A Constructivist e-Learning Model for Teachers

Jaime Sánchez, Julio Miranda, Felipe Vera.
Center for Computing and Knowledge Construction
Department of Computer Science, Universidad de Chile, Chile

ABSTRACT
It has been increasingly claimed that e-Learning needs to incorporate more educational value to its models. Some views propose modern pedagogical models that better fit the nature of the unique features of technology. A related approach proposes to embed modern learning and instructional design theory into new communication and interaction channels provided by technologies such as Internet. This study introduces a model for e-Learning that better exploits the added value of internet and associated Learning Management Systems. The model is illustrated with a specific training program for specialists in learning with digital media. After presenting and describing the model we analyze the design, implementation, and evaluation of an ongoing e-Learning program for school teachers that maps our model. We highlight the way teachers construct knowledge by reflecting on teaching and learning through virtual interaction. Intact e-communities were developed by interacting and communicating through Internet services to share meaning, views, and understanding. Thus knowledge was constructed by teachers to be used in a meaningful way during everyday pedagogical practices in the school.

Keywords: e-Learning, e-Learning models, teacher training, virtual interaction, knowledge construction

INTRODUCTION
Diverse views have been presented to add more educational value to distance learning programs. Many e-Learning programs pose great emphasis on the “e” side, centering on the Learning Management System used and searching for new tools to “improve” distance learning (Garrison and Anderson, 2003; Dillenbourg, 2000; Haddad, 2003; Kante, C., & Savani, 2003; Meyen et al., 2003; Pitt & Clark, 1998; Jonassen, 1995; Kozma et al., 2000). The emphasis of these innovations is on learning and centered on learners by including ways of fostering different modes of knowledge representation. They design a virtual space to construct knowledge and collaborative learning strategies supported by Learning Management Systems.

From these views we can describe some e-Learning principles that support any course implementation such as to promote an active role of learners in the construction of knowledge, meaningful, broad and deep learning, collaborative learning, and a changing role of teachers/tutors as learning facilitators. Other principles include developing skills, attitudes and values, to allow real experiences through real world activities, to involve learners as co-evaluators, to make learners to reflect on what is doing, to use technology to enrich learning, to enhance action on knowledge objects, and to solve cognitive conflicts

These principles emerge from underlying theories and models of learning such as constructivism, understanding as thinking, understanding as a network, social interaction, social distribution, situated learning, generalized learning, and self-regulated learning (Collis, 1997; Jonassen, 1998; Sánchez, 2003).

Since 1990 the Ministry of Education of Chile is implementing a major innovation in the Chilean curriculum by integrating information and communication technologies into teaching and learning. To do this a national Project was created to train teachers and assist them to use and integrate technologies into everyday classroom. This major effort was supported by most public universities by creating zone centers and executive units to implement the project inn the whole country. As a result, one of the increasing needs is to go further than taking computer literacy and curriculum integration courses by designing a diploma to train leader teachers in the use of technologies in a more systematic and deeper way.
The University of Chile created a Diploma in Informatics and Education for teachers that was delivered through face-to-face methods during seven years. These teachers were mainly from the Santiago, the capital of Chile. Since the last year we moved further by implementing an e-Learning version of this Diploma that was taking by teachers from different regions of the country.

This study presents the design, development, and evaluation of the e-Learning version of a Diploma in Informatics and Education for teachers. We introduce a model for e-Learning that is built upon these principles, models, and theories. We want to inform, describe, and share our experience, results, beliefs and thoughts concerning the use of e-Learning for training teachers to become specialists in the use and integration of information and communication technologies into curriculum. Our pedagogical model is illustrated with of a Diploma in Informatics and Education for teachers. We highlight the way teachers construct knowledge by reflecting on teaching and learning.

To implement this initiative we based our work on diverse studies concerning the design and implementation of e-Learning courses for teaching and learning (Dillenbourg, 2000; Kante & Savani, 2003; Pitt & Clark, 1998; Garrison & Anderson, 2003; Haavind, 2000; Kozma et al., 2000; Meyen, 2002; Tinker & Haavind, 1996; Sánchez, 2003; Sánchez, Miranda & Vera, 2004).

**METHODOLOGY**

We designed a whole e-Learning training program for teachers. We wanted to preserve academic quality and innovate in the way we deliver education both the technology and model of learning used. To do this we followed these steps:

- Technology evaluation: We selected a Learning Management System and evaluated the technical requirements
- Team organization: We created a multidisciplinary team to implement the e-Learning program with engineers, educators, and informatics and education specialists.
- Model of learning: Once we knew the characteristics of the LMS and content we designed a pedagogical model for e-Learning. This model is fully described below.
- Pilot testing: We designed a pilot testing course on methodologies for using information technologies with a reduced number of teachers. We tested the functioning of the LMS and the pedagogical model. We also evaluated diverse materials, working interfaces, learning strategies, type of interactions, and time spent in different section of the course.

Design of the e-Learning Diploma: We then designed the diploma by defining working stages, requirements, and team responsibilities.

Modeling: We designed and implemented the structure of the LMS by considering the learning model and the structure of the diploma. The content of the eight courses of the diploma was modeled. Most of this content was already in digital format facilitating the process.

Online classes: The students were selected and registered. Then the first week they inspected the platform by following an entrance module. Students also started to virtually communicate and know each other.

Online modules: To interact in each course we designed modules with individual and team activities to design products. They used different interaction tools such as chat and forums to do collective designs and constructions.

Face-to-face modules: We designed three out of eight course modules to be delivered face-to-face. They included content that needs more student-facilitator interaction. Each course was delivered in an intensive week with a day topic and collective works.

Evaluation: We finally evaluated the diploma through questionnaires and opinion polls to get ideas, comments, and suggestions concerning online and face-to-face classes. We also implemented a focus group with professors and tutors of the diploma to analyze and discuss the attainment of goals and objectives.

E-LEARNING MODEL

We designed a model is based on constructivist principles of learning (Jonassen, 1995; Sánchez 2001). Learning is viewed as the process of construction and modification of cognitive structures through learning by experience and collaboration. Each module of the learning cycle is oriented to obtain a contextualized meaningful learning. The learner is required to reflect, apply, criticize, argument, and solve problems and thus allowing them to construct their own representations. Our model is based on constructivist principles of learning. We view learning as the process of construction and modification of cognitive structures through learning by experience and collaboration. Each module of the learning cycle is oriented to obtain a contextualized meaningful learning. Learners are required to reflect, apply, criticize, argument, and solve problems and thus allowing them to construct their own representations. We identify five major processes: Realizing, Approaching, Conceptualizing, Structuring, and Applying (the model is fully described in Sánchez, Miranda and Vera (2004).
Realizing implies to identify the educational challenge. This phase consists of orienting learners in their studies by identifying the problem and making their point of view. They also understand the objectives of the course work proposed and the starting points. They know what they will learn and the reason why the activities are proposed. The learner has to make representations of the expected product and results, and the rationale for doing this. Realizing involves the process of motivating, problem identification, and pre-concept/concept contrasting.

Approaching consists of constructing a new learning and point of view by learners guided by a group of professionals that design diverse methodological proposals to fit their cognitive styles. The idea is to produce a cognitive conflict to question the learner’s intuitive models and to identify the strengths of the proposed models. It involves the process of reflecting, retention, adapting, exploring, and researching.

Conceptualizing involves identifying the concepts and possible conceptual changes when exploring and approaching to the content. It involves the processes of metacognition, representation, and adaptation.

Structuring implies to construct knowledge through didactic strategies such as synthesis, monitoring, and metacognition. This involves processes such as analysis, synthesis, retention, metacognition, and abstraction.

Applying consists of giving the opportunity to students to apply their conceptions to new and different scenarios. It involves evaluation, imaging, adaptation, abstraction, problem solving, contextualizing, and metacognition.

The virtual interaction triggers a synergic effect on the model by carrying these five processes of knowledge efficiently and thus allowing feedback, confronting ideas, discovering, and collaboration. All these processes are critical in the construction of knowledge.

E-LEARNING CYCLE

Our Center implemented a pilot e-Learning experience in order to design and evaluate the proposed methodological learning model. We also wanted to evaluate the Learning Management System used and to identify main components and strategies to implement an e-Learning course. In order to do this we followed five phases: Design, implementation, evaluation, feedback, and redesign. The design of the e-Learning cycle involved processes such as entering to a content unit, analyzing documents, negotiating meaning, and applying what learners have learned through collaborative constructing to end with a group synthesis (see Figure 2).

CONTENTS

The course and modules of the Diploma in Informatics and Education for teachers were the following:

Course 1 Context
- **Introduction**: This module is oriented to be familiarized with the LMS and the methodology of the course. It is also a way to get along between the students through open forums where learners have to introduce him/her self and talk common interest topics
- **Digital literacy**: The purpose of this module is to know a wide view about information and communication technologies, impact, uses, and applications to education
- **Learning and cognition**: The purpose of this module is to study and analyze theories, models and concepts of human learning and cognition. Different approaches to learning with technology are the main axis of the module. We review concepts, strategies, and the impact on educational practice with the use of technology
- **Informatics and education**: This module covers a wide scope of educational computing applications to orient the study and impact of using technology in education

Course 2 Software
- **Educational multimedia**: This module analyses a methodology for educational multimedia production. Students apply the concept learned by developing a personal
multimedia Project for learning purposes. They analyze the design, implementation and evaluation involved in multimedia development.

- **Educational software:** This module analyses the major types of educational software, characteristics, ways of using and learning applications. It also covers software evaluation through the use of questionnaires.

**Course 3 Methodologies**

- **Methodologies for using technologies in the classroom:** This module studies an integrated view of constructivist practices with technology. Students also learn about the evaluation of digital resources for learning.

- **Educational uses of Internet:** This module analyses and studies the educational uses of Internet. Learners design activities and projects to use Internet in the classroom for learning purposes.

- **Projects in Educational Computing:** The purpose of this module is to study and learn tools and strategies to design Projects in Informatics and Education with specific emphasis on technology integration into curriculum.

Each online course was divided in five working units during six weeks with a final evaluation. Units were developed in a week basis and ended with an individual or collective product. The last week was dedicated to prepare and take the final evaluation. Each unit consisted of unit description, objectives, general directions, activities, support materials, web links, and online discussions around each activity and working document.

During each module students were involved in activities such as document synthesis, term glossary, abstracts, graphic representations (schemes, concept maps), collective constructions of documents, comparative charts, and case studies.

Each course consisted of a virtual class section, synchronous communication with the professor responsible of the course and diverse discussion forums to implement activities and documents. The course was in charge of a professor, assisted by a coordinator and a teaching assistant facilitator.

Social interaction was our main bet to do collective constructions among students and between students and facilitators. This interaction was implemented by using asynchronous (discussion forums) and synchronous (chat) media with the following modes: Learner to learner, learner to facilitator, learner to content, and learner to interface.

**TECHNOLOGY AND LEARNING MATERIALS**

A Content Management System from Newtenberg was used ([www.newtenberg.cl](http://www.newtenberg.cl)). This is a Chilean made platform that is widely used for constructing and managing information-based Web sites. The system is easy to use and versatile for design purposes. We adapted this system for e-Learning purposes.

The main documents used were a book (Sánchez, 2001), electronic documents available through Internet, documents prepared by the working team, digital videos, web links, and presentation files. Collective documents prepared by the students were also published in the Web site.

**VIRTUAL WORKING ENVIRONMENTS**

The information was structured by differentiating working spaces per each unit within the platform. We used section labels in such a way to facilitate a natural interaction. There were eight virtual sections distributed in a tool bar:

1. **Home:** In this section students find general information about the diploma.
2. **My courses:** In this section there is information about the courses and working modules. Students can access to the modules, working units, grades, and a chat.
3. **Virtual news:** This space was created to satisfy communication and spare time activities such as news, chat, humor, and forum.
4. **Agenda:** Tool for getting information about homework and academic activities.
5. **Students:** List of students, pictures and key information to get a full identification of all students.
6. **Editing room:** Working tool to design, construct, and exchange course works collaboratively.
7. **Contact:** A form to send questions, comments, and suggestions.
8. **Help:** This section describes the main virtual working environments designed in the platform.

**Home:** This is the first screen of the system and presents the main information of the diploma and can be enriched with documents that are progressively Publisher (see Figure 3).

![Figure 3. Home](http://example.com/home.png)
My courses: In this section the learners can find all information about courses and working modules. Learners can access to working modules, working units and course grades (see Figure 4, 5 y 6).
**Agenda:** A tool to manage homeworks, assignments, and duties (see Figure 7).

![Figure 7. Agenda](image)

**Virtual news:** This virtual environment has been designed to support communication and recreation needs. It includes sections such as announcements, chats, humor, news, and games (see Figure 8). Learners can talk to each other, publish announcements, laugh in the humor section, and start conversations in the dialog room.

![Figure 8. Virtual News](image)

**Editing room:** A tool to design, construct, and deliver learning products (see Figure 9).

![Figure 9. Editing room](image)

**RESULTS**

We present the results obtained after applying questionnaires and opinion polls to the students during and after the courses. We implemented three evaluations: 1. After the first course was finished, 2. After the third course, and 3. At the end of the first face-to-face module.

The main questionnaire covered the following areas: General aspects of the courses, working environments, tools to work and communicate, academic aspects, technical and academic assistance. We used a grading scale from 1 to 7, similar to the one used in the Chilean educational system. We identify four concepts (Deficient: 1 to 3.9, Regular: 4.0 a 4.9, Good: 5.0 a 5.9, Very Good: 6.0 a 7.0).

**General aspects:** This variable included the access to information, structure of the site, and quality of the information available in the Web site of the course (see Figure 10).

![Figure 10. Opinions about general aspects of the course](image)

Students found that information accessibility, site structure and information quality were very good. They attained the academic expectations, the interfaces were well understood,
navigability, materials, tutors. Results such as accessibility and site structure are explained because the LMS design an intuitive and easy to use by connecting to the previous navigating experiences of users. This allows minimizing the learning steps involved in learning how to use the system. The quality of information was highly ranked because besides to the Web site students had a book companion that was highly valued by learners.

**Virtual working environments:** Students evaluated each section of the virtual environment: My courses, virtual news, agenda, contact, and help (see Figure 11).

![Figure 11. Opinions about the Virtual Working Environments](image)

Students considered of very good quality the working tools implemented. Virtual news has the lower average. This can be explained because this was the first time students were involved in an e-Learning course and this section works as a function of the interests and motivations of students who in the beginning were not very interactive with few informal discussions due to the lack of available time and shyness. This evidences the complexity of managing interaction between people in a public virtual environment. To ameliorate this problem diverse strategy should be used at the very beginning of the program in order to foster interaction, communication, and collaboration.

Our experience in implementing distance programs by using a LMS make us to highlight the relevance of certain e-Learning tools. A system to record entrance, navigation and participation is very useful to identify behavior and navigation patterns to better know the learners needs and learning styles. In this experience we did not have such a tool, and then we could not use these data to enrich our evaluation.

**Working tools:** The platform includes a set of tools to support diverse academic activities that were evaluated by the students: Dialogue room, online communication, editing room, and mail (Figure 12).

![Figure 12. Opinions about the working tools](image)

There are main differences between the evaluations of the four tools made by the students. Forums and mail were best evaluated. Chat and editing room got low evaluations. This can be due to the fact that these are basic tools not technically sophisticated with low functionality. Students tended to compare these tools with existing tools such as messenger systems and word processing software.

When we use tools that reproduce functionalities that users already have without adding a new value, they tend to compare both tools and use the most intuitive that fir better their mental models. The idea is to reuse them as accessory tools to the LMS used.

One key variable to be considered in a learning experience is the learner’s attention and motivation for learning. Many times we identify them through participation and the fulfillment of academic assignments. When we implement a year academic program this variable is very critical and makes designers to actively pose diverse challenges and tasks to involved learners emotionally and psychologically in the learning activities. This is why a Learning Management System should include a variety of learning resources such as forum, glossaries, Wiki, Chat, and videoconference.

**Academic aspects:** We determined five indicators to visualize the perception and opinions in relation of academic aspects of the program: Activities, directions, learning materials, methodology, and evaluation (see Figure 13).

![Figure 13. Opinions about academic aspects of the program](image)
Students evaluated as very good academic aspects such as activities, directions, materials, methodology, and evaluation. We believe that these results are explained by attaining a clear working sequence with simple and intuitive of presenting the activities. This made easy to understand of requested tasks and what they have to do. The course book helped a great deal because it covers most content of the diploma. We think that this result support the validity of the implemented pedagogical model.

The importance of learning and the utility of the learning products required in the sessions and working units are very relevant in adult learning. This can be implemented through creating publishing spaces in the platform or even in the Web portal for the virtual campus. In our experience we did this by publishing at the end of each week learning unit the best learners papers. This was not only a motivation to the selected learners but also other learners considered these papers as studying material to prepare the final evaluation.

**Technical assistance:** This item was thought to get information about the technical assistance of the whole e-Learning program to solve functioning issues of the platform (see Figure 14).

As we can see all evaluated aspects of the technical assistance were considered very good. This is a very important variable for the student motivation. When students don’t have enough technical support they tend to be frustrated and abandon the program. They need to be supported specially when they are novice in e-Learning. To get this result we had people dedicated to monitor, assist, and support students by giving permanent feedback and answering questions and requirements in a short period of time. Email system was the most commonly used communicated channel used by the students to ask for technical and academic support. The fact that we had users with basic knowledge about information technologies allows minimizing questions and technical problems. We gave them fast and permanent feedback avoiding learner’s frustration and loosing motivation that may end up with desertion.

**Academic support:** Academic support was very important to get a good quality diploma as we used to do in our regular face-to-face diploma. We did not want to loose quality because of the change in the way we deliver courses (see Figure 15).

All aspects concerning academic support were highly evaluated. Students highlighted the quality of answers, revisions of activities, and evaluations. Even though students mentioned academic demands many times exceeded the time available, it helped them to be more concerned about the course of action of the diploma, concluding that higher academic demands obligated them to higher compromise with the program and studies.

Most e-Learning courses deliver directions only through text. In doing so there is a risk of learners misunderstanding the assigned activities and tasks. For this reason it is critical to follow up the learners actions.

**KNOWLEDGE CONSTRUCTION THROUGH VIRTUAL INTERACTION**

We based our observation on knowledge construction when learners were interacting within the Virtual Dialog Classroom. There two processes can occur: Presenting and Comparing. Presenting involves posing an opinion, comment, information or knowledge. Comparing includes contrasting beliefs and personal known knowledge with other learners by verifying agreements and disagreements.

This implies three other processes: Falsifying, complementing, and discovering. Falsifying implies to assign falsity or error to a comment or judgments as a result of disappointing with a belief, comment or knowledge idea. Complementing means that we agree with the comment and accept it as a truth but we believe that it is incomplete. Discovering is new knowledge for learning or new ways of viewing a known knowledge. These processes are grouped within the most general process of comparing and can be externalized or just mentally processed without making explicit them.

The idea with our study was to go further of just presenting information. We foster discussions where personal known knowledge is proof tested because of the collective interaction ending with a collaborative social knowledge construction. If we wish to evaluate these processes as triggers for meaningful learning we observed a direct relationship between previous knowledge and the quality of the construction of knowledge. Thus the more knowledge a teacher may have on a specific
topic the more probability of falsifying. This is very relevant when assigning a role to content and support materials for the Virtual Dialog Classroom.

CONCLUSIONS
The main goal of this study was to develop a model for e-Learning and test it with a group of teachers by using modern learning theories and principles that better fit e-Learning. Some of the premises of our design were the enormous potential of collaborative work and virtual interaction in e-Learning as it is mentioned in the literature. However we have found that these learning strategies are not tacit and even though they can facilitate learning they can also impede it. To help to facilitate learning there are some strategies such as teachers sharing their interests in teams and to maintain permanent non formal communication during the course work. They favor confidence among students and group interaction around academic tasks.

One of the key aspects to facilitate collaboration was solving tasks involving educational problems. Teacher could discuss themes based on their everyday experience by connecting theory and practice, and, taking into consideration the teacher’s knowledge. A balanced mixture between individual and collaborative strategies is also recommended. e-Learning programs should exploit the unique capabilities and added value of Internet as a communication medium by going further than just student-teacher communication and emphasizing group work among students. Thus some constructivist theories and principles can be embedded into virtual environments to promote active learning and knowledge construction.

We have presented an e-Learning model and describe the design, implementation, and evaluation of a training program for school teachers. We analyze the teacher’s construction of knowledge by reflecting on teaching and learning. Through interacting and communicating we have developed electronic communities around pedagogical content. We believe that this experience reflects a way of knowledge construction from teachers that is not exclusive to e-Learning; rather it can be used in a meaningful way during everyday pedagogical practices in the school.

The academic diploma we implemented is blended learning. We train teachers in the use and integration of information and communication technologies into curriculum both virtually and face-to-face. We have developed and tested a pedagogical model of e-Learning that proved to fit well with the Learning Management System used. Our general course design was also tested in real everyday learning situations with real teachers from different contexts. Many of teachers connected to our site to follow classes and interact with other classmates from their schools and homes.

We identified some key aspects to implement e-Learning course for teachers. The time of the experience is very important. E-Learning courses such as the one we are presenting here should concentrate in time when teachers work load is not high. The time dedicated by the student to the course is a key to maintain them in the class. The role played by facilitators is very important to foster participation and knowledge construction. The Learning Management System used can determine the type of activities to be implemented but not necessarily the learning model involved. The follow up strategy is also relevant to the e-Learning experience. Facilitators and administrators should have tools to visualize learner’s action within the virtual environment. We also think that the time period dedicated to tutoring and coordinating can determine the quality of the learning experience in online courses. This means time for solving problems, follow up, and to create a working climate to motivate students to actively participate in the learning process.

As a consequence of this study we have gotten some field experience in delivering e-Learning courses for teachers. Contrasting the design in everyday situations gave us important information and learning that is not currently analyzed in the literature and may determine the success of an e-Learning program. The online support through virtual communication tools helped students to feel they were being permanently assisted and thus making them more engaged in the course activities. To design weekly learning activities allowed constructing a working rhythm that help students to be constantly connected to the course activities.

One of the aspects that took more time to implement was online discussions. Due to the fact that they did not know each other the interaction at the beginning was just isolated forums avoiding debate and discussions. We did implement some strategies to make them to know each other such as the virtual news and picture publishing. Little by little they started to interact to each other ending with a very good level of discussion that helped them to make collective constructions in each course.

Students valued more printed materials such as the books used than the exclusive use of digital material such as Web sites and documents. Apparently the use of these materials gave them more reliability and control over the content.

Virtual interaction in e-Learning systems is not naturally mapped in terms of learning. It is needed a carefully designed interaction to foster participation, use of documents and collective construction. Users worried a lot about security and privacy provided by the Learning Managing System and the Web site when they interacted in personal sessions. They value highly personal virtual spaces to discuss and maintain documents such as the editing room. The results are giving us enough data to improve some technical problems of our Web site to motivate and support actively the learning activities. We identify that any technical issue during courses impact heavily
on attitudes, motivation, and interests of learners. Thus the learning model should be implemented with proven virtual learning tools to assure a successful learning experience. New virtual working tools in a LMS should be carefully considered in order to avoid damaging the implementation of the whole learning model. They should be used only if they serve to the main objectives of the e-Learning program.

Finally, a strategy that helped to facilitate collaboration among learners was to work in solving real educational problems where learners can discuss based on their experience, connecting theory and practice and valuing their knowledge and accumulated experience as it is suggested by the andragogy theory.

REFERENCES