EDULEARN 18

10TH INTERNATIONAL CONFERENCE
ON EDUCATION AND NEW LEARNING
TECHNOLOGIES

PALMA (SPAIN)
2ND - 4TH OF JULY, 2018

CONFERENCE
PROCEEDINGS

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COLLABORATIVE LEARNING AND VIRTUAL LABORATORIES. A NEW WAY OF TEACHING AND LEARNING ON THE INTERNET

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Abstract

This paper illustrates the results of research activities on collaborative learning and the virtual laboratories that are available in the International Telematic University UNINETTUNO's platform. In particular, the interaction models, created in UNINETTUNO Island of Knowledge where the avatars of teachers and students contribute to realize environments characterized by a strong sense of reality that promote collaborative learning and learning-by-doing, are analyzed. Secondly, concrete applications, such as virtual laboratories controlled from remote and through smart phones, based on an in-depth study of the complex interrelations existing between communication technologies and cognitive models and between technologies and the theoretical models on which distance teaching and learning processes rely on, are illustrated. Thanks to virtual laboratories the students can apply the theories learnt in other learning environments of the cyberspace, they can handle and interact with virtual objects, formulate and test hypotheses. In this learning activity, the students, besides being assisted by a human teacher-tutor, can also have the support of automated pedagogical agents. Additionally, I describe the UNINETTUNO University's tridimensional virtual laboratories that are realized in the framework of international research programs allowing to connect with other laboratories worldwide as well as to redefine the geography itself of research and innovation.

Keywords: e-learning, distance education, virtual laboratories, remote laboratories.

1 RESEARCH ACTIVITIES

UNINETTUNO has always attached great importance to theoretical as well as applied research work. Beside research programs linked to single faculties and disciplines, there is a university research area whose aim is to:

- Conduct research work to keep on innovating the psycho-pedagogic-didactic models of the distance courses;

- Identify working models for applying technologies that allow enhancing the services provided by the University;

- Identify qualitative and quantitative assessment standards aimed at highlighting the effectiveness and efficiency of the whole University's system;

- Develop tridimensional and augmented-reality applications in UNINETTUNO's distance teaching and learning processes;

- Identifying models assuring the security of students' distance assessment systems.

The results of this research work allow for a continuous monitoring of the potentials of the various technologies to connect their development to new knowledge communication models in order to be able to rely on a consistent body of theoretical and operational knowledge granting a fair balance between the technological-engineering components and the cognitive, methodological, cultural and educational components specific of education.

This type of interdisciplinary research is connected to cognitive science, psychology, pedagogy, linguistics, computer science and engineering. These research teams have already produced epistemological models, strategies of analyzing problems in their respective disciplinary fields that allowed for identifying the complex interrelations existing between communication technologies and cognitive processes, in particular, among technologies and theoretical models on which the implementation of distance teaching and learning processes rely. On the basis of this research work we realized the three-dimensional worlds of UNINETTUNO Island of Knowledge. Collaborative teaching-learning environments are realized in the three-dimensional virtual classrooms and "learning-by-doing" processes are developed in the virtual laboratories".

2   VIRTUAL CLASSROOMS IN THE 3D ENVIRONMENTS OF UNINETTUNO PLATFORM

Collaborative learning activities are carried on also in the three-dimensional worlds of the virtual classrooms available in UNINETTUNO's platform. The three-dimensional virtual environment, by handling variables such as space, the roles and interaction between the avatars of actual individuals, creates a setting that is characterized by a strong sense of reality in which the actual individual-avatar figures out the potentials for interacting with the available environment and with the other avatars that are present. The individual is immersed in a new dynamic reality in which he is not a mere viewer, but a protagonist. The individual is surrounded by a new dynamic reality where he is no longer only a mere viewer, but an actual player.

The experience made in this reality is highly emotional and is deeply involving; the individual is "attracted" into a new virtual world which has all the features of the real world.

In the three-dimensional virtual classroom of UNINETTUNO Island of Knowledge, students and teachers-avatars develop learning processes experimenting a new immersive-collaborative learning dimension. The students use interactive tools, they make practical exercises, mid-term assessment tests, dialogue and learn in a cooperative and collaborative way and become active constructors of knowledge.

The training provisions envisage a teaching model resembling that of the "flipped-classrooms": students are led to learn in advance about issues linked to the planned discussion; then they study the video lessons, the reference texts, books, lecture-notes, articles, essays, preparing themselves to participate in the debate with the teacher-tutor. In the second phase, the avatars of students and teachers-tutors meet in the three-dimensional virtual world and they take their seats in the classroom in which the avatar of the teacher-tutor asks questions to the avatars of the students in order to assess their skill-level. In this phase, the questions being asked are more important than their relative answers; they represent the basis on which to start the discussion, or better, the *disputatio*. Through the *disputatio* – inspired to the learning model of the Medieval universities – they foster a learning process taking origin from dialogue and exchange, they learn from other people and reflect on their own ideas.

Learning becomes a process involving the student in thinking about and conceiving multiple perspectives and viewpoints. In their approach to knowledge, they promote creativity and critical appreciation. It is interaction, dialogue and exchange which add value to this type of learning. 3D immersive worlds allow for penetrating into the digital body to perceive oneself no longer as a person sitting before the screen of a PC, but, actually, as being in a virtual classroom animated by actual teachers and students. In the Island of Knowledge debates and conferences among students, experts and teachers coming from other universities around the world take place. In these virtual spaces social, entertaining and recreational aspects are experienced as well.

The utilization of a virtual world and of avatars as representations of one's own virtual body enhance involvement and participation, an essential feature of both educational and social interaction. The three-dimensional virtual world is becoming a a more and more interesting tool for uniting the two dimensions, the one which is more linked to education and the one that is more linked to socialization and entertainment. The aspect of social interaction, as a starting element for implementing UNINETTUNO's psycho-pedagogic model, finds a more appropriate environment for developing constructive and collaborative learning processes and socialization processes in three-dimensional virtual classrooms.

3   VIRTUAL LABORATORY

In the virtual laboratories of the three-dimensional environments realized in UNINETTUNO's platform, the student can put into practice the theoretical principles learnt in the video lessons, starting up a "learning-by-doing" process.

Human mind works better on concrete and specific cases than on abstract data. The strongest learning is that build by "doing", therefore making mistakes and correcting them, instead of learning in a mechanical way or passively watching the demonstration made by an expert.

In interactions taking place in virtual laboratories, the student is guided, along his learning path, both by an expert teacher-tutor and by an intelligent system. We know that is more difficult to teach

somebody to carry on complex assignments; in order to become truly skilled, a student is required to learn the abstract working principles as well as learning how to apply these principles into practice.

The apprenticeship method used in the old craftsman's workshop was an extremely efficient way of teaching complex arts such as painting, sculpture or woodcraft etc. Today, many teaching methods are relatively efficient in transmitting abstract principles, but less effective when it comes to teaching how these principles are applied. For this reason, knowledge and skills usually remain divorced from their use in the real world. As a consequence, the motivation to learn is often low and much of what is learnt is quickly forgotten or remains "non-integrated or inert"(Kass 1996). In order to avoid these problems, the didactic cyberspace contains virtual laboratories and exercises, which are an integral part of the video lessons and allow for a direct connection with the application of what the teacher explained at any time.

By now the realization and use of virtual laboratories is very widespread. There are various typologies of virtual realities differing as it regards their degree of immersivity and sensory involvement. Some peculiar features of virtual reality are:

- The possibility of exploration within a digital environment;
- Interaction with people and things;
- Immersivity;
- Sense of presence
- User's possibility of capturing and modeling things automatically
- The environment where the user finds himself

Anyhow, there features that are common to different kinds of virtual reality and often to multimedia applications. A common feature is that, thanks to their use, it is possible to overcome several boundaries, as that of materiality and, actually, you can manipulate any object in a digital format to put into practice what you have learnt in virtual space and remove space and time limits.

Thanks to computer networks, actually, the same virtual environment can be shared by several users at the same time. The concept of space, as a physical entity, also no longer applies, since, by now, it is possible to display the subject under study in any place and at any time, allowing for a faster and more democratic spreading of knowledge.

The forms of expression used by these media promote the removal of linguistic and cultural barriers. The knowledge of eminent scholars coming from difference places of the world can be easily spread, integrated and put in relation with new knowledge that, thanks to the Web, can be transferred in real time.

Virtual reality is developing new learning models that will tend to shift human cognitive from the symbolic/re-constructional mode to that of the motor-perception one. Re-constructional-symbolic learning is generally associated to learning processes: reading, understanding, reasoning, induction, deduction, conscious and self-conscious processing and this can normally happen by studying the texts.

Motor-perceptive learning is associated with practical, hands-on activities: you watch, touch, modify your behavior; you analyze its results, you try and re-try; the response, the reaction of the object results into knowledge since it is automatically linked to the action that generated it: it is a "trial-and-error", a "learning-by-doing" process

From a biological and psychological viewpoint, the motor-perceptive behavior is certainly more elementary than the symbolic/re-constructional one: the child, from birth to 18-month of age (as it has always been in primates) utilizes this common learning method. Until very recently, a strong limitation was due to the need of acting only on objects that you could see and touch. This limitation can be overcome thanks to virtual reality and the motor-perceptive learning system can be applied to different fields of knowledge. The big advantage of this cognitive mode lies in the fact that it is fast; it does not require much effort and is largely independent from differences in age, culture, education. Additionally, guided simulations and experiences offer the learner the opportunity of acquiring new methodologies of approaching knowledge as well.

The student can reflect on his own experiences, on the theoretical principles that are made operational and easily stored into memory thanks to his problem-solving activity. In virtual laboratories the learner is always guided by a system automatic intelligent agent or by an expert tutor who checks and controls

whether the path he started allows him to build his own knowledge and competences. This environment invests the student with an absolutely active role but always with appropriate tuition. A working environment, if sufficiently fertile, can encourage students to explore and learn on their own; however, exploration and activities without guidance can only work in a few limited contexts. In most cases and, in particular, for those skills that require complex learning and involve assignments that are not easy to solve, a student without a guide may have problems in correctly interpreting what happens in a simulation and can test only hypotheses that fit into the categories of knowledge already acquired during past experience.

An explicit point of reference is provided by the guide who can get round these difficulties and encourage students to explore theories and hypotheses that they would have otherwise not applied.

UNINETTUNO's virtual laboratories appear as true "learning-by-doing" environments where they teach how to avoid to acquired un-used knowledge, setting knowledge in the context in which they will have to be applied (see Lave, Wenger, 1991). Below you find the description of some virtual laboratories that are included in the Didactic Cyberspace and deal with humanities as well as with scientific disciplines.

A concrete example, related to the Cultural Heritage Faculty, is related to a virtual restoration laboratory, based on an actual setting: the restoration of two paintings of the visages of Saint Francis and Sainte Claire in the Basilica Superiore in Assisi, attributed to Giotto, and destroyed by 1997 earthquake.

Other laboratories are connected to electronics and physics. The highly innovative physics laboratories were realized by Livio Conti, a physics researcher at UNINETTUNO, and by a team of students, thanks to specific applications meant for smart phones. Livio Conti started from these hypotheses: "smart phones contain a processor and can be compared to a true processor allowing to exploit these equipment for alternative uses. Additionally, each smart phone contains some sensors used by the operational system for some functionalities that are peculiar to smart phones, such as screen rotation, orienting of the equipment based on the terrestrial magnetic field, geo-localization etc. These sensors are true measurement systems that, even though limited in terms of accuracy and sensitivity, in spite of this, can measure many and important physical parameters".

Starting from the above-described hypothesis, Livio Conti developed an application for mobile platforms (smart phones, tablets etc.) that allow to have a true laboratory in one's own pocket. The application acquires data from physical measurements sensors, contained in the mobile processor (smart phone, tablet etc.) and uses them to measure physical quantities exactly as measurement device do in traditional laboratories. Thanks to this application it is possible to acquire, process data, conduct physical analyses and interact with other remote devices in order to share data and results among distant users.

These applications, since they exploit the smart phones' bigger and bigger potentials, are constantly evolving. The realized applications required to modify some the features of the operational system to make it more appropriate to the laboratory scientific objectives. The measurements made by each sensor/device can be displayed according to several graphical and functional modes to enhance the comprehension level of complex scientific subjects. It is possible to change measurement parameters such as acquisition frequency, temporal interval, measurement unit etc. These data can be displayed online; they can be stored in a file and shared with other users or with the teacher through e-mails, SMS, clouds etc.

It is even possible to share the screen and make measurements with other users or with a single user under the guidance of a teacher. This allows to make exercises that are shared with the entire class. In addition, there is a whole set of additional functionalities such as data screenshots, background acquisitions, zooming on graphics etc. by which it is possible to implement a special section devoted to the analysis of statistical data.

Using the developed application it is possible to carry on remotely-controlled laboratory activities. The students, no longer on the spot, but from anywhere in the world, can download the app, install it on their own smart phones, access it using their own credentials, make measurements following detailed sheets prepared by the teacher and send the data and results of their laboratory activities to the teacher-tutor. All the files and data produced by the app are labeled by a student's identifier. The teacher, then, receives the files and can assess the activities carried on by the student.

Unlike traditional virtual laboratories that can be remotely access via the Internet, this application allows the student to have a laboratory of his own within reach, wherever he is. In fact, the application

does not require an Internet connection, unless in the registration or data transmission phase. Consequently, if they have a smart phone, they can make measurements anywhere, not only indoor in a physical laboratory, in a house or at the university. This greatly enhances the potentials of use, the pedagogical and emotional impact, the effectiveness of this application for learning sciences on the learning-by-doing mode and the control of the theoretical knowledge acquired working on the texts and on the video lessons in the field. Another key feature of this application is its cost-effectiveness since it allows to build a laboratory without using infrastructures, measurement devices and complex connections. In addition, the intrinsic modularity of this laboratory model allows to use it for teaching scientific subjects at university as well as at high school level.

Other virtual laboratories are realized to carry on research activities. Some research laboratories are included in UNINETTUNO's technological platform: hardware and software packages, tele- and videoconferencing systems, distributed processing, computer networks with other research laboratories in other countries of the world allow researchers to carry on their research activities using the Web to exchange data, standardize research protocols and share materials, equipment and laboratories. UNINETTUNO's platform allows to cooperate with other international research centers and teams and to work together at distance. The studies and research work carried on by these teams are divided in different units participating in the realization of complex experiments that required more and more diversified competences that can be found not in single research center, but in more research centers and universities across the world. Nowadays it has become essential for all research laboratories and centers to develop a model of permanent interconnection among different excellence poles and laboratories at global level in order to "get the best from who knows best", maximizing costs, reduce travels and missions, share knowledge and make assessment before, during and after the realization of expensive and complex experimentations. An example of what said above is given by the Engineering Faculty, in which two research team have been recently set up – whose names are "UNINETTUNO- High Energy" and "UNINETTUON-JEM-EUSO – gathering researcher and lecturers from different places of the world.

More specifically, the PCs set up in UNINETTUNO's premises are connected with the laboratories of the Telescope Array in the State of Utah (USA), of RIKEN (Japan), Wizard team of the University of Tor Vergata (Rome), of the University of Tubingen (Germany), of the laboratory of Lanzou and of the CEA (China) etc. The operation and data collection of some experiments that are being carried on are made directly by UNINETTUNO's processors. Through UNINETTUNO's processors it is possible to control the tests being carried out on the International Space Station, interact with the astronauts who manage, check operation parameters and data collection. Professors and researchers have a deep experience in these distance interactions. Through UNINETTUNO's connections available on UNINETTUNO's premises it is possible to work in constant contact with colleagues of other laboratories – exchanging documents and data – accessing databases of the most prestigious national and international journals treating several disciplines, allowing for a constant update of field knowledge and facilitating interdisciplinary interaction and exchanges.

Until recently studying and working at distance could be a makeshift solution in difficult and problematic situations that made us regret human direct interaction. Today, on the contrary, thanks to the quality of connections, lower cost for accessing the Web and to the spreading and multiplication of connection tools, the research carried on in cooperation with several centers represents the cutting-edge of a process on dematerialization and delocalization that enrich studies and research offering a unique opportunity for sharing ideas and projects with researchers and colleagues that would be otherwise unreachable, valorizing some aspects of social and human interaction. In the field of research the development of an immaterial and interconnected society is a concrete fact since a long time. The connection with the most important research laboratories of the world is making the globalization of science faster and this is redefining the geography itself of research and innovation. Today innovation has a global reach and the researchers who aim at making new discoveries are more and more interconnected. Thanks to the Web they do not work in isolation: the solution of a problem is often a collective event and the international scientific community often contributes to its solution. This allows for a significant increase of scientific productivity.

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