Web 2.0 technologies as cognitive tools: preparing future k-12 teachers

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Abstract - In the learning society we live in, educational systems must be aware that to learn and work successfully in an increasingly complex, information-rich and knowledge based society, students and teachers must use technology effectively. It is the classroom teacher who is responsible for preparing the learning opportunities that facilitate students’ use of technology to construct knowledge and to communicate. Situated in the theoretical framework of Papert’s constructionism the empirical study examined the creation of digital resources as an instructional method in an undergraduate-level technology integration course for pre-service teachers of History at the Minho University, Braga, Portugal. Throughout the course, pre-service teachers experienced constructionist pedagogy by using technologies to create digital artifacts, learned more about the different perspectives for integrating ICT in the curriculum and also gained the confidence necessary for them to integrate ICT as a cognitive tool in their future classrooms.

INTRODUCTION

We live in a society often called “information society”, “knowledge society” and, more recently, “learning society” (Pozo, 2002). In fact, most important than having access to the information, is being able to select the most valid and relevant one to transform it into knowledge. In the learning society individuals learns at any place and anytime, in formal and informal contexts, throughout lifelong, because the world in which we live in is competitive and what is advanced and relevant today, will be obsolete and useless tomorrow (Attwell, 2008).

For the school this means rethinking its mission – to build a learning community – and, from there, to implement organizational models that value the role of all the actors involved in the educational process, focused on a very clear goal: to prepare students for a competitive world that values adaptation to change, innovation and creativity. This means understanding the student that we presently have – the so-called net generation – for whom the school must be a prover of qualified information, meaningful and multimedia where the pedagogy of transmission looses its strength giving space to the processes of cooperation, collaboration, interactivity and dialogue, aiming the social construction of knowledge (Amaral & Vilarinho, 2008). It is throughout schooling that the student should have the opportunity to develop technological competencies and the main agent that can help them in that crucial task is the classroom teacher: “The teacher is responsible for establishing the classroom environment and preparing the learning opportunities that facilitate the students’ use of technology to learn, and communicate. Consequently, it is critical that all classroom teachers are prepared to provide their students with these opportunities” (Unesco, 2008, p. 1).

To train teachers to be competent in the use of ICT in favour of knowledge construction is therefore fundamental and recognized by the European authorities (EU, 2007). Meanwhile, what can be observed in the Portuguese educational contexts is that teachers’ training in ICT use has not been an educational priority in the same proportion to the supply of computers and internet access to schools, downsizing the importance of training teachers that use technologies as cognitive tools and assume the role of mediators in the process of knowledge construction, essential in technological environments, whether being face to face or at-distance (Coutinho & Bottentuit Junior, 2008). Recent research shows that although the number of “wired” schools increased across the country, educational practices have remained unchanged: teachers continue to teach in traditional ways and whenever they make use of computers and internet is for personal purposes and less with the intention of enriching technology-supported learning opportunities for their students (Alves, 2008). How to create conditions for this to happen? How to provide training that is capable of leading teachers to use ICT in the classroom as cognitive tools? This issues that trouble us and for what we seek to find plausible solutions. One of this sustained the development of the research project that we came to present and which involved a group of future History teachers who, in the scope of the Educational Technology program,
justified conceptually and created a set of pedagogical activities and digital artefacts for in-class use, taking advantage of the potential of the technological tools available today in the Web.

CONSTRUCTIONISM

The constructionist approach defended by Papert (1980) suggests the idea that human beings learn better when involved in the planning and the construction of objects or artefacts considered important and sharing them with the local community. The object’s external construction process is, in parallel, accompanied by the internal construction of knowledge about itself. The great innovation regarding Piagetian constructivism is the increased value put on the role played by the physical constructions as a support of intellectual constructions. The computational environments constitute powerful tools for the support of these new forms of thought and also for learning with the involvement of the students in the development of significant projects (Resnick, 1998). David Jonassen (2007) synthesized, in a very eloquent manner, the several forms in which computers can be used as cognitive tools for the support of significative learning, which may occur when: a) support the construction of knowledge (representing the ideas in conceptual maps or conceiving multimedia products), b) support the exploration through access to the information and the comparison of different perspectives, c) support learning through practice, such as when it occurs in the simulations, d) support learning through conversation (collaborating with others, discussing and defending ideas), e) support learning through reflection (cf. Jonassen, 2007, p.20-21).

More recently, inspired in Piaget’s constructionism, Richard Sennett (2008) developed the craft’s theory. Craft, as Sennett sees it, belongs to the category of “social capital”, knowledge and skill that are accumulated and passed on through social interaction. According to the author, the teacher is a craftsman who teaches students to develop skills and knowledge for future use. Its role is to create motivating learning situations which involve students, encouraging the so called wonderful ideas that Papert refers to and which reinforce the learning capacity of the individual, allowing distinctive forms of thought, of making use of knowledge, as well as new forms of creating personal and epistemological relations with other domains of knowledge (Sennett, 2008). In the teacher education course we present in this paper the instructor worked to motivate his students by encouraging imagination and creativity. According to Sennett, “…motivation matters more than talent” (2008, p. 11) and through craft, “skills…develop[s] through the powers of imagination…knowledge gained in the hand through touch and movement …that attempts to direct and guide bodily skill” (2008, p.10). By motivating the pre-service teachers in the course, the instructor’ goal is that, in turn, the pre-service teachers will take this level of engagement to their future classrooms.

Also engaging for students is the collective experience that can occur from the making of objects. Making objects involves completing a job and using higher order thinking, especially when students are asked to show and justify what they have done to others (Sennett, 2008, pp. 6-7). The act of discussing and judging others’ work is an evaluative exercise, leading to improvements in the skill of designing and making. This collective experience can translate into group work. In group work, people typically talk about what they are doing, making the experience a social activity that encompasses the creation of some artifact. Student-centered learning through group work is supported in research (Wang et al., 1998; Coutinho & Bottentuit Junior, 2008; Barroso & Coutinho, 2008). Digital content creation experts like Papert and Resnick have applied learning by design ideas to educational technology, allowing students to design and create educational software with positive effects (Papert & Harel, 1991; Resnick, 1998).

In our study students build multimedia artefacts as a way to develop technological skills at the same time that they produced digital resources to use in the classroom. According to David Jonassen (2007) it is important that education programs prepare teachers’ to use technologies in the classroom as cognitive tools that facilitate and stimulate students’ learning. For that to happen, it is necessary that teachers know how to work with technologies in order they are able to design curricular activities that motivate and engage their own students’ in meaningful learning activities.
METHOD

In the second semester of the 2007/2008 school year, in the discipline of Pedagogical Practices – Educational Technology, an innovative training programme was conceived with a group of future teachers who used ICT as cognitive tools which should integrate the teacher’s kit in the context of the learning society (Pozo & Echevarría, 2001). The main idea which was in the basis of the Project regarded the development, among future teachers, of competencies for the integration of technologies in the classroom, as well as a philosophy which values pedagogical strategies in which ICTs are cognitive tools used to help the teacher and the student in knowledge searching, constructing and sharing: “Schools and classrooms, both real and virtual, must have teachers who are equipped with technology resources and skills and who can effectively teach the necessary subject matter content, while incorporating technology concepts and skills” (Unesco, 2008, p.1).

The course took place throughout 15 weekly presencial sessions of 3 hours each, followed by at-distance activities. Ten future teachers from the 4th year of the History Teaching degree participated in the course and carried out the assignments in small groups, either during face to face classes or at distance, in the time period between each of the weekly meetings. The at-distance activities were aimed at finalizing the didactic-pedagogic activities carried out during the presentational meetings, since the access and exploration of the virtual environments requires many hours of dedication. Each teacher in training, according to its own knowledge of the discussed informatics tools, moved forward in the process according to its own rhythm. The non-presentential period was destined to the accomplishment of the theoretical collaborative writing assignments (developed with GoogleDocs) as well as to the reflexion, discussion and evaluation of the subjects proposed during the presentational meeting.

Considering that the subject’s goal was to discuss the pedagogical possibilities of internet use in History classes, a set of technological resources were selected with which future teachers should get acquainted and develop digital resources and pedagogical strategies to be used in classroom context.

The conceptual and pedagogic justification of the use of the tools in the classroom was always a priority in a logic of overcoming the technical and instrumental rationality of ICT use in education, presently understood as true cognitive tools, promoters of learning, autonomy, collaborative construction and knowledge sharing. In that context, in the tasks performed at distance, the future teachers elaborated, based on a list of bibliographical references, texts suggested by the instructor and/or documents selected by them in an oriented research on the Web, three essays on themes suggested by the professor (ICT integration in Portuguese Schools, Educational Multimedia, Web 2.0).

Since we currently live in the Web 2.0 era, we decided that this should be the main theme of the practical activities carried out in the scope of the Educational Technology subject. In this way, in the first class, an informal brainstorming activity was developed with the aim to detect the perceptions/expectations, as well as the previous knowledge of the students concerning the Web 2.0 theme. With this activity it was possible to verify the students’ enormous lack of knowledge either in what concerns the Web 2.0 concept or its tools. Some had already heard about the blog and also knew Wikipedia, but the concepts of wiki, podcast, social bookmarking or social software were completely new to them. However, the curiosity and the enthusiasm they had about knowing and experimenting the referred tools was remarkable.

In the following session, a powerpoint presentation was prepared, presenting the Web 2.0 concept and its underlying philosophy: a new paradigm in internet communication in which the student-consumer also becomes an information producer. Specific examples of educational use of the new generation of Web tools directed towards the History discipline. In the following sessions the students began exploring the different tools in a learn-by-doing logic, which proved itself very effective. In that sense, everyone had to compulsorily create an email account in Google. Besides the individual Google account, each group (the 10 class students organized themselves in 3 groups) also adhered to the Google Page Creator in order to create a webpage which worked as the groups’ e-portfolio throughout the whole semester. In the referred page, besides the elements relative to the personal identification of the groups’ elements (photo, contacts, mini curriculum), all the assignments accomplished by the group throughout the semester should also be placed in the page, such as the assignments carried out in the face-to-face sessions, the written assignments executed in group during the at-distance activities (GoogleDocs), the texts supplied by the professor for discussion or reflexion, the documents that the group considered relevant to sustain the discipline assignments and placed in the accounts created in Del.icio.us, conceptual maps (created in CmapTools), reflexions (posted in the groups’ blogs), etc.
Each group organized its own webpage in a personalized fashion, taking advantage of the functionalities the Web 2.0 tool provides, originating portfolios in very different formats. Available online, when accessing each group’s webpage/portfolio, the site’s visitor could follow the development of the collaborative activities carried out throughout the semester, by each one of the class’s groups (http://multihist.googlegpages.com; http://lucrdo.googlegpages.com/; http://asvcm.googlegpages.com/). The need for a space dedicated to the sharing of ideas, comments to the activities and debates, features that Google Pages did not possess, led to the design of a blog in the Blogger.com tool, which was linked to the group’s site.

Throughout the semester, the future teachers got acquainted and worked with the several tools mentioned above. Each new tool was presented by the professor who always put it into context in order to be used in a History class based on specific examples available on the Web. The potentialities/limitations of each tool were targets of debate, extended to the whole class and, from there, the students, in group, developed a practical task which implied working with the tool and developing a resource/strategy to be used in the History classroom. The conceptual maps were conceived in group and used for the students to spatially represent the concepts examined in the theoretical topics for justifying/sustaining the ICT use in education and in a particular History class. In addition, each group designed a CM on a topic of free choice within the curricular programme of K-12 History level which was presented to the class and saved into the group's site.

For the final evaluation of the discipline were considered all the assignments (theoretical and practical) accomplished throughout the semester and published in each group's website; furthermore, a final assignment was requested which required the accomplishment of a pedagogical proposal to be implemented in the classroom during the following year. This final assignment, carried out in group, should: a) integrate a structured and justified planning of a curricular unit from the Basic Learning programme of the History subject, b) take advantage of one (or several) of the tools explored during the course and c) be a target of self-assessment, by the group, and also of assessment by the colleagues and the professor.

**Instruments for Data collection**

The data collection methods employed in this study were used to assess preservice teachers’ experiences with constructionist Web 2.0 tools as well as to gauge their level of confidence in teaching with the technology in their own future classrooms. Data were collected through direct observation, focus group interviews, comments left on the blogs, the analysis of the group e-portfolios (digital artifacts and written essays) and a final online questionnaire fulfilled by students at the end of the semester.

Direct observation was undertaken by the instructor all along the semester through registers in a diary at the end of each face to face session. Focus group interviews were recorded every time students finish tasks with a new tool; 2-3 questions were presented for debate, for instances: *Now that you experienced to use Camptools to draw CM, what do you value the activity? Is it useful for a History teacher to explore this tool in the classroom?*

The final online questionnaire used a mixture of open and closed questions. It was composed of two sections, the first with 9 items in the format of a 5 five points Likert scale intended to evaluated students’ perceptions on the potential of Web 2.0 tools for teaching and learning History. The second part was composed of 10 items in the same format that assessed students’ opinions on the importance of the ICT program with Web 2.0 for their teacher education. Most items were adapted from similar items used by the author in previous projects (Coutinho, 2006). For each item it was computed the arithmetic mean, and this value was the basis for discussing results; as we used a 5 points Likert scale for degree of agreement (1=Strongly Disagree, 2=Disagree, 3=Neither agree or disagree, 4=Agree and 5=Strongly Agree), we considered the mean of 3 as the cut point for considering the existence of agreement/disagreement. Negative items were reversed for data interpretation and discussion.

**RESULTS**

**Content analysis of qualitative data**

Content analysis techniques were conducted to interpret data obtained during the four focus group sessions realized along the semester as well as on students’ comments and reflections published on the group blogs. Results show that all student teachers’ - except for one regarding the Google Page Creator application - had
no difficulties in using Web 2.0 tools. All participants considered that, among all Web 2.0 tools used during the course, blogs were the most useful and versatile to use for History teaching, because it enhances participation (n=3), promotes interactions (n=3), stimulates writing (n=2) and creativity (n=2). On the contrary, Google Docs was considered the least important tool to integrate in the classroom; two student teachers’ considered it was useful for collaborative group work at a distance, outside the classroom, and another pointed out its usefulness for coaching students with difficulties; however all other participants reported technical limitations associated with the tool (specially Powerpoint facilities) and also its poor usability.

Google Page Creator was also very valued by participants, who reported the intention to use this tool to build a class website, managed by teacher (n=3) or by students (n=2). Limitations were reported – it does not promote interactions, it is rather difficult to build and maintain – but, in general, most participants said they intended to use the tool in the future for classroom activities.

CmapTools software was a true revelation for all participants in the course, particularly considering the fact they were future teachers of History. All comments to the potential of the tool are impressive as one can see in the examples that follow: “As a future teacher of History I will use this tool with my students because it helps them as it helped me to relate concepts and organize the complexity of a topic” or “To develop concept maps allows for one to review a subject, finding points of intersection between contents in order to understand the whole issue. The tool is very useful and intuitive”.

Throughout students’ statements as well as the direct observation of the behavior in the craft of constructing the digital objects for their future students and planning student-centered lessons, we could feel the same positive effects that Harel & Papert (1991) and Resnick (1998) reported when they allowed students to design and create educational software. In fact, applying the content analysis techniques proposed by Bardin (1995) to all written messages left by students we detected a sample of nouns and adjectives that were insistently related to the learning activities related to building digital resources: “interactive”, “motivating”, “dynamic”, “enriching”, “useful”, “interesting”, “creativity”, “engaging”.

Online questionnaire

Web 2.0 as educational tools

Nine items of the questionnaire investigated perceptions on the potential of Web 2.0 as educational/communicational tools. One item was formulated in a negative format in order to avoid a response pattern (acquiescence response bias), and was used to confirm the corresponding positive statement. For each item it was computed the arithmetic mean, and this value was the basis for discussing results; as we used a 5 points Likert scale for degree of agreement (1=Strongly disagree - 5=Strongly agree), we considered the mean of 3 as the cut point for considering the existence of agreement/disagreement. Figure1 presents the results for N=10.

![Figure 1 - Web 2.0 as educational tools](image-url)
The first overall remark is that participants expressed rather extreme response sets either for agreement/disagreement showing therefore a solid opinion regarding this issue (7 statements over 4 and the only negative item=1, what means a 100% of disagreement). We can see student teachers’ considered Web 2.0 as powerful educational tools (It. 2=4.86 confirmed by the negative it. 5=1), important to develop students’ communication and writing skills (It 4=4.71) as well as knowledge sharing (It 8=4.57). Student teachers’ agreed they had developed ICT skills (It. 1=4.57), and that building digital resources with Web 2.0 tools stimulates creativity (It4=4.71), promotes cooperation and collaboration (It 7=4.71). Finally the learning activities with Web 2.0 tools were considered very useful for History teaching (It 9= 4.86).

Web 2.0 tools and the future of the profession

A global analysis of the 10 items (2 in negative statements) that evaluated this dimension show participants considered the learning experience important for their professional development (items 1 and 4 confirmed by the negative value obtained in item 5) (see Figure 2). Participants agreed that the learning activities with Web 2.0 opened new ideas for future teaching activities (It 2=4.71), encouraged to prepare different and more stimulating learning activities (It 9=5) specially for the History classroom (It 7=4.86). The intention to integrate technologies in the classroom is clear to most participants (It8=4.86), even admitting that some schools could not have conditions for integrating ICT in the classroom (It6=2). In sum, for pre-service teachers to use Web 2.0 tools in the classroom are indispensable competencies for any 21st century teacher (It 10=4.86).

![Figure 2- Web 2.0 and the future of the profession](image)

A final open-ended question closed the questionnaire and asked students’ to give an overall opinion on the ICT training program as well as suggestions for further editions. All statements test upon the importance of building digital artifacts as a key factor to increase ICT skills and develop teachers’ comfort with classroom technology integration. Future teachers’ much valued the importance of contextualizing technologies into the curricular programs of History teaching as a way for encouraging a student-centered tool-based pedagogy. They considered they had to work much more outside the classroom sessions and that one semester was not enough for developing all the activities proposed by the instructor: more time was needed to handle the tools and more time to discuss and reflect upon the pedagogical consequences of ICT integration.

**FINAL REMARKS**

In this paper we presented the results of a research project developed in an Educational Technology program with a group of ten pre-service teachers’ of History. The main goal of the project was to engage students in the activity of building digital resources with Web 2.0 tools that could function as cognitive tools to integrate in the real classroom.
Results show that for participants it was a surprise to verify that technologies had so much to offer to educators, enhancing learning environments and encouraging knowledge deepening and knowledge creation. The involvement and the enthusiasm in the different pedagogical activities, the quality of the artifacts produced and published on the web, the opinions obtained from online questionnaires, interviews and written open reports show that most future teachers had a firm intention to use internet resources for pedagogical purposes in the year to come (induction period). It was also clear for future teachers that the successful integration of ICT into the classroom depends on teachers’ ability to structure the learning environment in non-traditional ways, developing socially active classrooms and to use technologies as cognitive tools in the curriculum.

There are different goals for integrating ICT into the school curriculum and teacher education programs: ICT as a subject of study, ICT as a tool for learning and ICT as integral to both matter and pedagogy (Downes et al, 2001). Our project highlights the importance of integrated approaches in ICT-based teachers’ education as a key to develop positive attitudes towards technologies and to enhance the adoption of constructivist learning settings in the classroom routines: “Schools and classrooms, both real and virtual, must have teachers who are equipped with technology resources and skills and who can effectively teach the necessary subject matter content while incorporating technology concepts and skills” (Unesco, 2008, p. 1). The innovative nature of the pedagogical practices with ICT if not accompanied by training actions that can stimulate a practical and reflective practice among teachers, does not have, by itself, the capacity to operate great changes in the teacher’s pedagogical practices (Austin, 2004; Timothy & Jacobson, 2005). It is important to invest in initial training models which allow teachers to create digital learning resources, to share problems and to explore new ideas with the instructor and with their peers (Baylor & Ritchie, 2002). If we don’t show teachers how technologies can be used as tools to learn and communicate then we will have a generation of highly competent monolingual technicians with nothing much to say!

LIMITATIONS

The number of participants in the study was relatively small and limits the scope of the study. Future research with more participants will certainly lead to more robust results. The course instructor was also the researcher and the single evaluator of the experience. The data presented in this paper are only an initial feedback from the pre service teachers perceptions and expectations and we are considering the possibility of interviewing the participants in this study within a year in order to verify if they really have developed similar experiences in the real classrooms.

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