

# Enhancing Learning as well Individuals' Research and Content Production Skills through Information Visualization Systems and Web Based Technology Synergy

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## Abstract

This work shows that is feasible to enhance individuals' knowledge based on the convergence among low cost desktop virtual reality, information visualization and multimedia systems, interactive techniques, culture, arts, including web based standard languages and technologies, from basic to higher education.

Through four years experiencing with this human knowledge enhancements and technological interactive synergy, educators and students investigated as consumers and producers of digital content how to use these tools for building collaborative interdisciplinary and transdisciplinary educational projects.

In cooperation, technical and non technical individuals developed graphical user interfaces using current Web based standard languages state of maturity for constructing simulations, visualization programs, prototyping an easy to use tool for problem solving, within integrated real and virtual, as well interactive teaching and learning environments. Individuals used the power and flexibility of Web based standard languages such as Hypertext Markup Language- HTML, Virtual Reality Modeling Language - VRML, including their templates for formatting two and or three dimensional multimedia content.

Pedagogic support came from the convergence among Constructivism, Constructionism, Zone of Proximal Development and Multiple Types of Intelligence theories, adding to that the synergy among Sharable Content Reference Model, Entrepreneur and Projects Pedagogy, Management

principles, Spiral Model of Software Engineering and Experiential Learning concepts.

Citizens' benefits from this project implementation were individuals' digital and social inclusion, improvements on their traditional and digital literacy, better as well proactive student centered teaching and learning actions. In addition, educators and children enhanced their self-esteem and confidence for researching, communicating and sharing knowledge within their communities, as well learning to learn lifelong with autonomy.

**Keywords:** collaborative learning, desktop virtual reality, information visualization, literacy, digital inclusion

## **Introduction**

We used Web based technologies and multimedia tools and files as a way of motivating individuals for reading, writing and improving their knowledge for acting as users and producers on the information society of the XXI century [1]. The experiments proved to be effective to stimulate and keep individuals engaged on learning processes, as well as developing curriculum content with innovation, lifelong and with sustainability [2 - 4]. Hence, the actions attempted to reduce digital divide [5], and develop individuals' new skills and competences for dealing with market necessities on the information age, which are routine product services, services done peer to peer and analytic-symbolic services [6], including dealing with distance learning environments and tools [7]. According to Passarelli [6] Robert B Reich argues that, in general, the current school is preparing citizens for dealing with the first two types of services. So for preparing people for dealing with analytic-symbolic services it is necessary to improve their abilities for identifying problems, problem solving and strategic agency. Reich also argues that for achieving effective individuals' analytic-symbolic skills development in formal education four capabilities are relevant; abstraction, systemic thinking, experimentation, collaboration.

It is thought that is possible to address these types of skills development applying the concept of systemic cooperation on individuals' formal and informal education. The concept of systemic cooperation is supported by features such as; information exchange, collective research and knowledge sharing, reflection and agreement related to proposes and values, shared building of visions of the future, reflection about beliefs, formulation of innovative solutions for solving community problems, elaboration of development agenda and projects in consensus, collective search of diverse resources respecting and taking in consideration the possibilities of each agent involved in the process [8].

Using the concept of systemic cooperation in combination with diverse learning theories and methodologies, including traditional and new technologies in people's education within contextualized educational short, middle and long term projects proved to be feasible and effective to improve our educational learning environment and transform human cultural habits, values and attitudes.

A reflection we did after talks and diverse experiments with individuals who participate on the project development is that the philosophy of sharing

knowledge is a factor that are used to rise in these people and as consequence they benefit the surround school community.

For instance, some students reported that they taught their friends how to use VRML and that these ones were researching for learning how to do animations. On May 2006, influenced by school multimedia learning projects in 2004 and 2005, and current private information technology courses former Ernani's School students returned to school to offer support to increase other learners' knowledge on drawing software such as Photoshop™. Although, we did not have this software, it was an opportunity for us to do some experiments with GIMP™ drawing software [9] and explaining to the students about proprietary and free software similarities, and also the high quality that free software can offer for image processing. We also talked about the ethics and implications of using proprietary software without license because the school could not afford that. We offered them to investigate together us GIMP™ image processing possibilities while sharing knowledge and preparing ourselves to support other students and educators' digital knowledge enhancements through this software interface improvements in terms of being stable, multiplatform, user friendly with lots of English and Portuguese languages support [10].

The interactive educational environment supported better students and educators' communication and information technologies skills and competences, leading them to contribute for developing individuals' digital skills at their new school environments. An example is from former Ernani's School who are now secondary students. They met their new school computers' lab closed. Then they looked for the teacher who coordinates the computers' lab and offered their support in order to have the lab working. They investigated that there was not software package such as Microsoft Office™ or Open Office™. They returned to Ernani's School to get more information and after that installed the Open Office™ package. Students reported that they support their new mates in new school computers' lab during their free time, and offered to develop a Web designer course based on the Web standard languages (HTML, VRML) they learned on Ernani's computer labs projects.

For achieving the state of individuals' appropriation of these electronic and human skills, tools, values and attitudes in combination of curriculum development it was necessary to develop inter and transdisciplinary work, which involved internal and external, as well formal and informal collaborative learning experiences supported by enhancing individuals' knowledge based on the convergence among low cost desktop virtual reality, information visualization and multimedia systems, interactive techniques, culture, arts, including web based standard languages and technologies, from basic to higher education.

We describe the teaching and learning project in the next sessions attempting to address researchers' concerns related to the necessity of increasing the use of information visualization systems and desktop virtual reality techniques as part of the every day real world problem solving [11, 4].

Real world problems we face on everyday work are: the necessity of improving individuals' traditional and digital literacy skills and competences, as well keep them involved in developing projects that can enhance their mental models, instead of feeding a kind of cultural habit that is the tendency of children log in on a game web site and keep doing more "mechanic like actions" as we observed at school computers' lab [4].

It is thought that multimedia/hypermedia systems, which are used to attract individuals' attention and keep them entertaining for long hours are also excellent resources for engaging individuals in teaching-learning actions and attitudes that support them to understand the value of learning and using these types of resources in combination with pedagogic intervention and curriculum development, enabling people to investigate, reflect, build and express feelings and culture in diverse times and spaces. For example, transforming and stimulating children and adults' improved learning attitudes with support of Web based technologies and multimedia tools and files [12, 13].

From here we go to related work, the strategies and architecture that support the work carried out and give the base to sustain the convergence between diverse learning methodologies and theories and technology resources, cases of use, a prototype tool based on the interactive experiences with other school educators and children, discussion and conclusion.

## **Related Work**

In this section we present electronic interactive systems designed for improving individuals' education in diverse ways. We show individual and collaborative work that is related to developing ones' literacy and communication skills, stimulating reading through writing electronic documents using diverse interactive technologies and paradigms such as CAVE, virtual museum, desktop virtual reality. These works are based on web standard technologies due to World Wide Web universal appeal and the possibility of developing high quality interactive educational environments supported by low cost tools.

Environments Virtuels for Enfants (EVE) is an international co-operative project among schools and universities from France, Morocco and Romania (Gerval et al, 2002). It offers a distributed virtual reality environment designed to learn French based on software developed using Virtual Reality Modeling Language -VRML and Java languages. EVE environment has diverse sensorial activities (visual, audio) for supporting children reading and writing skills development. The main pedagogical goals are stimulating teamwork, encouraging curiosity and respect in a multicultural framework, at children level and not only [14].

Individuals can find similar characteristics at NICE (Narrative Immersive Constructionist /Collaborative Virtual Environment) project. This project focuses on informal and formal education, social content domains, embracing a constructivist approach, collaboration, plus narrative development. For that, 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 [15].

Literary Arts Program at Brown University uses Cyberworlds concept and tools in the project Writers Online, the audio internet archive of the Literary Arts Program attempting to make available to remote listeners, on campus and off, the pleasure of hearing, in real time, readings and performances by the many writers who have taken part in the Contemporary Writers Reading Series, Writers On Writing Reading Series, and numerous conferences and festivals sponsored by the Program during the last ten years [16]. The project is also

supported by the combination of text, interactivity and information visualization resources through The Cave Writing Workshop, which “is an advanced experimental electronic writing workshop, exploring the potential of text, sound, and narrative movement in immersive three-dimensional virtual reality. It brings together teams of undergraduate and graduate fiction writers, poets and playwrights, composers and sound engineers, graphic designers, visual artists, 3D modelers and programmers, to develop, within the environment of Brown’s “Cave” in the Technology Center for Advanced Scientific Computing and Visualization, projects that focus on the word” [17]. The argument is related to collaborative artworks of a type some have called “instrumental texts”, which are said to be played, in an analogy to musical instruments [18].

At Sussex University, The Future lab develops a project called Enquiring minds, which is a research and development work investigating how children can shape their own learning, by changing the emphasis from what they learn to how they learn. The project is essentially trying to put into practice the theories of fully personalized learning. In order to achieve this, it is developed a set of activities and practices to support young people in creating coherent plans for their own learning; a common vocabulary to enable children and teachers to reflect on the quality of this learning; digital tools and resources - to help children and teachers make these sorts of activities more achievable; approaches to assessment that enable children and teachers to evaluate and improve children's skills as collaborators, researchers and innovators [19].

The project “Creative Writing Co-Laboratory” is designed to set up reading and writing activities with children from 6 to 14. The set of activities proposed intended to motivate the children to write in a creative and collaborative way. The researchers of the project assume that writing is a difficult process and that providing suitable tools can overcome this difficulty. They realized when testing it with children the great potential of self expressing not only by writing, but by drawing, by using characters, balloons, text speech synthesized, backgrounds, pre-recorded sounds and talks recorded on the way. A character can have associated not only text balloons, but also music composed by the children, text speech or recorded voice. They developed also a character editor instead of using only pre-made characters [20].

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. In cooperation with students and teachers at school and students and scientist of the involved universities, several teaching scenarios are developed, tested, documented and evaluated. With digital media, new ways of designing and presenting interactive objects and new ways of communicating are reflected and accomplished in artistic projects. Thereby the analysis of the interface between the physical and the virtual world plays a major part [21].

At James Cook University the investigation carried out involves students from primary school who direct 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, not conclusive the use of VR in the classroom shows to be effective for the students' cognitive development, as well as providing active learning beyond a short-term novelty [54]

Related to virtual museum paradigm, within [55] Information visualization and interactive techniques have served as base for developing hybrid systems able to benefit communities' social and cultural development understanding. For instance, "In the early 1900s, particularly in the 1920s, African-American literature, art, music, dance, and social commentary began to flourish in Harlem, a section of New York City. This African-American cultural movement became known as The New Negro Movement and later as the Harlem Renaissance. The Harlem Renaissance transformed African-American identity and history, but it also transformed American culture in general. Never before had so many Americans read the thoughts of African-Americans and embraced their African-American community's productions, expressions, and style" [55]. Researchers wanted to convey the importance of this movement to students. They developed Virtual Harlem, a collaborative virtual reality (VR) tour of Harlem in which participants can travel back 80 years to see and hear historical figures, speeches, and music from that period. The interactive hybrid environment was designed to help students experience the neighborhood's life and culture on both visual and critical levels. The Virtual Harlem experience has been extended to distance learning investigation related to the use of emerging technologies such as VR [56-58].

### **Pedagogic and Technological Architecture that Supports Work Strategies**

The project pedagogical support is based on the combination of diverse well known learning theories and methodologies such as Piaget's constructivism and Papert's constructionism. These approaches can enhance individuals' understanding about how people learn and grow, providing better support for designing teaching and learning materials and environments in [15, 22, 23]. We incorporate the concept of scaffolding and/or software scaffolding use in education which is a process that requires direct teaching and monitoring by an adult and the distinguishing feature of scaffolding is the role of dialogue between teacher and student [24, 25]. In addition, we have support from Vygotsky's theory, which is of great interest to educators. It is what he called the zone of proximal development - ZPD. 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 [26]. We also include the application of Experiential Learning concept that supports school community inside and outside learning interactions [27-29].

Affective aspects are also relevant to the learning experiences success and were inspired on Paulo Freire and Ivan Illich' s thoughts about the necessity of making a revolution in the curriculum content and pedagogy of the present-day school, transforming them in more practical and inclusive based on horizontal relationship between educator and pupil, as well love, humility, hope, faith, confidence and respect for the freedom of expression [30-34], including the word *empathy* that can define successful communication in human relationship as suggested in [35, 36].

Thinking about software and Web based influence on the learning environment design and maintenance, the work development sustainability is based on the spiral model of software engineering [37], including the Sharable Content Reference Model - SCORM concept [38] as well its flexibility and usability in conjunction Goal Based Learning, Distributed Problem Based Learning, Independent, Experiential, Exploratory Learning, as well Learning Objects concepts, Entrepreneur and Projects Pedagogy principles described in [39-44].

Gardener's investigation about multiple types of intelligence in combination with the named learning models and concepts has formed an excellent base for using arts, culture and interactive technology's synergy in education [6, 44, 45]. For instance, such convergence can provide a better teaching/learning environment management [46], and further than that can bring about learners 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 [47].

This investigation and survey results support the recommendation that schools must learn and use with effectiveness multimedia tools and files [48]. This recommendation suggests educational and cultural transformation, which can be achieved through the use of technological art concept in teaching and learning actions. Due to its direct relation with life, art can generate productions able to lead individuals rethinking cultural concepts and developing knowledge related to the transdisciplinary aspects of managing, direct manipulating and understanding, in context, simple and complex mixtures between the real and virtual embedded on the information visualization domain [49-52].

The learning theories and advances on technology convergence brought about 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 (...)" [53].

Through Emergent Design experiences it is possible to meet 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 [53].

## **Cases of Use and Work Strategies**

### **Background**

The work has been carried out at Ernani Silva Bruno Municipal School environment, situated at Parada de Taipas, on the surrounds of the city of São

Paulo. There are many people under socio-economic disadvantage on this city area.

The development of projects that can bring about people's knowledge improvements are very important for stimulating their self-esteem and in consequence their social and digital inclusion. The project implementation started on the second semester of 2002 with a collaborative educational experience involving author1 and an educator and her learners from 4th grade. The experience used as tools VRML and HTML for developing visual aid to their cultural research related to Brazilian Carnival. According to her, the initiative had significance results in terms of supporting collaborative and cooperative work among students, improving communication between her and students, and enhancing students' self-esteem [59]. These work served as a introductory reference for the development of next ones, which were stimulated by hardware, software and fast Internet connection installed in the computers' lab.

After infrastructure technical improvements done in the first semester 2003 on the school information and communication (ICT) system, there were enhancements on educators and learners' interactions, including the approximation between basic and high education.

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 (Brazilian Science, Engineering and Creativity Fair) - Feira Brasileira de Ciências, Engenharia e Criatividade - FEBRACE 2004 [60]. During 3 days workshop, they authored a play based on Tarsila do Amaral life and artwork. During the workshop we develop research, reading and writing skill using books and digital media for collecting data and after that writing the script of the play and a text for the prototyped homepage. We designed a prototype homepage using Hypertext Markup Language – HTML, and a 3D computer graphics interactive background using Virtual Reality Modeling Language – VRM to create a scenario composed by Tarsila and children's paints and pictures, as well presented it within the CAVERNA Digital™ environment [61]. The transdisciplinary work had support of Laboratory of Integrated Systems – LSI team, a VDJ ;an Actress and Storyteller; and a Movie Maker [62, 63].

After the school participation on FEBRACE 2004, the number of individuals interested on developing curriculum projects using digital and multimedia tools and files increased. This was evident through the School participation on the project “A Cidade que a Gente Quer” (“The City We Want”) [73], 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.

Educators and students used diverse low cost software and interactive technologies such as Animator9™, Windows Movie Maker™, Power Point™, Paint™, mass for modeling characters and raw material to build scenarios background, manipulated video cameras for storytelling and producing animations. After they investigate and identify problems related to school's surround area, they produced their work attempting to express their ideas to problem solving supported by the necessity of developing people's skills to work with analytic-symbolic services and strategic agency as stated on this work introduction and in [6]. The work had the collaborative involvement of the school's head and pedagogic coordinators, as well as of the educators who



were not directly evolved on projects' construction. They contributed cooperating with the necessary changes on the learning environment. Such changes are related to time and space adaptation, including management. School's head and pedagogic coordinators went with educators and learners in two external presentations where students acted as protagonists teaching other children how to create background scene and characters using mass for modeling and animation techniques [2, 65].

### **Expanding Web Based Learning Experiences within Curriculum**

During 2005, improvements on the collaborative work carried out, brought about computers' lab coordinators Jorge and Sandra to more integrated teaching/learning actions. With school head and pedagogical coordinators' support, the computers' lab coordinators studying as well teaching time got more convergence, what served as a base for implementing an education, culture, arts and interactive technologies course evolving 6th, 7th and 8th grade students. Some of students from 7th grade, in 2005, were on 4th grade in 2002 and experienced the first authoring web based resources project at school environment. Students practiced with VRML and HTML languages through building simulated homepages, 3D virtual worlds, learning virtual reality and computer graphics techniques for supporting educational process related to the classroom curriculum development, including researching and reading Portuguese tutorials oriented by computers lab coordinators [66, 67].

Due to children's interest on 3D computer graphics and educators' hypermedia knowledge improvements; we used low cost desktop virtual reality trying to reduce students' difficulties related to Math and other curriculum subjects. Students were presenting difficulties for understanding measure 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 and used the metric system for designing a 2D school blueprint using Paint™ program. After that, due to the collaborative work between the computers' lab coordinators and exposition of other educators and students to 3D virtual worlds and Virtual Reality techniques, it was suggested to the students also modeling the school in 3D using interactive and universal tools related to the Internet. Students accepted the challenge and in conjunction technical and non-technical individuals started to build school 3D model through using VRML [68]. The model was composed in a hybrid way using texture, audio and video files. We also organized the partial model presentation in form of web page using HTML [69]. The model presentation to the community (district authorities, parents, educators and learners) happened at school birthday celebration party.

On the second semester of 2005 learners were invited for creating community's library homepage as their first external web based project. Such 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 to local community. The 3D model of the library was designed based on real world measuring, since educators and students went to the library for studying the place, measuring it and drawing a 2D blueprint on a paper before modeling that in 3D.

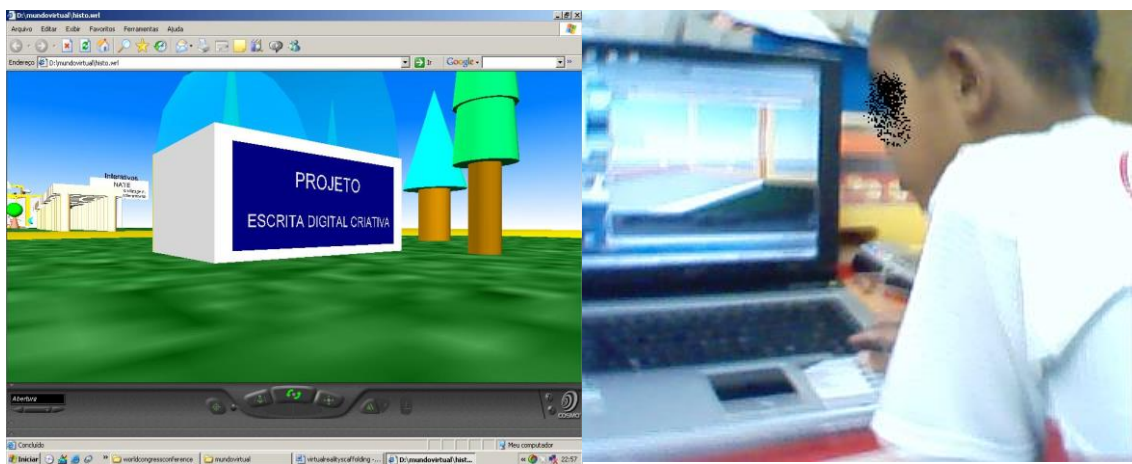
## Prototyping “Creative Digital Scribe” tool

The web based experiences and our school meetings with first and second grade teachers from basic education brought about support for developing a virtual environment related to improve children literacy. We did an experiment with two educators who were used to teach at first and second grades and a pupil who was finishing the first grade and had reasonable reading and writing literacy skills.

For the students who have good literacy skills it is not too difficult to create 2D and 3D virtual environments using Web standard languages and templates such HTML and VRML. This kind of digital scribe experience using hypertext support for developing individuals’ multimedia skills is recommended even before the current individuals’ access to powerful machines [70]. On the other hand, it is difficult for individuals with low level of reading and writing literacy abilities to build 2D and 3D virtual environments. So, based on our observation of children doing activities in the computers lab in combination with our talks with the teachers from fundamental teaching, which involves first to fourth levels, we developed an interactive 3D virtual environment prototype using VRML characteristics for scaffolding educators and children’s literacy enhancements.

It is thought that through using tools that can support to build 3D interfaces in a way that individuals can put their learning objects to work together in a meaningful mood they will be stimulated to enhance their digital and traditional literacy skill and competences.

After the creation of the prototype we did an experiment attempting an initial evaluation of “creative digital scribe” concept and the tool usability evaluation. The virtual learning environment was created with base on our observations related to educators and children’s cultural games and real world lessons used for developing reading and writing skills. Despite the fact that, to configure the virtual learning environment interface it was necessary to know a bit of VRML [71], the prototype seemed to be a good tool according to the tests in 13/12/2005 figure-1.



**Figure-1 – Hybrid VE developed based on VRML sensors, animation, video and audio files and textures. L. M. experiencing the interactive 3D World**

The interface configuration also involved the manipulation of a webcam for recording video files, after that we put them inside the virtual environment

through a VRML template in a combination with text based exercises using VRML sensors for drag and drop objects.

We interacted with the environment in an experiment that took 3 hours of human to human and human computer interactions. First it was explained to educator G how to use the Cosmos Player™ interface for navigating on the environment. So, G started fly through the environment. She was oriented to go to a virtual video room and watch a short video, in which a narrator was explaining a task she should solve. After that, she navigated through the virtual world to the virtual CAVERNA Digital™ where she “got into” and drag and drop some words in order to form the sentence “Children Love Education”.

She was told that the task concept was related to educators’ interventions and use of lyrics and songs in exercises they ask children to do for learning how to read and write through associating cultural sounds and symbolic image of letters.

It is expected through this kind of exercise that by using texts, which circulate socially, children can be able to identify, understand and use with more accuracy the arbitrary symbols culturally constructed that are used to compound the written language and represent the speech language. We are taking in consideration that language is an art transmitted from a generation to another throughout an intensive education [72, 73].

After doing the exercise, with author 1 support G adapted the exercise to her teacher experience. She recorded a video file with a task related to “Parlenda” textual gender that involves lyrics, sounds and children play. She recorded a piece of a parlenda called “Hoje é Domingo” = “Today is Sunday”. The exercise was solved by the child L. M. who finished his first primary school year in 2005 figure-1.

According to his report, he enjoyed doing the exercise and asked for adapting the environment to his cultural ideas and chose to record a new parlenda. He was told how to adapting the text in the drag and drop VRML template. Then, he typed the text, we saved the files and rendered them as they appear in figure-1 using a combination of Web base technologies such as Internet Explorer™ and Cosmo Player 2.1™.

After that L.M. explained to his mother, J., who is also a fundamental education teacher, how to navigate through the Cosmo Player browser. She navigated on the virtual environment guided by him and solved the problem. At the end of the day individuals approved the experience in [74]. The actions showed the importance of providing for children and educators opportunities for being protagonists based on the state-of-the-art-of technology and direct manipulating diverse “non-scholar” languages and systems, what brought about more motivation and self esteem for keeping engaged into the experience [75]. The motivation is based on the concept of “agency”, which is the pleasure related to the capability of individuals do meaningful actions and see the results of their decisions [76].

According to [76] digital environments are procedural, encyclopedic, participative and spatial. These properties make digital environments powerful tools for simple and complex literary creation. These properties allow to constructing a flexible learning environment base on the concept of scaffolding and/or software scaffolding use in education, which is a process that requires direct teaching and monitoring by an adult and the distinguishing feature of scaffolding is the role of dialogue between teacher and student [24, 25].

## High Education Cultural and Collaborative Work

Similar to [55], at the end of 2004, authors 1 and 3 shared technological, artistic and cultural knowledge through exploring an hybrid 3D virtual model authored by author 1, inspired on his visit to Brazilian Afro-Cultural Museum and on the teachers' cultural and artistic Afro-cultural skills improvements course called "Vozes da Africa" ("African Voices"). The course was related to ethno racial and cultural diversity and the Law 10.639 / 2003, which determines that African culture must be taught during Brazilian basic education curriculum development. For such construction, it was used the synergy of accessible standard web based languages, arts, culture, science, interactive techniques, multimedia files and tools in convergence with the virtual museum paradigm – VEP [77, 78] and in the related work [55].

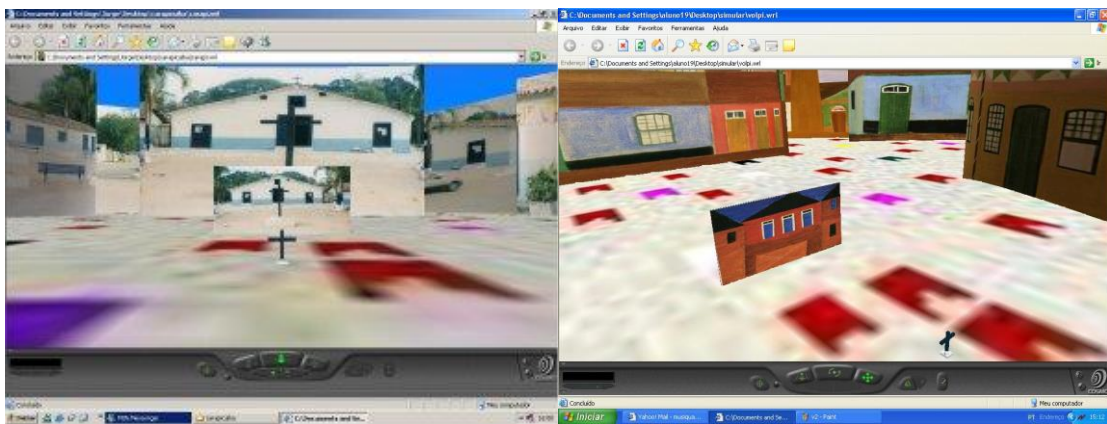
From that, it was formatted inter and transdisciplinary content based on the virtual museum paradigm. The project was called "A Poética da Madeira" ("The Wood Poetry"). Using VRML, information visualization and virtual reality techniques we converged within a unique 3D virtual environment diverse multimedia files inspired on the movie "A poética da Madeira", planned and built by author 3 during the Visual Anthropology course in 2004. The film construction involved educators and pupils of a state school called EESG Natalino Fidêncio, which is situated in the municipal district of Carapicuíba, including its surround community. The film covers themes such as ecology and the Atlantic Forest destruction on that district, social and urban development, authors'1 and 3 father skills related to manufacturing wood, as well how individuals reuse pieces of trunk that are met around the city fields for developing furniture artifacts and cultural products.

Further reflection about media and human resources used during the experience showed that the implementation and maintenance of high-quality technological infrastructure with low cost and free multimedia tools, beside teachers and pupils' lifelong learning preparation can be an important paradigm for improving Education. In middle and long-term investment, such infrastructure can generate qualitative and quantitative pedagogic, technological and human enhancements in diverse educational environments and on their surrounds, from the basic up to superior education. Through the VEP, it was converged diverse media languages such as music, film, 3D computer graphics and photography for expressing feelings and developing collaborative learning figure-2.



**Figure-2 - Screenshot of hybrid VRML 3D model using multimedia video and audio files and textures**

In 2005, authors 1 and 3 carried out another computer supported collaborative interdisciplinary experience, whose implementation contributed to amplify and combine their technological intellectual and pedagogical knowledge. The project was based on the synergy among Alfredo Volpi's painting style process, its historic, artistic and cultural aspects, as well the creation of a 3D visualization's interactive virtual environment based on information visualization theory and virtual reality techniques [51, 73, 77, 78]. The experiment proposed an approximation between the current preservation of "Aldeia de Carapicuíba" and Volpi's work. The experience reinforced the power of a balanced use of ICTs for supporting more dynamic and interactive ways of "learning to learn", "learning to think", communicating and representing knowledge with cost-effective, creativity and high-quality [79, 80]. Consumer devices such as photo cameras, Webcam, Web based technologies, low cost digital tools and files, books for researching were the instruments used for creating the environments below figure-3.



**Figure-3 - Screen shots of the research related to Alfredo Volpi and the Aldeia de Carapicuíba.**

## **Reflection**

From the initial goal of scaffolding educators and children's teaching and learning practices, the work carried out influenced individuals to improve and share knowledge. Individuals' multimedia experiences inside and outside school environment enhanced ones' general and specific knowledge, including spatial and mental models [81, 82]. The actions also contributed for developing individuals' collaborative skills through stimulating and increasing their knowledge, self-esteem, including communication, creativity and literacy skills and competences [83, 84]. This brought about enough confidence for expressing their ethnic and cultural identities with higher quality similar to the related work features showed on [14-21]. For example, the multimedia experiences in combination with his research influenced author 3 to produce at school environment a "soirée night", in which school and surround community people shared knowledge and expressed themselves through a learning environment supported by consumer devices, such as musical instruments, microphones, lighting special effects, multimedia tools, books and poetry. Related to the film making experience individuals had the opportunity of knowing better each other skills such as manufacturing and playing musical instruments, as well investigating Carapicuíba's district ecologic environmental problems. Increasing the use of well-known accessible Web standard

languages, such as HTML, VRML, Javascript and JAVA can open more democratic learning opportunities for under socio-economically disadvantage people and disable individuals meaning digital and social inclusion as well an effective preparation for them benefiting and contributing to distance learning education. For example, the creation of Voice Markup Language [85] has brought about possibilities and advantages for applying computer mediation in education using interactive speech applications in convergence with artificial intelligence techniques for scaffolding and stimulating children literacy skills improvements in short, middle and long term projects, also through game based education, interactive drama and hypermedia storytelling projects [86-90], with support of digital environments, which are procedural, encyclopedic, participative and spatial as discussed in the prototype tool section and in [76].

Inspired in [91], using the trilogy related to management, humanity and technology we attempted to improve individuals' social and cognitive processes in knowledge acquisition supported by pedagogic advice emphasizing the development of individual self-discipline for studying lifelong. The methodology for increasing knowledge acquisition is a balance between problem solving by trail and error and social community professional advice. Learning experiences attempting to solve the problems of a community client is a major source of knowledge in the development of expertise of an individual. However, learning from experience can be a slow and error-prone process. Then associate with professional communities that attempt to expedite learning and reduce errors through sharing experiences and knowledge is a sensible solution [92].

We used a combination between digital tools and learning types supported by the designing and producing media-based training. Paraphrasing [93] Learning types are named as; *cognitive learning*, which is associated with intellectual skills involving comprehension, analysis, problem solving, and evaluation; *cognitive learning*, which is most closely related to the teaching of facts, figures, concepts, principles and procedures; *psychomotor learning*, which is related to motor-skill development, muscular coordination, manipulation of materials, and objects; and affective learning, which involves attitudes, values, opinions, and motivation in [93].

The investigation carried out and the creative digital scribe tool prototype implementation and test attempted to give educators and students support for improving their technical skills and in conjunction with other individuals to understand and adapt traditional and digital media, as well Web based technologies to Brazilian educational context.

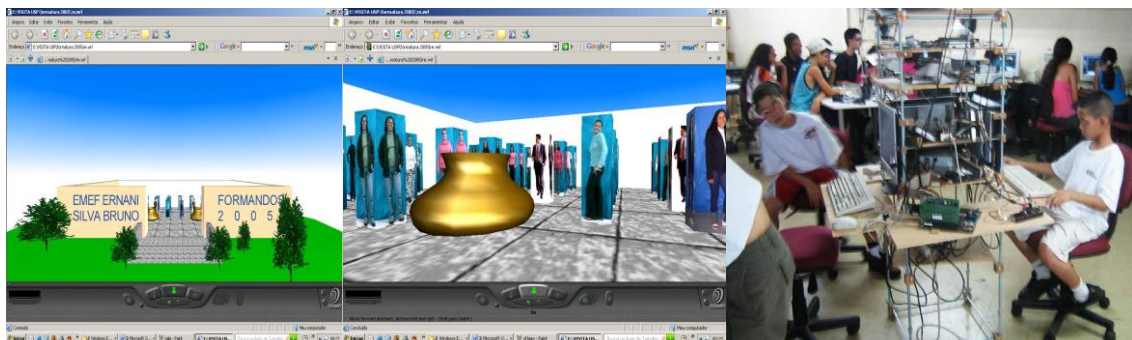
So if educators and students can appropriate themselves from the state of the art of technologies them the skills developed related to the domain of advanced technologies can be use with support of the combination of experiential learning, constructivism, constructionism, and entrepreneur and projects pedagogy. For instance, in the future students can work individual or collaboratively through the World Wide Web using digital tools for creating content for digital TV, designing Web pages, programming for delivering distance learning content, as well surviving form their talents that were stimulated during their school days, what means capital social benefits from this kind of educational approach.

The creative digital scribe tool prototype has been under research for transforming its interface in more automatic, however it is fundamental that its inputs can be done also using learning objects constructed with Web based

standard languages, which can bring about the tool be a companion for stimulating children's knowledge growth and expression lifelong. We are investigating approaches such as agent-oriented paradigm and expert system technology for learning how to improve the system designing, internal state and interface functionality [94].

On the other hand, the direct manipulation of Web based languages in combination with art, culture, technology and education proved to be sustainable. For example, as a result of the work described in the Web based experiences section, due to the students' excellent work using Web based technology and presentation within Erico Veríssimo 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. This kind of action is supported by the concept of reinforcement learning [94]. The workshop happened in Atelier-lab at a Polytechnic School, USP, and involved knowledge sharing with people from Laboratório de Sistemas Integrados -LSI team. It took place on December 06/2005.

The opportunity was offered by the LSI team under supervision of professor Roseli de Deus Lopes who coordinates the project FEBRACE, which attempts to stimulate collaborative learning experience for both teachers and learners, as well approximating higher and basic education. 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 [95-97]. During the workshop, Ernani Silva Bruno's students had the opportunity of showing their work, as well learning how to build a computer, create and install software, and how to directly manipulating such resources for producing content figure-4.



**Figure- 4 – On the left two screenshots of work done at school. On the right students at Atelier-lab**

Students' participation in this kind of workshop supports their new knowledge and the sustainability of the arts, culture, education and technology project. Due to the transport facility provided as reward for the young children's work in the library project, we invited 40 students from levels 5, 6, 7 and 8, including some who had not done any direct participation on the experiments offered. This kind of action serves as a base for developing a sustainable knowledge system and keep students telling 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. In May 25, 2006 another crew of 43 Ernani's students and two teachers were at "Atelier-Lab" and did a workshop.

We also observed individuals' concrete learning attitudes related to increase their research skills using virtual and real artifacts for doing experiments, which confirms that the kind of learning environment with educators and students have contributed for being developed in short, middle and long term projects worth it. For instance, we can add to the students' reports in this text introduction, the actions of learners from the 7<sup>th</sup> grade that after having had HTML introduction, asked to come back to computers lab for training in different time and space than the ones related to their class schedule.

At the time we were written this text, June 2006, a student from 8<sup>th</sup> grade also reported that he did an electronic experiment at home following a tutorial on an electronic magazine we are used to let on the table in order to stimulate their reading skills. This student was doing a previous research on the field of robotics via Internet, as a process of learning how to build a scientific text based on research. At the time the student talked with us he seemed proud of achieving the goal. He is one of the students who followed the multimedia projects during 2005 and was at atelier-labs on December 2005.

In the work carried out during the first semester 2006 students chose the subject they want to research in order to develop a multimedia project using as tools low cost software and open standards. We attempted to develop students' research, reading and writing skills, preparing them to build content through Web based technologies on the second semester 2006.

When we have access, we also let on the table game magazines and students from 4<sup>th</sup> and 5<sup>th</sup> grades are used to take the magazines to read at home. In general the magazines have texts that explain the technology used in virtual games construction. We think that the reading activity supports students to understand that computers do not do magic and it is necessary to enhance ones' knowledge for command the machines.

The work developed in the school computers lab seems to be of value for the students. That is because they asked us to orient them how to do a home page and how to create 3D content.

Based on students talks the idea is to use the virtual museum paradigm for developing content. It is something that can be achieved through Web based technology with cost effectiveness. Using VRML and HTML, including their templates we supported educators and students' research, reading and writing skills. This kind of action can contribute to the development of the field of distance learning according to [98, 99].

It is thought that associating computer skills to courses in universities can enhance the creativity and quality of the new professionals for using technology at school teaching or training in an innovative way. The application of these techniques can support the schools transformations and the learning to learn of institutions, teachers and students, as well as developing a new generation of skilled individuals from basic to higher education [100, 101]. The necessity of flexible and creative individuals for the new type of jobs rising with the information era implicates in developing individuals' computer skills during their courses in combination with the subject of study. It is a great opportunity for join experience that comes from teachers and the technology resulting in



high-tech quality education, developing a learning infrastructure that operates practical experimentation and testing, capacity building and diffusion, and standardization [102].

We found support for these two statements on recent informal talks with two educators on our learning environment. According to them who are doing supervision and management courses related to education, in their classes they heard about information technology, read about it, researched about it, but they did not directly manipulate any kind of ICT tool on their universities. So it seems there is a lot of work for improving individuals' skills and really enhancing the necessary education quality to increase people's literacy, reduce the digital divide, and transform the bad picture showed on Passarelli's research about Brazilian education [6].

## **Conclusion**

It was discussed how effective can be the use of information and communication technologies as resources for enhancing individuals' education. Obstacles, such as learning programming languages, understanding hardware and software issues, as well as sometimes learning the language in which software and applications are written (for instance, English), can be in another point of view an important incentive and challenge for individuals' development. The standardization of Web based languages and the Internet protocols can support high-tech clustering of social and cultural manifestations at low cost. So, the digital inclusion can be an effective way of supporting individual's self confidence and literacy enhancements with respect to cross-cultural aspects related to techniques, time, space, reason and emotion [103, 104].

Due to its complexity, learning how to read and write requires development of children, adolescents and adults' several skills and competences. However, when the citizens dominate the principles of the state-of-the-art of technology domain, they are used to become psychologically empowered [105]. Furthermore, they can be highly motivated to understand and use the arbitrary symbols culturally constructed that are mixed up on the language, which is an art transmitted from a generation to another throughout an intensive and effective education [51, 72, 73]. So, using the state of the art of human, technical and educational resources synergy for influencing citizens' learning can be a key point for stimulating them to be competent users and content producers of digital media content lifelong [1, 4].

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