Promoting ICT use in Portuguese schools.
A case of school-university collaboration

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Abstract

In this article we analyse a four-year period of collaboration between 36 k-12 schools and a higher education institution concerning ICT integration in the light of theoretical perspectives on educational change and innovation. The school and a team of experts of the University designed each integration project collaboratively, the school's needs were identified and actions were implemented to train teachers on ICT use and to give support to the integration of technology in their practices. Identified factors for successful integration are discussed within the frame of school-university collaboration contributing for the design of future similar initiatives.

Keywords

Introduction

Institutional collaboration by means of educational partnerships, namely between university and schools has been designated as a powerful strategy for change and reform in school settings. In recent literature review about this issue, collaboration is seen as a process that enables a broaden and shared vision of educational challenges leading to the generation of novel and more effective solutions, and to the willingness to change (Cohn, 2003). A sustained discussion about the gap between educational research and school practice as a major factor for the unsatisfactory implementation of innovations in the school and in teaching practice recommended, among other factors to overcome this situation, closer relationships between schools, teachers' professional associations and institutions of higher education and research, in order to promote communities of researchers and teachers.

School-university collaboration was a major strategy followed by two national programs for Information and Communication Technology (ICT) dissemination in Portuguese educational settings that attained expressive impact on schools: the Minerva Project that spanned from 1985 to 1994 and the Nónio XXI Century Program that promoted the collaboration of both higher education institutions and schools. From 1997 to 2001 the program funded schools' projects.

The Minerva Project was a nation wide program that aimed at promoting information technologies in both compulsory and secondary education. It involved several departments of the Ministry of Education, universities, polytechnic institutes, that became important nodes for the dissemination of ICT in elementary, middle and secondary schools. In some circumstances it also involved collaborative work with local authorities and enterprises.

The computer approached as a tool for pupils' learning was one of the major strengths of the program that led to innovative practices associated with project work such as, information search and management, information processing, problem solving, challenges, exploration and discovery (Ponte, 1994). Another Minerva's major strength was teacher education on ICT use. The development of appropriate modalities for training teachers using ICT as tools for learning stimulated the attention of educational researchers who started to approach the teacher as a major key for educational innovation to occur. Both strength and innovation was the de-centralised organisation of the project in *nodes* located in higher education establishments and composed by university professors and teachers from different teaching levels.

> Regardless of their own specific activities, all the nodes, generally speaking, carried out a set of common activities. These ranged from the provision of equipment and software to schools, training and support for teachers wanting to use IT, organisation of meetings, seminars and conferences, production of material, preparation of publications and, in general, curriculum development activities (Ponte, 1994, p.129).

During the years of Minerva activity nodes specialised differently. Some nodes centred on teacher training, others in the production of software, and the remaining in a range of specialities.

The Nónio XXI Century Program was a nation wide program launched by the Ministry of Education in order to promote and encourage the production, application, and utilisation of ICT in the educational system. Schools applied for funding with projects involving the use of ICT and special structures were created and funded – the Nónio Competency Centres – with the purpose to support schools' projects. These centres also functioned as cores for reflection, study and research about relevant issues for an effective approach of ICT in education. Many competency centres related to former MINERVA nodes, which has enabled to put into action much of the experience and knowledge, originated from that program. Associations of schools that, presently, play an important role on inservice teacher education constituted a significant number of competency centres.

Nónio competency centres throughout the country showed different structure, organization and specialization. However, a basic structure – the Centre's Team - has been common among them: the unit formed by the coordinator and a small number of teachers (one for each 10 schools associated to the centre) who, with the permission of the Ministry of Education, were released from school activities for renewable periods of one year. These teachers, in general with previous experience on collaboration with higher education institutions, ensured continuous connection among schools and between these and the Centre with the purpose to enable collaboration.

School-university collaboration despite the advantages it brings to the adoption of innovations and subsequent change and renovation is a difficult aim to pursue. Wiske (1989) characterized the relation between schools and universities as a "fickle romance" given the substantial differences that exist among them concerning culture, autonomy, decision-making, and professional conduct.

It is our assumption that studies centred on actual experiences are relevant contributions for a better understanding of school-university collaboration leading to improved practices with positive effects in any project involving the integration of an innovation – ICT in this case – in schools. This is the case of a collaboration that has occurred between k-12 schools and a higher education institution during a period of 4 years (1997-2000) in order to integrate ICT in regular practices of the schools. Within this framework the purpose of this paper is to evidence issues, extracted from that case, which may contribute for a better understanding of school-university collaboration processes as a factor for successful ICT integration.

An overview of literature about change and diffusion of innovations and about school-university collaboration follows this introduction. Next section contains a description of the school-university collaboration that took place emphasizing relevant elements for ICT integration that emerged from the process. Last section contains a discussion about identified factors for successful integration within the frame of school-university collaboration contributing for the design of future similar initiatives.

Diffusion of Innovations and Change

Based on Rogers' definition of social change (1995) educational change is meant in this article as the process by which alteration occurs in the structure and function of an educational system. Change occurs when new ideas or an innovation are adopted leading to certain consequences in the educational setting in which it takes place. Fullan (2001) clarifies that educational change involves change in practice according to three dimensions:

> (1) the possible use of new or revised *materials* (instructional resources such as curriculum materials or technologies), (2) the possible use of new *teaching approaches* (i.e., new teaching strategies or activities), and (3) the possible alteration of *beliefs* (e.g., pedagogical assumptions and theories underlying particular new policies or programs). (p. 39)

For Rogers (1995, p. 11) "an *Innovation* is an idea, practice, or object that is perceived as new by an individual or other unit of adoption." ICT can be an innovation for teachers who may have known about it "for some time but not yet developed a favourable or unfavourable attitude toward it, nor have adopted or rejected it." (p. 11)

According to Fullan (2001) the history of intensive educational change is less than half a century old, and started around the 1950s. Since then, many perspectives on the issue have evolved following the social and cultural influences that schools have undergone and change has been proved a difficult endeavour by different authors who comment a persistent absence of it in the classroom despite all the efforts undertook. A wide set of models have been proposed aiming at successful change. Fullan (2001) summarizes educational change models proposed in research literature as a three-phase process. Phase I – *initiation*, also called mobilization or adoption involves a decision to adopt or proceed with a change. Phase II – *implementation* or initial use lasts for most cases the first two or three years of the process and includes the first experiences to put an idea or an innovation into practice. Phase III – *continuation*, incorporation, routinization or institutionalization implies a decision about keeping up the process of change or leaving it. In this context, change is a nonlinear process since events at one phase may turn back and interfere on events at previous phases and many factors working in combination influence each phase. Moreover, it is not an individual process but the result of the interrelations between groups of people in different contexts.

Concerning change in the scope of integrating technology in different settings, including educational ones, two models have been largely referred in specialized literature: the model developed by researchers in the former Apple Classrooms of Tomorrow (ACOT) group (Dwyer, Ringstaff, & Sandholts, 1990; Sandholts, Ringstaff, & Dwyer, 1997) and the model of diffusion of innovations developed by Rogers (1995).

The ACOT model includes four phases encountered by teachers from the time they start using the computer with students until they become experienced. This evolution involves important changes in teachers' beliefs and practices. The phases are: (1) *Entry*, involving introduction of devices in the classroom as well as restructuring the classroom; (2) *Adoption*, involving the teachers' implementation of the technology to support familiar methods and materials; (3) *Adaptation*, in which the new technology becomes thoroughly integrated into the traditional classroom practice; (4) *Appropriation*, when teachers come to understand the technology and use it effortlessly as a tool to accomplish real work. This

phase generally comes after two years of experience in which teachers interact with colleagues and other professionals in the school and beyond, sharing difficulties and successes, reaching new levels of awareness; and (5) *Invention*, a placeholder for further development by teachers and for new learning environments they will create.

Rogers (1995) defines diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system. Decisions are not authoritative or collective, consequently members of a given social system face their own innovation-decision that follows a 5-step process: (1) *Knowledge* occurs when an individual (or other decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions. (2) *Persuasion* occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation. (3) *Implementation* occurs when an individual (or other decision-making unit) puts an innovation into use. (4) *Confirmation* occurs when an individual (or other decision-making unit) seeks reinforcement of an innovation-decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation. This means that individual decisions depend on the innovation-decisions of the other members in a certain project involving change. We adapted the five categories of adopters described by Rogers (1995) to the school context. These categories interfere with each other with an impact in the change process: 1) *innovators* – venturesome, with sound knowledge and experience about the technology, and many sources of information, 2) *early adopters* – teachers with prestige in the school and respected by their peers. Show positive attitudes toward the innovation which is perceived by his/hers colleagues as an example to follow, 3) *early majority* – constituted by teachers who grasped the potentialities of ICT before most of their colleagues but who do not hold a position of opinion leadership in the school. In general they take a certain time before completely adopting the innovation. Using Rogers' words: they follow with deliberate willingness in adopting innovations, but seldom lead" (1995, p. 265), 4) *late majority* – formed by skeptical teachers who adhere to initiatives related to ICT because of the pressure they felt from colleagues, and 5) *laggards* – who tend to be suspicious and resistant to the innovation. They are the last group to adopt the innovation and they only do it when they'll be certain that it will fail.

Change is an emotionally loaded process, since the actors, either individuals or groups of individuals have to deal with the uncertainty that the innovation brings. All the models presented in this review entail communication and collaboration among participants with different expectations, attitudes and expertise regarding the innovation. The quality of these complex social interactions determines the success or failure of any project involving change in participants' common practices. Therefore, collaboration needs a careful and timely planning as well as a continuous building process in which every participant plays a specific role.

Developing School-University Partnerships

Under the scope of Nónio XXI century Program the Nónio Competency Centre of the Faculty of Sciences of the University of Lisbon (FCUL Nónio Centre) collaborated with 36 schools from 1998 to 2001 with the purpose to implement in each one of these participant schools ICT-based projects with a focus on science, mathematics and technology. 19

schools (4 primary, 7 middle, 8 secondary) initiated the partnership in 1997. 17 schools (1 kindergarten, 5 primary, 3 middle 7 secondary, 1 private all levels) were added to the initial number later in 1998. All these schools were awarded a grant from the Nónio XXI Century Program in order to develop a three-year project on ICT integration. A contract was established with the Ministry of Education, the direction of the school, and the teacher who was the coordinator of the project. This way the projects were recognized within and beyond the school in which the school direction accepted the commitment to grant the necessary conditions enabling the development of the project. The FCUL Centre's Team was formed by the coordinator, a full-time professor and researcher at the Faculty of Sciences, and three teachers from the areas of physics, biology, and mathematics who had been released from activity in their schools (middle and secondary). These team teachers had different degrees of expertise on educational use of ICT, educational research, and collaborative work. Whenever needed (given the nature of a school's project) the team was complemented by other professionals such as two primary teachers and one expert on multimedia communication. About 30 professors belonging to the Faculty of Sciences staff showed availability for providing scientific support.

The collaboration was initiated by each school's request for support from FCUL Nónio Centre in order to design a project proposal to submit to the funding Nónio sub-programme. A number of schools were familiar to proposal submitting and were looking for a clarification about the programme demands and approval criteria concerning ICT implementation strategies. Other schools, especially those that applied the second year of the sub-programme, showed several difficulties not only regarding ICT implementation in the school and integration in the classroom but also concerning project building and the formalization of project proposals. Overall, the role of the FCUL Nónio Centre in this first stage of the partnership consisted in giving guidelines about how to conceive and design a project involving the statement of clear objectives, the creation of consistent activities and the definition of adequate evaluation procedures. Working sessions with the participation of members of the Centre and coordinators of each participant school were dedicated to discuss and decide the appropriate ways to integrate ICT according to the school's specificity and teachers' expectations as well as to updated research-based principles for ICT use in science, mathematics, and technology in teaching and learning.

After the project's approval, new working sessions were conducted aiming at defining the kind of collaboration between the school and the FCUL Nónio Centre. A negotiation took place in which the implications of ICT integration on innovating both the school and teachers' practices was approached according to criteria adapted from former ones suggested by Cuban (1986) to describe the impact that any technology has on schools: *accessibility*, *purpose*, and *extent of use*. A*ccessibility* refers to the set of conditions that determine the extent of computer availability, such as the number of working sets in the school, the number of teachers sharing each set, the level of maintenance, and the number of software programs available. *Purpose* encompasses the kinds of situations that teachers consider appropriate for using the computer, for instance, to deliver basic curriculum, to provide enrichment activities, or to fulfill the "empty" periods that always occur during the school day. *Extent of use* refers to the ways the computer is used, when it is used, and how often it is used. At the end, an agreement was established between the Centre and each school containing a definition of the types of support the Centre was expected to provide and the respective price.

Guidelines for Action

The overall project of FCUL Nónio Centre presented a flexible design open to continuous renovation and to progressive update in order to respond to the schools' needs. However, a core of fundamental principles, mostly grounded on principles and theories in the domain of science education, mathematics education, ICT-based approaches to education, and educational change, guided the team's decisions and the type of intervention. These guidelines were:

- ICT provides a wide range of tools for teaching and learning.
- ICT does not necessarily promote change, but enable a diversity of uses that are adjusted to student-centred, constructivist approaches to teaching.
- ICT is continuously evolving. Continuous updating, discussion and research about new materials and possible educational uses with implications in teaching practices are needed.
- The adoption of ICT by teachers implies the development of meaningful, authentic contexts in the classroom.
- Project-based learning and problem-based learning are adequate methods to train teachers on the use of ICT as a tool for teaching and learning.
- The success of ICT integration leading to change in teachers' practices implies collaboration in all phases of the process.
- School-university collaboration needs a careful and timely planning as well as a continuous building process in which every participant plays a specific role.

Integrating ICT: A Collaborative Endeavour

Working sessions between the FCUL Nónio Centre and each participant school took place throughout the entire 4-year period with the purpose to clarify the appropriate support given by the Centre. From the analysis of each school's project a range of support modalities were implemented: teacher training workshops centred on topics relevant for the concretization of the projects, seminars on themes of interest, short sessions on a specific topic requested by a school, and specific continuous support.

In a later phase, and as a result of what was going on in each school, new modalities of workshops and seminars were designed and implemented, respectively *collaborative contexts* in which teacher preparation was framed within the study of a certain science topic and *sharing spaces* for presentation and discussion of each school products and results.

Workshops

Twenty workshops were designed and implemented throughout the project in order to encompass a range of topics, in science, mathematics, education, and technology addressed to different schooling levels, and involving different kinds of technologies as well as to topics relevant for understanding and managing ICT integration (table I).

Table I - *Workshops offered*

Technology	Science	Mathematics	Primary	Integration
Educational use of Internet	ICT as resources for experimental work in the Science classroom	The dynamic of Geometry through ICT	Using the computer in primary schools	ICT and project work
Multimedia design and publishing I	Data logging in science	Technology in mathematics teaching	ICT in the school	Management and innovation
Multimedia design and publishing II		Internet in mathematics teaching and learning	Using ICT in kindergarten and primary schools	Assessing school organization
Internet publishing I	Internet in science and mathematics			
Internet publishing II	Science in space	Graphical calculators		
	The ocean in the school's laboratory			

The workshops shared a common model of 50 hours (25 hours in-presence and 25 hours of work in the school in order to use materials in development) and were integrated in the national system for continuous teacher education earning 2 credits by the official entity that leads teachers' career progression. These workshops were mainly practical and aimed at exchanging experiences among participants, approaching questions raised by each project implementation, updating and disseminating innovative practices, reflecting and solving problems of both practical and didactical nature regarding ICT integration in classroom activities.

In-presence sessions ran preferentially in participant schools that offered their facilities in a rotating system encouraging exchange among participants in order to build a network of people sharing many interests and facing the same kind of uncertainty. The participation of more than one teacher of the same school in each workshop was encouraged expecting that such groups would constitute more effective dissemination vectors of ICT-based teaching practices developed in the workshops. It was also expected that these groups would function as support groups facing the sense of isolation that many use to feel in their schools. Emotional support from colleagues with the same kind of intervention in the school emerged as an important issue.

Using Rogers' nomenclature (1995) these initial groups were mainly formed by early adopters (in general the project's coordinator) and teachers belonging to the early majority. Later workshops attendance was formed by early and late adopters and in the end almost exclusively by late adopters. In general the workshops were highly accepted by participants as they demonstrated in their evaluations. However in the last year of the schools' projects a decrease in participation quality was observed as well as difficulties in recruiting teachers for the workshops. An analysis of the situation revealed that most of these teachers had low motivation toward ICT. Special attention should be given to these teachers in collaboration

with each school direction. The project format of the Nónio XXI Century Program, despite observable qualities, revealed this limitation concerning widening ICT integration to all teachers in the schools.

Seminars

Several seminars were organized throughout the project, dealing with pedagogical and scientific issues related to the projects in development. Progressively, participant teachers asked for opportunities to share experiences with colleagues from other participant schools and with experts and researchers in the field of ICT in education. Accordingly, several seminars, called sharing spaces, were organized enabling schools to present and discuss issues related to their projects and experts – FCUL professors – to present updated perspectives relevant for the discussions. These spaces constituted rich contexts for reflection and originated many statements and hypotheses that were the basis for a critical view about ongoing work. Several factors for ICT integration were identified and published (European Schoolnet, 2001).

Other ICT Integration Support Modalities

Short sessions lasting about 4 hours were also organized according to schools' request focusing on specific technical issues related to the integration of a certain technology. These were materials belonging to the school, such as calculators, webcams, data logging stations, computer based laboratories, specific software such as Sketchpad.

Another modality was specific continuous support. At school's request a member of the team could intervene as a consultant of the project, giving continuous assistance to the school. This kind of support was requested in the beginning but it was very difficult to keep because of the Centre team's lack of time.

Dimensions of Change

The project between the FCUL Nónio Centre and the 36 schools had visible impact in the schools where deep changes were observed with different intensity levels in a range of dimensions.

Concerning accessibility to the technology new hardware was acquired, the old one was updated, and new access modalities were designed. New and diverse access points were created reaching far beyond the former concept of "computer lab". In many schools the computer became a regular tool for a wide range of activities available to every school member. Different kinds of hardware and software were added as resources for the development of each school's project, such as: data-logging tools, graphical calculators, probes, computer-based laboratories, and digital cameras. The range of teaching aids was also enlarged especially in the field of projected visuals, Powerpoint and video projector became increasingly used substituting the old overhead projector. New kinds of software became a presence in some classrooms: simulations, modelling applications, specific

software for Mathematics and Geometry such as CabriGeometre, and Sketchpad, among others.

Access to information changed radically with networked computers in the school connected to Internet. Some schools developed Intranets changing the information flow within the school. Internet became accessible in different locations, especially in the school's library or resource centre, expanding the sources of information available to students. Communications changed too with the increasing use of email and instant messaging. Schools' involvement in international projects gained new dimensions with the use of communication tools available in Internet.

Most schools designed and published their own website and became visible to a wider range of people. New instructional materials emerged such as lesson plans involving the use of ICT in different disciplines, CD-ROMs with students' projects, webpages in the school's website showing the productions of teachers and students. A much wider range of instructional materials and activities became accessible to the teacher through Internet, stimulating diversity in classroom strategies and, hence, students' motivation.

Changes in teachers' purpose and beliefs about ICT use were also observed. Formerly seen and mainly used as a tool for teachers' management tasks (e.g. tests, grading, handouts) and as a teaching aid to deliver basic curriculum, new perceptions arose about ICT as a tool with the potential to bring to the classroom student-centred experiences not possible before. Much attention has been paid to the enormous information processing possibilities of the technology, resulting in different strategies to approach Internet in the classroom.

In spite the obvious widening of perspectives about the role of ICT in the educational field, the extent of use was irregular. A brief analysis of the situation concerning ICT in 35 participant schools (one was closed) done in 2005 revealed that 15 schools presently use ICT extensively on a regular basis; 10 schools are still dealing with problems related to ICT dissemination, and 10 schools are not using it significantly.

Blueprints for Future Projects of Collaboration

A comparative analysis of the conditions of the schools that reached different degrees of success revealed that higher successful ones had a strong project's coordinator who kept his/her leadership throughout the entire project. This teacher with high status in the school was able to maintain fruitful professional relations with the direction, acting as a mediator between colleagues and organizational structures of the school. With the FCUL Nónio Centre he/she was the contact person but especially an interlocutor, giving feedback concerning the Centre's actions and suggesting about what to do next. In general he/she was sustained by a stable group of teachers who had high participation in the Centre's initiatives, forming a support group for the integration of ICT in their practices.

Another distinctive issue was the continuously supportive attitude of the schools' direction committed to the projects' objectives. The school's direction has been described as a major factor for successful innovation in school contexts (Chagas & Abegg, 1996). The direction in this case acted as a facilitator creating supportive conditions, solving technical problems, adequately managing participant teachers' schedules and recognizing the relevance of the project within the school community.

Regarding the school-university collaboration that took place workshops and seminars were central for the process of ICT integration. Even the schools that had lower success experienced some change and innovation infused by the teachers who attended the sessions. The social structure that was created was particularly fruitful. Groups of teachers from different schools working on the same themes easily engaged in confrontation of ideas and perspectives. Sessions in different schools were also an opportunity for exchange and widening of perspectives since participant teachers could contact different school cultures with different organization and observe how the same kinds of problems were solved differently. Seminars reinforced the social interaction among participants from different schools allowing exchange of experiences and ideas. These seminars were also a place for scientific and pedagogical update highly appreciated by teachers who usually did not have easy access to this kind of information in the school.

Different results observed in different schools suggest that the support given within the scope of school-university collaboration should have a stronger individual dimension, allowing schools to develop their projects at different rhythms according to existent conditions. More attention should be given to the attendance in the workshops encouraging the formation of heterogeneous groups (early majority and late majority) from the same school and the creation of supportive groups within the school with the help of the coordinator and the direction. School-university collaboration should be continuous and not dependable of 3 years cycles which in some cases were a definitively short period for successful ICT integration having in consideration the change in school organization and teachers' practices that it demands.

Particularly influent issues related to the Nónio XXI Century Program were: i) the formal recognition of each school project by the Ministry of Education raising the status of the project within and outside the school and originating a commitment of the direction of the school and the associated Nónio Centre for the project's good achievement; ii) the direct financial support to the schools making them responsible for the selection and acquisition of equipment and services. High involvement of the commercial providers was observed as well as the acquisition of material adequate to the actual needs of each school.

From the analysis of the ICT integration process we experienced emerged two new guidelines for action that should be taken into account in future projects. The school-university collaboration as a creativity tank since it enables informal, non hierarchical kinds of interaction among people with different expertise in the fields that have implications on ICT integration in educational settings, and the school-university collaboration as a promoter of rich social interactions among participants levering them up to higher levels of ICT use in their teaching practices. The evolution ICT has experienced in the last five years give new perspectives and possibilities to this kind of collaboration given the increasing accessibility of Internet-based communication tools that open new channels for social interaction and collaborative work to happen in the frame of the schools' regular conditions.

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