Adaptive Media: Problem-solving Courseware

Teachers may find the topic of problem solving both attractive and ambiguous. No goal in education seems more important today than making students good problem solvers, yet no area is as ill-defined and difficult to understand. Sherman (1987-1988) was somewhat specific, claiming that all problem solving involves three components: recognition of a goal (an opportunity for solving a problem), a process (a sequence of physical activities of operations), and mental activity (cognitive operations to pursue a solution). Sherman said that problem solving is a "relatively sophisticated mental ability which is difficult to learn" and that it is highly idiosyncratic. That is, problem-solving ability depends upon "knowledge, prior experience, and motivation, and many other attributes".

This definition covers a wide variety of desired component behaviors. The literature mentions such varied subskills for problem solving as metacognition, observing, recalling information, sequencing, analyzing, finding and organizing information, inferring, predicting outcomes, making analogies, and formulating ideas. Since even the definition of problem solving inspires an ongoing controversy in education, it is not surprising that opinions differ dramatically about the proper role of courseware and other technology products in helping to foster this important capability. The positions seem to lean toward two general ways in which teachers can view problem solving. Which of these views a teacher uses will determine the strategy for teaching problem solving and the application of technology resources to this activity (Roblyer, Edwards and Havriluk, 1997).

2.10.7 How to Use Problem-Solving Courseware in Teaching

Roblyer, Edwards and Havriluk (1997) explain how problem-solving courseware can be used in teaching:

a. Directed strategies with problem-solving courseware. Integration of courseware into direct teaching of problem solving skills places even more responsibility than usual on teachers. Usually, teachers want to teach clearly defined skills. To teach problem solving, they must decide which particular kind of problem-solving ability students need to acquire and how best to foster it. With clearly identified skills and a definite teaching strategy, the motivational aspects of problem-solving courseware has unique abilities to help focus students' attention on required activities. This kind of courseware can get students to apply and practice desired behaviors specific to a content area or more general abilities in problem solving.

b. Constructivist strategies with problem-solving courseware. Like many technology products, some products labeled as problem-solving courseware can be employed in directed ways, but they are designed for implementation in more constructivist models. These models give students no direct training in or introduction to solving problems. Rather they place students in highly motivational problem solving environments and encourage them to work in groups to solve problems.

Constructivists believe that this kind of experience helps students in three ways. First, they expect that students will be more likely to acquire and practice content-area, research, and study skills for problems they find interesting and motivating.

Second, constructivists claim that this kind of activity helps keep knowledge and skills from becoming inert because it gives students opportunities to see how information applies to actual problems. They learn the knowledge and its application at the same time. Finally, students gain opportunities to discover concepts themselves, which they frequently find more motivating than being told or, as constructivists might say, programmed with the information (McCoy, 1990).

2.11 Discursive media

Teleconferencing is the use of electronic channels to facilitate communication among groups of people at two or more locations via audio, video, or computer. Teleconferencing is the generic term that refers to a variety of technologies and applications, including audio-conferencing, video-conferencing, and computer-conferencing.

2.11.1 Discursive Media: Audio-conferencing

Audio-conferencing is two-way voice communication between two or more groups or three or more individuals in separate locations. The two types of telephone formats currently used are analog and digital. Analog has been the traditional means of telephone communication, with the information encoded as a continuous electronic wave. On the other hand, digital is presented in discrete binary signals that enable faster switching and have the capacity to simultaneously transmit voice, data, and compressed video signals over the same line. When more than one person is in a single location, speakerphones or special audio-conference terminal equipment should be used to reduce echo and other interference. When more than two locations are involved, multipoint network bridging equipment is used. (Distance Education Modes, 1999).

Components of an audio-conferencing system include:

a. Telephone handsets, speakerphones, or microphones.

b. An audio bridge that interconnects multiple phone lines and controls noise.

c. A speaker device to facilitate multiple interactions.

While audio-conferencing is not as glamourous as some computer applications, it is a low cost, low tech solution that allows easy entree to distance education and does not require special technical skills or a technician. Telephones are ubiquitous, easy to use, familiar and comfortable with a minuscule learning curve that allows many people to interact in real time and to build a sense of community and sharing in a familiar environment. While there may be some difficulties with participants occasionally speaking over each other, audio-conferencing is certainly worth investigating as part of a total delivery package. As Moore (1994) states, "Audio-conferencing is a learner-centered, relatively inexpensive, robust, and flexible medium that can be well integrated with other media in a distance program".

The characteristics of audio-conferencing are similar to those of the face-to-face groups because is a partially discursive medium, offering no opportunity for interaction at the level of actions within a 'world'. The discussion needs someone to act as a moderator, simply to do the job of making sure that everyone knows who is on-line, and that everyone who wishes to is able to speak. (Laurillard, 1993).

2.11.2 Video-conferencing

Videoconferencing is electronic voice and video communication between two or more groups or three or more individuals. It can be fully interactive two-way voice and video, or two way audio and one-way video.

In Mexico there are some universities that have their own video-conference system to link campuses in different locations. Also, Telmex, the largest telecommunication company in Mexico, has installed some video-conference rooms for rent. These facilities can be used to interact with people who are located in any other part of the country.

Two-way video comes the closest to bringing teacher and remote student into the same classroom. This feat is usually accomplished using digital transmission systems, such as digital telephone lines (ISDN) or fiber optics, although microwave and satellite may also be used. A Coder/Decoder (CODEC) is used to digitize the audio and video to send over the digital telephone line. The CODEC also converts the incoming audio and video from digital to analog. The CODEC compresses the data to fit the transmission system being used.

Each site in a two-way video system is equipped with a camera, microphones and monitors. Activities at each site are transmitted simultaneously, so teachers and students across a wide area can see and hear each other "live."

Traditional two-way video can be very expensive. For instance if transmission is by microwave and the terrain is rough or if there are weather difficulties, costs will rise. Newer, Internet-based videoconferencing systems may be less expensive.

Teachers can view students and their reactions, students can see other students, and interaction is much like that in a traditional classroom environment. This kind of course may be produced in a classroom specifically designed for two-way transmission or in a studio. In either case, other technologies may supplement both teacher presentations and student interactions. Two-way remote learning systems are both the most complex and most expensive to manage. The costs of video transmission services and hardware continue to drop, however, while advances in existing copper-wire infrastructure and the rapid development of fiber optic systems combine to make this technology affordable and easy to use.

2.11.3 One-way Video

One-way video with audio return resembles traditional educational television, except that students can interact with the teacher and students at other sites by telephone (audioconference) or fax. Common transmission systems include satellite. The students at remote sites can see the teacher on their television monitor, but the teacher cannot see them. Students may ask questions by phone, fax, or FM radio during class and sometimes by electronic mail. Both, the inquiry and the teacher's answers may be broadcast, although the large networks that distribute courses nationally use teaching assistants to help handle the large volume of student questions. The system can gain increased interactivity by faxing materials and using other computer enhancements. With its visual component, one-way TV can work effectively for large-group instruction featuring teacher presentations as well as small-group instruction.

One-way video is widely used in Mexico and Central America for elementary school. There is an institute that produces all the sessions to be transmitted all around these countries. The institute is an organism sponsored by the governments of these countries (ILCE, 1999).

Satellite delivery equipment includes a satellite (device orbiting the earth), an uplink antenna, and a Television Receive Only (TVRO) downlink station. Satellite transmission covers any space within an electronic "footprint." It costs as much to transmit to one site as to transmit to one hundred sites; transmission costs do not increase with the number of receive sites. However, satellite technology is complex, requiring a considerable capital investment and full-time technical personnel.

Compressed video is analog video signal converted into digital signal. The digitized signal is then transmitted along a narrower bandwidth allowing many digital signals in the space of one analog signal. Therefore compressed video provides a cost-effective delivery alternative. However, during compression the quality of the visual image is altered. This alteration may be more acceptable when crisp detail and full motion are not essential.

2.11.4 Computer-mediated conferencing

This is the only asynchronous teleconferencing medium. It operates in a similar way to electronic mail, delivering written text in digitized form down data lines, and requiring both ends of the communication link to use a computer connected to a network, which may be local, national or international. Access to the medium therefore depends on having a computer linked into a network either via cable or via a modem.

The standard way to use the system is for the student to join the conference they are interested in, and ask the system to display all the messages sent into it that they have not already looked at. Each message is displayed in turn, and the student may either contribute comments relating to a particular message, or append a message at the end of the existing discussion. Their message will then appear on everyone else's system next time they join the conference. Computer conferencing is therefore a little like taking part in a normal conference discussion, but via text alone, and over a much longer span of time, as the discussion is asynchronous. An obvious pedagogical advantage over the normal face-to-face tutorial is that students can take time to ponder the various points made, and can make their contribution in their own time. Topic negotiation is also possible, as in face-to-face discussion, and a tutor may pursue several lines of discussion with different students within one conference, though a good moderator would probably separate them out into different 'topics' within the conference. Student control is therefore relatively high for this medium, allowing us to acknowledge the possibility of students being able to redescribe their conception in the light of the teacher's redescription. It is therefore a more fully discursive medium than the synchronous conferencing media.

The skill of conducting a fruitful dialogue via conferencing whether one-to-one or one-to-many, is as Important here for the success of the interaction as it is in face-to-face situations, perhaps more so, as there is less information from body language and facial expression to help the interlocutors. From evaluation studies of computer conferencing in many different educational contexts (Kaye, Mason and Harasim 1989), it becomes clear that the moderator (the conferencing equivalent of a chair) must, in addition to the normal duties of a chair:

a. negotiate goals and timelines for the conference
b. set up new branches and topics as the discussion progresses
c. nurture group collaborative processes
d. ensure that adequate responses and reactions are given to all relevant contributions

The work required to play an adequate role as moderator, to ensure that the interaction will indeed be successful, is considerable, as the above list shows.

The asynchronous, text-based format of computer conferencing offers a better opportunity than the other conferencing media for reflection on participants' contributions, and improves on print by offering two-way communication, allowing students to express their own viewpoint. The success of the medium is totally dependent on a good moderator, however, and this can easily be as time-consuming as any other form of face-to-face tutoring.

The value of conferencing in all its forms is that it supports discussion between tutor and student, and theoretically, at least, allows each to express their viewpoint. In practice, the relationship is asymmetrical, as it is in any face-to-face tutorial, and the tutor is more likely to be responsible for establishing the ground rules of the interaction. Tutors generally have little trouble in articulating their own view, whatever the medium, that is their art. The more difficult trick for them is to give the student the space to express theirs, and to encourage them to elaborate it sufficiently for the tutor to make sense of any points of departure. Analysis of tutor-student messages in a computer conference running during an Open University course showed that the average length of student contribution was 200 words, equivalent to over a minute of continuous speech, which would be rare indeed in the standard face-to-face tutorial (Laurillard, 1993).

Laurillard, et al, says that by virtue of the fact that conferencing supports a discussion, it is possible for the tutor to adapt the focus of talk in the light of what the student expresses, but this requires considerable time and care on the part of the tutor, and is hardly yet commonplace in the use of the medium. The student is always able to control the interaction, however, by asking questions, and redirecting the topic, though under time constraints if it is real-time synchronous audio conferencing. The discussion is interactive at the level of descriptions, but not tasks. Moreover, discussion allows intrinsic feedback on descriptions, in the sense that every statement by the student affects what the tutor says next. It is this aspect that makes dialogue so well suited to helping students to refine their understanding at the level of description.

The conferencing media, contribute more to logistics than to pedagogy. If students are necessarily at a distance from their tutor, then these media provide an extremely important lifeline to interactive discussion which is otherwise not available to them. The written form of computer conferencing offers a better opportunity for reflection in participants' contributions, and improves on print by being interactive and adaptive and allowing students to express their viewpoint. The success is totally dependent on a good moderator, however, and this is as time-consuming as any other form of face-to-face tutoring. It is not the kind of medium where students can be left to work independently. In the next section, we consider discussion between students alone.

2.11.6 Collaboration

There is increasing research on collaboration between students using computers, and this work is beginning to look at the nature of the student-to-student discussion that results. Student-to-student discussion undoubtedly has some important educational characteristics. It supports the communication of the student's point of view; it is controllable by the student; it supports interaction at the level of description, although the fact that the feedback offered on a student's description is from another student, and not from a teacher is a significant difference. Argument between students about a topic can be an extremely effective way of enabling students to find out what they know, and indeed what they do not know, but it does not necessarily lead them to what they are supposed to know.

The medium provides interaction at task level, and allows the student to reflect on this to produce their own description, but it is neither discursive with the teacher, nor adaptive by the teacher. In couple with adaptive media, of course, it would be quite powerful.

2.12 Conversational framework and teaching media

Table 2.1[*] shows the relationship between the conversational model and every teaching media expressed in its canonical form. This table is useful to select the right teaching media for a specific part of the teaching-learning process as it will be proposed by the author in the following chapter.

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[*] Laurillard, Diana (1993). Rethinking University Teaching. A framework for the effective use of educational technology. Routledge. New York, NY, USA

Table 2.1 Conversational framework and teaching media

		Print	Audio-vision	Television	Video	Hypertext	Multi-media resources	Simulation	Microworld	Modelling	Tutorial Program	Tutorong System	Tutorial simulation	Audio.conferencing	Video conferencing	Computer conferencing	Computer supported collaborative work
1	T can describe conception	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
2	S can describe conception		✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
3	T can redescribe in light of S's conception or action										✓	✓	✓	✓	✓	✓	
4	S can redescribe in light of T's redescription or S's action		✓			✓	✓				✓	✓	✓			✓	
5	T can adapt task goal in ligh of S's description or action										✓	✓	✓				
6	T can set task goal		✓	✓	✓			✓	✓	✓	✓	✓	✓				✓
7	S can act to achieve task goal		✓				✓	✓	✓	✓	✓	✓	✓				✓
8	T can set up world to give intrinsic feedback on actions		✓	✓	✓		✓	✓	✓	✓		✓	✓				✓
9	S can modify action in light of intrinsic feedback on action		✓				✓	✓	✓	✓		✓	✓				✓
10	S can adapt actions in light of T's description or S's		✓						✓	✓	✓	✓	✓				✓
11	S can reflect on intereaction to modify description		✓		✓		✓		✓	✓		✓	✓				✓
12	T can reflect on S's action to modify redescription										✓	✓	✓				

CHAPTER 3: METHODOLOGY

The methodology used by the author to develop this work is the action research, that could be described as a teacher-initiated, school based research. Action research is a type of practitioner research that is used to improve the practitioner's practice; action implies doing or changing something. Action research is a process in which individual or several teachers collect evidence and make decisions about their own knowledge, performance, beliefs, and effects in order to understand and improve them. In action research, it is the teacher who identifies the research topic related to his or her practice, the teacher who collects information to investigate the topic, and the teacher who interprets and judges the research results in terms of their meaning for his or her practice. The teacher is at the center of action research.

Action research is directed toward both understanding and improving practice. Thus, the last step in the action research process is relating the interpreted data and the decisions emanating from the data to plan what steps, if any, need to be taken to alter or improve practice. This is the ultimate aim of this research.

The methodology used by the author is based on Elliot (1993) and its steps are described in this chapter.

3.1 Action Research

3.1.1 Identification and clarification of the general idea

The situations are ones that interest or concern the teacher and are derived from issues in his or her practice. Two notable aspects of the situation deserve mention. First, the selected situation should impact on the field of the researcher and, second, the researcher should have the aim of improve that situation.

So, the idea of this research appeared with the author's observations while he was performing his everyday work of providing technical services and support to the teachers. Specifically those teachers from the ITESM Mexico City Campus who are incorporating computer based technology into their teaching practices. These observation can be concluded as follows: "The teachers will not integrate technology into their practice just because they have to. Even more, if they are currently trying to use it, they may abandon an innovation (with computers and/or related technology) just because they are unable to use it consistently and effectively."

It is necessary to take into consideration that the problem is circumscribed to the case of the ITESM Mexico City campus because it is the environment of the author.

3.1.2 Recognition of the Problem and explanation of the facts.

This is a diagnosis phase to clarify the problematic situation. In our case, the author had a lot of informal chats with students, teachers, chairs of department, deans and technical staffs who are involved in the development of one of the main strategies proposed in the mission of the ITESM for the year 2005. The strategy suggests the reengineering of the teaching-learning process and, its implementation is characterized by the usage of technology.

Some other data were collected from the last three months reports generated by the main frame where the information of every reengineered course was placed. The chats and the reports were useful to gather information about the attitude of the teachers toward the utilization of technology. The facts the author found are in Appendix A and can be summarized as follows:

1. More or less 50% of the students who are enrolled in one reengineered course access the server weekly. It was expected to be 100% percent.
2. The groups where the teacher decided to train his or her students in the usage of the technology (computer software in this case) during one or two sessions, where the ones with a greater percentage of technology use.
3. There were some teachers who abandoned the technology while others expressed they were happy with it.
4. A lot of teachers did never use some key components of the technology. Specifically, the computer support collaborative software is not frequently used.
5. Some students asked the deans to train the teachers in the utilization of the technology they are using.

All these lead the author to formulate the hypothesis of this work: "If the teachers understand how the teaching-learning process is developed and how technology can be used to collaborate in this process, they will integrate it more efficiently".

3.1.3 Review of literature to find out if the problematic has been studied before

This step pretends that the researcher knows all the theoretical and practical approaches that could help him or her in the implantation of the solution of the problem that it is being explored. So, the author presented mainly the thinking of Oblinger and Rush (1997), and Denning (1997) about the trends in higher education. Also the relationship between teaching media and the conversational framework proposed by Laurillard (1993).

3.1.4 Structure of the general plan and its implantation

The action plan must have the general purposes, the objectives of the improvement, and the planning with all its activities. In our case, the aim of the author is to help all those higher education's teachers that want to learn how to be more effective in the Information Age. Using most of the electronic and computer based tools available until now.

Section 3.2 presents the procedure that was used to develop a prototype (see Appendix D) based on the correlation between the teaching media available on the Internet and the conversational framework proposed by Laurillard (1993). The prototype uses only the applications related with Internet, but they can be replaced by any other set of applications or teaching media. So, while the technology advances, the applications could be replaced by the new ones to find out their value in the teaching-learning process and to create brand new teaching-technology models.

For example, in the prototype the author decided to select a mix of synchronous and asynchronous technologies, but the teacher can select another mix based on his or her pedagogical design.

3.1.5 Establish the criteria for evaluation and the feedback techniques

Elliot (1983) says that it is important to plan the way the implantation process and its effects will be supervised. He recommends to use those measurement techniques that emphasizes the effects derived from the action and the unexpected ones, and also those that can give us different points of view to correlate all them. In this case the author used the correlation method to establish the similitude (and dissimilarity) between the observations of the different groups that could be involved in the implementation of the innovation (prototype): the people of the Innovation for Education Center who are expert in pedagogy and are responsible for the implementation of the reengineering strategy in the ITESM Mexico City Campus, the department of Virtual University and a group of engineers of the same university campus who have a wide expertise in the implantation of technologies related to the distance learning model. The comments and feedback of all these groups are presented in Appendix F.

All of their comments and the observation of the author are fundamental to build the results and recommendations presented in the following chapters.

3.1.6 Interpretation and integration of the results

To integrate the results it is necessary to establish a relationship between the theoretical research and the observations derived from the implementation and development of the prototype. The final chapter integrates this relationship and adds the recommendations generated after the implementation of the proposal of this work.

3.1.7 Report the action research

Finally Elliot (1983) recommends to elaborate a written report to finish the first loop of a specific action research. The report should have a structured description of the facts with the interpretation of the researcher and the data gathered from the application of the solution. The main objective of the report is to make possible the recreation of the research. In this case, the report is represented by all the information showed in this thesis.

The recreation can be useful if another researcher wants to validate the conclusions of this work in another context. Remember that the context of the author is the Mexico City campus of the ITESM. So, if someone else wants to validate the conclusions of this thesis, he or she can begin reviewing this report.

Although, the report can be used to replicate the research, it is necessary to understand that there are some aspects that are the result of the authors experience and thinking. An example of this is the design of the procedure.

The following parts conform the report:

1. The definition of the problem.

2. The conclusions of the literature studied and related with the problem.
3. The methodology followed by the author.
4. The results of the research.
5. The conclusions and recommendations.

3.2 Design of a procedure to integrate technology into the teaching-learning process

To deal with the problem stated in section 3.1.1 the author proposes a procedure that helps the teacher to integrate a given set of technology applications into the teaching-learning process.

The procedure is based on the relationship of the Conversational Framework and the canonical form of the teaching media detailed in Table 2.1. It pretends to be a teacher's reference to facilitate the integration and actualization of different technologies that evolve and emerge as the time pass on.

The procedure is explained in several steps that let the teacher understands how to develop it. It also considered that the teacher already designed and programmed all the activities to be carried out in his or her course. Figure 3.1* shows the procedure in detail.

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* Proposed by the author

Figure 3.1. Procedure to integrate technology into the teaching-learning process

Step 1 Compare the teaching and learning activities designed for the course with every part of the Conversational Framework.

Step 2 Make an equivalence of every technology applications available for the teacher with its canonical form of the teaching media.

Step 3 Re-do the table that relates the Conversational Framework with the teaching media, but replace the later with their equivalence according with Step 2. All the columns that are not replaced should be removed.

Step 4 Based on the comparison of step 1 and and the table of step 3, chose all the technology applications available to integrate them into the teaching and learning activities designed for the course.

Step 5 If there is an activity that can be developed with more than one technology application, select the ones that are more appropriate with the design of the course.

Step 1. Compare the teaching and learning activities designed for the course with every part of the Conversational Framework. The idea is to establish a relationship between the Conversational Framework and the activities designed by the teacher.

Step 2. Make an equivalence of every technology applications available for the teacher with its canonical form of the teaching media. This step is just a preparation for the next one.

Step 3. Re-do the table that relates the Conversational Framework with the teaching media, but replace the later with their equivalence according with Step 2. All the columns that are not replaced should be removed. The result is a reference that is used by the teacher to understand how every available technology can helps in every part of the Conversational Framework.

Step 4. Based on the comparison of step 1 and the table of step 3, chose all the technology applications available to integrate them into the teaching and learning activities designed for the course. With this step the teacher defines which technology can be used to develop every teaching and learning activity.

Step 5. If there is an activity that can be developed with more than one technology application, select the ones that are more appropriate with the design of the course. To do this step the teacher has to know how every activity is going to be done. He or she must know if the activities are going to be developed synchronously or asynchronously and if it is best to have a one-to-one or one-to-many communication.

To understand better how to apply the procedure, in Appendix D there is an example. The example was developed with a set of Internet Applications explained in Appendix C and it was used to do a prototype, explained in the same Appendix D.

Finally, the procedure and the prototype were presented to a group of experts to ask them for a feedback. The results are presented in the following chapter.

CHAPTER 4. RESULTS

With the aim of having a feedback the author presented the procedure designed in Chapter 3 and the prototype explained in Appendix D to some groups of experts involved in the implantation of several teaching media. The results of their comments are presented in this chapter.

4.1 Description of the experts' groups

Three kind of groups were selected to review the procedure and prototype developed by the author. The groups were selected to of different areas in order to have different points of view, but all theirs members are related with some kind of technology implantation into the teaching-learning process.

I. **Pedagogical Advisors.** The author asked the people from the Innovation for Education Center to attend the presentation. All of them are expert advisors in the reengineering of a course according with the ITESM strategy in the Mexico City campus. So they know how to do an instructional design and, also they help the teachers to incorporate the technology in that design.

II. **Coordinators of logistic for the Virtual University.** This group was composed by the members of the department of the Mexico City campus that collaborate with the Virtual University of the ITESM. All of them provide local support to the teachers and students enrolled in the Virtual University. Currently, the Mexico City campus transmit classes to two others campuses of the ITESM via videoconference and also transmit classes to the hole Virtual University via broadcast television.

III. **Technical support staff.** The people responsible for the telecommunications and the webmaster of the same campus where required to evaluate the technical aspect of the prototype. All of them work for the same campus.

The author presented the procedure designed and the prototype developed with this procedure. The main aspects reviewed in the presentation are:

1. Explanation of the Conversational Framework.
2. The relationship between the Conversational Framework and the teaching media.
3. Explanation of the procedure designed to incorporate technology into the teaching-learning process.
4. Presentation of the prototype.

4.2 Questions asked to the experts

After the procedure and prototype explanation and presentation to the experts all of them were asked to give feedback by answering some questions. It was not mandatory that every expert answered every question, because the questionnaire was just a way to activate the comments. Although some of them answered each of the questions. The questions are:

1. If the technology evolved or appeared a new applications, would it be easy to incorporate it into the prototype following the procedure proposed?

2. Do you think that the prototype is complete from the pedagogical point of view?

3. Explain your comments about the prototype and the "technology models" you already know. Consider a reengineered course and the Virtual University models: broadcast and videoconferencing.

4. Do you think that the prototype proposed is feasible to be a complement and/or to substitute the existing models?

5. What are the advantages of the procedure and the prototype?

6. In the case the prototype was implanted, what are your concerns about it?

7. What would you improve in the prototype and the procedure?

8. Please, add any comment you want.

The comments made by the experts are transcribed in Appendix E. And in the next section there are the comments structured to have a better understanding.

4.3 Comments of the pedagogical advisors

The pedagogical advisors' comments are summarized here:

1. The prototype could be a complement of the videoconference model or any on-line course.

2. The prototype could be an alternative for the technology used in the reengineered courses

3. Advantages of the procedure:

a. the proposal helps to link successfully a pedagogic design with the use of different technology media

b. based on the proposed procedure, it is easy to incorporate new technology to a given model

c. facilitates the work of the pedagogical advisor and the teacher on the selection of the technology tools

d. facilitates the actualization of old technology

e. the procedure has a lot of versatility and permits the adaptation of different technologies to a given instructional design

4. Advantages of the prototype:

   a. the navigation is easier if it is compared with the technology used in the reengineered courses

   b. the student has just one “window” that integrates all the teaching media required in the course

5. Concerns about the prototype if it was implanted:

   a. the lack of the right technology facilities

   b. an effective training in the usage of technology

   c. the absence of a correct pedagogical basis

   d. the equipment of teachers and students

   e. the way it function with a great number of users

6. Recommendations to the prototype:

a. improve the graphical interface to make it more attractive to the user

b. put an emphasis on the use of interactive tools

c. incorporate the constructivism

4.4 Comments of the Coordinators of logistic for the Virtual University

The comments of the coordinators of logistic for the Virtual University are summarized here:

1. The prototype could be a complement of the videoconference model.
2. The prototype could be an alternative for the technology used in the Virtual University courses
3. Advantages of the procedure:
   a. based on the proposed procedure, it is easy to incorporate new technology to a given model.

   b. facilitates the actualization of old technology and the integration of a new one maintaining, at the same time, the instructional design

   c. the modularity of the model

   d. the procedure has a lot of versatility and permits the adaptation of different technologies

   e. the proposal is a tool that facilitates the right incorporation of technology into the communication developed in the teaching-learning process
4. Advantages of the prototype:
   a. the interface is user-friendly

b. facilitates the integration of new Internet applications

c. the integration of new interactive technology like the video-conferencing on the Internet

5. Concerns about the prototype if it was implanted:

   a. the scalability of the hardware needed

   b. the variability of the students' and teachers' hardware, and the compatibility with the software needed for the proposal

   c. the capacity of the telecommunications links

   d. the capacity of the servers

   e. the logistical problems to coordinate the interactive and synchronous tools like the video-conferencing

6. Recommendations to the prototype:

   a. analyze other similar software that already exists

4.5 Comments of the technical support staff

The comments of the technical support staff are summarized here:

1. Advantages of the prototype:

   a. the integration of new technology because it uses the concept of "plug-ins" that are widely used with the Internet browsers

   b. mix most of the available tools on the Internet

2. Concerns about the prototype if it was implanted:

a. the telecommunications links' capacity

b. the acceptance of the students to this new technology

c. the servers' capacity

3. Recommendations to the prototype:

a. to include more interactive tools

4.6 Interpretation of the results

Tables 4.1 shows the comparison of the comments of all the groups of experts. The last column of these table shows the conclusions that the author found after comparing all the comments of the experts in every category.

Finally, the author founds that the hypothesis was validated by the experts. So, the procedure facilitates the teacher's work in the integration of new technology and the actualization of the old one into a given instructional design.

In the following chapter there are the conclusions and recommendations of the author considering all these comments, the bibliographic references, and the new discoveries found during the development of these work.

Table 4.1.A Summary of the experts' comments and general conclusion

	Pedagogical advisors	Coordinators of logistic of the Virtual University	Technical support staff	Conclusions
Prototype and other models	1. Could be a complement of the videoconference model or any on-line course. 2. Could be an alternative for the technology used in the reengineered courses	1. Could be a complement of the videoconference model 2. Could be an alternative for the technology used in the Virtual University courses	No comments	The proposed prototype could be a complement of the actual videoconferencing model and could be an alternative for the technology used in the reengineered and Virtual University courses.
Advantages of the procedure	1. It is easy to incorporate new technology to a given model 2. Facilitates the actualization of old technology 3. Facilitates the work of the pedagogical advisor and the teacher on the selection of the technology tools 4. Has a lot of versatility and permits the adaptation of different technologies to a given instructional design 5. Helps to link successfully a pedagogic design with the use of different technology media	1. It is easy to incorporate new technology to a given model 2. Facilitates the actualization of old technology and the integration of the new one, maintaining the essence of the instructional design 3. Has a lot of versatility and permits the adaptation of different technologies 4. Is a tool that facilitates the right incorporation of technology into the communication developed in the teaching-learning process	No comments	Because of its versatility and modularity, the procedure facilitates the teacher's work in the integration of new technology and the actualization of the old one into a given instructional design.

Table 4.1.B Summary of the experts' comments and general conclusion

	Pedagogical advisors	Coordinators of logistic of the Virtual University	Technical support staff	Conclusions
Advantages of the prototype	1. The navigation is easier if it is compared with the technology used in the reengineered courses 2. The student has just one "window" that integrates all the teaching media required in the course	1. The interface is user-friendly 2. Facilitates the integration of new Internet applications 3. The integration of new interactive technology like the video-conferencing on the Internet	1. The integration of new technology because it uses the concept of "plug-ins" that are widely used with the Internet browsers 2. Mix most of the available tools on the Internet	The prototype integrates several technologies trough a single interface that is user friendly. Its modularity allows to incorporate several "plug-in" Internet technologies.
Concerns about the prototype if it was implanted	1. The lack of the right technology facilities 2. An effective training in the usage of technology 3. The absence of a correct pedagogical basis 4. The equipment of teachers and students 5. The way it function with a great number of users	1. The scalability of the hardware needed 2. The variability of the students' and teachers' hardware, and the compatibility with the software needed for the proposal 3. The capacity of the telecommunications links 4. The capacity of the servers 5. The logistical problems to coordinate the interactive and synchronous tools like the video-conferencing	1. The telecommunications links' capacity 2. The acceptance of the students to this new technology 3. The servers' capacity	The concerns about the protorype implantation are: 1. The capacity of the servers 2. The capacity of the telecommunications links 3. The scalability 4. The variability and capacity of the equipment of teachers and students 5. The technical training of the users
Recommenda-tions to the prototype	1. Improve the graphical interface to make it more attractive to the user 2. Put an emphasis on the use of interactive tools 3. Incorporate the constructivism	1. Analyze other similar software that already exists	1. Include more interactivity tools	The recommendations are: 1. Include more interactivity tools 2. Improve the user interface 3. Incorporate the constructivism 4. Analyze other similar software

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the author presents his conclusions sustained on the results showed in Chapter 4 and his own experience, specifically the one generated during the development of this work.

It also presents the recommendations collected from the experts and other valuable sources that should be considered by anyone who pretends to apply the procedure designed in this thesis and/or simply by anyone who is involved in the "reinvention" of higher education.

5.1 Conclusions

Here are the conclusions the author found after the development of his research. They are based on the authors referenced in chapter one and two, the author experience and the feedback obtained from the experts after the procedure and prototype presentation.

The conclusions about the procedure to integrate technology into the teaching-learning are:

a. Based on what the experts said " the procedure facilitates the work of the pedagogical advisor and the teacher on the selection of the technology tools", and "the procedure helps to link successfully a pedagogic design with the use of different technology media".

b. The procedure helps to clarify where a particular medium fails, and to suggest which media it should be combined with.

c. It shows how to integrate a range of media in order to best exploit the strengths of each.

d. It can generate several technology mixes based on the same instructional design.

e. Facilitates the actualization and scalability of technology.

f. Provides the teacher the possibility to exchange technology for the same learning activity.

g. Allows the traditional teachers to incorporate technology gradually.

h. Facilitates the implantation of the same instructional design into different technology mixes

i. Allows the teacher to correlate the instructional design and the Conversational Framework.

j. It is not a prescriptive process. A final selection of media is required, based on the media characteristics and the instructional design.

Based on the conclusions stated before, the author propose the following generalizations:

New possibilities with technology. Information Technologies allows access to a rich interactive learning experience which can, in some cases, exceed the interactivity in a traditional classroom. The prototype shows how a mix of various teaching media provides new possibilities to the instructional design, collapsing boundaries to learn that have existed in traditional teaching. Boundaries like time and space. But other more subtle boundaries are evaporating too, such as geographic monopolies by universities or by regional campuses within an institution.

Student-centered approach and interactivity. Due to the reengineering course strategy of the ITESM, the interactions planned by the designers of instruction are moving from a teacher-centered focus toward a more student-centered approach. The media design needs to include interaction with content, with the teacher, with some library resources, and more often with peers. The procedure provides assistance to the pedagogical advisors and the teachers to perform this transition.

Criteria to select from various technologies. All technologies possess unique capabilities. And the strengths and weaknesses of a technology to teaching may be best described by the medium's characteristics. Characteristics represent criteria used to determine the strengths and weaknesses of various technologies for communication. Some of these criteria are (a) type and level of interactivity; (b) teacher and student access to the technology, (c) learner style, and (d) costs for development.

Use multiple technologies. Although the answer to the question "which technology is best to my course" is not straightforward, contributing authors do concur that teachers should entertain the use of multiple technologies to increase learner access, maximize interaction and facilitate diverse learning outcomes. It seems that improvements in university teaching are likely to come from multiple media.

Teachers' new role. We can say that with the procedure proposed the teachers retain a key role. Technology resources just help teachers to shift their emphasis form delivering information to facilitating learning.

Technical staff collaboration. The technical staff (telecommunications experts and computer specialists) most collaborate with teachers and pedagogical advisors to align its IT strategy with the requirements derived form the teaching media implantation. The aspects that should be considered are: technical training; infrastructure deployment, quality of support and maintenance schedule.

Finally, many of the barriers that have previously existed in workplace and society are being dismantled. Now, we need to develop ways to think about learning and the infrastructure to support new interactional frameworks of learning in the changing environments that exists today and will exist tomorrow. The procedure presented in this work is a tool that helps to link those new instructional frameworks with the emerging technology that will be part of the infrastructure in the near future.

5.2 Recommendations

This thesis is just the fist 'goal-action-feedback-action review' cycle of the action research methodology, and as in learning process, there has to be a meta-level that reflects on the process at the next level down in order to set up improvements to it. Therefore, it is recommended that further research occur in the following areas:

a. Application of the procedure, proposed by the author, by a group of teachers.

b. Validation of this research in a different context: other campuses or, even, other universities.

c. Generation of new technology models for the Virtual University and continuing education courses of the ITESM.

d. Transferring of redesigned courses among different ITESM's campuses.

e. Prediction about the optimal balance of time a student should spend in working on learning activities.

f. Determination of the balance of media and time among different subjects.

APPENDIX A. UTILIZATION OF TECHNOLOGY INTO THE TEACHING AND LEARNING PROCESS: THE CURRENT SITUATION

In this appendix there is a brief evidence of the current situation in the reengineering course strategy of the Mexico City campus of the ITESM. The purpose of this section is to obtain a general idea of how the teachers have assimilated the technology that the ITESM is using.

Data gathered from the log file of the server where the LearningSpace is loaded show the results of Figure A.1. The chart represents the average use of the technology platform in all the courses that are redesigned in the Mexico City campus of the ITESM. The time scale should be referenced to the last semester of 1999.

The figure shows also the average for every school of the campus: the business school (DNAD), the social sciences and humanities school, the engineering school (DIA) and, the high-school (DP) is included.

We can notice that the average use of the technology is between 50 and 60 percent. The teachers that use more the technology are the ones form the engineering school, while the teachers with the lowest average of use are the ones from the social sciences and humanities.

This means that almost half of the total amount of teachers involved in the redesign process do not use the technology.

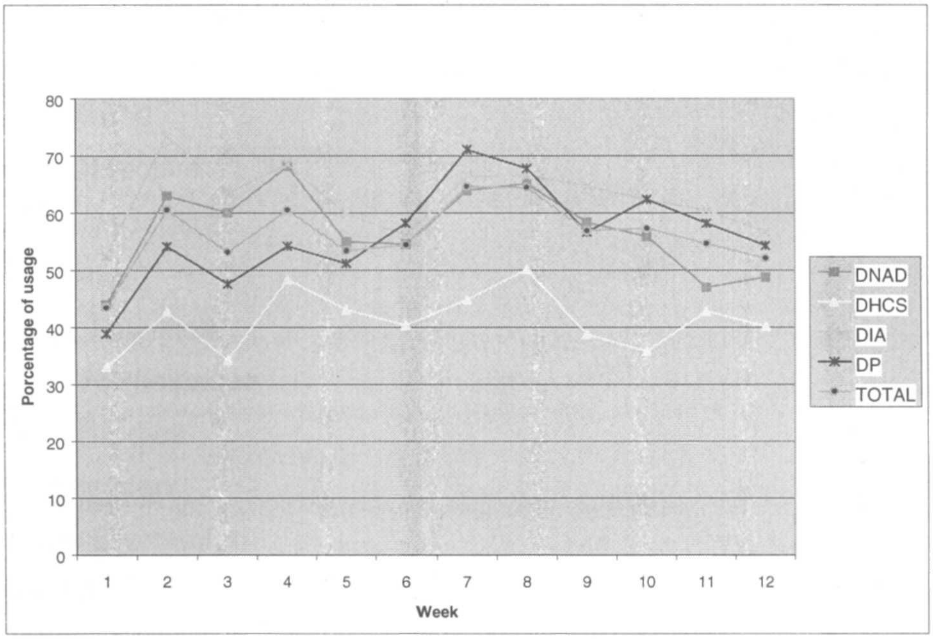

Figure A.1. Average use of technology

APPENDIX B. COURSE STRUCTURE

I. Course Information

1. Course Name
2. Course Objective
3. Course Description
4. Evaluation
5. Learning Activities
   a. Class Participation
   b. Case Studies
   c. Written Work
   d. Group Discussion
   e. Reading
6. Grading Criteria
7. Text Book

II. Schedule

Week 1: Course Presentation
Syllabi
Chapter 1

Week 2 Chapter 2
Learning Activity

. . .

Week 6 Middle Term Exam

Week 7 Chapter 7

. . .

Week 12 Final Exam

APPENDIX C. INTERNET APPLICATIONS

Table B.1 Internet Applications

Service	Description
E-mail	Enables you to send text, binary files, sound, and images to others
Telnet	Enables you to log on to another computer and access its public files
FTP	Enables you to copy a file from another computer to your computer
Usenet and newsgroup	Focuses on a particular topic in an on-line discussion group Format
Chat rooms	Enables two or more people to carry on on-line text conversations in real time
Internet phone	Enables you to communicate with other Internet users around the world who have equipment and software compatible to yours
Internet videoconferencing	Supports simultaneous voice and visual communications
Content streaming	Enables you to transfer multimedia files over the Internet so that the stream of voice and pictures plays more or less continuously

APPENDIX D. PROTOTYPE OF THE CONVERSATIONAL FRAMEWORK BASED ON INTERNET APPLICATIONS

Based on the procedure presented in Chapter 4, now the author explains how to develop a prototype of the Conversational Framework with a set of applications available and compatible with the Internet.

The author could have chosen any other set of teaching media, but he decide in favor of the Internet applications because:

1. The Internet is world wide used and it is expected to keep growing on.
2. The set of applications could be taken as a representative set of the total canonical teaching media.
3. The essence of the Internet is similar to the concept of Hyperlearning explained by Denning (1997) in Chapter 1.
4. Nowadays, the Internet is integrating some emergent technologies that give the prototype the possibility to be a feasible model by now and for some years in the future.

Suppose there is a teacher responsible for the course presented in Appendix B. Also suppose that the only way the teacher has to communicate with their students is via Internet, and the specific applications are the ones explained in Appendix C.

Given that context, now lets find out how every application can be useful to and, in which part of the conversational framework. To do so, follow the next steps:

Step 1. Compare the activities the teacher has to do in the class with the conversational model. The result of these comparison is in Table D.1.

Table D.1. Course Structure and the Conversational Framework

Course Activity	Conversational Framework
General Course Information	1
Class participation	2
Case studies/Written work	6, 7
Group discussion	2, 6, 7, 8, 9, 10, 11
Reading	1
Teacher lecture	1

Note: Numbers have to be referenced to the Conversational Framework in Table 2.1

Step 2. Make an equivalence of the applications available on Internet with its canonical form. Based on the explanation of Appendix C, the result is Table D.2

Table D.2. Internet applications and teaching media

Internet Application	Teaching Media (Canonical form)
E-Mail	Computer Supported Collaborative Work
Telnet	Simulation/Microworld/Modelling
FTP	Print
Usenet & Newsgroups	Computer Support Collaborative Work
Chat Rooms	Computer Conferencing
Internet Phone	Audio-Conferencing
Conferencing	Video-Conferencing
Content Streaming: audio	Audio Vision
Content Streaming: video	Television
World Wide Web	Hypermedia

Table C.3. The Conversational Framework and the Internet applications

		FTP	Content Streaming: Audio	Content Streaming: video	WWW	Telnet: Simulation	Telnet: Microworld	Telnet: Modelling	Internet phone	Video-conferencing	Chat Rooms	E-mail, Usenet & Newsgroup
1	T can describe conception	✓	✓	✓	✓				✓	✓	✓	
2	S can describe conception		✓		✓		✓	✓	✓	✓	✓	✓
3	T can redescribe in light of S's conception or action								✓	✓	✓	
4	S can redescribe in light of T's redescription or S's action		✓		✓						✓	
5	T can adapt task goal in ligh of S's description or action											
6	T can set task goal		✓	✓		✓	✓	✓				✓
7	S can act to achieve task goal		✓			✓	✓	✓				✓
8	T can set up world to give intrinsic feedback on actions		✓	✓		✓	✓	✓				✓
9	S can modify action in light of intrinsic feedback on action		✓			✓	✓	✓				✓
10	S can adapt actions in light of T's description or S's		✓				✓	✓				✓
11	S can reflect on intereaction to modify description		✓	✓			✓	✓				✓
12	T can reflect on S's action to modify redescription											

Step 3. Replace the teaching media of Table D.2 with the applications available for the teacher in the conversational framework. The result is Table D.3

Step 4. Compare Table D.1 with Table D.3. The result is a chart where the teacher can consult the applications available for his or her course.

Table D.4. Scene 1: course structure and Internet applications

General Course Information	FTP, Content streaming (audio & video), WWW, Internet phone, video-conferencing, Chat rooms
Class participation	Content streaming (audio & video), WWW, Telnet (modeling & microworld), Internet phone, Video-conferencing, Chat room, E-mail, Usenet & Newsgroup
Case studies/Written work	Content streaming (audio & video), Telnet (simulation, modeling & microworld), E-Mail, Usenet & Newsgroup
Group discussion	E-Mail, Usenet & Newsgroup
Reading	FTP, Content streaming (audio & video), WWW, Internet phone, video-conferencing, Chat rooms
Teacher lecture	FTP, Content streaming (audio & video), WWW, Internet phone, video-conferencing, Chat rooms

With this final table, the teacher has the hole vision of which Internet applications he or she can use for every part of the different "pieces" of the course proposed.

Step 5. Finally, the teacher has to decide which of the technology available for each activity is the most appropriate. For example, the first activity is better if the teacher selects FTP, Content streaming (audio & video) or WWW because any of these let the teacher communicate with all the students at the same time. The others (Internet phone, video-conferencing and Chat rooms) are only one-to-one communication. One possible configuration could be the next one:

Table D.5. Scene 2: course structure and Internet applications

General Course Information	FTP, Content streaming (audio & video), WWW
Class participation	Internet phone, Video-conferencing, Chat room, E-mail, Usenet & Newsgroup
Case studies/Written work	Telnet (simulation, modeling & microworld), E-Mail, Usenet & Newsgroup
Group discussion	E-Mail, Usenet & Newsgroup
Reading	FTP, Content streaming (audio & video), WWW
Teacher lecture	FTP, Content streaming (audio & video), WWW

In the case of Class participation and Case-studies/Written-work we decide to take the one-to-one communication tools, while in the Reading and Teacher lecture we leave the one-to-many that is more appropriate because the teacher (one) needs to transfer the content to all the students (many).

Based on Table D.5 the author designed and implemented a prototype on HTML with the following configuration:

Table D.6. Prototype: course structure and Internet applications

General Course Information	WWW, Content streaming (video)
Class participation	Usenet
Case studies/Written work	Telnet (simulation, modeling & microworld), Usenet
Group discussion	E-Mail, Usenet & Newsgroup
Reading	FTP, WWW
Teacher lecture	FTP, Content streaming (audio & video), WWW
Tutoring	Internet phone, Video-conferencing, Chat room, E-mail, Fax
Exam	E-mail

Notice that a tutoring section is added because the technology create a new possibility to communicate the students and the teacher synchronously and asynchronously. Also the exam activity is added with the E-mail because it provides some kind of confidentiality to send the exam.

Prototype

The prototype considered almost all type of communication between the teacher and the students, and provides always a single window to establish the conversation: the Internet browser.

The home page of the course, that is showed in Figure D.1, is the main place where we can navigate to the following sections:

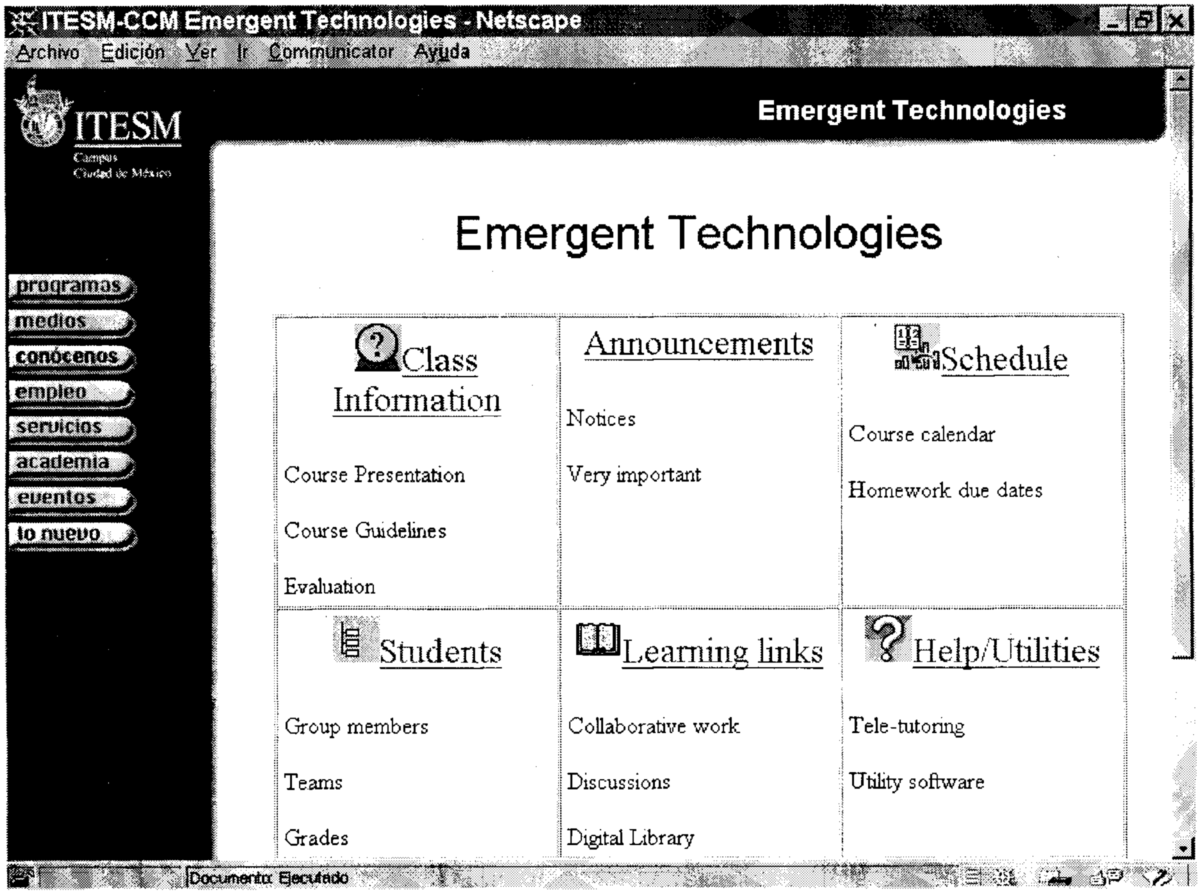

Figure D.1. Prototype: Home Page

1. **Class information.** This section is used by the teacher to present himself or herself and the course in general. Contains the overview of the course, the politics, the way of evaluation, the guidelines and the bibliography. In general, it is the equivalent to the syllabus plus the course presentation. Figure D.2 shows how this section looks like in the prototype.

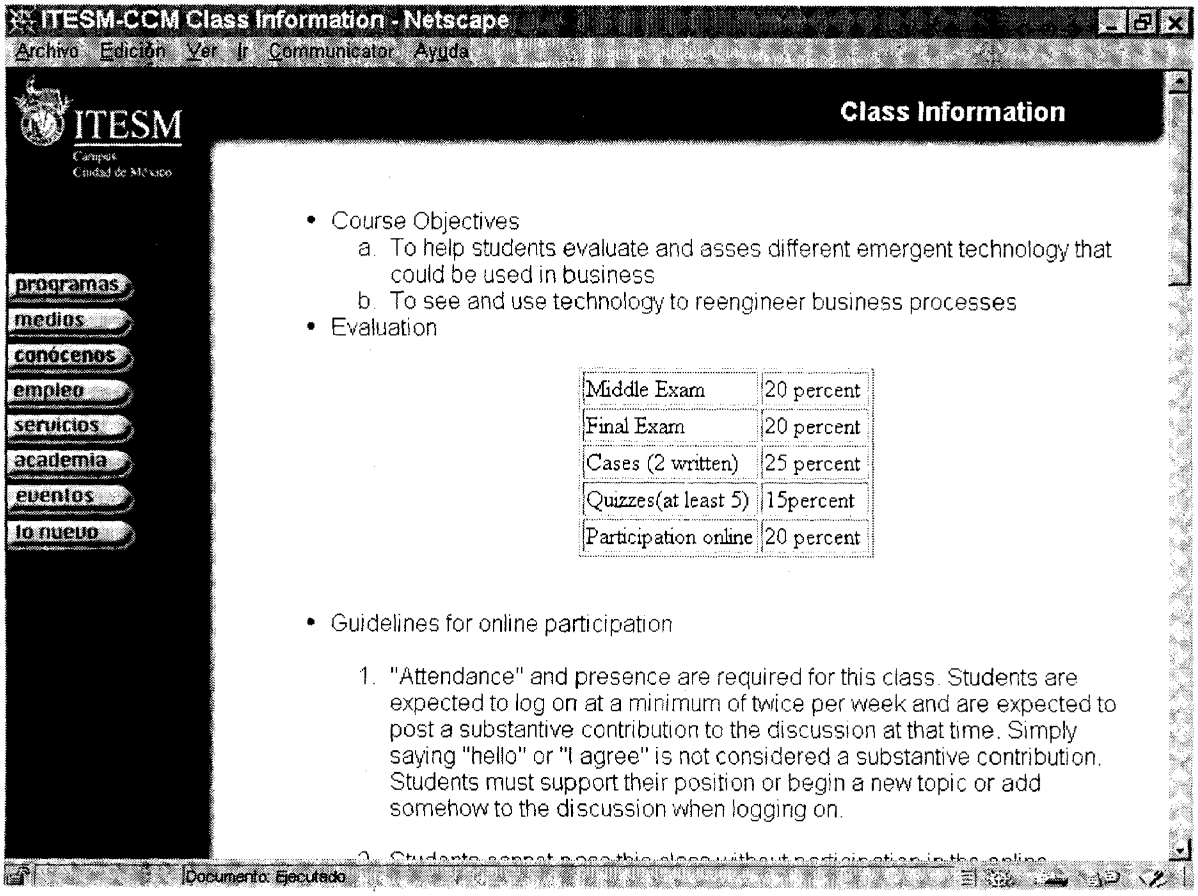

Figure D.2. Prototype: Class Information

2. **Announcements.** Through this section, the teacher and/or his or her assistance can communicate the students several urgent and important notices. It is expected that the students check this section out every time they log in. Figure D.3 shows an example of one announcement.

Figure D.3. Prototype: Announcements

3. **Schedule.** This is the core section of the course because it contains all the sessions programmed (see Figure D.4). The author introduced a new concept that he called "Digital lecture". What he try to express with this term is that the teacher lecture is going to be transmitted via a digital medium. In this case he used content streaming (audio and video), see Figure D.5. These media are mixed with the FTP to download the slides used by the teacher in that specific session. The FTP is also used when

the teacher wants his or her students to read a case or any kind of reading. Finally, there is a section where the students (or a group of them) can send theirs written reports via Usenet, see Figure D.6. Also the students can discuss asynchronously if it is required by the teacher.

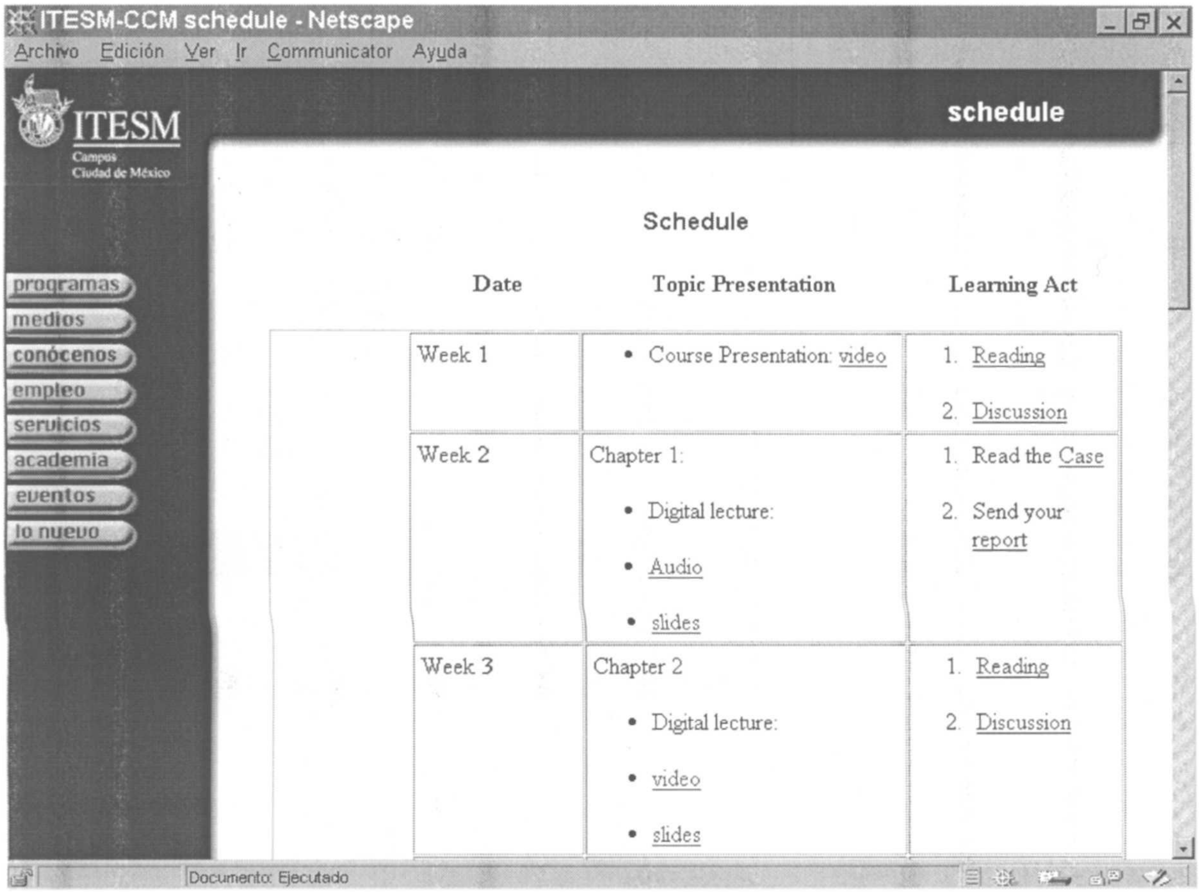

Figure D.4. Prototype: Schedule

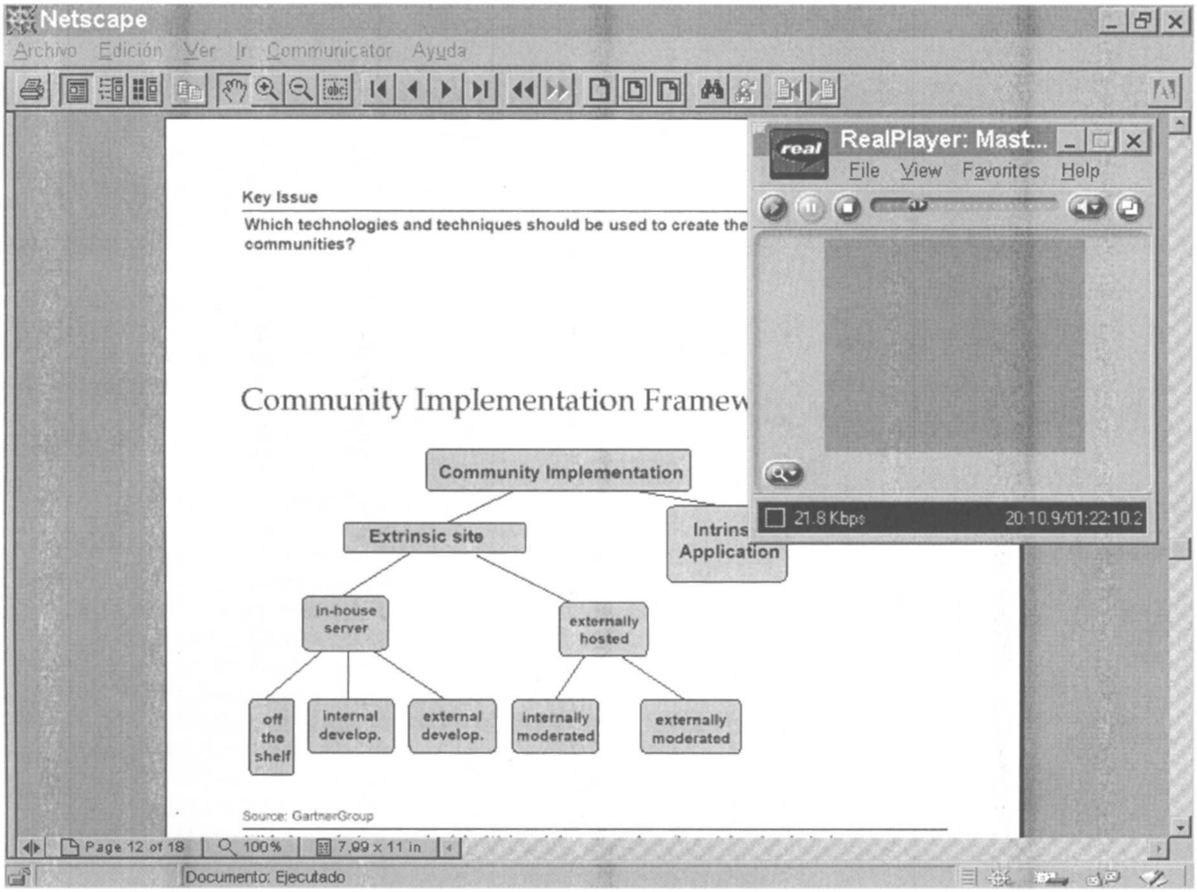

Figure D.5. Prototype: Video- streaming with slides

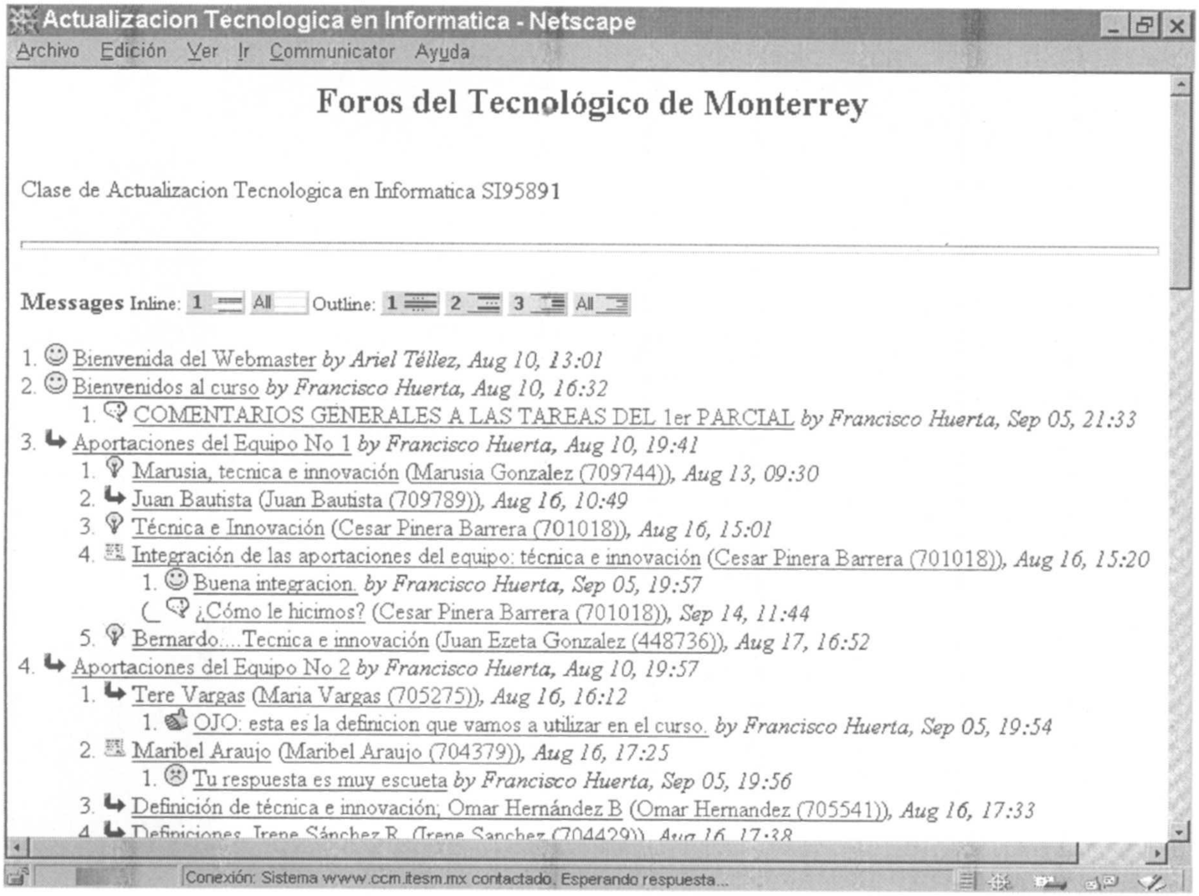

Figure D.6. Prototype: HyperNews (Usenet)

4. **Students.** This section contains the general information about the students: names, teams members, E-mails' addresses and theirs grades. See Figure D.7.

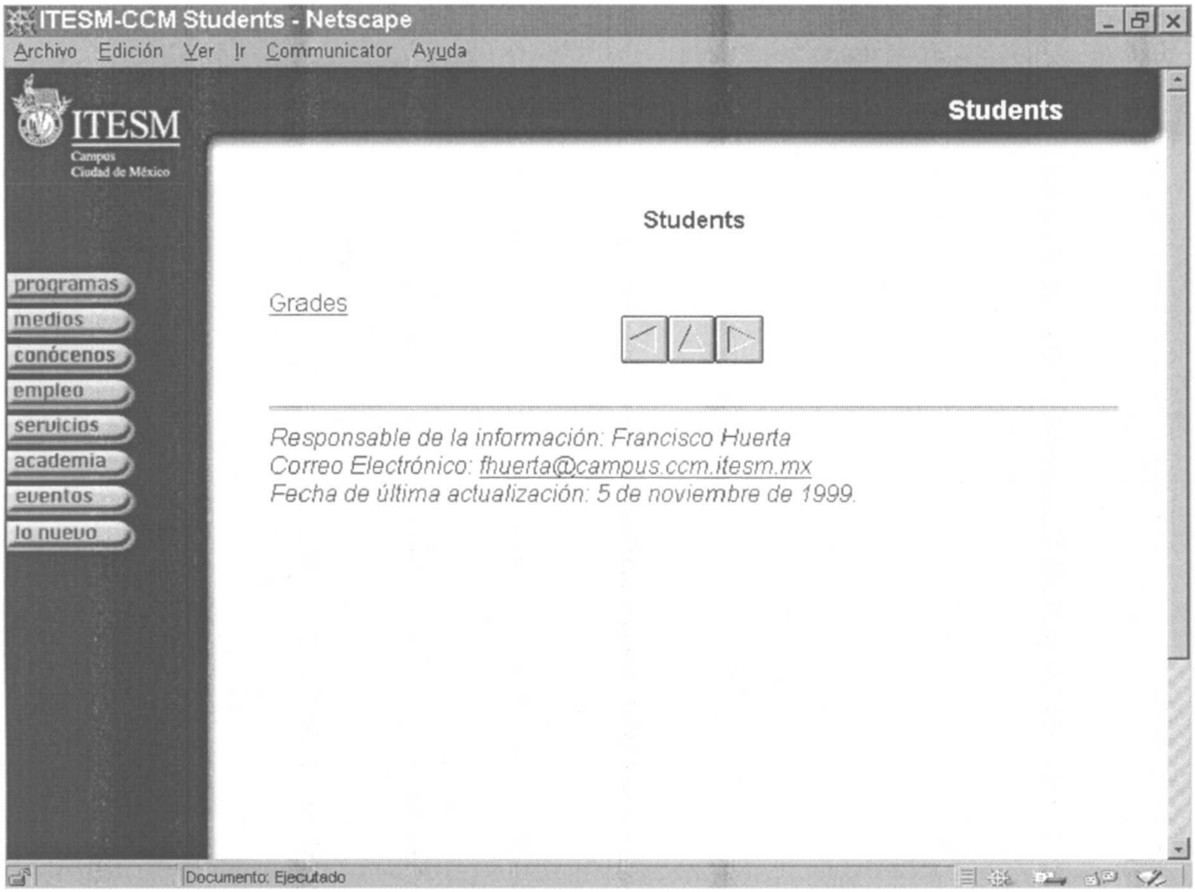

Figure D.7. Prototype: Students

5. **Learning links.** In this section the students will find the links to all those references that can be helpful to find additional information related to the course. It also provides access to some generic, but important resources like the Digital Library. See Figure D.8.

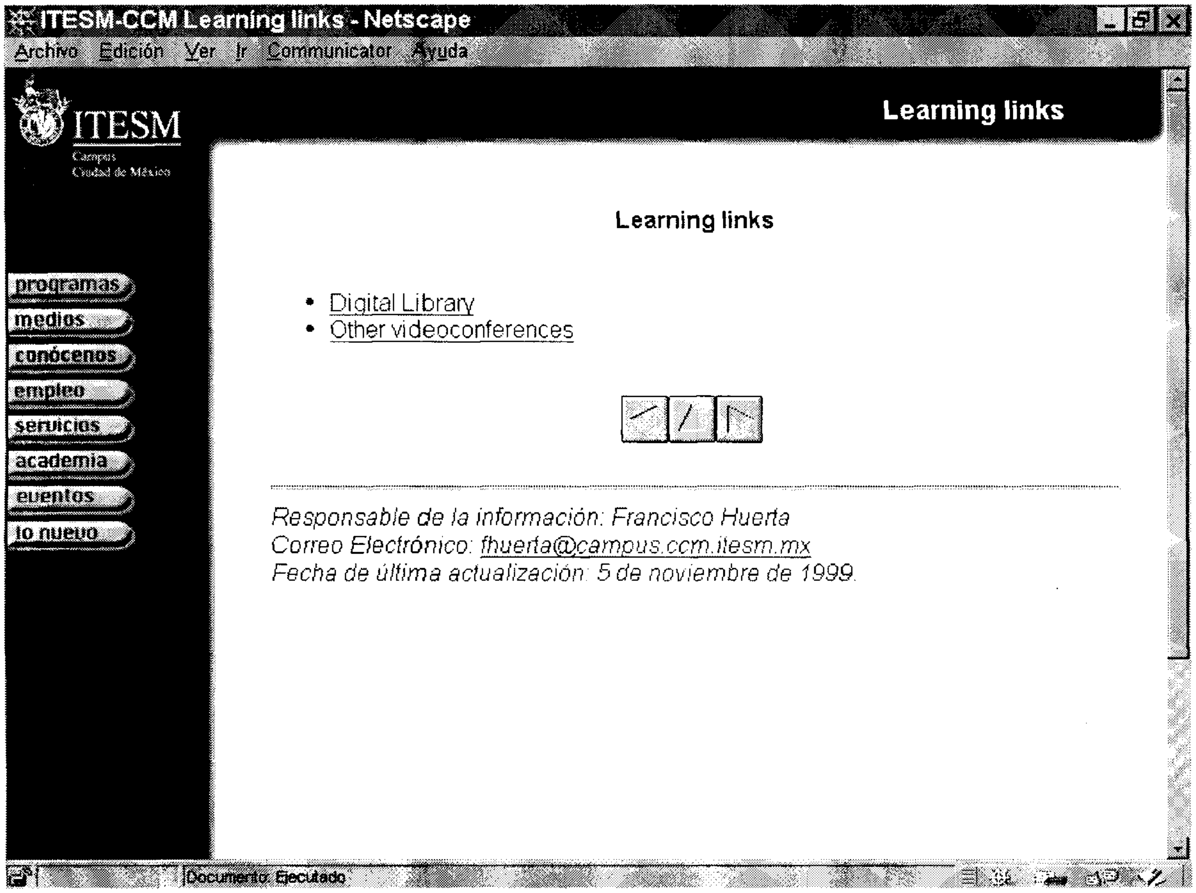

Figure D. 8. Prototype: Learning Links

6. **Help/Utilities.** It contains the links to establish contact with the teacher for a tutoring session via video-conferencing , audio-conferencing or chat room. And via E-mail or fax if the student chose an asynchronous way of communication. Finally, this section provides all the links to those places where the students will find all the utility software needed to have access to all the course resources. See Figure D.9.

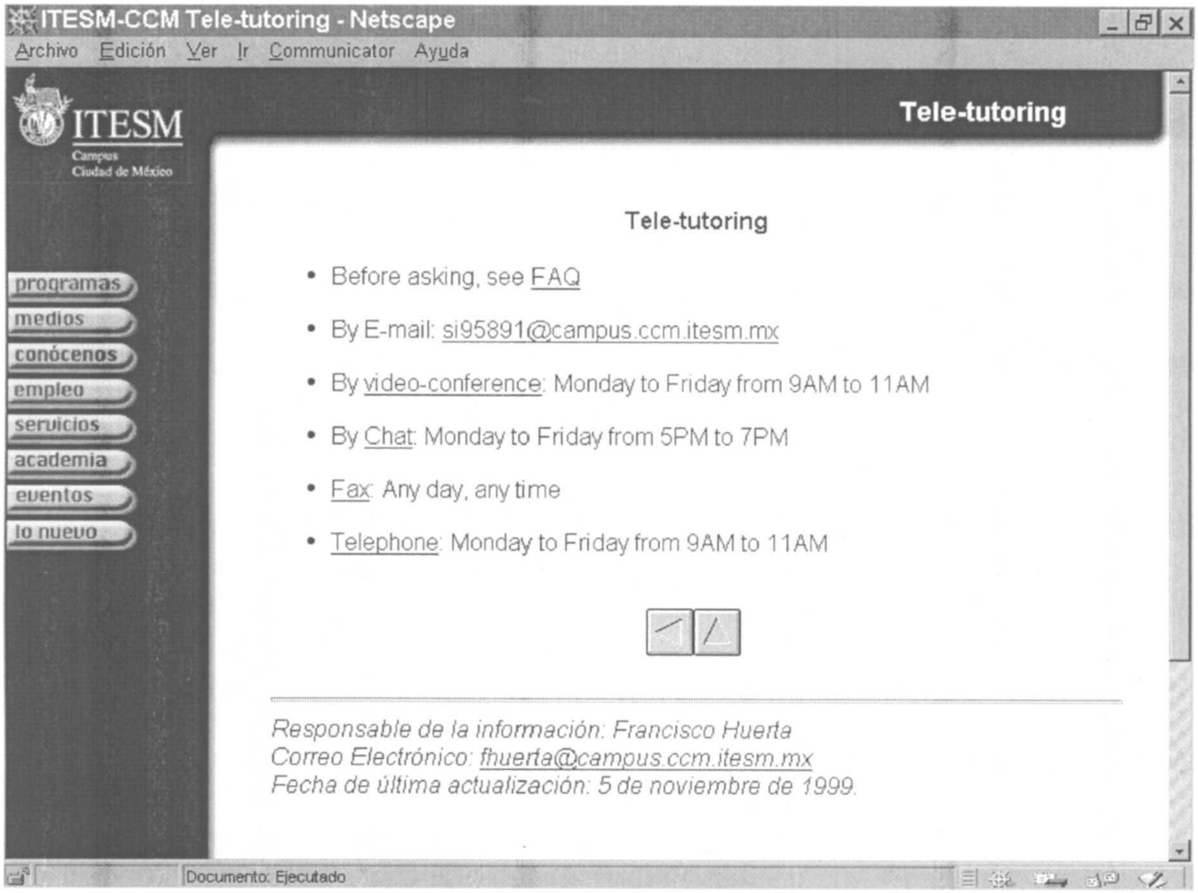

Figure D.9. Prototype: Help/Utilities

APENDIX E. COMMENTS

This appendix presents all the original comment of the experts consulted. The questions the experts answered are the following:

1. If the technology evolved or appeared a new applications, would it be easy to incorporate it into the prototype following the procedure proposed?
2. Do you think that the prototype is complete from the pedagogical point of view?
3. Explain your comments about the prototype and the "technology models" you already know. Consider a reengineered course and the Virtual University models: broadcast and videoconferencing.
4. Do you think that the prototype proposed is feasible to be a complement and/or to substitute the existing models?
5. What are the advantages of the procedure and the prototype?
6. In the case the prototype was implanted, what are your concerns about it?
7. What would you improve in the prototype and the procedure?
8. Please, add any comment you want.

It was not mandatory that all the experts answered all the questions. They were only requested go give a evaluations of the procedure and the prototype.

Note: the numbers in the comments correspond to every question

E.1 Pedagogical advisors

Comments of Cynthia Villanueva Espinosa:

1. *Creo que cualquier tecnología se puede incorporar a este tipo de modelo ya que se encuentra sustentado en diversas formas de propiciar una interacción sincrónica o asincrónica, así que cualesquiera que sea la tecnología podría ser recuperada para desarrollarse bajo el modelo conversacional.*

2. *Lo que va a determinar su viabilidad pedagógica es el fundamento pedagógico que lo sustente, por lo que si se fundamenta en un excelente diseño pedagógico podemos hablar de que ambos diseño pedagógica y plataforma son completos desde el punto de vista pedagógico.*

3. *Hacer un juicio a priori sería arriesgado, ya que no existe una experiencia previa que permita valorar el desempeño del prototipo en la realidad. Además las posibilidades que nos da cada uno de los modelos que se pide comparar son diversas, no podría comparar el prototipo con el broadcast de la UV ya que el sustento tecnológico y la base pedagógica son diferentes, considerando, además que el broadcast no es el elemento esencial de la clase vía satélite o por Videoconferencia, ya que se encuentra complementado con el uso de herramientas de interacción electrónicas sincrónicas y asincrónicas, incluyendo entre ellos el hypernews, el Chat-Room, etc.*

   En este sentido el prototipo podría ser comparado con la forma en que se presentan las herramientas de interacción que complementan un curso que usa sesiones satelitales o videoconferencia. En ese sentido el prototipo es ventajoso en tanto integra las tecnologías de manera que el alumno puede contar con un solo canal que integra y presenta ya depuradas las posibilidades de interacción. Por parte del maestro también tiene una ventaja, las herramientas de interacción ya han sido previamente depuradas y seleccionadas en cuanto a sus posibilidades, ofreciendo estrategias de aplicación viable para la interacción en el proceso de enseñanza-aprendizaje.

   Si lo comparo frente a Learnig Space estaría hablando de algo mas susceptible de comprara en tanto que cumplen tienen apartados muy similares, solo que retomo el comentario inicial, necesitamos el pilotaje del prototipo para poder dar un juicio de valor mas cercano a la realidad.

4. *Yo creo que más que reemplazar sería ampliar la oferta de medios para la enseñanza.*

   Para al caso del modelo de clases por videoconferencia sería un excelente complemento, ya que amplia las posibilidades de interacción de los alumnos con su profesor y sus compañeros.

Para los cursos de rediseño sería otra opción de plataforma tecnológica, pudiendo sustituir al LSpace.

Para cualquier tipo de curso, susceptible de convetirse en un curso en línea, sería un medio de enseñanza fundamental para apoyar la labor de enseñanza-aprendizaje.

5.
   a. *Hace una selección adecuada de las tecnologías de acuerdo a sus posibilidades de interacción*
   b. *Facilita la presentación de las herramientas de interacción para el usuario ya que las concentra en un sólo "paquete"*
   c. *Facilita la labor del asesor en diseño instruccional y del profesor al seleccionar las herramientas de interacción*
   d. *Al saber cuáles serán las herramientas de interacción a utilizarse la Institución puede determinar áreas prioritarias de soporte técnico*

6.
   a. *Que no existe una infraestructura tecnológica adecuada*
   b. *Que no se de una capacitación efectiva en cuanto al uso de la Tecnología*
   c. *Que no exista un sustento pedagógico que lo fortalezca*

7.
   a. *Hacer un diseño gráfico más atractivo para el usuario*
   b. *Establecer un módulo introductorio de descripción de las partes, así como anexar un manual de uso a cada una de las herramientas tecnológicas a utilizar.*

8. *Me parece un muy buen desarrollo de integración de tecnologías de la información para la Educación, te felicito por el análisis.*

   Algo que considero debes tener muy en cuenta es la compatibilidad que debe existir entre el modelo conversacional con la fundamentación pedagógica que en la actualidad utiliza el ITESM, esto es, el enfoque constructivista. Por lo que nos explicaste, el modelo conversacional esta desarrollado por una investigadora que se basa en la experiencia de la Open University, eso me parece muy bueno, ya que estamos hablando de un ambiente de aprendizaje a distancia, lo que faltaría es enmarcarlo o mas bien, que tu conceptualmente lo pudieses relacionar con el enfoque constructivista ya que pienso que en tu examen de grado podrían hacerte alusión a la necesidad de hacer referencia a dicha corriente pedagógica.

Comments of Georgina Villanueva Espinosa

Desde la experiencia que tengo como asesora pedagógica he observado que se presenta una problemática para vincular exitosamente los aspectos *educativos con el uso de diferentes medios tecnológicos. Con base en ello, el prototipo me parece muy interesante ya que cubre perfectamente un espacio vacío en dicha vinculación.*

En la presentación conocí solamente aspectos generales del prototipo, sin embargo considero por lo que el Ing. Huerta comentó, el marco teórico contempla los aspectos pedagógicos necesarios para argumentar la propuesta.

En comparación con el modelo de los cursos rediseñados que asesoro y que se auxilian de la herramienta tecnológica Lotus Notes-learning Space, el prototipo tiene ambiente que como Learning Space trata de integrar los diferentes momentos del proceso enseñanza aprendizaje. La ventaja que le veo al prototipo es que su navegación es muy sencilla y hace uso de otros medios tecnológicos en un esquema muy interactivo.

Finalmente felicito al Ing. Huerta por esta aportación tan valiosa.

Comments of Alberto Gastelú Martínez

1. *La propuesta se presenta lo suficientemente versátil para poder integrar diferentes tipos de tecnologías emergentes que pudiesen dar un valor agregado al diseño instruccional del maestro autor.*
2. *El prototipo tecnológico es versátil, sin embargo desde el punto de vista pedagógico me permitiría hacer las siguientes observaciones:*
   a. *Existen alumnos con un estilo de aprendizaje cuyas características particulares hacen que requiera el contacto "personal" con el maestro y/o otros alumnos. Sugiero que dentro del prototipo se haga énfasis en actividades de inter-relación entre maestro/alumno y alumno/alumno con el objetivo de eliminar lo "frío" que para este tipo de alumnos pudiese resultar el manejo del prototipo.*
   b. *¿De que forma consideras que el prototipo favorezca la construcción del "aprendizaje significativo" y no solamente la memorización o repetición de conceptos?*
   c. *Mi percepción es que la estructura del curso que planteas esta más dirigida hacia contestar los qués que los porqués.*
3. *Se trata de una propuesta más versatil, diversa y actualizable en comparación con otros modelos. A la luz de la teoría de sistemas, esta diversidad y versatilidad hacen de la propuesta un sistema más estable y factible de evolucionar. De igual forma, presenta características de adaptación hacia diferentes circunstancias de equipamiento y redes.*

Algunos de los elementos del prototipo son herramientas que permiten una interacción más cercana y menos fría entre profesor/alumno y alumno/alumno.

4. *Sí. Siempre y cuando se consideren; el equipamiento, la capacitación para alumnos y maestros. Y como funcionaría a un nivel más "masivo" de usuarios.*

5.
   a. *Facilidad de aplicación de diversas metodologías de diseño instruccional.*
   b. *Capacidad de actualización permanente*
   c. *Posibilidad de ir integrando diversas tecnologías emergentes*
   d. *Versatilidad de adaptación frente a diferentes equipamientos*
   e. *Posibilidad de funcionamiento sincrónico y asincrónico.*

6.
   a. *Equipamiento*
   b. *Capacitación*
   c. *Diseño de una metodología instruccional ad hoc para este prototipo*

7. *Balancear el diseño gráfico de la pantalla de inicio para facilitar su navegación. Desde mi percepción, esta favorece una navegación más hacia habilidades del hemisferio izquierdo del cerebro, es decir de una manera lógica y sistemática, frente a las habilidades más subjetivas e intuitivas del hemisferio derecho.*

8.
   a. *Hacer más explícita la(s) innovación(es), del modelo propuesto.*
   b. *Realizar una serie de sugerencias sobre el diseño instruccional factible a utilizar, (conocidas como White Pages), buscando que a la optimización educativa del prototipo propuesto.*

E.2 Logistic's coordinators of the Virtual University

Comments of Angel Luis Ibarra Jiménez

1. *Si es factible, el método utilizado de la estructura modular lo permite*

2. *La integración de las tecnologías de ambos modelos tecnológicos (Lotus Notes y Web) se integran en el modelo propuesto. La gran ventaja que vi es utilizar videoconferencia y representa un gran avance.*
3. *No creo que sea reemplazo, por el contrario, es integración de ambos y está listo para adaptarse a cambiar la tecnología educativa que se desarrolle continuamente sin perder su objetivo de facilitar la educación a distancia.*
4. *Sencillez, estructura modular, adaptación a los cambios tecnológicos.*
5. *El ancho de banda y la capacidad de nuestros servidores para masificar la oferta y lograr capacitar a mayor número de alumnos.*

Comments of Elizabeth Romero Fuerte

1. *Considero que sí. Además de fácil de integrar permite integrarlo adecuadamente sin perder el contexto del diseño completo del curso.*
2. *Me parece completo, dado que cubre, de acuerdo al estudio presentado, todas las formas de comunicación educativa de manera integral.*
3. *Que es más amistoso para los usuarios que muchos otros, que presenta una integración adecuada de recursos tecnológicos y que es más adaptable al no estar sujeto a una tecnología específica.*
4. *Con base en mi experiencia en la UV, por supuesto que lo creo.*
5. *Fundamentalmente dos: primero, que es más completo y que permite integrar recursos tecnológicos de manera modular a un sistema que si tiene congruencia como un todo. Con la rápida obsolescencia del software hoy, esta puede ser la alternativa de solución para la adecuación de tecnología en el momento en que haya algo nuevo y se decida incorporar, de manera transparente (o lo mas transparente posible) para el usuario. Segundo, que provee una herramienta de decisión para la incorporación adecuada de esa tecnología al proceso de comunicación educativa.*
6. *Que soportara la cantidad de usuarios que se requiere en la aplicación. Que contemplara las contingencias tecnológicas y que se adaptara fácilmente a diferentes capacidades de hardware.*
7. *Básicamente no tendría comentarios al respecto, salvo que cuidara la implantación y el mantenimiento, que en muchos casos son factores de fracaso de algunos sistemas. Que se considere que los recursos de hardware son muy diferentes en distintas zonas y se planeen, con base en ello, modificaciones o adecuaciones acordes a las necesidades particulares.*
8. *Ojalá pueda ser implantado y evaluado, pues en la UV, al menos en las clases por videoconferencia a los campi de la Rectoría Zona Sur, creo que puede aportar buenos resultados.*

Comments of Carlos Sandoval Valdés

1. *Pienso que sería posible siempre y cuando esta nueva herramienta esté desarrollada o pueda ser montada dentro de la plataforma del Internet de manera natural.*
2. *Si consideramos que de acuerdo a la propuesta se pueden incluir las herramientas que sean necesarias de acuerdo al diseño del profesor, diría que es completo.*
3. *Mas que compararlos yo diría que es una manera de complementar estos sistemas y darles un enfoque integrador en un ambiente más amigable para el usuario.*
4. *En principio, creo que como un complemento pues a pesar que muchas de las herramientas que se integran en este modelo funcionan de manera independiente pero al integrarlas pueden surgir problemas en cuanto a la validez de una u otra herramienta. En cuanto a reemplazar los modelos existentes pienso que sería a mayor plazo, ya que se depende de los avances tecnológicos para que las herramientas funcionen sin problemas de recepción, calidad de imagen, tiempos de respuesta, especificaciones técnicas, etcétera.*
5. *La integración de diferentes herramientas para la recepción e interacción a distancia de manera sincrónica o asincrónica en un ambiente o plataforma de fácil acceso.*
6. *La facilidad para poder integrar diferentes herramientas en un curso, ya que al tratarse de herramientas distintas las especificaciones para que un usuario pueda emplearlas puede causar demasiada incertidubmre. Si la adaptación de los contenidos es transparente para el profesor y usuario, sería excelente.*
7. *Revisar la compatibilidad para integrar las diferentes herramientas con los requerimientos técnicos, ya que también depende del tipo de equipo al que se tiene acceso para poder recibir los cursos.*
8. *Revisar información sobre herramientas como LearnLinc que ya integran este tipo de herramientas para ver las ventajas y posibles mejoras al proyecto.*

Comments of Juan Eligio Duarte Rodríguez

1. *Definitivamente, una de las grandes ventajas del prototipo mostrado es su capacidad de integrar un kit de herramientas, pudiendo modernizarlas según el proveedor que mejor se ajuste a nuestra necesidades.*
2. *Esta pregunta es difícil de responder, ya que los diferentes programas manejan diferentes herramientas tecnológicas que faciliten su materia.*

Desde un punto de vista general el paquete ofrece una buena variedad que puede ser aprovechada según sea el caso.

3. *La fusión me parece interesante ya que conserva las bases de LearningSpace y las grandes ventajas del Web. Todavía queda en duda su efectividad de la videoconferencia o la audio-conferencia sincrónica, pues desde mi punto de vista se presenta un problema logístico o de coordinación y no tecnológico.*
4. *Por su modularidad y por su estructura me parece que puede reemplazar a los modelos existentes, desde el punto de vista de la interacción en línea (incluyendo videoconferencia).Pues aunque parezca mentira el alumno no desecha del todo la idea de la convivencia presencial.*
5. *Tener en forma estructurada y modular, las herramientas que mejor se ajusten a un curso en particular, es decir dependiendo de las objetivos del curso y las características de los alumnos o el medio, se configura la interacción que necesita.*
6. *Ninguna en particular, sin embargo podría generar una polémica dentro del sistema, no dentro del campus.*
7. *Hacer una revisión desde el punto de vista del usuario, es decir el prototipo pueden contar con un gran número de ventajas tecnológicas, sin embargo el receptor (usuario) debe contar con el equipo o características mínimas para soportarlo. Aunque cada día los alumnos del sistema cuentan con mejor equipo, existen algunas características físicas que limitarían algunas herramientas, por ejemplo mas velocidad de procesamiento, más capacidad de memoria. Para utilizar las Webcam se necesita Windows 98 y contar con entradas USB además de adquirirlas.*

E.3 Technical support staff

Comments of Ariel Téllez

1. *Si, al utilizar plug-ins en los navegadores, prácticamente se puede adaptar cualquier tecnología nueva en el momento en que se desarrolla.*
3. *Le falta mas interactividad a tiempo real. Algo interesante, como propuesta, seria desarrollar clases con un profesor completamente virtual, metiendo inteligencia artifical al sistema, de tal suerte que si en el momento el alumno hace alguna pregunta o cuestionamiento, el sistema puede contestar o consultar sus bases de datos y dar un respuesta, y si no puede, se la transfiere al profesor para que este por correo conteste después.*
4. *En estos momentos creo que es una buena herramienta para complementar los modelos existentes. La gente todavía duda mucho en tomar cursos completamente en línea. En un par de años creo que va a ser una buena herramienta para reemplazar los modelos actuales.*
5. *Aprovecha la mayor parte de las herramientas de web.*
6. *Como siempre... velocidad de transmisión y capacidad de los servidores para aguantar a los usuarios... si el curso tuviera muchas películas, sería*

recomendable tenerlo en CDROM y sólo dar en el servidor espacio para la interactividad.

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