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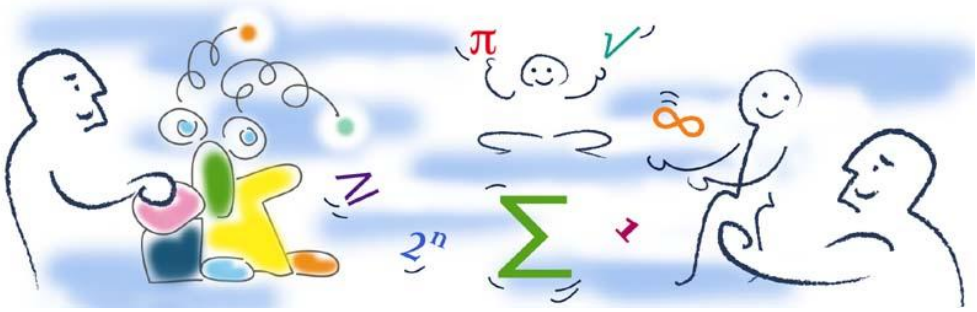

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Editorial: Technology Enhanced Science Education

In recent years, ICT advancements have changed the way we think about science education in primary and secondary schools. New mobile user-friendly products are available to help schools incorporate new units and activities in their science curricula. However, as most educators know, equipment alone cannot alter the way teachers, or schools, approach science education in the classroom. In other words, better tools do not necessarily lead to developing better pedagogy. Of course, society wants both for its children: schools should provide challenging environments for learners, teaching them valuable ICT skills, whilst also cultivating a desire for learning and discovery. Recent research and development projects have worked on bringing technological and pedagogical requirements together to make advances in improving science education in Europe.

This special issue of eLearning Papers will provide examples of the way ICT can enhance science education from the perspectives of the learner and the teacher-trainer. Based on the new technologies and the technology-enhanced research-based knowledge now available, which strategies and pedagogical approaches benefit most from the use of ICT? What is the impact of technology-based science education on curricula and assessment? How can teacher training take recent ICT innovations into account? We know that students learn not from ICT, but rather from the interactions between their thinking and activities (with or without ICT). It has been found that teachers and their pedagogical approaches establish significant differences in what pupils learn and achieve in a classroom. The study carried out by BECTA, for instance, demonstrated a strong correlation between ways of using ICT and students' achievements (Cox & Abbott, 2004). With this in mind, as school access to ICT increases, it is clear that we must analyse appropriate forms of incorporating and using this technology in a fruitful manner.

The articles selected for this issue highlight a number of projects that take into account not only the technical but also the pedagogical innovation that ICT can bring to science education. In doing so, these studies present diverse solutions for incorporating ICT in the classroom by focusing on pedagogical models and effective training methods.

Opening the issue, the article entitled "The Role of Thinking, Experimenting and Communicating in the Science Lab" looks at how to improve the quality and critical potential of science education through teacher training and ICT support. By questioning the objectives of science education, it emphasises how developing pupils' techno-scientific knowledge can result in a broader, more ethical world view. The second article, a case study of the European pilot programme Pollen, presents a road map for introducing comprehensive, inquiry-based science education in local schools through the support of an extended network of experts and institutions.

The third and fourth articles present specific, practical applications that assist teachers through efficient use of ICT. The FICTUP project, funded by the Lifelong Learning programme of the European Union, deals with the process of designing and implementing training materials that combine ICT use and research-based learning. The following article details the Geoscience Concept Inventory (GCI) WebCenter, a virtual platform that offers teachers an innovative student assessment tool that is sensitive to ICT-related learning.

Finally, the Centre for Research on Science and Mathematics Education article offers a thorough and critical review of the role of specific ICT in pedagogical models of science education. It gives practical examples of how to use ICT to implement inquiry-based learning in the science laboratory. These different examples of ICT use in science education provide a well-rounded vision of how new technology is taking part in creating a more dynamic approach to learning in the classroom.

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“Importance is given to teachers’ ability to respond to pupils’ inquisitiveness and their own interests, as well as their capacity to help pupils develop mental agility and promote attitudes and values such as respect for others, independence, a critical mind and the ability to work in a team.”

Keywords
Critical thinking, critical pedagogy, learning processes, student experience, early childhood and primary education, science education

Full text
http://www.elearningeuropa.info/files/media/media23231.pdf

The Role of Thinking, Experimenting and Communicating in the Science Lab

In this article, we discuss early childhood and primary science education supported by ICT. We propose an approach that incorporates thinking, experimenting and communicating as a means to develop technical and scientific thought, in addition to encouraging pupils to control their learning outcomes and work together. The research presented focuses on a number of important ways in which this type of pedagogy can take place. Importance is given to teachers’ ability to respond to pupils’ inquisitiveness and their own interests, as well as their capacity to help pupils develop mental agility and promote attitudes and values such as respect for others, independence, a critical mind and the ability to work in a team. Also crucial to developing technical and scientific thought is the emphasis placed on understanding the world around us, interacting with it and relating it to everyday life, in addition to the use of cognitive and linguistic skills, which are the building blocks of learning and communication.

Based on a socio-critical educational model, we are interested in improving the quality of science teaching and fostering its critical potential. This includes, among other things, understanding the key role emotions play in the process of creating scientific knowledge.

Article originally published as part of the “Aulas de Verano” [summer school] collection by the Instituto Superior de Formación y Recursos en Red para el Profesorado [Institute for online training and resources], Ministry for Education, Social Policy and Sport, Spanish Government, July 2008.

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AMSTEL Institute

“Pollen pilot programme involved working with communities to develop a hands-on approach to science education in primary schools.”

Keywords
Inquiry-Based Science Education (IBSE), curriculum innovation, primary education, educational technology

Full text
http://www.elearningeuropa.info/files/media/media23255.pdf

Pollen Spreads Inquiry-Based Science Education throughout Europe

In recent years, ICT advancements have changed the way we think about science education in primary and secondary schools. Current expectations are that schools provide challenging environments for learners by teaching them valuable ICT skills whilst cultivating a desire for learning and discovery. This case study reviews the activity carried out by Pollen, a European network for promoting Inquiry-Based Science Education. The Pollen pilot programme involved working with communities to develop a hands-on approach to science education in primary schools. During the project, ICT played a crucial role in supporting teachers, classes and the project as a whole. The result was a promising model for bringing ICT and innovative pedagogy together in ways that enhance pupils’ experience at school.

Pollen was a European research and development project supported by the European Commission Directorate-General for Research under the Science and Society part of the Sixth Framework Programme for research, technological development and demonstration activities. The project began in January 2006 and lasted three-and-a-half years. The research team was made up of a consortium of pedagogical and scientific organisations from 12 European countries and was launched in 12 European cities. Representing all areas of Europe (north, south, east and west), the network addressed their research questions in a diverse set of local educational contexts.

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“The innovative training material, developed by experienced and newly qualified teachers to ensure accessibility, focuses on specific classroom activities that use ICT.”

Keywords
Case study, ICT, research-based learning, teacher training

Full text
http://www.elearningeuropa.info/files/media/media23119.pdf

Fostering the Use of ICT in Pedagogical Practices in Science Education

The FICTUP project (Fostering the Use of ICT in Pedagogical Practices), funded with the support of the Lifelong Learning Programme of the European Union, aims to (1) create innovative training material for pedagogical activities using ICT, accompanied by a close tutoring process, and (2) test the impact of the material and the tutoring on newly qualified teachers’ use of ICT in the classroom.

The innovative training material, developed by experienced and newly qualified teachers to ensure accessibility, focuses on specific classroom activities that use ICT**.** Each case includes a detailed description of the activity (PDF file) and three short, pedagogical videos (lasting approximately two-six minutes each) that describe the transversal ICT skills brought into play during the activity. During the first year of the project, nine cases were implemented, some of which focused explicitly on the use of ICT in science education. This paper presents a number of different sample applications, such as “Device – measurement – evaluation: use of ICT in physics (Hungary)”, “Exploring growth factors: applying inquiry learning to biology (Finland)”, and “GeoGebra software: mathematics teaching (France)”.

The increased use of ICT has led to the introduction of new pedagogical approaches, including Resource Based Learning (RBL), through which various learning needs are supported by a wide range of ICT assets. Science subjects in particular are extremely amenable to the advantages offered by RBL and the associated ICT assets. The implementation of technology-supported collaborative inquiry allows teachers to design the educational setting as an integrated whole that provides pupils with relevant technological tools, encourages them to work together effectively, and promotes epistemologically high-level and creative ways of working with knowledge.

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LON-CAPA Project

“The WebCenter’s customised LON-CAPA platform facilitates the inclusion of digital images created by ICT technologies to assess student learning.”

Keywords
Evaluation, learning metadata, mobile learning, research, ICT, education technologies

Full text
http://www.elearningeuropa.info/files/media/media23117.pdf

The Geoscience Concept Inventory WebCenter provides new means for student assessment

Teachers adopt information and communication technologies (ICT) on the assumption that these enhance student learning. In the area of geoscience, new curricula employ tools such as Google Earth to assist with the interpretation of three-dimensional landscapes and the processes that create them. In many cases, the evaluation of learning that occurs through this technology use is neither explicit nor necessarily matched with the overarching curricular goals of ICT. Arguably, assessment should be embedded in curriculum design according to the Backward Design model (Wiggins & McTighe, 2005) for effective instruction. We propose embedded assessment appropriate to ICT, specifically online assessment that takes advantage of automated scoring and feedback mechanisms through the Geoscience Concept Inventory (GCI) WebCenter.

As an instructional tool, the WebCenter contains concept inventory questions that are carefully designed to ascertain a student’s conceptual understanding in a range of geology subtopics. The WebCenter’s customised LON-CAPA platform facilitates the inclusion of digital images created by ICT technologies to assess student learning**.** The WebCenter’s online venue facilitates community participation in assessment development by allowing teachers to review existing questions and submit their own. Furthermore, the WebCenter’s testing function provides an authentic online assessment experience that aligns with ICT practice and takes advantage of its technological capabilities to provide immediate feedback and detect fine-grained data such as time on task.

Currently, portal user activity is limited to viewing and student evaluation on a small scale, with only a small fraction participating in the development of new concept inventory questions. Thus, it may be that on-site teacher training workshops are needed to help initiate partnerships and use of the technology. However, the WebCenter has already made an impact with its online, open-source nature, encouraging participation from around the globe, as evidenced by the number of users (n=130) and range of institutions using the GCI. Statistics collected via online testing with a variety of student populations will allow for powerful comparative analyses of student learning across institutions.

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“What ICTs are the most useful, and how can they contribute to better learning in the science classroom?”

Keywords
Learning, research, secondary school, Information and Communication Technologies (ICT), laboratory work, inquiry approach

Full text
http://www.elearningeuropa.info/files/media/media23254.pdf

An inquiry-oriented approach for making the best use of ICT in the classroom

Many decades after the introduction of ICT into science classrooms, there are still many unanswered questions about the impact technology has on students’ learning. This article addresses the general question**:** “What ICTs are the most useful, and how can they contribute to better learning in the science classroom?” We understand ICT as tools that can enhance particular learning situations or environments and, in this sense, this article elaborates on the most appropriate technologies for particular learning environments and discusses in what order, and with what purpose, these technologies should be used.

The first part of this article highlights the most commonly used technologies in science classrooms, reviewing the unique opportunities they offer that would not be possible otherwise. After discussing the potential (or lack thereof) of these technologies, the second part of the article presents a proposal for using some of them in a specific pedagogical context: an inquiry-based learning cycle for laboratory work. The main aim of the proposal presented here is to discuss how a certain teaching and learning approach, such as inquiry-based learning, and a certain teaching and learning situation, such as school laboratory work, can be enriched by the use of ICT. Finally, a detailed example of how specific ICT are used in laboratory work sessions with an inquiry approach is also explained. This practical case comes from a research-based activity sequence on kinematics and dynamics developed for secondary school students within the framework of the local project REVIR.