USING REMOTE LAB NETWORK TO PROVIDE SUPPORT TO PUBLIC SECONDARY SCHOOL EDUCATION LEVEL

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ABSTRACT

The advantages of networking are widely known in many areas (from business to personal ones). One particular area where networks have also proved their benefits is education. Taking the secondary school education level into account, some successful cases can be found in literature. In this paper we describe a particular remote lab network supporting physical experiments accessible to students of institutions geographically separated. The network architecture and application examples of using some of the available remote experiments are illustrated in detail.

KEYWORDS

Remote Lab, education, e-learning, remote experimentation.

1. INTRODUCTION

The Remote Experimentation Laboratory (RExLab) concept encompasses the access to resources to those who do not actually detain them. It is widely known the critical role that lab activities play in the formation of students, in particular in courses from the natural sciences area. In this context, RExLab represents a form for sharing resources, allowing costs savings for adhering educational institutions, besides contributing to student empowerment. The Brazilian Government is implementing a project named "One Student - One Computer" that aims to distribute laptops for all public school students, thus contributing for the digital inclusion of those youngsters.

This work presents remote experimentation as a support tool for teaching-learning environments meant for compulsory education (according to MEC, compulsory education includes infantile, fundamental and secondary levels), under the assumption that such a tool will contribute to leverage the outcomes of presently used educational models. RExLab is characterized as a computer-mediated reality. Similarly to a traditional "hands-on" lab, it requires physical devices and a host space. However and in contrast to a traditional lab, experiments and users are geographically distant. RExLab may help students to perceive real world phenomena, in the areas of natural sciences and engineering, where lab activities play a crucial role in education. It also allows resource sharing, contributing to costs savings in Institutions of Higher Education (IHEs), while also enriching the students educational experience. The proposal of using remote experimentation seeks to increase the students possibilities to carry out practical type activities, from any computer connected to the Internet, either from their homes or from computer classrooms located at their institutions. One of the most positive characteristics of remote experimentation is the ability to provide students, living faraway from the IES where they are enrolled in, with the opportunity to participate in lab classes as in this scenario students and lab equipment no longer need to be physically close to. Furthermore, students may conduct real experiments in remote labs offered by other IES (apart from their own), a possibility that increases the flexibility of running courses, besides diminishing the associated costs. It is also expected that the concurring opportunity to conduct real experiments through remote labs, in parallel with

hands-on labs, promotes the quality of the educational process and potentially increases the learning results. In this overall context, it is possible to list the following points as positive factors towards the implementation of our project (i.e. a remote experimentation lab):

- The growing number of students enrolling in the Brazilian network of public schools.
- The growing number of computer resources available in public schools, with (large bandwidth) Internet access.
- The reduced number of laboratories (or lab resources) available for practical classes on those same schools. Notice that we believe our project will contribute to the acquisition of lab competences by students, given the resemblance of remote experimentation labs with real hands-on labs.
- The creation of collaborative teachinglearning environments. In our project, we have used the Moodle platform.

2. REXLAB AS AN ALTERNATIVE

The RExLab concept is related to the three domains established in Bloom's taxonomy: cognitive, emotional and psychomotor. It is also a logistic challenge that requires some ability and knowledge to deal with. In fact, synchronizing a large number of small student groups, requiring one (or more) hour(s) of continuous access to the RExLab, while accounting for lab tutoring facilities, is a quite a challenge, which may present significative costs. This sort of situation is a continuous challenge for those IES willing to offer alternative lab resources (like RExLab) to the general educational community.Enter the text here. There are good reasons towards the offering and utilization of RExLabs. A first one is to tackle situations where no other alternative is possible, i.e. real hands-on activities. A second one, among many others, is the reinforcement of the teaching-learning process. Regarding the first mentioned reason, it is possible to point out the growing number of students enrolled in e-learning or distance/computer delivered courses, where the access to traditional hands-on labs is not always possible. In this situation, RExLab provides a valid solution for such students needing to conduct practical work. Another example, is the opportunity (perhaps one of the most important ones) for sharing lab resources among different institutions.

The second referred reason (reinforcement of the teaching-learning process) has not been explored indepth in current literature about on-line labs. There are many papers regarding the technological aspects of on-line labs but few about the quality improvement in the teaching-learning process, i.e. their educational value. It is clear from the consulted literature that online labs have been evaluated as an alternative to hands-on labs, while pursuing the same learning outcomes. However there is few research work about how remote labs can be used to increase the learning outcomes. As the use of RExLabs is becoming more popular and widespread (due to technological improvements), they constitute a parallel training route to hands-on labs. In this sense it is important to question about: what is the impact, of using online labs, in the teaching-learning process of students also using hands-on labs.

3. REXLAB IN EDUCATION

Presently, there is an all range of e-services offered as educational alternatives. Among those e-services are: information storage and distributing platforms, knowledge management systems, educational platforms, collaborative work environments, remote access to electronic and computer systems, etc. In the two last ones, there are reported cases of collaborative environments associated with remote labs. These environments seek to promote the same type of actions that exist in a traditional lab, where students interact while doing a certain experiment, according to a give lab script. Those environments also allow the students of a given group to better organize their time, according to their own affairs and not to the physical lab schedule. Traditional labs present other problems like the necessity to maintain and update the lab equipment, in particular due to erroneous use made by freshmen. This practice is however fundamental in students of natural sciences and engineering, namely to sediment the learnt theoretical concepts. Given the restrictions presented by traditional labs, the use of a REXLab allows to:

- Increment the number (and/or duration) of lab activities in a given course (the students may carry out those activities without teacher support and without displacing themselves to the traditional lab);

- Reduce lab management and maintenance costs (by reducing the number of staff allocated to the lab);
- Enable lab access from any place, thus reducing or minimizing displacement costs. Access by students from different time zones (in a scenario of international collaborative work) is also facilitated;
- Integrate, in one single environment, practical applications, remote and virtual experiments, and other educational activities, depending on the integration possibilities of educational materials, simulation tools, and remote access to physical lab equipment and devices.

Courses delivered in an e-learning modality and at the same time requiring lab activities are therefore a natural target for a remote experimentation lab, as they often require the typical student (one that lives far from the educational centre) to stay a one or twoweeks period in a residencial hall for carrying out those activities. The non-presential component of traditional courses should also be considered, i.e. many courses require a number of hours related to offclass study, resolution of "paper and pencil" exercises, and the conduction of simulated experiences. Considering these two situations, the development of online labs has received a strong boost, from the early 90's, being now possible to find implementation cases in large large educational centres like the MIT, in the USA, and the University of Siena, in Italy, among others.

4.   SCENARIOS FOR USING ONLINE LABS

An applicable scenario for a RExLab is within courses delivered in distance education. In these scenario students are able to carry out practical experiments from their homes or workplaces. This sitution is encompassed by on going efforts to reproduce in the distant learning modality the same conditions present at university classrooms. Given the facility to develop online tutorials or to convert educational materials into a web-accessible format, it is perceived the greater difficulty in creating a larger number of online labs exhibiting the same conditions as traditional labs. However, it is important to recall a critical aspect of experimental work: it is fundamental in any natural sciences or engineering curricula.

Another important scenario for online labs are the so-called "ed-to-ed" applications. In this scenario, students located in one IHE access a RExLab hosted by a second IHE. Although the access is remote, the students are locally grouped so as to facilitate the cooperation/collaboration among them. This situation allows a particular group of IHE to offer their students the possibility to carry out experimental activities in lab environments that are either expensive, require too much preparation time, or are hard to maintain, in an individual basis.

Finally, another most interesting scenario is the possibility to integrate demonstrations of real physical phenomena in traditional theoretical classes of natural sciences and engineering courses. In this situation, a teacher accesses a particular RExLab, during a theoretical class, and shows to the students (using a simple computer connected to a videoprojector and to the Internet) a particular practical demonstration, thus bringing the lab into the classroom.

5.   CHARACTERISTICS OF REMOTE EXPERIMENTS

Lab experiments done with devices and equipment shared through the web (in a remote fashion) present the following evident advantages:
- Accessible by students of distant delivered courses, without time and place restrictions.
- Students may access expensive equipment that could be unavailable in a traditional lab.
- Share lab equipment among universities, in a national or international dimension.
- Facilitated scalability – it is easier to add measurement equipment according to the needs posed by a particular experiment or a larger number of simultaneous accesses.

In an attempt to provide an example of a remote experiment currently made available to the Brazilian public school system, by our RExLab, we present in www.rexlab.unisul.br.

6. REXLAB: A MULTIDISCIPLINARY ENVIRONMENT

An all range of new perpectives is open when considering the use of remote experimentation labs and cooperative/collaborative systems for creating virtual teaching-learning environments. These may be directed to the discovery, practicing, and learning of knowledge, in a situation where class materials, lab experiments, library books, and educational events or actions are available simultaneously, at the student fingertips. Necessarily, it is important to consider the pedagogical aspects associated with the use of such environments. Moreover, if these resources are made available by a group of IHEs or if students from different IHE cooperate/collaborate to achieve a given learning goal, then it is also important to consider the overall dimension of the network of IHEs.

Education may benefit from the use of computer networks. In a general way, it has the potential to reduce the sense of isolation felt by some institutions, particular in rural zones , while allowing both teachers and students to access vast sources of relevant information. This reality allows students separated by several thousands of kms to become "class mates", easing collaboration in joint projects, and also allowing teachers to benefit from information or materials created by other teachers, or researchers, form all over the world. It may be said that provides teachers with better opportunities for enhanced, updated, and continuous training (Adell, 1998). Finally, computer networks also contribute to improve the communication links between a given educational institution and the central education authority, or its surrounding social community.

7. USE OF INFORMATION AND COMMUNICATION

Technology evolution and the high costs associated with some experimental labs difficult the delivery of courses in certain areas, either in a presential or distant delivered modality, as it is onerous to make available a number of workbenches for all students, with up-to-date material and equipment. In this sense, it is more attractive to create a set of remote lab workbenches, connected in a network and able to serve those courses / students. We do not expect remote labs to replace for good real labs, but in any case they will help students to familiarize themselves with the lab equipment, thus being a powerful and helpful auxiliary didactical tool in educational contexts.

We refer the possibility to combine collaborative environments and shareable remote experimentation resources in order to stress their potential for transforming and improving the teaching-learning processes in use, nowadays. The idea is to combine technology with education in the most reasonable way, i.e. in a way favouring the achievement of better and faster learning results by every student that has been given the possibility to use such a blended approach in its education.

Many areas of education require well-equipped labs. Considering the technology evolution pace and the scarcity of resources faced by many educational institutions, some important questions are raised in terms of sustaining a high-quality learning teaching process. For instance, how to provide students with significant and up-to-date lab experiments in a scenario of limited resources and connectivity? The high cost of lab equipment and of communication infrastructures is still an impairment, in particular in developing or less developed countries. As pointed out, a possible solution for this problem is to invest more in communication infrastructures and develop labs that can be shared through that infrastructure. Even if the several labs and potential users are distant thousands of kms (Brazil farmost East point is 4,200 kms distant from its farmost West point), they can still be accessed and shared through the Internet. The important point is that any teaching-learning process where traditional labs can be "replaced" by remote labs, should place the student as the most important element. This is to say that the pedagogical evaluation of such an approach should always be considered as more important than any simple cost evaluation formula. By other words, the educational value of a particular educational technology should always be considered in any cost analysis formula.

8. CONCLUSION

The RExLab concept allows users to access resources they do not have, and it also provides a lab environment that values experimentation as a mean to develop scientific reasoning. The concept described in this paper had a starting point based on technology. Yet, it now goes in a far more distant and valuable

direction, i.e. it proposes the use of remote experimentation as a dissemination and popularization agent for natural sciences and engineering. It is therefore a unique and innovative experience. It does not stop itself in the "virtual" domain but rather proposes students to carry our real physical experiments in order to learn natural science topics in a more interesting and funny manner. These activities are made accessible to all public schools, from fundamental levels, so as to early attract students from younger ages into the study of natural sciences and engineering related courses. The popularization of science and technology is considered an important theme and critical factor for the scientific and technologic development of a number of countries, Brazil included. It is also a fundamental condition for the integration into the digital era.

We believe that our project offers a model, applicable to fundamental level education, where students are invited to develop their own critical view of the real world and of science itself, including the way it progresses. In this sense, it may also be an important factor for stimulating and helping students to structure their own career selection processes, at an early stage of their education.

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