The challenge of curriculum by the integration of ICT in the professional practice of the science teacher

Maria Elvira Monteiro & Guilhermina Lobato Miranda Instituto de Educação Universidade de Lisboa Portugal elviraprojectos@yahoo.com; gmiranda@ie.ul.pt

Abstract: The Web has enabled a renewal of the concept of education which includes a new educational model that enables learning anywhere and at any time. The expansion of the Internet allows students to have a more active role in the learning process. The curriculum can be (re) built and integrated in an interdisciplinary way. The educational use of ICT in the formal curriculum may be done through collaborative learning processes of interaction and negotiation of meanings, using diverse tools. Regular use of computers and the Internet in the classroom allows the development, dissemination and evaluation of students' achievements. This article describes an ongoing research which included integration of computers and the Internet in the teaching and learning methods and strategies in the subjects of Biology and Geology in a Portuguese high-school.

Introduction

In 2007 the Portuguese PTE - Education Technology Plan defined what was considered essential to build the Knowledge Society in Portugal, namely the creation of physical conditions to enable the achievement of students and consolidate the role of ICT (Information and Communication Technologies) as a basic tool for learning and teaching in the new era. The presence of ICT in schools is a reality, teachers and students can now focus on what really matters: teaching and learning more and better. To make this possible, schools have been equipped with many computers, have increased teacher training in ICT and Internet portals, with the aim of providing resources and disseminating good practice. However, many of the Portuguese teachers are still afraid of using ICT in their classrooms. Only a few have the courage to do so.

Among the various learning environments enhanced by technology, the Web stands out as a strategy to motivate and encourage learning, due to the great appetite of youths for its use. As the Internet is increasingly used in the context of the classroom, it is imperative that teachers and students take advantage of this resource to construct knowledge and develop skills in the research, selection and processing of information.

Easy access to computers and the Internet enables teachers to take ownership of new tools. For ICT integration to be successful it is necessary for teachers to believe in its relevance. It is urgent that teachers establish bridges between ICT and specific didactics underlying their subjects (Yelland, 2008). A new pedagogy is expected to emergence and encourage at the same time a personalized and collaborative learning network where the teacher's role is to model (Lévy, 1997).

The Study

Given the great propensity of youths to exploit new technologies, the Web can be used as a strategy for motivation and encouragement but also as a means of learning. As the Internet is increasingly used in the context of the classroom students develop skills to use and take advantage of this resource throughout life because they are learning informational literacy skills.

Science education plays a crucial role in educating and training young people as citizens of an information

society, characterized by constant transformation, cultural diversity and growing technological complexity that leads to very diverse ways of being and thinking. From the perspective of the 'Inquiry Instruction Methodology' (e.g. Dewey, 1997; Cachapuz, Praia & Jorge, 2000, among others) the scientific contents are placed at the service of education in order to build concepts, develop skills, attitudes and values from a global perspective of science.

This study is theoretically based on the cognitive model of mediation proposed by Barth (1993) grounded in the social constructivism framework of Vygotsky (1994). It develops in five stages: 1) choose an appropriate way to define the knowledge, 2) express knowledge in a specific manner, 3) involve the learner in a process of elaboration of meaning, 4) guide the co-construction of sense, 5) prepare the transfer of knowledge and the ability of abstraction (making sense of the complex reality surrounding us, structuring).

The strategies we have developed include the teaching of thinking processes together with the syllabus as an integral part of teaching and learning processes (Nisbet & Shucksimth, 1986; Veiga, 2002; among others)

We also planned motivational strategies as they are important for significant learning to occur, as noted by Bruner (1999) where the intrinsic motivation promotes a more durable learning since it does not depend on external reinforcements. The teacher's attitude and commitment is a key to student involvement in proposed activities and plays a key role in promoting students' intrinsic motivation. By choosing educational settings with resources to ICT tools focused on learners, where interactions with peers are common, students make choices and decisions that we believe will enable them to develop a meaningful learning.

The learning and the motivational strategies used were built on the collaborative model advocated by Reid et al (1989).

The central question that guides the research is: How an educational intervention that culminates in the effective integration of ICT into science teaching can be designed and implemented? This intervention involves the regular use of computers in the classroom with different software, development of e-portfolios (Barrett, 2006; Costa & Laranjeiro, 2008), increasing the use of the school's Moodle Learning Managment System and the forums (Harasim, Hiltz, Yeles, & Turoff, 1995), wikis (Augar, Raitman & Zhou, 2006), and the construction of multimedia resources by students. The objectives of this research was to transform the science classroom in an environment rich in technology to enhance learning, to describe this process and to study its impact on students attitudes towards ICT, logical thinking, and students academic results.

Methodology

The intervention took place in the regular science classroom of Biology & Geology and also on the Internet and integrated two studies. The first one involved 75 students aged 15 to 16, from three classes of 10th and 11th grades in the Science and Technology Curriculum. The study lasted for two years (2008-2010), was completed with the national written examination at the end of the second year. The second study involved all students in their final year (12th grade) who attended the subject of Geology. Most of the students are 17 years old.

For both studies we chose a quantitative approach with a quasi-experimental design, combined with a qualitative description and interpretation of the process (Punch, 1998; Tuckman, 1994; Bogdan & Biklen, 1994). The first study began in September 2008, each class corresponding to one of the study groups: experimental group E consisted of 26 students and two control groups, C1 and C2, with 26 and 23 students respectively. Proceeded to completion of pre-test to three groups with the passage of the questionnaires¹: Q1: Demographics; Q2: Collective Scale of Logic Development (ECDL – Échelle Colletive du Development Logique, supported in the theoretical work of Jean Piaget – cf. Balday & Paterne, 1979, and adapted to an representative sample of Portuguese Adolescents by Helena Marchand, 1994); Q3: ICT - use of computer and Internet access (only for descriptive analysis); Q4: Attitudes

¹ Some are constructed only to apply to this research and to obtain descriptive data (Q1 and Q3). Others are adaptations from previous scales developed by other researchers (Q4 and Q5). We have the authorizations to translate and validate these instruments to Portuguese samples. We only show one indicator of reliability (Cronbasch's alpha interne consistence) not to tire the readers. We do not give indicators of the sensitivity of items in each questionnaire, nor do we in relation to construct validity (made by exploratory factor analysis in principal components with varimax rotation) because the original studies did not exhibit these indicators and we are drafting them.

related to the computer and the Internet (developed by Liaw, 2002 - Cronbach's alpha = 0.93, and validated to Portuguese representative and significative samples, first by Jorge & Miranda (2002) – Cronbach's alpha = 0.95, second by Gil Luzio (2006) – Cronbach's alpha = 0.95, third by Micaelo Fernandes, 2006, – Cronbach's alpha = 0.94, and in the present study – Cronbach's alpha = 0.93; Q5: Use of ICT (first developed by Gil Luzio, 2006 – Cronbach's alpha = 0.93, and in the present study – Cronbach's alpha = 0.91). This allowed characterization of the three groups as being equivalent. Each Biology & Geology class had an independent teacher in charge of each group. The distribution of teachers for each class was conducted by the school directly based on years of service. The characterization of teachers' classroom practices was conducted through semi-structured interviews.

Throughout the intervention, data was gathered from different questionnaires about strategies and achievements of students. Some video images were taken too. At the end of the first year all students responded to the new questionnaire Q6: ICT as a resource for learning - students' perspectives. In June 2010 we proceeded with the post-test, 'focus-group' interview (based on the work of Barrett, 2006) and with semi-structured information was included in some open questions.

The second study began in September 2009 and ended in June 2010. The participants were the K-12 students of two Geology classes. Both classes followed the methodology with ICT integration in class based on the same teaching model as study one. One class were taught by the researcher-teacher and another class had a different science teacher who agreed to participate in the experiment and joined the challenge of trying to introduce ICT in his practice from a new pedagogical point of view.

At the end of each term, each student presented her/his e-portfolio to the class. The e-portfolio was subject to assessment according to the model proposed by Hassard & Dias (2009). Most of the students' work was evaluated through the use of rubrics for content items, discussions and oral presentations that allowed the establishment of criteria for self-assessment and peer-assessment. The students also carried out written tests because it is mandatory in the Portuguese Educational System.

Conclusions

We believe that the learning strategies developed allowed students to engage in a process of elaboration of meaning, guiding them through the process of its co-construction; preparing the transfer of knowledge and the ability of abstraction according to Barth's model.

As for the results, we are currently undergoing statistic analysis for quantitative data, using the program PASW (SPSS, version 18.0) mainly analysis of variance and correlations and for the qualitative data by using the program Atlas.ti, version 6.0., which allows a more consistent content analysis. Therefore, we are only able to share a few descriptive data analyses.

It is possible to note that 74.1% of the participants of the second study have a profile on a social network, 29.6% have a blog and 29.6% have a personal page on the Internet.

As for the use of the e-portfolio, in the learning domain, 70% of students answered questions related to the development of skills and competencies, saying that this was a valuable experience. Most students felt that building an e-portfolio enabled them to learn from their own mistakes and about 63% intend to continue to use the e-portfolio throughout life. In the evaluation domain: 85.2% of students feel comfortable using the e-portfolio as part of their evaluation, 81.5% of students fell that the e-portfolio is a good way of assessing their teacher knowledge. For the question, "the teacher evaluates better my knowledge through an e-portfolio than through a written work," 44.4% agree, 40.7% do not know and 14.8% disagree.

In the domain of attitudes, in relation to comments that classmates and teachers left in the e-portfolio, 96.3% of students considered them as constructive criticism that enabled them to improve.

Most students indicated the need to give more attention to the frequent updating of the e-portfolio and the best aspect of using this strategy was that it provided a more direct contact among students, Internet and online publication.

Final Thoughts

We hope that this study help to understand the integration of ICT in the context of formal education in the of Biology and Geology of Portuguese secondary education, channelling students' interest in social networks strategy for meaningful learning. To decrease the gap between ICT and teaching of Biology and Geology through the different tools and strategies, the use of e-portfolio, this seems to be of high importance in terms of formative and summative assessment.

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