

Assisting or creating the future?

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Abstract: The goals, methodology and results of the EducaDi Project (Distance Learning in Mathematics and Science) are discussed. This project was supported by the CNPq, the Research National Council in Brazil. The purpose of this project was to develop new models for the educational virtual networks. The project assumed that the introduction and use of digital technologies must be supported by structural, operational and cultural changes in the schools. It required understanding the learning process and the cognitive, moral and social development of the learners. New roles and practices were designed to change communications and interactions among teachers, students and knowledge. The methodology used was a new interdisciplinary approach to learning projects. Key success factors were the ability to cooperate in groups and to create new forms of information search and data organization as well as the flexibility to acquire the skills required for new jobs, including research skills needed for the production process.

Keywords: Virtual networks, school culture, teacher interactions

1. INTRODUCTION

We are, no doubt, living a process of fast transformations in the form of living with great advancements in the area of communication and information processing. It has become almost impossible to plan in advance, to define what has to be learned, and which skills are necessary, in order to inhabit this “new world.” When we speak of education, though, we can be sure of some needs:

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- To update sources of information and to develop new talents/skills, in all areas.
- To develop attitudes and values for the autonomous and co-operative conviviality.
- To develop new skills for the same profession, whose activities vary, and are easily transformed.
- To develop skills which permit changes from one profession to an emergent one during lifetime.

The great majority of the educational methodologies, and of technologies presently taught in the courses of teacher preparation, has proved inefficient to help the student to learn and to develop new talents. How can we offer opportunities to the new generations to develop their talents in science and beauty, in solidarity and harmony? How can we help them to know, to construct new worlds of distributive exchanges, of positive administration of the conflicts and of the adventures? Such questions disturb and challenge us to search new answers. What should we do?

The necessary shift has occurred from an empiricist practical view, control and manipulation of the changes in the learner's behavior, that has oriented the pedagogical practice, to a problem-solving constructivist view, favouring the interactivity, the autonomy in formulating questions, the search of innovative resources. Some feel that the arrival of the computer technology at schools will not simply introduce the external social changes. Is it possible that this arrival will offer new possibilities for us to search for contextualised information, the experimental confirmation of the critical analysis?

It is called a shift because school systems are organised for a general and standard model of functioning. So, to change from an empiricist view to a constructivist view requires that practising educators put everything we have been trying and dreaming into practice.

In Brazil, only a few teachers working with small groups of students have been able to experiment with innovative practices. These practices have not been disseminated and have not become generalized. May help ICT to enrich the learning environments, to expand the classroom spaces, overcome time barriers, to serve as cognitive "prosthesis"? ICT may help to expand the social-affective processes and the awareness to assist the learners as true agents of their own learning. ICT may guarantee the collective inter-communication, and help to create learning and development communities. How and why can this happen?

Up to now, in the Northern Hemisphere, the evaluations have indicated the denial of these possibilities. Only very recently the need of the change from the empiricist model to the constructivist one started to be discussed.

This is reason we have emphasised the need to investigate how to change the paradigm, and how to apply new technologies to our school system.

This paper analyses some common experiences of the EducaDi Project, Distance Learning in Mathematics, Science and Technology. The project was supported by CNPq, the Research National Council of the Ministry of Science and Technology in Brazil. It was developed with four regional centres, in 29 public elementary and secondary schools during 1997 and 1998. The author was the national co-ordinator and co-ordinator of a regional centre. She worked together on the project with the professors Schiel Dietrich, Mauro Pequeno, and Maria da Glória Noronha Serpa, all researchers from public universities in different regions of our Brazil.

2. THE PHYSICAL AND CULTURAL SITUATION OF THE SCHOOLS

Brazil is a South-American country with a large extension of land, formed by 27 federative states where the population (more than one hundred and sixty million people) lives in diverse contexts. A strong national identity is shared by communities with different historical and geographical backgrounds, all speaking the same language, Portuguese. The possible implementations of the educational system must also take into account the extreme social contrasts. The country has one of the highest levels of concentration of income in the world. There is a great diversity of situations in the public state educational systems.

In the last 30 years there have been successive curricular reforms in the Brazilian secondary level education. One of them, in 1971, consisted of the transformation of the existing secondary level schools, that offered three types of training (scientific, classic or technological studies) into a general secondary school offering a low level professional training, named "professionalizater," to be developed in a short time. The curricular propositions aimed to prepare "auxiliary workers" in different professions. However, study time was cut down and the content of each subject was strongly reduced. The schools did not have the concrete conditions to develop the practical activities. This reform failed in both aspects, basic and professional formation.

One new curricular reform was initiated gradually, whenever the cracks in the educational system started to show and when democratic governments returned to govern the nation. At the present, the system is structured with an emphasis on basic studies, represented by the eight years of fundamental education for all. The professional training has then been assigned to specific technological schools. The three years of secondary level are named

"medium teaching" that has to complement fundamental studies. Their legal foundations are in LDB law #9394 / 1996. In search of substantial changes to adapt the National System of Education to the new social, economic and cultural changes in the world, and in search of new solutions available to promote human and social development in our Country, the ongoing reform states in "Diretrizes Curriculares para o Ensino Médio" approved in June, 1998. The Guidelines of the LDB Law point to General Directions and not to Specific Points:

Article 21 - The school system is formed by:

- I. Basic education that includes Kindergarten (3-6 years old) Fundamental Level (7-14 years old) and Secondary Level (15-18 years old)
- II. High Level Education

In this article of the law, the secondary level must then become a progressive expansion of the fundamental level, the universal public and free education as the right of all citizens.

Article 35 - The secondary level is the final phase of Basic Education. It must then provide the basic preparation for work and citizenship obeying principles of identity, sensitivity and equality by:

- A. Stimulating creativity, the spirit of invention and curiosity about the unknown;
- B. Developing the acceptance and the ability to cope with the unexpected; and
- C. Leading to the recognition of and respect for the individual and group differences and values.

The general preparation for work should be basic, that is, for everybody and for all kinds of work, emphasising the ability to go in learning.

At the moment in Brazil, there is no obligatory sequence of content for each of the school years. Each school receives national general guidelines and chooses content according to the contexts of the community. In spite of this, the textbooks widely used throughout the country present a very similar arrangement of content. These arrangements also are very similar to standard lists from the NCTM Web site (www.nctm.org). The insufficient amount of public schools to meet the needs of the population within the age groups of secondary level is still a barrier for the democratic life.

The major problem remains the educational culture, the conceptions of the educators that resist using these new possibilities. In many schools the curriculum has been designed into parallel, segmented courses, overloading the content of each subject, because the time for teaching is scheduled into pre-defined periods. The teachers teach the same content in the same way, in the same amount of time for groups of hundreds of students.

Some progress has been made. During ten years, for instance, in the SPEC Project/CAPES/MEC/1885-1995 (Science Teaching Enhancing Program) produced new instructional materials and teacher training in accordance with the innovative methodologies of teaching. A large number of texts, books, experimental kits, instructional materials were produced by researchers and experts in the technology of science education.. Teachers were trained. Research projects were developed to test and to evaluate their applications. These results were restricted to the inner groups of their authors. The dissemination was localised and restricted.

During the year of 1996 researchers proposed CNPq, a consortium between four centers in the country to develop the EducaDi project, because they wanted develop experiences connecting teachers and students from different situations to form a learning community. There were some similarities between the schools, such as:

- A. All the schools were public and situated in marginal urban zones.
- B. The students came from low income population and had little access to ICT.
- C. The schools were in the Basic System, fundamental and secondary level, that included 7 to 18 years old students.

On the other hand the cultural, historic and geographic conditions of these populations were very different in aspects such as ethnic, tradition, economic resources, economic production, weather, landscape, work, industrialisation, means of transportation, parents instructional level, and artistic expressions. However, two conditions supported these experiments. First, there were well-defined policies in the Brazilian educational system to favour the use of ICT in the public schools. Second, many teachers wanted to use ICT according to the constructivist approach.

3. THE STRUCTURE OF THE CONSTRUCTIVIST LEARNING ENVIRONMENT

The purpose of this project was to develop new models for the educational virtual networks. The project assumed that the introduction and the use of ICT in the school must be supported by structural, operational and cultural changes.

The rationale of this project was designed using a genetic epistemology which enhances a constructivist understanding of learning process as well of the learner's cognitive, moral and social development. However, the project tried to address questions about the fast transition in the shift of paradigm in the interchange between the partners of the team of educators and researchers. The resources in the space of the server were organised to meet

both the needs for a pure constructivist approach as well as the needs for a content delivery service. The difference is more or less control of the activities about information search and the decision making by students.

3.1 Implementation of interactivity

The virtual learning environment is online and utilises a Windows platform, because all the schools use PC compatible computers. We developed the resources to assure interaction in two kinds of interactive communication, synchronous and asynchronous.

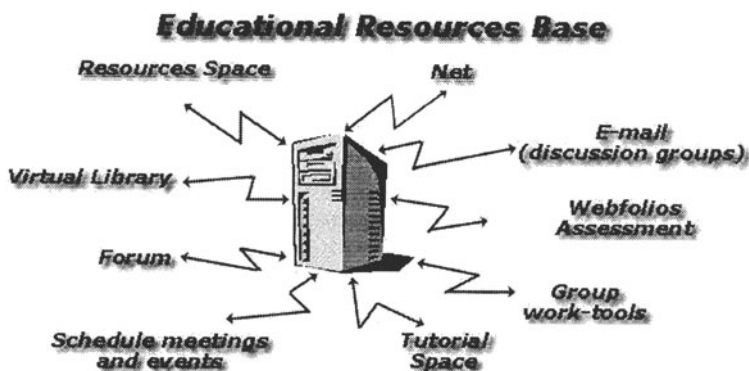


Figure 1. Educational resource base

As shown in Figure 1, free resources were available on the main server in LEC/UFRGS, to enhance interactive communication. Others resources like e-mail, lists, forums, storyboard, forms, CGI scripts were provided to support the collaborative work and to decentralise the decision making. There were also free spaces such called “cafes” for all teachers and students. The project directors used spreadsheets and different databases to made registrations, to schedule activities and programs, and to aid in the management of this learning environment.

The environment included a virtual library with texts, hyper documents and educational materials chosen by educators. It also offered the possibility for each user to edit and to publish their productions as home pages, sites, documents, experimental reports, pictures, photos, music, texts, all sort of compositions, as well as the software that was needed. This included resources for individual use and group portfolio assessment to keep a track

of the work of students and teachers. The server also contained the information about the learning environment and the community of users. A special space was reserved for the publication of the Learning Projects.

3.2 Infrastructure and organisational aspects

We have chosen the constructive activity of designing and implementing projects to become a methodology for learning in the EducaDi Project, because the activity of conceiving projects is symbolic, intentional and natural to the human being. Through it, man looks for the solution to problems and initiates a process of knowledge construction, which has generated not only the arts but the social and natural sciences as well.

The word "project" is quite recent in our culture. The word describes both the intellectual effort to devise the project and the multiple activities involved in carrying it out. The devising of a project constitutes the first step in every research, which will then be carried out based on a set of questions, either about itself or about the world. As a student (Mir, 15 years) says: "To me a project is like an architectural project, the guy draws a plan to guess how things are going to turn out in the end, but the difference is that we can keep changing it."

3.2.1 The learning project

When using the expression teaching through projects in school, one might be referring to the school's plan, to the school's project, to the teachers' projects. In this kind of teaching, which criteria would the teacher use in order to select the themes or questions that will define the project? What advantage does the selection of these questions present? Why are they necessary? In which contexts? Which indicators do we have to measure their levels of need? Whom would they satisfy? The curricula? The objectives of the school plan? A training tradition?

In fact, in the field of teaching, every action comes from the teacher's decisions and should return to his control. It is as if the teacher was the sole owner of knowledge to be passed on to the student and, furthermore, as if the decision of what, how and to which extent this knowledge should be acquired by the student was also his unshared responsibility. The student is not given the opportunity of making any choices or decisions. He is supposed to be completely submitted to the rules imposed by the educational establishment.

However, we soon became aware of our mistakes. Research in the area of genetic psychology, mainly on the development of intelligence and on the learning process, have shown the possibility of there existing teaching

without learning; that learning can be taken as development; and development results in the subject's operational actions, who constructs knowledge when interacting with his environment, with other individuals and with objects of knowledge which he wishes to appropriate.

When dealing with "learning through projects" we necessarily refer to the formulation of questions by the project's author, that is, by the individual who will construct knowledge himself. For us the student is never a blank page, that is, he was used to thinking before the project began. And it is from this previous knowledge that the learner will set off to interact with the unknown, to appropriate specific knowledge, be it either in the sciences, in the arts, in the traditional culture or in the present changing culture.

A Project to Learn will be generated by the conflicts, by the disturbing interference in these signification systems, which constitute the learner's individual knowledge. How can we access these systems? The student himself is not aware of them! That is the reason why the choice of variables to be tested in this problem solving attempt has to be supported by a survey of questions made by the student himself.

In a Learning Project, who manifests doubts that will generate the project? Who wants to search for answers? The student himself, while acting in a certain context, in his life environment or in a challenging situation, faces such challenges. But can the school allow the student to choose the theme, the question, which will generate the development of a project? It is essential that the students' curiosity, doubt, questionings generate the subject to be researched, and this is not to be imposed by the teacher, as motivation is intrinsic to the individual.

The inversion of these roles is extremely significant. When the learner is challenged to question, when he is uneasy and needs to think in order to express his doubts, when he is allowed to ask questions he considers meaningful, and which emerge from his life history, from his own interests, he begins to develop the competence to formulate and solve problems. One, who is able to pose a problem clearly, and sort it out, is learning to define the aims of his activity.

The key statement about the new types of learning in our model of learning environments using ICT is "learning through projects" is quite different from "teaching through projects"? Table 1 illustrates this.

Our strategy is to conduct a preliminary survey on the students' provisory certainties and temporary doubts. And why temporary? When researching, questioning, and investigating take place, many doubts are transformed into certainties and certainties become doubts; or, still, they generate other doubts and certainties which, in turn, will be also temporary, provisory. Teachers and students engage then in negotiations, in a permanent

interchange process, for, with each new idea, with each discovery, new paths are open to be investigated and the actions are reorganised.

Table 1. New types of learning

	Teaching through projects	Learning through projects
Authorship Who chooses the theme?	Teachers, pedagogical co-ordination	Students and teachers individually and/or in co-operation
Contexts	Decisions based on external and formal criteria	Student's real life
Whom does it satisfy?	Curricula content sequences	Student's curiosity, desire, will
Decisions	Hierarchical	Heterarchical
Definitions of rules, directions and activities	Imposed by the system, follows determinations; no options	Established by the group; students and teachers reach consensus
Paradigm	Transmission of knowledge	Construction of knowledge
Teacher's role	Agent	Stimulator/adviser
Student's role	Receptive	Agent

There are different paths that lead to the construction of a project, with the students needs as a starting point. It is by inventing and deciding that the students/authors are going to activate and strengthen their motivation. Thus their autonomy must be respected and guidance offered so that the following actions may take place:

- Decide on judgmental criteria about the relevance of a certain context.
- Search/find out/select/collect information
- Define/choose/invent proceedings to test the relevance of the information assembled to the problems and questions formulated.
- Organise the constructed knowledge and make it available.

The introduction of ICT serves to empower the environment and serves also to be useful the Learning Project because we will have not time and space for individual attendance without ICT. We will have not the fundamental aspect of an easier communication and interaction if we will have not ICT in these schools.

3.3 Changes in the curricula

Will the introduction of ICT at school, through the referred methodology, demand changes in the curricula? How have these schools implemented these changes?

In our traditional secondary schools the curricula have been proposed to meet the needs of the greatest number of students. They do not plan for each student but for many groups of students hierarchically organised in levels, according to their ages. This organisation is supposed to reach 40 or 50 students in a class, from whom a uniform response is expected.

In our pilot-experiments with the EducaDi/CNPq Project, with the resources of ICT, we made available some conditions for these schools. Their teachers could choose between "Teaching Projects" and "Learning Projects." The students did not need to study the same content at the same time. The projects could be diversified, but interdisciplinary. There were themes that would run across the totality of the activities. Each student would explore the content in his own time, according to his own pace. His needs could be better cared for, as now they were easily expressed. But, at the same time, he would relate with other students and teachers, with whom he shared interests, in other different spaces and times. These interchanges between partners would allow a permanent activity of construction and "reflexive adaptation."

But how can the teacher manage this "interconnection" between different spaces and times, keeping the identity of the subjects in the collective interaction process, be it an in-class or distance situation? Without technology it is almost impossible. The interactivity afforded by the Web adds a new dimension to the curricula. The student is going to be inserted in the world.

When one intends to bring outside life experiences to the classroom, there are restrictions of time and space, of conceptions and of traditional practices. In the traditional situation, objects of nature and culture are absent from the classroom and the environment is poor with little information and opportunities for exploration and practice. The computer is used to experience virtual environments in simulated situations. When the school itself cannot contain the complexity of all aspects of life, it is then possible to enrich its space with digital objects. With the computer the distant and invisible reality can be accessed and when connection nets are established, new spaces are created.

3.4 Changes in the role of the teacher

Our experience in EducaDi Project shows that the teachers have been surprised with the amount of information the students bring about subjects and technologies not yet discussed at school! Let us see, then, how the students decide for different, original and relevant questions! These questions generate projects with great opportunities for research and experimentation. The search in the Web multiplies chances to get different kinds of information. Differences and contradictions cannot be assimilated without reflective criticism. The students are, then, engaged into discussion and analysis to select the valid information. They may search collaboratively, always present in this virtual net.

Which are the new roles the teacher needs to exert in this new context? In our model new roles and new practices were designed for the teachers, by the teachers themselves in an attempt to change the interaction among teachers, students and knowledge. A teacher may play more than one of these roles (activator, articulator, adviser and specialist) in different moments in our model of learning.

A teacher who never ceases to be a learner, does not do solely cognitively. So, in a constructivist learning environment, some aspects other than the intellect must be activated. The constructivist approach proposes learning of both the physical and the social universe. Activating one's mind and the spiritual conscience in order to learn more about one's interior and subjective world is a fundamental issue under this perspective.

The role of activate the learning process implies the following:

- Work the perception of one's own value by oneself and promote self-esteem and the enjoyment of conviviality and co-operation.
- Develop an environment where respect and self-respect will thrive, which means that the following actions should take place:
 - stimulate free expression about one's special way of perceiving
 - promote the establishment of paradigms concerning interpersonal relationships, and define their rules, taking into consideration the joy of sharing differences;
 - make people aware of the need to evaluate, alone or in groups, their own actions and their consequences;
 - search for transcendental values and consider them as each individual's inherent qualities

The role of articulate real and digital worlds requires good skills for social interplay, besides being flexible with the use of ICT when taking decisions. The articulator will be the fundamental link between the various groups of teachers, students, parents, and could articulate the local interactions and at the same time the interactions in digital word.

To the adviser and to support the Learning Projects development the teachers need to use ICT, but in EducaDi Project they not have need specific training. They have received the assistance of tutors in-service. A constructivist learning environment (software for distance co-operative work) was made available (The TecLec).. The use of the ICT resources as well the Internet server were oriented by tutors, who were high school students or college students, also in distance training at the universities. The production of instructional materials was made by the users aided by the experts of the team researchers on duty in the Web.

3.5 Technological infrastructure of the schools

We show (Figure 2) that the relationship between the number of students and the number of machines and Web connections was insufficient. This was the major challenge for all of us. If we could attain the goals that we have proposed using the minimum of technological resources the model could be replicable in the very restricted conditions.

Local School Technical Infrastructure		RS	SP	DF	CE
Computerised Schools		6	7	7	9
Equipment	Computers for Intranet connection	85	32	46	70
	Computers for Internet connection	50	7	4	19
	Printers	8	5	7	18
	Scanners	1	2	3	6
Attendance	Teachers	85	59	66	139
	Students	2550	1157	1780	4800
Human Resources	Tutors	12	14	6	18
	University experts	28	16	12	30

Figure 2. Relationship between the number of people and resources

4. SHORT TERM RESULTS

Education is a long-term investment. Structural, operational and cultural changes as we assumed in this project proposal occur in a lifelong process for individuals and their communities. Fortunately, the use of ICT gives us

new scales in new dimensions of time and space, making possible to accelerate this process. Therefore we could not measure these first results in a credible basis in the period of the last two years.

We have three types of data collected: archives of written interactive communication, hypermedia documents published by users and registrations of processes. The analysis of this data was made during the execution of the activities making possible the feedback. Students made the more formal analysis in different research projects in post-graduate courses.

However the evidence of success of the project can be seen in many ways. First of all, the teachers of different schools in diverse regions of the country used the technology, showing a pedagogical appropriation of ICT. The good results in their published productions spread the wish in the community to experiment with ICT and also decreased the teacher's resistance to change. This wishes spread out appeared in the new PROINFO Project from MEC: during 1998/1999 (<http://www.psico.ufrgs.br/mec-nte2> and <http://nte.ferj.rct-sc.br>) conquered a post graduate degree 1400 public teachers. These specialists are working now in 240 Nucleus of Educational Technology (NTE) that was already created in 27 states to train other public school teachers. The public school demand is growing too fast every day and the EducaDi' schools became a permanent reference for it.

The teachers have free access to all of the production of EducaDi' s server. We used the Learning Environment (software TEC-LEC) and other tools developed by the users and the experts of this EducaDi Project, to train the team teachers (named multipliers) of many NTEs . The University in other virtual course experiences for Distance learning developed in EducaDi is used the resource. The methodology model of the Learning Project (Fagundes, Macada, & Satto, 1999) been adopted gradually by the training staff of many NTEs. The teachers trained also used this model in their classrooms. This work can be seen in the homepages in WEB.

The data collected in a short time (1997/1998) showed two different attitudes by teachers in EducaDi classrooms. Some teachers engaged easily in the Teaching Project model, others engaged directly in the Learning Project model. Many teachers tried to work in Learning Projects but they had great difficulties to understand and to practice all the aspects of the model, working in a transition process. We could search for relations (Figure 3) between the number of students in projects, the number of projects developed, the number of teachers engaged, or not, in projects. The measurement of these relations in a short period of time would not be reliable because this changing process is too dynamic. This scenery changes continually and nowadays the number of homepages that publish Learning Projects hyper-documents is growing. These materials have students' ownership.

Centres	Schools	Students in Projects	Projects	Teachers in training	Teachers in Projects	Computers
RS	06	2550	263	85	80	85
SP	07	1157	45	59	43	32
DF	07	750	19	66	60	46
CE	09	4800	32	571	139	70
Total	29	9257	359	781	322	223

Figure 3. Statistics on participation

We realised that a learning community was established where everyone could become a spontaneous partner when interested in the planning and development of similar projects with the use of ICT. All the partners were autonomous to choose the problems to solve and to search for answers. In a collaborative way to learn, to co-operate and to create. This ability consists also in the flexibility to acquire the new skills required for new jobs, including research skills.

5. THE FUTURE

The acquisitions of EducaDi project became support to the development of the new project I VEN (Internet Virtual Educational Networks), for the preparation of 50 schools by Knowledge Enterprise, Inc (BID) for the Brazilian government. IVEN proposes, as our own experiences do, the following characteristics for the programs:

- Hands-on: Students are actually allowed to perform science
- Minds-on: Activities focus on core concepts, allowing students to develop high-order thinking, process and skills
- Reality-on: Students are presented with problems solving activities that incorporate authentic, real-life questions and issues in a format that encourages drawing on multi-disciplinary knowledge, collaborative effort, dialogue with informed expert sources, and generalisations to broader ideas and application.

This new project will be an integral part of continuing the development of schools in the future in Brazil.

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BIOGRAPHY

Lea da Cruz Fagundes received her Ph.D. in psychology and masters degree in education. She is full professor at the Psychology Institute of the Federal University of Rio Grande du Sul (UFRGS), Brazil. She is a professor of education and teaches courses in cognitive psychology and computing in education. She is a fellowship researcher of the National Council of Research (CNPq) of the Science and Technology Ministry. She is the founder of the LEC, Cognitive Studies Laboratory, where she has been the scientific director since 1980. She has developed projects about the integration of teaching of mathematics and sciences since 1976. At the same time, she has been conducting research studies in epistemology and genetic psychology. Since 1981 she has been investigating the effects of the interaction of the learner with digital learning environments, having coordinated national projects in distance learning and digital networks. She has been a member of the assistant committee on Computing in Education of the Education Ministry since 1984.