TRENDS ON ICT IN MATERIALS SCIENCE EDUCATION

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Abstract: Information and Communication Technologies (ICT) probably represent the greatest opportunities for and challenges to the formal educational process. One of the main power of ICT is that students are highly familiarized with new technologies and they represent a friendly tool and a nearer and free-flowing communication channel with the professor and the subject it-self. This work shows up the great advantages that ICT represent in the education work, focused on the materials science education and its laboratory practices. The study is not limited to the implementation of the use of pcs and/or tablets in the classes. The idea is to import to the normal behavior of the teaching process the tools that these ICT provide and with the ones the students are very familiarized.

Key words: ICT, Information and Communication Technologies, Materials science education.

1. INTRODUCTION.

Building upon the disruption to lecture-based methods triggered by the introduction of problem-based learning, approaches to promote self-learning are becoming increasingly diverse, widespread and generally well accepted within materials science education. New technologies are changing the world and, consequently, the classic educational activities. Information and Communication Technologies (ICT) arrived some decades ago revolutionizing our day to day. This ICT are already implanted in most of the syllabus of the Spanish universities. However, their huge potential has not been exploited in most of the cases. Students today need to learn new abilities as how to search for databases, interpret models, or criticize electronic sources to succeed in school and in the workplace. They are indeed required to master ICT effectively [1-3]. Digital technologies offer new resources for learning, support new modes of instruction, and amplify opportunities for science education research [4].

Our primary thesis is ICT represent an improvement in learning opportunities in the education work, particularly in the field of materials science education and its laboratory practices. Academic achievement only based on traditional methods had shown unsatisfactory results. The many abstract subjects studied during the science bachelor degrees become in obstacles that make students difficult to establish the concept of knowledge. Learning by using ICT allows students using computer animation to understand the concepts learned and help that learning can be done independently, making learning becomes easier [4]. Indeed, Chi's Interactive-Constructive-Active-Passive (ICAP) framework [5, 6] highlights the advantages and skills that are developed under this approach. Among them the interactive learning (co-constructing new information with others), constructive learning (generating new information) and active learning (selecting information for emphasis).

In contrast, it takes too much training, preparation and production of appropriate materials for such learning to be more effective [7]. The idea of this work is to import to the normal behavior of the teaching process the tools that these ICT provide and with the ones the students are very familiarized [8]. As first approach, the use of tutorial videos instead of the classic practice manual paper can result in a larger number of students attending with the needed background knowledge to the practice. Moreover, the employ of simulation software not only for the explaining of abstract concepts but for the repetition of lab practices at home will also increase the probability of success of the students as well as an increase on the interest of them for the subject. In fact, nowadays are plentiful of strategies that can help to the student in the success of their studies. This is the aim of this study: the analysis of the impact of ICT tools in the material science classes and the providing of example that can be implemented by the professors in their daily teaching activities.

2. BENEFITS OF THE USE OF ICT.

Instructional technology seems to have reached a tipping point in the ease of creating, maintaining, and delivering digital media over the Internet as well as in learners' readiness to use such technologies in place of attending lectures [9]. ICT has the potential to play an important role in making the study of science more relevant, interesting and motivating for students, and it offers opportunities to break the boundaries between university and society. This interest has been generated by widespread recognition that content can now easily be made available online in advance of class so that resources, including class time, can be dedicated to review, consolidate, and

apply that content. In the specific case of materials science, there is a huge number of ICT available for both, professor and student that can be easier the teaching and learning labors [8]. As has been mentioned, the simple use of youtube videos make closer to the students the topic of study. It has been reported the important role that Youtubers play in the life of teenagers [10] and it is one of the first source of information used by them. The uploading of videos by the professor or the suggestion of ones already uploaded and revised can be a successfully practice for the teaching labor. However, ICT provides more advantages than youtube. Consequently, it is now possible to imagine that in-class lectures with the primary goal of covering course content will become obsolete, as will students' willingness to sit through lectures in the classroom that they can watch at their own pace and time.

Multimedia software for simulation of processes and carrying out 'virtual experiments', publishing and presentation tools, digital recording equipment, computer projection technology, computer-controlled microscope and tools for data capture, data logging systems, databases and spreadsheets, graphing tools and modelling environments, are ICT available to help in the education process. These forms of ICT can enhance both the practical and theoretical aspects of science teaching and learning, being their potential contribution of technology conceptualized in six ways: (i) Optimizing work production. Computer-based simulations may provide better support for the development of theoretical understanding than practical work, expediting and enhancing work production. It is based in following facts: It is not needed to deal with the use of any apparatus. Results will not depend on the machine handling. But the main advantage is that simulation can offer simultaneous representation of the real and theoretical behavior of the system under investigation for comparison. Moreover, the data sets generated can be more extensive than could be gathered experimentally by one group or class of students [11]. (ii) Bring up to date and increase relevance of practices and experiences. Simulation software allow to reproduce experiments that are not possible to carry out in a standard university lab. Moreover, the possibility to use web-based learning materials increase the authenticity of the results thanks to the continuously updating. There are several examples where students can communicate with researchers and participate in research projects in collaboration with others [12, 13]. (iii) Develop exploration and experimentation. The use of graphing or modelling tools provides dynamic, visual representations of data collected electronically or otherwise. Through providing immediate link between an activity and its results, the likelihood is increased that students will relate the graphical representation of relationships to the activity itself [8]. (iv) Focusing attention on overarching issues. The interactive nature of tools such as simulations, data analysis software and graphing technologies can be influential in allowing students to visualize processes more clearly. Computer analytic facilities are advantageous over manual methods in allowing a more holistic and qualitative approach to student analysis of trends and relationships between variables in a graph rather than individual data points. (v) Fostering self-regulated and collaborative learning**.** Students working with various tasks at the computer may work more independently of the teacher, and at their own pace. Digital learning environments can be designed so that students can work collaboratively [1,14]. (vi) Improving motivation and engagement. The idea that using ICT enhances student motivation has gained currency in recent years [15-18].

The most effective uses of ICT are those in which the teacher and the software can challenge student understanding and thinking, either through whole-class discussions, using an interactive whiteboard or through individual or paired work on a computer [19]. Both whole class and individual work can be equally effective if the professor has the skills to organize and stimulate the ICT-based activity.

3. USEFUL FREE SOFTWARE FOR MATERIALS SCIENCE TEACHING.

There are several software and tools available in the science community that can be used during the Materials Science teaching. The use of research software has the advantage to provide professional tools to the student that can be used in their future career. To help in the implementation of such uses, here are proposed different free-access software for different aspects of the teaching/learning process.

3.1 Vesta software [20]. This simulation software allows the design and manipulation of several crystal structures and drawing specific crystallographic planes. The three-dimensional environment permits the student to have a better spatial vision, and understand concepts as interplanar spacing, lattice parameter or unit cell. The use of planes can help in the learning of miller indices and planar direction. Moreover, all kind of structures with their specific lattice distances can be designed supporting the professor for the explanation of Bravais lattices and the different crystal systems. The use of this software also brings the possibility of realize many different exercises and examples.

3.2 SRIM software [21]. As an introduction to the monte-carlo simulation, SRIM software allows student to understand concept as the electron/ion beam penetration, carrier transport or energy loss as well as statistic concepts. But it can be also very useful in the understanding of materials properties since there is the possibility to simulate different materials of beam impinging, noticing the relevance of their properties.

3.3 Kahoot platform [22]. It is a web platform that converts the tests into games. It allows professor to motivate student with a game-based web platform and

testing friendly their aptitudes. There are different kind of quizzes that can be used for different purposes. This tool also push student learning based in the competition sense, and can be used individually and in groups. Moreover, it can be a useful instrument to check the improvements of the class by realizing the same test before and after the lectures.

4.- CONCLUSIONS.

This work highlights the interest in using ICT for the materials science teaching. Based on the literature, authors push professors to implements new technologies in their class, the use of real data from web sites and the introduction of research software in their examples and exercises. To help in the achievement, at the last part of the manuscript, three different softwares are proposed. They cover a large range of uses, are free and have a friendly interface.

9.- REFERENCES.

[1] Linn M. C., "Technology and science education: starting points, research programs, and trends". International Journal of Science Education, 22(6), 727-758, 2003.
[2] Oliver R., "The role of ICT in higher education for the 21st century: ICT as a change agent for education". HE 21 conference proceedings, 2002.
[3] Ananiadou, K. and M. Claro., "21st Century Skills and Competences for New Millennium Learners in OECD Countries". OECD Education Working papers, No. 41. OECD Publishing, Paris, 2009.
[4] Attewell J, et al., "Impact of mobile learning: examining what it means for teaching and learning". London, Learning, and skills network, 2009.
[5] Chi M. T. and VanLehn K. A., "Seeing deep structure from the interactions of surface features." Educational Psychologist; 47:177–88, 2012.
[6] Chi M.T., "Active–constructive–interactive: A conceptual framework for differentiating learning activities". Topics in Cognitive Science; 1:73–105, 2009.
[7] Livingstone S., "Critical reflections on the benefits of ICT in education". Oxford Review of Education, 2014.
[8] Osborne J. and Hennessey S., "Literature Review in Science Education and the Role of ICT: Promise, Problems and Future Directions". (No. 6): Nesta Futurelab, 2003.
[9] Cook D. A., Levinson A.J., Garside S., Dupras D.M., Erwin P.J. and Montori V.M., "Instructional design variations in internet-based learning for health professions education: A systematic review and meta-analysis". Academic Medicine; 85:909–22, 2010.
[10] Westenberg W., "The influence of YouTubers on teenagers" Msc Thesis, University of Twente, 2016.
[11] McFarlane A. and Sakellariou S., "The Role of ICT in Science Education". Cambridge Journal of Education, 32(2), 219-232, 2002.
[12] Globe program, https://www.globe.gov/
[13] European Organization for Nuclear Research, CERN https://scool.web.cern.ch/content/downloads
[14] Scardamalia M. and Bereiter C., "Computer Support for Knowledge-Building Communities". In T. Koschmann (Ed.), CSCL: Theory and Practice of an Emerging Paradigm. Mahwah; NJ: Lawrence Erlbaum, 1996.
[15] Campbell L. P., "On the horizon: A computer in every classroom". Education, 104(3), 332-334, 1984.
[16] Rieber L. P., "Animation, Incidental Learning, and Continuing Motivation". Journal of Educational Psychology, 83(3), 318-328, 1991.
[17] Schofield J. W., "Computers and Classroom Culture". New York: Cambridge University Press, 1995.
[18] Cox M., "Information and communications technologies: their role and value for science education". In M. Monk & J. Osborne (Eds.), Good practice in science teaching. What research has to say. Maidenhead, Philadelphia: Open University Press, 2000.
[19] Cox M. and Webb M.E., "ICT and Pedagogy: A Review of the Research Literature". Coventry, London: British Educational Communications and Technology Agency/Department for Education and Skills, 2004.
[20] VESTA software, http://jp-minerals.org/vesta/en/
[21] SRIM software, http://www.srim.org/
[22] KAHOOT web platform, https://kahoot.com/