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Elissavet Spyridoula Zotou

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Can schools become innovative learning environments by using virtual laboratories in science courses?

Zotou Elissavet Spyridoula[1]

[1] *10th grade, Evangeliki Model High School of Smyrna, Athens, Greece*

Abstract

Being a High School student, having innovative science courses in schools is a very important issue. It might be difficult to reply in a single way on how to achieve this and there are different approaches of how our educational system could be improved in order to prepare the next generation of researchers. It is clear that technology involved in education has benefits that affect both teachers and students as it offers access to many recourses, digital tools and assignments. Due to the technological evolution, virtual laboratories have become an inseparable part of many students' lives. Based on my personal experience and references of international bibliography, the aim of this paper is to inform students and teachers about methodological teaching and learning approaches in science courses using virtual laboratories.

Key words: Virtual Laboratories; Innovation; Technology; Education.

Introduction

Nowadays, a fundamental characteristic of our society is the rapid evolution of technology. Computer science has influenced the educational process and provides us with many opportunities that we can exploit. One challenge faced by many STEM teachers currently is the integration of Inquiry Based Science Learning (IBSL) in

teaching. Supporting inquiry-based learning with technology is more effective than traditional teaching methodologies where the teacher is placed in the center of attention and the students are passive viewers and learners [1]. Inquiry-Based Science Education (IBSE) has proved its efficacy in school education extending "traditional" frontal instruction and motivating students to actively participate in science. IBSE-methods receive support by means of learning technology on hardware and software wise. Digital technologies can support the necessary training innovations and can be the catalysts for change in educational processes(form, space, functions, services, tools, roles, procedures) [2]. One of the best examples, for the connection of education with computers and technology is virtual laboratories. This paper provides a literature review of creating innovative learning environments by using virtual laboratories. It also presents real examples of learning science in classroom with the use of virtual labs as a tool giving additionally the point of view of high school students.

Theoretical Framework

There is still a heated debate on how technology affects our society; the implications of quick and easy online access to information for knowledge and the effect of technology on young people's social, emotional and physical development. In order to evaluate the impact of technology in students' lives researchers took into consideration students' attainment across a range of tested curriculum outcomes and their personal experience of technology used in their schools [3].

Connecting the learning process with environments of virtual laboratories is an essential digital tool. Many European schools are equipped with computer classes, tablets and high-speed internet connection using a huge variety of web-based learning applications, simulations and visualizations. [4]

While students use real environments to carry out the experiments, they can use all their senses. On the other hand, using virtual laboratories enables them to use specific tools on the computer. Daily experience shows that many students like being into real laboratories, seek and find new things and methods to carry out surveys and experiments. But in the real environment, they are not able to come across man y available tools, materials, chemicals and students face difficulties so the effectiveness of teaching and learning is reduced [5]. So strong are sometimes the measurement inaccuracies that learners focus on them. As a result, they lose the purpose of their survey. With the virtual laboratories, students acquire tools of experimentation without limitations of space or time. They can be used everywhere, and all year round opposed to the limitation of time and space of a traditional

library. Virtual laboratories, contribute greatly to understanding concepts in organizing observations, notes and conclusions. Finally, they can be useful in the practice of the review and evaluation of relevant information [6].

Methodology

Searching the literature of using virtual laboratories in teaching science provided by international research, resulted in also searching the results of implementation in science lessons in my school. The review of case studies of using virtual laboratories were complemented by personal experiences and personal interviews.

Results

Benefits of using Virtual Laboratories

The first thing to take into consideration, as far as the Virtual laboratories are concerned, is its efficacy and how the students will be supported. Chris Dede, who studies simulations for education at Harvard University in Cambridge, Massachusetts, states that "You only understand something when you know how to do it." And there is so much truth behind these words. Now the students can participate actively in the class, sharing their opinion, paying attention, and watching their experiment in real life. This method is beneficial, as they can understand easily what is going on without searching the answer on books, as the answer is in front of them. They are challenged to face the difficulties as if they were in a real laboratory, gain experience, knowledge and develop practical skills. Students and teachers all over the world can collect real data, work on them, draw conclusions and compare them. "Labs are where we offer students the opportunity to engage with real lab equipment, to analyze authentic data, to experience the wonder of observation," says Mike Sharples, an education-technology researcher at the Open University in Milton Keynes, UK [7]. Of course, this kind of class brings the lesson closer to the student as it is about technology. Young people interact with new technologies all the time, for example their cellphones. Thanks to them, Virtual laboratories seem appealing to the students since there all about the computer and other electronical devices. The use of Virtual environments can provoke students to get involved into many actions connected with the computer and acquire skills that are useful for a lifetime. The use of that kind of technology can also develop many STEM projects [8]. There are of course cases where Virtual labs are extremely necessary. They are the perfect solution if a real experiment, in a lab that otherwise can cause health problems if certain chemicals or other substances and tools are involved. With Virtual laboratories there is no limitation of time and space, as this tool is available

during all the year; and students can easily have access to it [9]. Apart from the gain of time, there is gain of money too. Schools are not obliged to buy all the necessary equipment for students getting into real life laboratories, as it is all on the computer. Moreover, according to the "second generation* " of cognitive scientists, [10] what finally appears to be sought and may be achieved by the contemporary goal of scientific literacy is more related to learning "practices" than to learning content connected to scientific texts [10]. Summing up, this method is cheaper, safer and more beneficial for students and teachers.

Personal experience on how Virtual Laboratories can be used

Although I was able to recognise the benefits of Virtual Laboratories, I could not conceive how they can be useful into our everyday life at school, until we used them too at our biology class. They ended up being extremely helpful for us, the students, to understand a complicated concept, synapses. Synapses are areas of functional connection of a neuro's axon with other neurotic cells or with specially modified areas of executive organs (muscles and glands). It was too complicated for us to understand the synapses function without being able to see it. Therefore, our teacher lead us to the computer and systematically, we discovered how they look like. Firstly, we connected the new concept with our existing knowledge about how neurons travel across the body. Then, we used a program that allowed us to watch a video about synapses connect the presynaptic and postsynaptic end in order to allow to the neurotransmitter substances to diffuse into the synaptic cleft and the postsynaptic end. It was the image that made us understand more easily that concept, but at the end of the lesson, we also took a little quiz on the computer to check what we had learned. The aim was to learn to lead the neurotransmitter substances through the right path, to connect the right ends, and allow the body to move.

Finally, I was curious to see how virtual labs can be used by older people during their studies or at their job. Fortunately, I was lucky to discover that, thanks to a visit at National and Kapodistrian University of Athens that was organized by our club's teachers. There, I had the opportunity to discuss with students of biology and ask them if and how they used Virtual Laboratories. I was surprised by how many ways students could use the Labs, and how helpful they are. The students specifically talked about the use of Virtual Labs in molecular biology. Thanks to Virtual Labs they are able to use simple tools in order to become more familiar with basic concepts and techniques of genetic engineering, such as recombinant of DNA, transformation of bacteria, plasmid vector and host cell etc. They also told me that they prefer virtual laboratories, as it is easier for them to modify in vitro by recombinant DNA techniques and introduce them into live cells.

Interview of a student telling her experience about Virtual labs

Comparing the two ways of learning, the "traditional" one and the virtual laboratories one which one you consider more helpful or the one with more advantages?

…First of all, I would like to maintain that the traditional way of learning has not been a problem for me the last years; and I am really pleased by the teachers in my school. Although, this year has been difficult for me, as far as chemistry is concerned. I do not know if it was due to the teacher or the book or the way of carrying out the course. I just could not understand the moles, no matter how hard I studied. Therefore, I decided to take part in a Virtual lab and see into the laboratory the meaning of molarity, concentration and moles in general. It was amazing. I could see all these that I could not understand and somehow it became really easy. It is definitely true that Virtual labs have so much to offer when we know how and when to use them. It is up to us to take advantage of this opportunity and try the best we can. Although, I can understand that there are some difficulties to face, otherwise, it would be already more known and spread at schools. In my opinion, the most significant condition is for the school to have the money in order to buy computers so the students have access in a Virtual environment. Moreover, under no circumstances must the students believe that Virtual labs can completely replace the traditional labs. It is imperative they understand that they must be ready to front a real lab like a virtual one. I also believe that it would be really creative if there were for both tutors and learners representation of themselves, avatars. Finally, it is important that students and teachers are able to handle correctly the computer...

Examples of virtual lab environments used in teaching science

The **Go-Labs** (http://www.go-lab-project.eu/) which is a project co-funded by the European Commission within the 7th Framework program. It offers online laboratories in education and its aim is to motivate people from 10 to 18 to engage with science topics, acquire scientific inquiry skills and experience. It allows teachers to develop particular scientific spaces and makes it easier to exchange all the activities through an online community.

The **UniSchooLabS** (http://unischoolabs.eun.org/web/guest/home) which is a project that provides schools with an online toolkit for being able to access high quality universities science laboratories remotely and creates inquiry-based learning activities for students. Its goal is to improve the level of education in sciences in

Europe. Its characteristic is the collaboration between schools and universities so the teachers can use whenever they want universities' laboratories.

Library of Labs; an initiative of eight universities and three enterprises, for the mutual exchange of and access to 1) Virtual Laboratories 2) Remote experiments (real laboratories that are controlled via the internet). http://www.lila-project.org/about/presentation_neu/LiLa_Presentation.pdf

Labshare is central to science education. Allowing primary and secondary school students to "experience" science through experimentation supports their learning and motivates their engagement while fulfilling specific curriculum requirements. http://www.labshare.edu.au/about/sectors

Molecular Work-bench is a powerful, award-winning software that provides visual, interactive computational experiments for teaching and learning science. Now thanks to Google's generosity and the power of HTML5, we are bringing this versatile way to experience the science of atoms and molecules to Web browsers. http://mw.concord.org/

Gizmos are interactive math and science simulations for grades 3-12. Over 400 Gizmos aligned to the latest standards help educators bring powerful new learning experiences to the classroom. They give everyone something to graph, measure and compare. Students become mathematicians and scientists. http://www.explorelearning.com

Conclusion

Summing up, I spent a lot of time searching about the use of virtual laboratories as an innovative method of learning. Taking into consideration all the facts that I found related to virtual labs, my personal experience and the opinions of my classmates, I think that adopting this kind of teaching and learning can offer a lot to our educational system. Let us also think the fact that many European countries have already adopted the use of virtual labs in their teaching; and it is a part of their routine. Although, like in every system there are some difficulties, I think that the positive aspects can be a motivation to face these difficulties. Therefore, it is our duty to gain as much as we can, open our horizons and learn new things.

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