Distance Learning: Teaching Probability and Statistics to Petroquimical Engineering Students

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Abstract — *In this article we present some considerations about distance teaching especially about teaching probability and statistics to petroquimical engineering students. This is an entirely new experience been conducted by EAD/PUCRS (Distance Learning Division of Pontifical University Catholic of Rio Grande do Sul - Brazil). The teaching is made using a mix of web-based teaching resources and videoconferencing. This course is the first undergraduate course in the country running completely at distance. We had some experiences in the graduate level, but at undergraduate this course is a pioneer.*

Index Terms — *Distance learning, teaching probability, teaching statistics, videoconferencing, web-based teaching*

INTRODUCTION

The purpose of this article is to relate the experience of teaching statistics and probability to chemical engineering students (with an emphasis on petrochemistry in the distance learning courses). The same contents are found in both the distance learning course and the current version being taught at the university. The difference is found in the number of credits. While in the current version there are six weekly meetings of two hours class each, in the distance-learning version there are only two weekly meetings of two hours each. In addition, one of these meetings of the distance-learning course is used for videotaping the class and the other for distance teaching coaching.

THE HISTORY OF VIRTUAL PUC

The undergraduate and graduate teaching at PUC has always been set towards the face-to-face classroom. As communication systems evolved and the university acquired infrastructure in this area, it realized that it was necessary to meet external educational demands. Thus, in order to make way with its virtual project some strategic decisions had to be made.

When it was decided that the broadcast topology (1) would be via satellite, the university aimed at offering courses anywhere and at anytime. The first important decision made was that there should be a nationwide communication system. The Internet and the telephony**,** due to costs and /or technical difficulties**,** gave way to satellite communication systems. The use of a satellite not only met the goal of a nationwide coverage, but also significantly reduced educational costs, making it more accessible.

The problem of proximity was another relevant aspect considered. The solution adopted foresees, an educational process that is distant but one in which the teacher is in virtual contact with the student. Available pedagogical resources, participation and interactive teaching make this possible.

Unlike the present method, distance learning has been structured so that it is available to the student 24 hours a day, a characteristic that may seem paradoxical [05]. This allows for constant contact with the student, be it through the teacher during the taping of the class, through contact with tutors (post graduate students), through monitor, or even through the virtual (email, chat) infrastructure.

THE FRAMEWORK

The structure of distance learning at Virtual PUCRS (2) consists of physical resources (facilities), telecommunication resources (Internet, satellite and telephony), support structures (teachers, tutors and monitors), communication and control software (WebCT™, Excel™, PowerPoint, ™ VTEL™), and the number of courses being offered.

Facilities

The distance learning courses at PUCRS, also known as Virtual PUCRS, have been running for four years with a structure which covers approximately 1000 square meters, where the monitoring and creation of EAD programs take place. The classes are created in four classrooms (located on the ninth floor of building 40 of the central campus, situated in Porto Alegre, RGS, Brazil). Two of the classrooms fit approximately 20 to 40 students (3) and the other two are micro studios, which do not fit any students, but the teacher and one operator. The classrooms are similar to television studios and they have been prepared with acoustic treatment, lighting and the appropriate scenery in order to guarantee that the broadcasting of the class has the best audio and video quality possible.

The two broadcasting rooms have strategically placed microphones so that the students at distant points can hear the colleagues in the generation room. In addition, they are equipped with four TV monitors of 29". Two of these monitors are placed in front of the teacher, next to the camera, and the other two are placed opposite to those. The monitors placed in front of the teacher help him see his own image and also allows him to receive the images from other distant learning centers. The other two monitors have the same function but for the operator.

Virtual PUCRS has reception points spread through the main cities in the country, being that the majority of them are located in the states of Rio Grande do Sul, Paraná and Santa Catarina (the tree south most states in the country). More than 3500 students from 300 different cities take classes through the university's distance learning program. In the state of Rio Grande do Sul, there are almost 20 teleconference rooms and four videoconference rooms. If one adds all the southern states the total is of approximately 50 classrooms, including Brasília (the country capital city).

Telematic Resources

The communication system uses different protocols (satellite, internet, telephony) through a structure consisting of integrated media and covering the whole national territory. The main media used are the videoconference (broadcasting), which are mediated by satellite.

During the videoconference, information is generated at PUCRS Virtual Center and transmitted by satellite (Brasilsat B-3/Embratel) at a speed of 256kbps. The students and teachers can, in real time, see and hear other teachers and students of more distant areas, who have equivalent equipment available. During teleconferences, the signal is generated and transmitted nationwide by the same satellite, only in its TV Digital version, with a 2,5 MHz band. This allows the student to see the teacher in real time and clear any doubts he or she might have through audio and telephony (0800 - at no cost to the students). In both cases the Internet and the World Wide Web integrated support are available.

The university is making the Digidial system available through Embratel (nationwide long distance telephony operator) so as to broaden and open the videoconference net of PUCRS Virtual. This technology is a communication service (no voice) that can be added to telephony allowing to dial directly from the computer to the PBX-system phone. The Digidial can be used for videoconferences (up to six channels), facsimile, digitalized voice and CAD/CAM/CAE solutions. Videoconferences of transmission rates varying between 64 to 384 kbits are also made possible with this service. Furthermore, it can allow for voice-activated communication through a 64 kbit/s circuit, with no compression. It can be directly installed from the PABX, which is connected to an Embratel telephone central through a transmission mean of 2 Mbit/s. During videoconferences and teleconferences, the service will use Datasat Plus and RTV Digital Plus technology, respectively.

The Courses

Having all of its courses approved by the National Board of Education, the university is broadening its course offerings though the levels of Specialization and MBA. In its fourth year running, the program is offering, in 2003, courses such as an MBA in Hospital Management and Specialization in Agribusiness, Public Management, Educational Orientation, Child Education, and Energy Efficiency. It is also offering others courses such as Community Journalism, Market Research, Management Assessment in Energy Efficiency, as well as the courses that had already been offered in 2002 [06].

In its third year running, the graduate course of Chemical Engineering could receive this year a new graduate course in First Grades Education, which will take place in partnership with the Education Secretariat, looking at fulfilling the legal issues mentioned in the law concerned with Educational matters.

Informatics Structure

Besides having the computers running windows 2000 and XP, servers running Unix and the VTEL software by the American VTEL company for the generation of video and teleconferences, the university has also opted for he use of the WebCT3

program, in order to control and manage the distance learning courses. The decision of using this program is left up to the teacher. The VTEL platform consists of a videoconference camera, which not only captures the image of the teacher, but it can also capture the image of a computer being used by the teacher. Thus, this resource makes it possible to balance out the image of the teacher and the computational resources. The teacher can then present PowerPoint slides, computations using spreadsheets, texts of a word processor and any other result from applications that the teacher chooses to use. Through a control table an operator can make these changes whenever needed, being that the teacher is in charge of the computer. It is possible to present an image of a computer and the image of the teacher (a small image on the corner of the screen - Picture In Picture - PIP system), but in this case the operator needs to be in charge of the computer not the teacher.

Another resource of this platform is the document camera, which can be used to present illustrations, texts, figures from books, and even to perform manual calculations. Finally, there is also a digital board in which the teacher can write with a special pen and it can be directly captured by the camera.

The WebCT, which is basically the manager of the students' virtual life, is not part of the hardware of the platform. Everything that is done through it gets registered in the system. Besides that, it controls e-mail, discussion group, chat rooms, the forum and it can also manage and make available the access to web pages. The coordination mechanisms include: news, information about the course or scheduling of events, as well as tasks, assessments, reports (participation activities), and examinations also is possible through it. The cooperation mechanisms provide the means for a joint action between teacher-student and student-student, as well as services such as the Digital library. Thus, a cooperative learning structure is formed [07].

The pedagogical Framework

The main factors considered in choosing the satellite platform were: accessibility, and connectivity. The accessibility is the property to reach (connect) the student at any place. The connectivity is the possibility to address people and places considering the huge dimensions of the potential territory included and the conditions of the data network of the country.

Videoconference and teleconferences were the options chosen because the Internet today is only one possibility of high quality and high speed signal transmission (audio and video), that is, in a continuous and stable manner. Thus, PUCRS decided that this was the most adequate means of communication, since in the case of videoconference the teacher can communicate with the students and vice-versa, as though they were all in the same classroom.

In the present way of teaching, the media is the teacher. The student usually receives only a lecture. Student and teacher rarely communicate once the class has finished. In the case of distance learning the contact with the teacher is more frequent and it takes place through telephony and e-mail. The student can also count on the virtual version of teacher's lecture and resources such as hypertext-formatted contents, which are almost inexistent in a normal classroom.

Every course can count on the support of a central library, digitally accessed through the Internet, with an international database of papers made available through the Portal of the governmental Capes agency. This database is only accessible to the universities that have high quality doctorate programs.

TEACHER TRAINING

Some may consider distance learning as a relatively simple task since they assume that the classes taught at school are simply transferred to the technological apparatus available. However, that is not the case as one soon notices when faced with the first contacts with the new medium. One usually leaves the first recordings with an empty feeling. The teacher can no longer rely on the quick reaction of the student sitting in the first row. He can no longer pause in order to give the content a more dramatic effect. Silence is death in a virtual classroom. Spaces need to be completely filled. Thus, the content, which would usually be taught in one week, can now be taped in an hour and a half or two. It is not easy getting used to talking to an indifferent camera instead of speaking to a crowd of thinking heads. Putting a class in an synchronous mode is very different than one planned for the asynchronous mode. Even the class that is being broadcasted live needs to be thought about and designed in order to last, to be of use to those students who cannot watch it at that exact moment. Thus, the resulting medium (Tape or CD-Rom) needs to naturally flow without interruptions, without empty spaces and, preferably, without mistakes because rarely is the editing of a tape done due to the costs and the time consumed. Furthermore, the teacher would need to be present in order to reedit the tape, cut and add, which is usually unavoidable. The class has to flow as a live performance and not as a performance that is taped to be broadcasted later, even if it were possible.

For these reasons, teacher training at EAD is considered a vital strategy by the institution and for the success of the virtual modality. The nature of EAD implies not only control of the technical operation, but also of its pedagogical assumptions. There is a need to be certain that the media, the means, or the equipment used can transmit the nature of

learning, which is sharing knowledge in order to build new relationships and connect with previous knowledge. The structure needs to be provided to allow the student to notice that he or she is indeed in familiar terrain [03].

The teacher training courses try to make the teacher live the experience, even if for a short period of time, of using the new media. One important change is the manner of presenting the content, which now needs be hypermedia, that is, in a hypertext format in addition to other media besides the text. It is a radical change for those who have mostly used the board and a structured and linear book. Thus, I can say with certainty that in order to be successful in his or her new environment, the teacher needs to have a previous hyper textual experience, since the appropriation of a new medium will not happen suddenly or without difficulties.

Teacher training is a volunteering program. Teachers are not obliged to get involved with distance learning unless they want to. This may be the most positive point. If the teacher does not have all the abilities necessary, he or she will at least have the curiosity and willingness to learn them. We know that in order to do anything well one needs not only know how to do it, but also want to do it. Teacher training takes place through advising, workshops and lab classes.

The advising presents the following goals:

- Planning of various leaning environments
- Organization and set up course and personal sites
- Forecast of resources and services and
- Organization of individual and collective activities.

This activity is developed throughout the course, thought scheduled meetings with an advising professor from the EAD and directed at meeting the demands of students and teachers, as well as the various needs of different courses in distance learning [09].

Another type of training is offered through workshops, which consist of independent modules that intend to develop competencies in the use of synchronous and asynchronous resources. Among the asynchronous resources are the basic knowledge and control of some software (Word™, Excel™ and PowerPoint™), the appropriation of hypermedia knowledge, the control of the WebCT™ course manager, the presentation in html and knowledge of the FrontPage™ software. The synchronous resources include television classes in which the teacher perform some activities and critically analyze the results. First, one can place himself/ herself as a teacher taping some activities to keep track of time, which is very different from a normal classroom. Then, one can place himself/herself as a student, on the other side of the screen, to see, discuss and constructively criticize the performance of his or her colleagues. The modules are developed as workshops so that teachers can choose which ones they need to attend.

The lab classes have as a goal to solidify the metacognition processes about the presuppositions of virtual learning. They are developed through theoretical and practical actions with an analysis of pertinent topics, acquisition of philosophical and sociopedagogical presuppositions that are part of the EAD.

THE COURSE

There isn't a set format to teach Statistics and Probability in an usual classroom, much less in a distance learning format. Traditional teaching, as a rule, is done through lecture, where the teacher usually fills the board, answers or clears some more obscure points and the student merely copies what is on the board, while the most courageous ones venture to ask a question or two [10].

Obviously, if the teacher does not make an effort to modernize, that is, become conscious of the existence of new means of displaying information, he will tend to teach through the new medium much the same way, changing only the audience and resources. Instead of having dozens of heads lowered copying the board he/she will have an indifferent camera.

One of the great advantages of traditional teaching is the possibility of dialogue, face-to-face interaction. While that can happen to some teachers, it isn't usually the case in math classes at our universities. Especially when in order to ask even the most simple of questions in front of a group the student must have understood the content or at least have read it from the previous class. How many students show this sort of behavior? Some could even show interest, but how many teachers have a chronogram or an organized bibliography to discuss with the students?

What we are trying to say is that in order for a teacher to change his or her attitude towards distance learning he or she needs to already have a similar attitude during traditional teaching**.** He must not be a traditional teacher whose only means of teaching are the board and lectures. The adaptation and modernization process is slow and in increments. Nobody will become an efficient virtual communicator overnight. First of all, one needs to be willing to change and learn. Most importantly, one needs to persevere because the technology is still precarious and most of the equipment is still in their baby stage, requiring much work and ability in order to increase learning productivity.

Managing The Course

The distance learning course at Virtual PUCRS is managed with the help of WebCT™. The use of this resource is left up to the teacher. However, it has been proved to be very useful because it can provide all the navigation statistics of the students. Besides the material available through WebCT, the students could also count on the facilities of the traditional course, which has received special treatment to accommodate the material for the distance-learning course. The WebCT™ was mostly used for email control, chat and hypertext formatted material. A link located inside the resource (04) makes it possible to get to the site of the face-to-face course, which had already been using Internet resources to distribute material to the students. In order not to create a specific alternative for these students, they could search for material much the same way as the students in the traditional course**.**

The Structure

The course was formatted in the "in company" mode, that is, it was a specific course created to give an engineering background to current business operators. It started with 28 enrolled students. Thirty to fourty percent of class hours are given through teleconference or videoconference. For legal reasons, 25 percent of the classes need to be face to face**.** The rest is taught through Internet support. Assessment is part of the presence classes and takes place at the Virtual PUCRS facility [01].

According to [06], the courses and projects from EAD/PUCRS present differentiated levels in its actions. It is said, for example that "in the course of chemical engineering a certain difficulty is noticed implementing the on-line proposal, due to attach to traditional method, even when done through distance learning".

The statistics and probability course is taught on the fifth semester, which allows students to have acquired the basic knowledge regarding content and distance learning. A good deal of the presupposed knowledge of traditional learning has been eliminated or attenuated and the insertion of students in the new modality facilitated the work and student-teacher relationship.

The Student

The students of the course consist of professionals from a Petrochemical Company called OPP, who have a diverse practical experience. Many of them had been away from school for quite some time, being that the majority had stopped studying after completing high school. Some students had had prior enrollment in engineering courses but gave up due to incompatibility of schedules. The reason for choosing this method of learning was the employees' work schedules [04]. They usually have irregular shifts, which would make it difficult for an employee to meet the requirements of a traditional course.

The computational background of the students was heterogeneous but usually better than most of the students from the face-to-face course. This helps the development of the course since a great deal of the content is developed through the spreadsheet Excel™. The most important factor contributing for the good development of the course was that it was administered during the fifth semester. This allowed students to have acquired a solid knowledge of EAD (having fulfilled all pre-requisites such as Calculus I), which in turn facilitated the process.

The Discipline

The course is taught during the fifth semester and it was administered in the second semester of 2002 for the first time. The contents are exactly the same as those from the face-to-face course. The only difference is that the virtual course offers four credits, while the other one offers six credits. The content includes basic univariate statistics (descriptive, sampling estimates, parametric hypothesis testing), univariate probability and some bivariate statistics (correlation and regression) [10].

The content is extremely comprehensive for a six-credit course and it gets even more complicated when taught in a course of only four credits in a distance learning modality. Talking about hours in a distance course is theorizing since what the student really needs to do is to acquire the content. Nevertheless, the number of hours or credits is maintained due to legal requisites and to keep a parallel with the traditional course. Actually, the mode used consisted of two hours a week for the taping of teleconferences and two hours a week destined to assisted learning.

Support Material

Besides the videoconferences lessons (lesson which these students received in CD since the company did not place a point of satellite reception), the students could count on material in pdf and xls format. The first material in pdf format is a collection of class notes including the following contents: descriptive statistics, probability, sampling and estimate, parametric

hypothesis testing, correlation and regression. The goal of this material is to detail the content of the videoconferences through structured (sequential) contents.

The hypertext-formatted material is available through WebCT™ and it is only accessible to students enrolled in the distance-learning course, while the rest of the material is public (available in the Internet). There is also material available in PowerPoint slide format, which have been used in the videoconferences and the traditional classes. These slides, approximately a thousand of them, are used to give an overview of the course and present it structured and in context. It presents different examples from those found in the class notes. Another type of material (pdf format) is formed by the slides in groups of six. This way of presenting material was suggested by a student who liked to make notes on slides but who thought it was too expensive to print all of the slides. Thus, the content of 'Descriptive Statistics', which consists of approximately 200 slides, is presented in 35 pages, saving money and keeping its clarity.

The last type of material used consists of spreadsheets carefully planned to reinforce the contents, which were presented in conferences, in a laboratory. These files include the six basic areas taught in the course. Through this material the student can practice what he learned in exercises that simulate problems of real data. From the 16 conferences (CDs) recorded, four are dedicated to lab work. On the whole, there were approximately 20 studio hours recorded and seven gigas of mpeg files.

CONCLUSION

Initially, the experience of undergraduate distance learning encountered some problems. It would be surprising if there hadn't been some difficulties being that it was such a pioneering initiative. The faculty as well as the student body did not have a deep enough experience with this type of teaching and learning. However, throughout the course a new mindset was established among the faculty and the students, reflecting on their behavior. Once the students and teachers became more conscious of the new medium things became more structured, and the chronograms, which were always late, eventually went back to normalcy. Nowadays, the course practically follows the same deadlines and chronograms of traditional teaching.

As far as the experience of teaching a course that involves mathematics (probability) and applied mathematics (statistics), it can be said to have been very productive. The students were successful and the course proved that without prior preparation, specially involving content and the necessary material tailored to the new medium, it is not worth taking the risk since the probability of being unsuccessful is very high.

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FIGURES AND TABLES

FIGURE 1
PUCRS VIRTUAL VIDEOCONFERENCE TOPOLOGIE

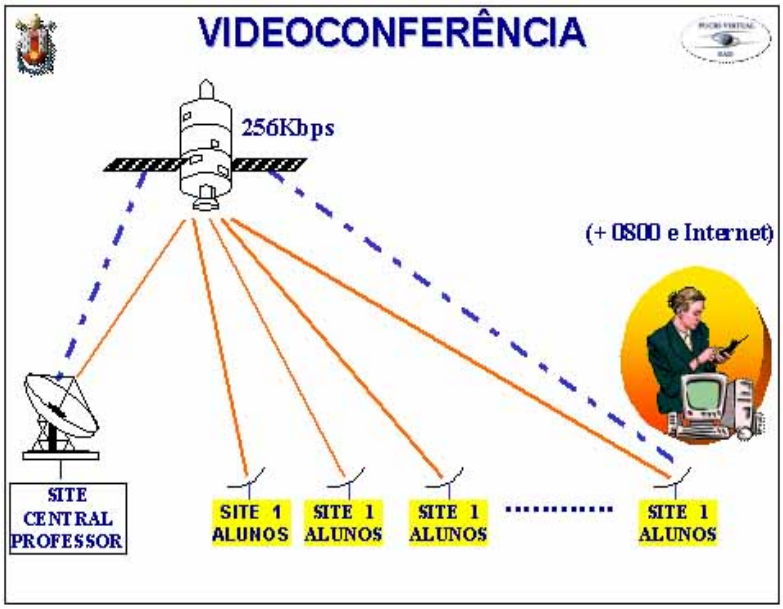

FIGURE 2
PUCRS VIRTUAL DISTANCE LEARNING PAGE

FIGURE 3
PUCRS VIRTUAL VIDEOCONFERENCING GENERATION ROOM

FIGURE 4
THE WEBCT COURSE