The number of people connected to the Internet and the number of Web page visits have increased exponentially over the past years. The Internet has become one of the most important and most used media for communication and learning, as it allows for the creation of interactive and collaborative environments, whose contents and resources can be shared with a limitless number of users.

Among the vast and diverse number of potential virtual environments (Singhal & Zyda, 1999)—which may involve chats, blogs, forums, virtual communities (Rheingold, 2000), and many others—the Internet also witnessed the design of virtual laboratories as means of making real-world laboratories—for instance: chemical, physical, and biological laboratories—available through the Web.

A virtual laboratory is a tool for distance learning and/or experimentation that allows people to share knowledge, data, voice, video, tools, and many other resources. It provides a suitable environment to extend, improve, integrate, refine, and assist the learning and/or experimentation process of many subjects, thus contributing to an increase of the effectiveness of scientific research and widening the use of scarce or costly equipments.

This special issue emphasizes the use of virtual laboratories as tools for the support of teaching and learning. It starts by discussing the many uses of and motivation for the study and development of virtual laboratories, and then stresses some of their main features when they are employed to support teaching and learning activities. It then follows with a brief review of the contributions to the special issue.

Virtual Laboratories to Support Teaching and Learning Activities

The virtual environments, named virtual laboratories, vary from static Web pages with didatic videos and texts, to dynamic pages with sophisticated environments, collaborative authoring (Emigh & Herring, 2005), videos on demand, virtual meetings, and many other features. These virtual laboratories may also allow remote access to measurement instruments, video cameras,
microphones, electrical and mechanical circuits, chemical reactions, biological experiments, and so forth.

The diversity of models and structures for virtual laboratories is large and varies according to the nature of the project under investigation, the goals, and the technologies involved. The motivations for the implementation of virtual laboratories include, but are not restricted to:

- The limitation on the resources and space in the real-world laboratories. This type of limitation may cause delay in the learning activities of the students, who may face the situation in which they have to compete or wait for the availability of a given resource, in addition to the fact that one’s experiment may be interrupted before it is concluded, due to the need of sharing resources.
- The possibility of sharing usually expensive equipment.
- The stimulus for the collaboration of research or work in groups independently of their physical distance.
- The existence of a learning environment outside the school, allowing the students to participate or develop their own projects together with other students in their spare time.
- The possibility of developing different parts of an experiment at different locations.
- The remote supervision and intervention in potentially dangerous experiments, thus helping to prevent accidents.
- The remote access and control of precision equipment.

There are currently many examples of virtual laboratories in varied domains, from computer science (Federl & Prusinkiewicz, 1999; Leitner & Cane, 2005), to biology (Raineri, 2001; Subramanian & Marsic, 2001), to physics (Forinash & Wisman, 2005; Sethi, 2005), to chemistry (Dalgarno, Bishop, & Bedgood, 2003), to engineering (Arduino, Macari, & Wyatt, 1999), and several other fields. Virtual laboratories, as tools for the support of the teaching and learning of a given subject, should present some key features (Dalgarno et al., 2003; Ertugrul, 2000; Georgiev, Roth, Stefanova, Georgiev, Stoyanov, & Rösch, 2002; Kouzes, Myers, & Wulf, 1996; Lawson & Stackpole, 2006):

- Facilitate the learning of a subject by allowing the distance experimentation with chemical reactions, biological mechanisms, physical simulations, or other subjects.
- Allow for the creation of virtual communities about a central subject, and thus result in the convergence of people with similar interests to the same virtual environment.
- Bring together resources and information related to a specific subject matter.
- Provide guidelines for the use, teaching, and learning of the subject, together with means for its assessment.

This special issue presents a set of papers that explore the use of virtual laboratories and/or their specific technologies for the support of teaching and learning activities. The next section makes a brief overview of the contributions.

**Overview of the Contributions**

Selouani, Tang-Hô, Benahmed, and O’Shaughnessy’s work context is a virtual laboratory based on natural language interaction. This virtual laboratory incorporates a new approach, which has a speech modality and uses synthesizers and learners’ personal documents, to perform an adapted training and avoid demanding reading sessions. It is designed to be used in a real mixed-mode
learning context, including both distance and face-to-face interactions. The learners can navigate and search the learning environment by using the speech modality, receive answers through an artificial voice, and tailor the system to their specific profile and interests. Evaluations carried out with the different parts of the system suggest that incorporating speech technology into a virtual laboratory has promising results.

Tejedor, Martínez, and Vidaurre’s paper presents a remote, Web-based, electricity virtual laboratory that enables electrical and electronic engineering students to practice building circuits of both direct and alternating current. The main novelty of their work is that students can design and implement an electrical circuit in a similar way as they would do in a real laboratory. From the instructor’s point of view, it can be configured to suit diverse practical sessions just by editing a file, in which the main options of the program are defined. A pilot study showed that the virtual laboratory on electricity has helped students in laboratory classes with real devices.

Najjar addresses the issue of correcting learning errors in activities carried out in a virtual laboratory. To accomplish this, an approach based on a student model with the aim of providing scaffolding feedbacks and adapted teaching prompts is proposed. The distinctive characteristic of the computational model knowledge representation is that it is inspired by the human memory subsystems and processes, and explicitly considers learners’ goals. An experiment carried out validates the individualised feedback generation process of the proposal. Besides, an authoring tool allows an instructor with no computer programming skills to graphically model any domain according to the knowledge representation and remediation approach.

In the contribution of de Castro, Muñoz, de Freitas, and El-Hani, the authors seek to provide a Web-based virtual laboratory on Natural Computing. More specifically, the virtual laboratory provides didactic contents about the main themes in the Natural Computing area, as well as interactive simulations, videos, exercises, links for related sites, and a forum, among others. The paper focuses on an evaluation of the virtual laboratory carried out with students of a one-week event (School of Computing). The evaluation aimed at assessing the degree of satisfaction of the students with the environment, evaluating the potential of the virtual laboratory as a self-learning and self-evaluation tool, and evaluating its usefulness as a tool to support the teaching and learning of Natural Computing. Overall, the experiment results indicate a positive evaluation of the virtual laboratory structure and contents. The students also considered the experience of working with a hybrid teaching approach—mixing traditional lectures and e-learning—as appropriate and productive.

ACKNOWLEDGMENT

The guest editors would like to thank the invaluable work of the reviewers for the papers submitted to this special issue: Auri Vincenzi, Cesar Teixeira, Francine Bica, Hermes Senger, Itana Stiubiener, Lucia Giraffa, and Patricia Tedesco. Their contribution was essential to the quality of the set of papers accepted. The guest editors also thank the support of CNPQ and FAPESP research agencies.

REFERENCES


Leandro Nunes de Castro received the BSc degree in electrical engineering from the Federal University of Goiás, Brazil, in 1996, MSc and PhD degrees in computer engineering from Unicamp, Campinas, São Paulo, Brazil, in 1998 and 2001, respectively. He was a research associate with the Computing Laboratory at UKC, Canterbury, UK from 2001 to 2002, a visiting lecturer at Unicamp from 2002 to 2003, a senior research fellow at the Wehrner von Braun Center for Advanced Research from May to December 2004, and a visiting lecturer at the Universiti Technologi Malaysia (Johor, MY) in September 2005. In May 2003 he joined UniSantos as an assistant professor in computer science. He is the main author of Artificial Immune Systems: A New Computational Intelligence Approach published by Springer-Verlag (London, 2002), one of the editors of Recent Developments in Biologically Inspired Computing published by IGI Global (2004), and the author of Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications, published by CRC Press LLC in June 2006. In February 2007 he started a company on Natural Computing, named NatComp, and is currently its Manager for Research, Development and Innovation (RDI).

Marta Costa Rosatelli is an assistant professor in the graduate program in computer science of the Catholic University of Santos (UniSantos), Brazil. Previously, she was a research assistant in the Knowledge Systems Laboratory, Department of Computer Science and Statistics, Federal University of Santa Catarina, Brazil. She received her PhD and MSc degrees in production engineering from the Federal University of Santa Catarina, Brazil. She developed part of her thesis at the Computer Based Learning Unit, University of Leeds, UK. Dr. Rosatelli's research interests are: Artificial intelligence in education, intelligent tutoring systems, personalisation, computer supported collaborative learning, e-learning, and virtual reality in education. She is a member of International Artificial Intelligence in Education Society and Brazilian Computer Society.