Computer Graphics, Interactive Technologies and Collaborative Learning Synergy Supporting Individuals' Skills Development

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ABSTRACT
In this paper, we describe work carried out using the synergy of interactive technologies, computer graphics and collaborative learning to improve educators and students' knowledge of basic education by supporting interdisciplinary work.

Through direct manipulating accessible Web standard languages such as Hyper Text Markup Language - HTML and Virtual Reality Modeling Language – VRML and their templates, we used interactive graphics techniques and tools, including learning theories and methodologies such as experiential learning as support for enhancing children's interest on studying and authoring content related to subjects such as Mathematics, Geography, Geometry, Languages and Arts.

As a consequence of these human and technical interactions, including knowledge acquisition, we achieved an increase in individuals' traditional and digital literacy skills, social inclusion, and community collaborative work engagement inside and outside school environment. Further we found an improvement in curriculum development.

Categories and Subject Descriptors
k.3.1 [**Computers in Education**]: Computer Uses in Education -Collaborative Learning; K3.2 [**Computers in Education**]: Computer and Information Science Education – Literacy.

Keywords
Literacy, virtual reality, interactive graphics, education, social inclusion, hypermedia

2.INTRODUCTION
Computer labs have gradually been installed in the São Paulo municipal schools network since 1994, but, only in 2003 there was effective government investment for linking all the labs to the Internet. The Internet links feature fast connections where is feasible and frame relay otherwise.

Simply linking labs to the Internet is not enough to ensure that individuals enjoy possible benefits of having such hardware and software facilities available. For instance, we observed children using computers in the lab, and we realized that most of them tended to log into a game website and stay there for long periods of time doing mechanic actions.

This kind of individuals' attitude towards computer resources suggests a need for pedagogic intervention in order to orient and stimulate better use of Information and Communication Technologies ICTs on individuals' education. This situation is an interesting opportunity for addressing specific issues such as improving individuals' traditional and digital literacy skills. A low literacy level seems to be a relevant factor for those who keep themselves playing computer games with "more mechanical attitudes". On the other hand, the educational scaffolding concept says that when individuals have their cognition challenged and receive intellectual and practical supported for improving skills, their creative and productive talents are used and can be enhanced.

This paper also addresses some of Potel's concerns (2004) related to a survey consistently indicating that computer graphics research and applications tend to be academic and not sufficiently real world [1]. According to him *"(...) It still seems that across the refereed publications in our field there's more emphasis on solving computer graphics problems than using computer graphics to solve real world (non-computer-graphics) problems. (...) most graphics articles originated from computer graphics professionals in computer science departments or computer technology companies. Their job is to extend and refine graphics technology itself, and tell us of their progress. But real world problems are often pursued in noncomputer academic departments and non computer industries, where the focus is on solving their practical problems and not on communicating their graphics problem-solving techniques back to us. In addition, a lot of applied work takes place in nonacademic settings where publishing is not emphasized as much and, for confidentiality and/or intellectual property reasons, even discouraged. Plus many academicians (and the journals they publish in) view interdisciplinary work as not quit on a par with main stream topics in their fields. Applications articles are always viewed as "soft" and as "engineering, not science," since their methodologies and results are less clear those arising in more formal technical or scientific work .(...)"*

Using information visualization techniques and tools proved to be a good way to address problems such as the concerns raised by Potel´s and low individual literacy skills through middle and long-term multimedia projects. This work was carried out in a basic education school. Within this context information and visualization interactive systems and applications brought the school community to explore both the real and virtual, increased understanding technology and individually and collaboratively creation of artifacts [2].

From 2002 to 2005, through the use of interactive techniques, collaborative learning, Web base technologies and digital media,

including video, audio and text files, we obtained the knowledge necessary to develop a sustainable system within a school environment and the surrounding community.

We expect the culture of sharing knowledge we have cultivated and the inclusion of hypermedia applications within curriculum development to lead to an improved system in the coming years. The experiences contributed to enhance individuals' knowledge about media resources and served as real world examples of how such knowledge can support improvements on ones' cognition [2-5].

It was necessary to use media in a way that enabled individuals to understand the content that media delivers is important. In particular, the media is not the only message. Experience shows the relevance of individuals' comprehension of how media is composed, be it with video edits, display layouts or hyperlinks. This knowledge is also important for both the end-user in final presentations, and for the author in selecting raw media for incorporation into presentations. Since its beginning, such composition has been a fundamental component of the World Wide Web, which has implicit in its form to connect media, ideas and people [6].

It is thought that through the use of hypermedia, computer graphics and virtual reality techniques in connection with inter and transdisciplinary curriculum development, individuals can learn in a more dynamic, interactive, high quality, and creative educational environment [7, 125]. Further individuals can investigate how media is composed and how best to exploit this compositional structure. Paraphrasing [6] *"Primary compositional components include space, time and navigation. Here, media is both final presentations and raw source media that can end up in final presentations. Media processing starts with its capture and creation by different people with different tools. We expect it then to connect media in different formats from different locations. Finally, good cutting-edge hypermedia and multimedia should make all media available to anyone, anywhere at any time, in the means best suited for them."*

By using multimedia resources, VRML and HTML templates and creating files this work addressees some of the concerns highlighted in this introduction. From here we discuss the related work, the evolving pedagogical infrastructure, technical tools, related work, evaluation and conclusion.

3.Related Work

Electronic interactive systems have been designed for improving individuals' education in diverse ways. Such work is based on accessible web standards due to the universal appeal Word Wide Web and the possibility of developing high quality interactive educational environments supported by low cost tools. These environments also support individual and collaborative work that is related to developing ones' literacy and communication skills, stimulating reading through writing electronic documents [8-15].

The NICE (Narrative Immersive Constructionist /Collaborative Virtual Environment) project focus is on informal and formal education, social content domains, embracing a constructivist approach, collaboration, plus narrative development. It uses virtual reality main power: a combination of immersion, tele-presence, immediate visual feedback, and interactivity. Software development is based on open standard languages such as HTML, JAVA, VRML and C++. The virtual reality environment is designed for both multi-projection CAVE™ and PC systems [9].

The rehabilitation of aesthetics in the context of teaching computer science and digital media in schools is on the *ArtDeCom*. It is a creative, collaborative learning project, which involves all human senses, even when the process is digital media-supported and computer science teaching-oriented. The project shows how interdisciplinary, digitally extended learning environments can be created with the help of free or low cost applications. Such learning environments focus especially on the idea that sensorial perception and co-construction of knowledge should be an integrated part of a creative learning process [10, 11].

At James Cook University the investigation carried out involves students from primary school who directly manipulate virtual reality (VR) software on a Pentium 90MHz computer with 8 MB RAM. The school is officially recognized as a socio-economically disadvantage school. Although, results are not conclusive the use of VR in the classroom seems to be effective for the students' cognitive development, as well as providing active learning even beyond a short-term novelty period [13].

At Associação Meninos do Morumbi – AMM, a project called "Meninos do Linux", which covers digital and social inclusion for a community of children under socio-economic disadvantage is carried out. AMM promotes interdisciplinary work focused on supporting children's growth in positive learning environment where children have contact with both theoretical and practical concepts related to music, English language, photography, and information and communication technology. In the digital area the project Meninos do Linux offers to children opportunities for learning computer graphics and digital animation concepts, JAVA programming (using freeware environments such as Netbeans™ from SUN and JavaBuilder™ from Borland), including teaching digital audio, which involves music theory, audio digital theory, as well as production and mixing. The incorporation of Knowledge development related to digital content, including the use of Web standards and 3D information visualization comes from 2002. At that time author 1 shared knowledge with individuals involved in AMM project who were experimenting with HTML and VRML. This sharing of knowledge occurred during an AMM project called "Garagem Digital", in which it was used proprietary software platforms for digital productions [14, 15].

4.Infrastructure

4.1Technical – Hardware and Software Used

The tools used for running the project are low cost third-party and free **software** such as Paint™, Notetab Light™ and GIMP™, as well as accessible **standard languages** from WEB such as (Hypertext Markup Language – HTML, Virtual Reality Modeling Language – VRML, JavaScript) and their templates [16-18]. An Intranet and the Internet are also used for researching and developing off-line and on-line projects. Browsers used are Cosmo Player 2.1™, Cortona VRML client™, Netscape™, Fire fox™ and Internet Explorer™.

Other multimedia resources employed for researching as well creating content are the school's library and computers labs, as well as multimedia instruments such as video cameras, webcams, tape recorder and microphones. **Operating systems** used are Windows XP™ and Linux Conectiva 8 ™ installed on dual boot machines. However, on Linux Conectiva 8™ was impossible to install browser for visualizing 3D content formatted in VRML.

4.2Pedagogical and technical synergy

The pedagogical support for our project comes from the convergence of diverse and well known learning theories and methodologies such as Piaget's constructivism and Papert's construcionism. Such approaches can enhance individuals' understanding about how people learn and grow, providing better support for designing teaching and learning materials and environments in [9, 19, 20]. Also, we integrate the concept of scaffolding and/or software scaffolding use in education, which is a process that requires direct teaching and monitoring by an adult [15, 21, 22]. It should be noted that one of the distinguishing feature of scaffolding is the role of dialogue between teacher and student. In addition, we use from Vygotsky's theory, which is of great interest to educators, the zone of proximal development – ZPD concept. The ZPD is the difference between the child's capacity to solve problems on his own, and his/her capacity to solve them with assistance [23]. We also use in our project the Experiential Learning concept that supports school community inside and outside interactions [24-26].

Affective aspects are also relevant to the student's learning experience success. Our consideration on these aspects was inspirited by Paulo Freire and Ivan Illich' s thoughts about the necessity of revolutionizing the curriculum content and the pedagogy of the present-day schools. In particular, transforming them to be more practical and inclusive based on a horizontal relationship between educator and pupil, as well love, humility, hope, faith, confidence and respect for the freedom of expression [26-30]. We include in this list the word "empathy" that can define successful communication in human relationship as suggested in [31, 32]. Thinking about software and Web based influence on the learning environment design and maintenance, the work has development sustainability on the spiral model of software engineering [33, 34], the Sharable Content Reference Model - SCORM concept [22] as well its flexibility and usability in conjunction with Goal Based Learning, Distributed Problem Based Learning, Independent, Experiential, Exploratory Learning, as well as Learning Objects concepts and Entrepreneur Pedagogy principles described in [35-40].

Gardener's investigation into multiple types of intelligence in combination with the named learning models and concepts has formed an excellent base for using arts, culture and interactive technologies together in education [41, 42]. For instance, this convergence can provide a better teaching/learning environment management [43]. Further learners can preserve content on memory with high quality for 3 hours in 85% of the cases when they are exposed to teaching-learning methods which uses oral and visual presentation against 72% only visual and 70% only oral. In addition, the average of 65% of preservation in 3 days for visual and oral against 20% only visual and 10% only oral according to (Joan Ferrés' survey (1996)) adapted in [44]. The survey results support the recommendation that schools must learn and use multimedia tools and files with effectiveness [45]. This recommendation suggests schools educational and cultural transformation, which can be achieved through technological art. Due to its direct relation with life, art can generate productions able to lead individuals to rethink cultural concepts and develop knowledge related to the transdisciplinary aspects of managing, directly manipulating and understanding, in context, simple and complex mixtures between the real and virtual embedded on the information visualization domain [46-49].

The convergence of learning theories and advances in technology created a space for the growth of innovative educational design and intervention, which is called Emergent Design. "*It is an approach used for educational intervention; the claim is a more general one, however, in that the strategy is appropriate in settings for technologically enabled paradigmatic change* (…) " [50].

Through Emergent Design experiences it is possible to create a balance between digital technology and the approach to management of organization and of organizational change that has come in the wake of the technology. A distinction must be made because the temptation to use either of them alone has led to failure. It is the combination that offers an optimistic vision for the future of learning—the combination of these two products of the digital age along with a theoretical framework based on the work of pre-digital-age thinkers who knew what to do but did not have the means to do it. Among these the most central is Paulo Freire, but also represented are John Dewey and Jean Piaget, although he did not focus on education per se [50].

5.Work Strategy

The work in school computers lab is headed by two teachers who are Professor Orientador de Informática Educativa (POIE) (Teachers who teaches computers principles to other educators and children). Improvements to both the technical and human relationship skills (empathy) of these POIEs, originates from a long term sharing knowledge. Formally and informally, they have exchanged experiences and supported various projects that aim to provide better educational support to other educators and students researching and authoring content to diverse computer languages and multimedia tools [51, 52].

5.1Project Implementation

The project is carried out at Ernani Silva Bruno Municipal School environment, situated in Parada de Taipas, in the suburbs of the city of São Paulo. There are many people under socio-economically disadvantaged in this city area and the implementation of projects that bring knowledge to people can be important for increasing their social and digital inclusion. The project implementation started in the second semester of 2002 with an experience involving author1 and an educator and her 4th grade students. According to her, the initiative supported collaborative work among students and improved communication between the educator and the students. It also was found enhance students' self-esteem [53]. Such work served as a reference for later work including that presented in this paper.

In 2003, after infrastructure technical improvements to the school information and communication (ICT) system, there were enhancements to educators and learners' interactions, as well as collaborative work between basic and high education. As consequence, we stimulated and followed the growth of individuals' using interactive technologies, combined with arts and cultural information at our basic education environment and extended it to the outside community. For example, through the participation of educators and children as protagonists in a workshop grounded on interactive media, arts and culture at CAVERNA Digital™, Poli, USP, during Feira Brasileira de Ciências e Engenharia - FEBRACE 2004. During a 3 days workshop, participants authored a play based on Tarsila do Amaral life and artwork, developing a text, a 3D computer graphics background using Virtual Reality Modeling Language – VRML, and a prototype of homepage using Hypertext Markup Language – HTML, as well, they presented it within the CAVERNA Digital™ environment.

After the school participation in FEBRACE 2004, the number of educators and students interested on developing curriculum projects using different material and multimedia tools and files increased. This was evident through the School participation in the project "A Cidade que a Gente Quer" ("The City We Want") [54], which was a partnership project between Secretaria Municipal de Educação – SME and Laboratório de Sistemas Integrados – LSI from Polytechnic School of University of São Paulo – USP between 2002 and 2004.

Individuals used diverse low cost software and interactive technologies such as Animator9™, Windows Movie Maker™, Power Point™, Paint™, mass for modeling characters and backgrounds, video cameras for storytelling, producing animations and investigating the problems in the school's surrounding area in order to produce their work. The work had the collaborative evolvement of the school's head and pedagogic coordinators, as well as of the educators who were not directly involved the projects' construction. They contributed cooperating with the necessary changes on the learning environment. Such changes included adaptation of time and space management. The head of the school and the pedagogic coordinators went with individuals in two external presentations where students acted as teachers showing other children animation techniques [51].

5.2Collaborative Work, Culture, Presence

At the end of 2004 in an informal meeting within Ernani's computers lab, the POIEs were exchanging ideas about building web based learning projects while exploring an hybrid 3D virtual model, which was produced by author 1. This model was inspirited by his visit to Brazilian Afro-Cultural Museum and on the teachers' skills improvements course called "Vozes da Africa" ("African Voices"), which was related to ethno racial cultural diversity and the Law 10.639 / 2003. This law determines that African Culture is to be part of Brazilian basic education curriculum. To meet these requirements, accessible standard web based language and interactive technologies files and multimedia tools were used in combination with a virtual museum paradigm [55]. Educators and students reused and adapted the model for the youths and adults education at the graduation ball in December 2004 and July 2005. On December 2005, they improved it with students photos as textures and VRML animation features, bringing about a more lifelike feel and increasing the sense of individuals' presence figure-1.

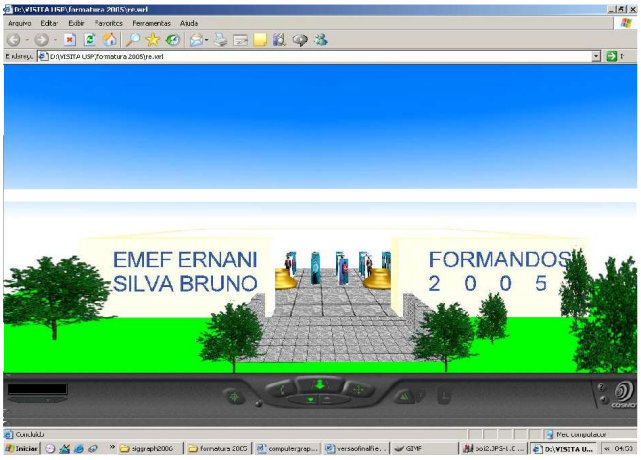

Figure - 1 - Environment created with students' photos and enhanced with animation to bring about a sense of presence

5.3Expanding Web based learning experiences

During the first semester of 2005, the collaborative work carried out between POIEs Jorge and Sandra brought about a more integrated teaching and learning actions. With the School head and pedagogical coordinators' support, their studying as well teaching time got more convergence. This served as a base for implementing an education, culture, arts and interactive technologies course involving 6th, 7th and 8th grade students.

Some of the students from 7th grade, in 2005, were in 4th grade in 2002, when they experienced the first authoring Web based resources project in our school environment [53]. Students practiced with VRML and HTML languages by building simulated homepages, 3D virtual worlds. They also engaged in learning virtual reality and computer graphics techniques by researching and reading Portuguese tutorials oriented by the POIEs. Further students used this knowledge in conjunction with information visualization systems and techniques for solving problems related to the classroom curriculum development and supporting other ones' knowledge improvements [16, 17, 56-60].

Because of children's interest on 3D computer graphics and educators' improved knowledge of hypermedia concepts and applications, such resources were used for solving teaching learning problems. Due to the difficulties students had for understanding measurement systems and scale concepts related to Math, Geometry and Geography subjects, in March 2005, students from 7th grades A, B and C measured the school walls and objects. After that, lead by a Math teacher and using a scale system, learners designed a 2D school blueprint using Paint™ program. Because of the collaborative work between the computers' lab coordinators and the teaching of 3D virtual worlds and Virtual Reality - RV techniques to other educators and students, it was suggested that the learners also modeled the school in 3D using interactive and tools related to the Internet.

After presenting some VRML examples, Sandra invited students for build a 3D model of the school and present it to a community audience during the 10 years celebration of School existence on May 7th. Students accepted the challenge and in conjunction technical and non-technical individuals started developing the model, which was partially presented at school party to the community (district authorities, parents, educators and learners).

In the second semester of 2005 learners were invited to create community's library homepage as their first external web based project. This project happened due to a cooperative partnership between Ernani School and Érico Veríssimo Youth Children Library management. After working 3 months on the project, in November 23, on the occasion of library birthday party students presented off-line homepage prototype the local community. A 3D model of the library was designed based on real world measurements. Educators and students went to the library for studying the place and drawing a 2D blueprint on a paper before modeling that in 3D figure-2.

Due to the students' excellent work and presentation at library birthday celebration, and the positive impression it made on Pirituba's education authorities, Pirituba Schools District Coordination hired a bus to transport students and educators to an interactive hypermedia workshop. The workshop was held at a Polytechnic School and involved knowledge sharing with people from LSI team. It took place on December 06/2005.

This opportunity was offered by the LSI team under supervision of professor Roseli de Deus Lopes who coordinates the project FEBRACE, which is a stimulating collaborative learning

experience for both teachers and learners. The workshop was planned through a partnership between author 1 and Professor Etienne Delacroix, whose current work is related to digital and social inclusion. Etienne uses a combination of artistic and engineering knowledge that leads to individuals' direct manipulating high-tech raw material, in a process of teaching how to deconstruct modern technology and how to reconstruct it into new forms [61, 123, 124]. During the workshop, Ernani Silva Bruno's students had the opportunity of showing their work figure-2, as well learning how to build a computer, create and install software, and how to directly manipulating such resources for producing content.

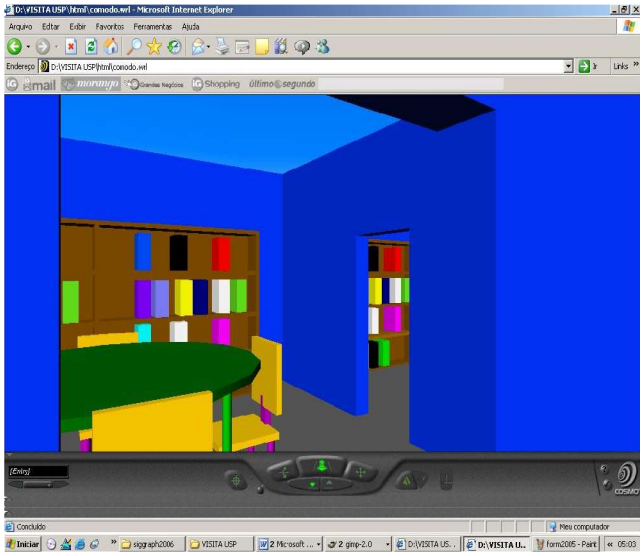

Figure-2 - Screenshot of the library model designed by students

Students' participation in such a workshop supported the sustainability of the arts, culture, education and technology project. Due to the transport facility provided as reward for the young children's library work, we could invite 40 students from levels 5, 6, 7 and 8, including some who had not done the course. As in the past, we expect students will tell to others about the place where they were, the activities they did, and the possibilities they can have on their lives if they can learn and combine knowledge about culture, art, education and technology. The goal is for the interactive experiences to keep students engaged, and that they will invite and bring new individuals to build and rebuild this interactive project.

6.Evaluation

Implications of educators and students' involvement in the multimedia experiences both inside and outside school environment are that they improved their general knowledge, their collaborative abilities, and their self-esteem. These improvements led to enhanced individuals' communication, creativity and literacy skills and competences [62, 63], which is similar to the features of the aim of projects presented on related work section [8-14]. For instance, students who left school in 2003, 2004 and 2005 are used to return to Ernani School to get more support on how to keep developing their information technology knowledge and skills. Some of the students reported that they spread knowledge and skills related to computers at home and within the neighborhood. When it is applicable, also these students share their knowledge with other children through other school projects such as EDUCOM.radio [71].

Within a long-term project, we have got to work with the CIC sciences (computation, information, complexity) as well as elements of engineering attempting to giving them at least the same status as the traditional sciences (biology, physics, math, geometry etc…). This direction, worth it because of the various possibilities these disciplines can offer for supporting interdisciplinary and transdisciplinary projects. In particular, projects that involve transversal themes and that inspire learners to produce content based on their skills and competences both existing and those acquired during the learning to program process [20, 42, 64, 65]. The way we achieved these goals was by getting individuals to build small programs (scripts), and to learn to think through construction of interactive 2D and 3D virtual environments. Also students had fun creating interactive interfaces, improving their knowledge through collaborative work, and using Web based standard languages. The experience with Web standard languages and multimedia tools and files aggregated value to basic education curriculum development and increased students' motivation across learning involving affective computing aspects. In part, motivation comes from the current power and inspiriting psychological influence of the ICTs on ones' mind [16, 17, 66-69].

The use of information visualization systems, interactive techniques and multimedia tools in teaching and learning experiences tends to be effective. This statement is supported by the fact that these tools can be effective in improving students' learning and data retention for 90% of learners when they verbalize something and then implement it according to Ferrés' survey 1996 in [44]. The systems and techniques named allow students verbalize and act. For instance, due to the results of the project carried out two English researches visited Ernani School in August 03, 2005. The researchers Fred Garnett from British Educational Communications and Technology Agency – Becta and Rosemary Luckin from The Human Centered Technology Research Group at University of Sussex shared knowledge with young children [62, 63]. During the 3 hours of interactive meeting, students from 7th and 8th grades showed the researchers their 2D blueprint and 3D models. As well they programmed HTML and VRML codes in real time as a result of previous learning experience by verbalizing and acting to produce visual information.

For finishing the event, based on the knowledge, skills and competences acquired and practiced through Arts, Culture and interactive technologies, as well EDUCOM.radio projects, learners interviewed the researches and simultaneous produced a radio and a TV program. During the interview, students experienced their traditional/digital reading, writing and communication skills, including vision related to world issues, as well rapid and global habit to adapt themselves to diverse situations "improvisation skills" and thinking abilities [70-72]. Such learners' actions showed the importance of education, technology and emotion synergy, as well as its socio-interaction and cultural use demonstrating that interactive technologies and 3D computer graphics can support children's learning motivation and their traditional and digital literacy development [73, 74].

Using electronic systems in coordination with Web based applications has brought about a flexible learning environment, which is appropriate for improving technical and non-technical individuals' knowledge and skills based on scientific rigor. In particular, it supports learning through collaborative work. Important characteristics of such an environment is the respect it offers to individuals' diversity and effective teaching and

learning practices, to be able to support lifelong learning [41, 48]. Technologies are supports, media, which allow us to implement learning activities in different ways from the pre-digital era [75].

However, when it is analyzed the nature and use of current electronic technology, as well as traditional alphabetization within its historic dimension, it is noticeable that writing is a technology, which manifests itself through diverse technological instruments. Furthermore, electronic technology implies both more and more individuals' developing skills and competences in writing and reading [76], and also more means for improving individuals' skills and competences in writing and reading. Unfortunately, apart from few excellence islands, on Brazilian context, individuals' alphabetization in its historic dimension has not received the attention and interventions necessary for improving its quality since the implementation of the basic education system as investigated and recommended in [53-55]. For instance, pedagogic resources were reduced, because of both lack of investments and population growth. Our school's science lab, which was also reused to Art classes and cultural space, was transformed in a common classroom in 2003.

There was also the raise in the number of students per educator in basic education from 35 to 40 during 2005. It is a factor that decreased the teaching/learning quality in terms of physical space in the classroom, as well as increased the challenge for educators trying to follow learners' needs and tasks. For example, it reduced educators' interventions per lesson in individual and complex learning process that is individuals' (self ("alphabetization")), in order to help them to become more confident for building new knowledge. This process must involve educational interventions of high quality to be able to give people support for "learning to think" and "learning to learn" [77].

On the other hand, on-line courses quantitative and qualitative investigations have appointed 20 students per educator as a reasonable average for educators' interventions and program quality maintenance to post-graduate students that are able to read, write and research independently [78]. In addition, an experienced researcher and educator, Ana Taberosky, said in an interview that she would not know how to teach alphabetizing in a class of 40 children. She suggested that 20 to 25 would be better, and also commented that in Barcelona, there are experiences related to flexible groups, mixing groups of diverse levels, with twelve students and three or four educators for supporting them. She completes her reflections by saying that there are some possibilities for developing good work, but in fact it necessary public management contribution [79].

Following Taberosky's ideas, in general, we have seen success with educational and social projects using arts and culture, as well as interactive and WEB based technologies synergy within well designed microstructures. Further providing educational environments with smaller numbers of learners per educator, as well continuous educators' training and adequate technical, material and human support what have produced good results in terms of the state-of-the art of technology supporting pedagogical actions [9, 12, 14]. The same success has occurred with high-level quality projects that evolve sports, art and culture. For instance, Brazilian basketball selection improved performance in 2005. The twelve players had their skills and competences enhanced in the art and culture of playing basket from a team of 4 coaches within a human, technical and environmental infra-structure of high quality. Another example, it is the well know infrastructure that supports the Brazilian soccer team. The results and benefits it provides for its members and the country in terms of marketing and economic resources speak for themselves.

So, it is easy to visualize how difficult is the situation of one educator and 40 children within the process of alphabetization, often bringing about a homogeneous and chaotic learning environment due to its high system entropy [70, 80]. Such environment tends to be socially and intellectually exclusive in terms of providing and perpetuating low literacy level according to Freire's ideas in [81] and Florestan Fernandes' investigation in [82]. On the other hand, a learning environment that is more learners centered and collaborative has been a major catalyst for the use of small groups. It allows for integration of critical thinking and other language processes. Talking, listening, writing, and reading can be interrelated, and the spoken word can interact with the written word [93, 94]. As demonstrated by the examples on the project implementation section, adding such a framework to Information and Communication Technologies can influence changes in the traditional school pedagogic paradigm, based on teacher-directed, to a constructivist concept learning process, learner-centered [73, 95].

With reference to the space and time relation on pedagogic interventions, the situation sometimes improve when the class goes to the computer's lab. There, a POIE and an educator of the class work in collaboration, once or twice a week. However, even in this situation, due to the high average of children per educator, it is still difficult to do learners' centered alphabetization interventions. According to [83] such situation will tend to be worse in 2006, since the public management decision about pre and post class project may bring about decreased possibilities for two or more educators in collaboration to do pedagogic interventions in the same time and space with learners. This may result in less interdisciplinary and collaborative work.

In addition, investments in teachers training were reduced in 2005. This fact shows the low professional value of educators to authorities who manage the education [86]. The diverse courses related to educators' lifelong learning offered by the public management from 2001 to 2004, have been decreased or terminated. Educators' low salaries imply in double and triple journey, meaning health problems and lack of economic resources and time for doing up to date courses of high quality. These limitations make it difficult for educators to improve their knowledge of new technologies and instruments, and lower the probability of doing effective and high quality pedagogic interventions [87-89].

Conversely, at Ernani School, pedagogic experiences involving arts, culture, science and technology, proved to be relevant, as a possible model for offering appropriate and high-quality lifelong education to individuals. The educators, who participated in the courses that are related to arts, culture, new technologies, Educommunication, edutainment, and literacy, offered by the public management from 2002 to 2004, had their skills and competences improved. This fact resulted in better collaborative teaching and learning practices, including contributions for transforming and enhancing curriculum development. The concept of "open mind architecture", which involves the educational environment, brought about to educators and learners, sharing, learning, adapting and using together the synergy among interactive technologies, artistic languages and cultural diversity to develop simple and complex teaching and learning projects with effectiveness [87-90].

The results of such experiences empower a real possibility of stimulating changes in the learning cultural habits and research. In particular, a change towards the use of basic education to support "learning to learn" and "learning to think", through configuration of new learning spaces [9, 12, 14], and mainly through more proactive participation of individuals involved on the teaching and learning process. This can increase individuals' motivation and improve their attitude towards learning in a stimulating educational environment built with excellence of resources of information and visualization [48, 77, 91], and the current inspiriting psychological influence of the information and communication technologies on individuals' perception and cognition [41, 44, 48, 66, 89].

According to Maturana [92], independent from the media used on the knowledge construction, it is the emotional involvement of the individual, which will help him/her to understand, for example, that the named technologies, theories and experiences within the educational system have a relation of interdependence. For him it depends of all human beings a coexistence in which love, mutual-respect, honesty and social responsibility will be something spontaneous instant after instant of life. This attitude cannot be imposed, must be experienced spontaneously as a "course theme", and taught and learned since the childhood. Papert, Teixeira, Ribeiro, Freire and Maturana's ideas, appoint that for building such configuration, it is necessary to challenge and empowering children's mind and personality since the childhood, orienting children in a way to touch their essence, in order they can become adults who are aware of their attitudes towards the importance of building a better society, in which the commonwealth is everyone goal [20, 27, 96-98]. So, it is relevant to invest in education system improvements, for reaching a status of excellence, which involves basic and higher education, as well as other interactive and social living spaces proper for individuals' knowledge building and literacy skills development, including stimulating their multiples types of intelligence.

A way to reach such goals, it is the development of a sustainable knowledge network based on the convergence of interactive technologies, culture and arts. The construction of such a model, for sure, depends on improvements on children's social conditions, as well human, technical and environmental infrastructure enhancements, including better qualitative and quantitative access to the education and entertainment services that public school as well other public spaces can offer. For example, it is necessary to improve the entertainment areas and cultural spaces on the community surrounding the school [99]. Better environmental conditions can provide teaching and learning experiences able to stimulate individuals' diverse sensorial aspects (their multiple types of intelligence), and in parallel human beings' nature approximation [100]. For instance, teaching through cultural and arts activities which involve the human essence in interaction with nature (public parks and squares) in synergy with the technology which compounds the digital world, far beyond school walls [102]. The interrelationship dependence between culture and nature shows the dialogic infrastructure of the human beings according to Saviani [103], "(…) man is nature, but modified nature (culture), and is culture, but culture conditioned for something previous given (nature) (…)".

With the renewal of the contact between human beings and nature there is a hope that people will become more patient enjoying with wisdom the facilities and benefits of contemporary life in conjunction with nature, and learning how to adapt themselves to diverse media and the growth of information quantity. In this way, individuals can have the possibility to use better their natural intelligence faculties [104]. So, it is necessary to use with wisdom and moderation interactive electronic systems and multimedia instruments in children's education, particularly the use of such resources in the development of children's sensory and mental capacities and the building of their value systems which starts since basic education.

We finish this reflection with Janet Murray's words in [105] commenting about the inspiration for building her work, which investigates the convergence of arts, technology, culture, including forms of traditional and cyberspace narrative creation [106], as well as telling about the necessary patience we referred when we were reflecting that wisdom is needed to enjoying modernity facilities. *"Those of us who have spent our lives in love with books may always approach the computer with something of my grandmother's terror before the crystal radio," writes Murray, "but our children are already at home with the joystick, mouse, and keyboard. They take the powerful sensory presence and participatory formats of digital media for granted. They are impatient to see what is next. This book is an attempt to imagine a future digital medium, shaped by the hacker's spirit and the enduring power of the imagination, and worthy of the rapture our children are bringing to it."* Murray in (Kats 1997).

7.Conclusion

Learning the complexity that is to read and write requires the development of several skills and competences in children, adolescents and adults' education. Then, they can be able to understand and use the arbitrary culturally constructed symbols that are mixed up with the language, which is an art transmitted form a generation to another throughout an intensive education [48, 107]. Obviously, qualitative intensive education does not mean the current 40 children everyday immobilized inside a classroom for four, five or six hours in bad environmental learning conditions and its high system entropy [70, 80, 122].

Our project showed the importance of providing for children and educators' opportunities to be participants while using the state-of-the-art-of technology and directly manipulating diverse "non-scholar" languages and systems, which brought about increased motivation and self investment in their lifelong education [108, 109]. For example, motivation people got as a result of "agency" concept, which is the pleasure of taking meaningful actions and seeing the results of our decisions [106]. Accessible WEB standard languages such as HTML and VRML combined with 2D and 3D interactive computer graphics and virtual reality techniques, as well as multimedia instruments and files can bring about "agency" when individuals can see the tangible results of their programming.

The use of this combination of tools also contributed to reduce the "digital divide" and improved individuals' literacy by supporting "*procedural literacy*" concept [27, 50]. *"By procedural literacy I mean the ability to read and write processes, to engage procedural representation and aesthetics, to understand the interplay between the culturally-embedded practices of human meaning-making and technically-mediated processes. With appropriate programming, a computer can embody any conceivable process; code is the most versatile, general process language ever created. Hence, the craft skill of programming is a fundamental component of procedural literacy, though it is not the details of any particular programming language that matters, but rather the more general*

tropes and structures that cut across all languages" in Mateas [126].

Individuals' technology appropriation is a key point for determining peoples' participation as content producers on the information society of XXI century [110]. With good orientation, individuals can practice their citizenship with full awareness, understanding and appropriating themselves of the culture, which is the conjunction of objects resulting from human's productive, social and symbolic activities [111]. This way, using a broader concept of technology, we applied during the project development the inter-relation of physical technologies = equipments; symbolic technologies = communication interfaces; organizing technologies = relations with the world; and their interactions and interdependency with the culture, which is related to a specific social, politic and economic moment [112].

Educational practices and researched material proved that it is possible to enhance individuals' literacy skills and competences through the use of interactive media, arts and culture synergy from basic to higher education. The strategies used, seemed to be effective, interesting and proactive ways of increasing individuals' literacy and quality lifelong learning. According to the educator Fernando de Almeida, "(…) *Brazil will need schools with high-quality educational environment yet* (…)", in [113].

It is thought that to achieve such excellence it is necessary to reduce the number of children per educator, rethink educational time and spaces, design learning environments based on ethics, high-quality technical and human structures able to provide citizens' skills and the competences necessary to be dynamic, creative and well prepared people for a good and effective professional life [64, 73, 114, 115]. Through this mood, contribute for changing the historic tendency of homogeneous and low quality mass education. Such facts are obstacles for socio-economically disadvantage individuals to free themselves from their socially marginal position, as well from the forms of social exclusion such as economic, politic and intellectual [114].

The technology is moving ahead, and significantly influencing our behavior in many areas, like business and communication. Educators can become part of the research and development effort for employing and exploring further technologies in educational processes [116]. So, approximating education, technology and communication synergy and their diverse languages from classroom environment can influence with effectiveness for transforming traditional languages linked with the pedagogic speech in convergence with non-scholar languages (magazines, cartoons, tele-journal, soap opera, videogame, virtual reality, mixed reality, etc.), contributing for enriching individuals' interactions quality, knowledge acquisition and sharing, including providing a more inclusive educational environment. Such picture implies observing these languages' video/technologic social influence, indicating to start urgent alphabetization/literacy process related to the icon, musical, and perceptual elements, as well the complex media's languages that simultaneous use image, word, gesture and sound [117].

This project combined Web based authoring of content, multimedia and interactive technologies. The results of the project include an improvement in educators and children' literacy, communication skills and competences, and contributed to enhance their mental models and spatial cognitive abilities. An increase in collaborative and cooperative work occurred within the context of the learning environment at Ernani School and the surrounding community, as well as between basic and higher education [116, 118-120]. Our experience supports the idea that the application of the concept of capital social is necessary for the success of such projects. This concept is related to a community members' capacity for associating and organizing themselves when aiming to solve their social problems, for instance building and improving individuals' better literacy standards, as well as increasing social and economic prosperity… [39, 67]. It is thought that individuals' organization and improved traditional and digital literacy skills and competences can serve to the citizens as ways to build strategies and have tactical tools for freedom themselves from excluding situations [122].

We conclude this work paraphrasing Foucault [70], …from there, through basic education empowering children's through body and mind, increasing their self-esteem and working capacity; providing conditions to develop their thinking and vision to be rapid and global, strong hands, as well consistent educational, cultural, technological and artistic habits. From there, encouraging their tendency to take part on the most important, central, productive society sectors, while enjoying and fixing themselves within some of the essential social functions: on manufacturing production, on knowledge and know-how sharing and transmitting, on skills and know-how diffusing…[70]. From there, the determination and tough thinking implied in a message left to author 1, on the computers lab bulletin board by a young student who participated on the first phase of the Web based technologies, Arts and Culture project: "Teacher it is difficult, but I am sure we will solve the problems" – Emanuele – in [53].

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9.References

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