Chapter XIV
Enhancing Individuals’ Cognition, Intelligence and Sharing Digital/Web-Based Knowledge Using Virtual Reality and Information Visualization Techniques and Tools within K–12 Education and its Impact on Democratizing the Society

Jorge Ferreira Franco
Universidade de São Paulo (NATE –LSI/USP), Brazil

Irene Karaguilla Ficheman
Universidade de São Paulo (NATE –LSI/USP), Brazil

Marcelo Knörich Zuffo
Universidade de São Paulo (NATE –LSI/USP), Brazil

Valkiria Venâncio
Universidade de São Paulo (NATE –LSI/USP), Brazil

Roseli de Deus Lopes
Universidade de São Paulo (NATE –LSI/USP), Brazil

Marlene Moreno
Secretaria Municipal de Educação de São Paulo - SME, Brazil

Marlene Gonçalves da Silva Freitas
Secretaria Municipal de Educação de São Paulo - SME, Brazil

Ana Luiza Bertelli Furtado Leite
Secretaria Municipal de Educação de São Paulo - SME, Brazil

Gláucia Almeida
Secretaria Municipal de Educação de São Paulo - SME, Brazil

Sandra Régina Rodrigues da Cruz
Secretaria Municipal de Educação de São Paulo - SME, Brazil

Marcos Antonio Matias
Universidade Bandeirante, Brazil

Nilton Ferreira Franco
Universidade Presbiteriana Mackenzie, Brazil

ABSTRACT

This chapter addresses an ongoing work strategy for developing and sharing knowledge related to digital/Web-based technology and multimedia tools, information visualization, computer graphics, desktop
virtual reality techniques in combination with art/education. It includes a large body of research about advanced and contemporary technologies and their use for stimulating individuals’ education. These interactive processes of researching, developing and sharing knowledge have been carried out through interdisciplinary and collaborative learning and teaching experiences in the context of k-12 education in a primary public school and its surrounding community. The learning and direct manipulation of advanced and contemporary technologies have improved individuals’ technical skills, stimulated cooperative and collaborative work and innovations in the way of developing school’s curriculum content as well as supported ones’ independent learning. Furthermore, there have been changes on individuals’ mental models, behavior and cultural changes related to reflecting about diverse possibilities of using information and communication technology within collaborative formal and informal sustainable lifelong learning and teaching actions.

INTRODUCTION

This chapter addresses an ongoing educational experience of sharing digital/web-based knowledge (Franco & Lopes, 2005b; Franco, Stori, Lopes & Franco, 2005) related to disseminate and use a combination of contemporary and advanced technologies (Barbosa, 2006), culture, science and arts in the context of a primary education school for supporting individuals’ collaborative, interdisciplinary, dynamic, interactive, sustainable, high quality and lifelong learning (Burdea & Coiffet, 2003; Cunningham, 2008; Estação Ciência, 2009; Franco, 2000; Franco, 2001; Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008; Grasset, Woods & Billinghurst, 2007; IINN-ELS, 2009; Kaufmann & Meyer, 2008; Projeto Clicar, 2009; Sherman & Craig, 2003; Tan, Lewis, Avis & Withers, 2008).

The educational experience has been developed through using a wide variety of technologies such as web-based technology, desktop virtual reality -VR, information visualization and computer graphics techniques, and low cost multimedia tools and files, which in this text, we call contemporary and advanced technologies. The contemporary technologies have been applied in the context of a public primary municipal school that is situated in the Parada de Taipas neighborhood, in the suburb of the city of Sao Paulo. Many students that live on this area are from low-income families, are under socio-economic disadvantage and at risk situation (Franco, Cruz & Lopes, 2006; Projeto Clicar, 2009; Estação Ciência, 2009).

On the other hand, within the goal of contributing to improve this uncomfortable social situation, through learning and using information and communication technology in combination with other multimedia, advanced and contemporary technologies for stimulating individuals’ education, students and educators have developed technical skills, as well as engaged in cooperative and collaborative and independent learning attitudes (Franco, Ficheman, Venâncio, Moreno, Freitas, Leite, Franco, Matias & Lopes, 2008c; Franco & Lopes, 2008).

According to Singer (2002) individuals’ will and attitudes to learn and experiment are key points for developing a solidarity economy able to support under socio economic communities improvements. Furthermore, the learning situations and activities based on contemporary and advanced technologies have encouraged a community that by its own initiative has improved its life condition, renewed its cultural tradition and rebuilt individuals’ human dignity.

We believe and our observations related to individuals’ learning attitudes when they are dealing with the learning situations proposed for problem solving have highlighted that using contemporary
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and advanced technologies, including information systems knowledge in combination with human mediation can stimulate individuals’ will to learn. For instance, through exploratory learning, bringing about more possibilities for supporting human’s dignity enhancements, stimulating lifelong learning (Wikipedia Lifelong Learning, 2009) and impacting on democratizing society.

The design of information systems requires the application of techniques from experimental psychology like exploratory learning, which is the combination of problem solving and learning behavior, covering trail and error and instruction taking activities (Reiman, Young & Howes, 1996). The use of these techniques in combination with diverse learning paradigms plus contemporary and advanced technologies in formal and informal educational environments can stimulate individuals’ will to learn, as well as inspire and reinforce collective intelligence (Levy, 1993) development for understanding the relevance of ones’ dominating and using digital/web-based and other contemporary and advanced technologies for supporting individuals’ education enhancements.

In this work ones’ education enhancements has been supported by the application of the combination of ICT and techniques from experimental psychology in synergy with well known learning theories and methodologies such as constructivism and constructionism (Piaget, 1987; Papert, 2008), experiential learning (in Maier & Warren, 2000), the concept of zone of proximal development – ZPD (in Fonseca, 1998; Vygotsky, 2007), the theories of Mediated Learning Experience - MLE and of Structural Cognitive Modifiability - SCM that are related to Feuerstein’s work (in Wikipedia, 2008; Fonseca, 1998) and the Theory of Multiple Types of Intelligence (Gardner, 1991; Kassin, 1995).

Other contemporary learning concepts, projects and scientific investigation that support this work are: ‘ambient intelligence’ – AmI in (Ambient Intelligence Org, 2008; Ducatel, Bogdanowicz, Scapolo, Leijten, & Burgelman, 2001; ISTAG, 2003; ISTAG, 2004); Computational Thinking (Wing, 2006); Systems Dynamics (Forrester, 1992; Forrester, 1994; Forrester, 1996); projects such as the New Media Consortium (NMC)’s Horizon Project (2008); International Institute of Neuroscience of Natal Edmond and Lily Safra - IINN-ELS (2009) and the “Campus of the Brain” project (Nicolelis, 2008) related to the use neuroscience and neurotechnology for social and scientific development; and Alice programming project (Alice org., 2008) that investigates tendencies and suggests practices related to the use of emerging and contemporary technologies on education and their influence to develop, for instance, individuals’ technical skills, having as a consequence ones’ collective intelligence and perception improvements (Lévy, 1993) to apply these tools effectively, as well as approximating people from computer science, technology, arts and culture such as (Colson, 2007; Franco and Lopes, 2008; Gardner, 1994; Popper, 2007; Wands, 2006).

The use of advanced technologies has also influenced students and educators’ engagement in active learning and teaching mediated practices that have brought about individuals’ psychological empowerment (Mrech, 1999) for increasing their intellectual attitudes of learning and sharing contemporary digital technologies and related knowledge inside and outside the school environment (Franco, 2005a; Franco & Lopes, 2005b; Franco, Cruz & Lopes, 2006; Franco, Mariz, Lopes, Cruz, Franco & Delacroix, 2007).

Such individuals’ practices and attitudes have brought about opportunities for the school community participating in innovative educational collaborative projects such as the one-to-one learning model from the ONG - One Laptop Per Child - OLPC and Feira Brasileira de Ciências e Engenharia - FEBRACE (Febrace, 2009; Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008; Portal Aprendiz, 2009; OLPC, 2008).

Fonseca (1998) states that the computing revolution, which has been run within the called
‘cognitive society’ has implicated in stimulating individuals’ knowledge creativity and innovation, ‘which are cognitive attributes by excellence, and of excellence’ and individuals can not develop them by passive perception and massive information. For instance, according to Glasser (2009) and his investigations on how we learn, an interactive learning process and active ones’ knowledge, creativity, innovation and perception development can be the result of:

10% of what we READ; 20% of what we HEAR; 30% of what we SEE; 50% of what we SEE and HEAR; 70% of what is DISCUSSED with OTHERS; 80% of what is EXPERIENCED PERSONALLY; 95% of what we TEACH TO SOMEONE ELSE. (William Glasser, 2009)

Glasser’s investigation supports the logic of using digital/web-based knowledge, contemporary and advanced technology, including information visualization tools on students’ learning and educators’ training to stimulate ones’ interactive learning and knowledge based sensorial perception (visual, auditory, mental, tactile) development (in Reilly & Munakata, 2000).

The application of this logic can also support to reverse the idea of a “black box” that many non-technical individuals have about possibilities of producing two-dimensional 2D and tri-dimensional 3D virtual environments VE by using computers graphics principles (Foley, Dam, Feiner & Hughes, 1993), Virtual Reality VR (Burdeau & Coiffet, 2003; Sherman & Craig, 2003) and related technologies. For example, Brutzman & Daly (2007) state that 3D graphics is best known from movies or computer games. It is something “special” created by others, and viewed only in movie theaters, by DVD playback, or by locally installed computer-game programs.

On the other hand, due to the decreasing costs of hardware and software and the evolutionary work that has been carried out related to web-based technologies, individuals under socio-economic disadvantage have had an increase in their access to information systems devices and technologies. Furthermore, they have had their mental models and perception stimulated by playing and sharing video games at home and LAN houses.

These facts have brought about ones’ mental models and knowledge development for understanding explanations about how to create simple and complex 2D and/or 3D VE using computers graphics principles (Foley, Dam, Feiner & Hughes, 1993) and related technologies at school and at home (Franco & Lopes, 2005b; Franco, Cruz, S. R. R., Aquino, Teles, Gianevechio, Franco, Ficheman, & Lopes, 2007b).

We believe that increasing individuals’ fluency to deal with contemporary and advanced technologies can bring about benefits to them and impact on democratizing the society. For instance, relevant benefits can be opportunities for improving ones’ “capabilities of more efficiently utilizing geographically distributed technological assets and skilled labor forces” through understanding and dominating “innovative knowledge and technology creation, arguably the most unique by-products of the human brain, are likely to become the most valuable commodities fueling the global economy” (Nicolelis, 2008). And developing individuals’ technical skills to create digital content and turn the activity to an income, which is an important social and learning work achievement that have been carried out in the projects such as (Computer Clubhouse, 2008; Meninos do Morumbi, 2008).

Within the belief that it is possible to provide similar work through a primary school learning environment, since 2002, in Parada de Taipas district, inside a primary school, here called Ernani Silva Bruno - ESB, this digital/web-based knowledge and technology work has been carried out. We have attempted to introduce contemporary and advanced technologies to individuals from the school and surrounding community and supporting possibilities of stimulating and
improving ones’ knowledge and lifelong learning attitudes.

The development of the learning and teaching experiences based on contemporary and advanced technologies have supported individuals’ cognition, perception, attention and intelligence enhancements under supervised, unsupervised and reinforcement learning actions (Luger, 2002; Russell & Norvig, 2003). It includes ones’ knowledge development on how to meaningfully organize and visualize information, through stimulating human’s primary sensory apparatus, vision, as well as the processing power of the human brain (Schroeder, Martin & Loresen, 1998). Vision is the most studied of our senses and our somewhat unitary and transparent “subjective visual experience is constructed from a wide array of processing areas, each specialized to some extent to a particular aspect of the visual world (eg. shape, color, texture, motion, depth, location and so on)” (Reilly & Munakata, 2000).

Due to the growth influence of visual information on citizens’ lives, this work has also attempted to stimulate ones’ use of information visualization techniques and tools as a support for their traditional (verbal), digital and visual alphabetization and literacy processes (Demo, 2008; Donis, 2007; Franco, Cruz & Lopes, 2006; Gombrich; 2007). By involving school and surround community in a collaborative, interdisciplinary and sustainable work (Barber & Fullan, 2005; Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008; OLPC, 2008; Fullan, 2005; Fullan 2008).

Within a long term process, through applying such techniques and tools, it has been achieved an increase on the level of individuals’ conscience about the relevance of developing their skills for reading, writing, researching, communicating, producing digital content and sharing knowledge.

Individuals’ knowledge, creativity, innovative and technical skills development have been achieved under the strategy of providing students and educators learning situations in which they can direct-manipulate web-based technologies such as (Hypertext Markup Language – HTML (Zakour, Foust & Kerven, 1997), Virtual Reality Modeling Language – VRML (Ames, Nadeu & Moreland, 1997) and Blogs and reflect about technology application. It includes the named technologies integration and interoperation with web-based knowledge and standard multimedia files such as MPEG, JPEG, and WAV (Brutzman & Daly 2007; Web3D consortium, 2008).

Through learning how to manipulate contemporary technologies and tools and reflect about their uses, individuals have adopted independent learning attitudes (Maier & Warren, 2000) for producing digital content, sharing the developed knowledge with the surrounding community and using diverse technologies as problem solving tools.

By applying their technical knowledge, individuals have achieved innovative ways of improving and developing school curriculum and human interactions within a cooperative and collaborative construction of more dynamic, innovative, effective, high quality and interactive learning environments inside and outside school (Cook, 1998; Dede, Salzman, Loftin & Ash, 1997; Franco, 2001; Franco, Cruz & Lopes, 2006; Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008; Gardner, 2001; Johnson, 2006; Osberg, 1995, Osberg 1997a; Osberg 1997b).

Across cooperating and collaborating, individuals have learned and contributed to diffuse the art of stimulating cultural and educational changes at local community and beyond. These actions have formed a cognitive and digital learning ecosystem (in Ficheman & Lopes, 2008; Levy, 1993) supported by cross media approach (Miller, 2004) in synergy with cross-disciplinary orientation, which has been fundamental to role of innovation in economic and social change (Fagerberg, 2006). According to Lam (2006) inspired in (Weick 1979, 1995; Walsh, 1995) “cognition” or “cognitive” refer to the idea of individuals develop mental models, belief systems, and knowledge structures.
that they use to perceive, construct, and make sense of their worlds and to make decisions about what actions to take”.

Following this introduction reflection and logic, this chapter focuses on the formal and informal use of digital and web-based knowledge through virtual reality, information visualization and computer graphics techniques on individuals’ learning and cognitive development. It also addresses how the use of these technologies has brought about innovative learning opportunities for the school and surrounding community.

For achieving such goals, paraphrasing Resnick’s ideas (2006) this chapter presents an alternate vision of how children might use computers. In this vision children use computers more like paintbrushes and less like televisions, opening new opportunities for children to playfully explore, experiment, design, and invent.

Hence, the combination between the theoretical and practical examples that will be showed on this chapter highlight how children, young students and adults have become protagonists by using computers as paintbrushes. By supporting individuals’ knowledge and capabilities improvements we have applied the concept of stimulating ones’ development as freedom (Sen, 2000).

This way, we have contributed for reducing the problem of digital divide within a sustainable mood. And also for decreasing the problem that computers are stifling children’s learning and creativity, engaging children in mindless interaction and passive consumption, which is a problem that a growing number of educators and psychologists have expressed according to Cordes & Miller (2000) and Oppenheimer (2003) (in Resnick, 2006). For instance, we have seem this kind of situation related to children’s preference for games that require ‘mechanic like actions’ instead of reflective thinking at ESB’s School computers lab (Franco, Cruz and Lopes, 2006).

According to Sancho (2006) and Istance’s (2006) investigation, this chapter development can also contribute to the reflection about how to decrease education problems such as to provide protagonist opportunities to a learning community in a way that a community can act as an agent of transformation, bringing about school development; to offer alternatives that can support to overcome the limitations that have caused difficulties to improve learning environments such as the necessity of reducing the number of students per class (currently about 35-40) for (15-20). The reduction can impact on the educators and students’ communication and scaffolding quality in a very positive way (Ficheman, Saul, Assis, Correa, Franco, Tori & Lopes, 2008b; Franco, Cruz and Lopes, 2006); and improving educators’ training opportunities lifelong in quality and quantity (Demo, 2009b).

Sancho and Istance’s investigation also includes the necessity of providing a school scenario of high level of research and development, individuals’ lifelong training, group activities, professional networks and mobility inside and outside educators’ carrier, equality of learning opportunities for all, respecting the diversity of ones’ learning capabilities but within good human and technical support, enhancing the economic resources available to develop schools’ quality.

According to our observations and practical work, in this kind of school scenario, contemporary and advanced technologies can be used for constructing knowledge such as in universities and scientific communities (Durlach & Mavor, 1994; Istance, 2006; IINN-ELS, 2009).

We have applied contemporary and advanced technologies to mediate learning situations (Franco, Cruz & Lopes, 2006; Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008). This is a fact that has stimulated ‘face-to-face knowledge exchanges’ and human computer interactions enhancements (Te’eni, Carey & Zang, 2007, p. 393), as well as influenced changes on individuals’ mental models. Ones’ mental models transformations have led them to the culture of using better the informational resources related to the internet culture, which has been built based on the
"techno-meritocracy of science and technological excellence that comes from the big science and the academic world" (Castells, 2003, p. 53).

This ongoing cultural change in the learning environment object of this chapter has brought about ones’ lifelong learning attitudes, which have implicated on improving individuals’ wisdom for using contemporary and advanced technology attempting to reach and demonstrate knowledge of excellence. As Nicolelis (2008) states, it is the use of “Science as an agent of social transformation”.

From here, during the chapter’s development we will present the initial motivation for developing this work, the background highlighting technical tools, learning and economic concepts including related work, methodology for keeping this work sustainable, case study, evaluation and conclusion.

MOTIVATION

The initial support for developing this work comes from author1’s motivation for offering better education quality to the students. The initial desire and vision were to increase students’ motivation for learning English within practical and real world applications by using better school’s computers lab and other multimedia digital resources available (Franco, 2000; Franco, 2001a).

Through researching and learning how to develop web-based standalone applications, author1 shared knowledge with his high school students on how to directly manipulate web-based technologies and how to construct web pages developing HTML files and using its templates, in 1999. It was a period that the school did not have Internet connection. The work was carried out using a text editor such as a notepad, and installing a browser such as Internet Explorer™ in the Window 95™ operating system and using an image editor such as the Paint™ software.

Educator and students improved and shared reading, writing, researching and communication skills. They developed curriculum content related to the English language and produced digital material with support of the digital/web-based technology standalone features. Students worked in teams sharing their common interests and knowledge for achieving their group goals. For example, students designed and prototyped their web pages related to their subjects of interest such as cartoons, fashion shop, online car sales, marketing, and artifact projects (Franco, 2001a).

At that period, one of the students who worked on a cartoon project related to airplanes and had good drawing skills, suggested that he could learn how to develop the project in 3D using a computer. After that, by investigating new tools, author1 bought and shared a computer magazine with him, showing a picture of a 3D VRML model of an airplane (in Internet Guianet, 1999). Although, the magazine brought a VRML code on it, there was no browser available to test the sample. Either author1 had enough knowledge for solving that problem.

On the other hand, that interactive, dialogic (Freire, 2004), collaborative and mediated learning experience has led to author1’s lifelong and independent learning attitudes based on open learning possibilities (Peters, 2001, p.179). By synchronism of actions related to ones’ attitudes and lifetime opportunities, in the year of 1999, author1 got a scholarship for doing a master course through the program (British Council Chevening, 2008).

The active mediated multimedia learning experience that occurred at school inspired author1 to chose a Master Science Course in Virtual Environments (NICVE, 2008), at the University of Salford, United Kingdom, where he begun to deepen his knowledge, among others, on 3D graphics and on the Internet technologies (Franco, 2001b). After coming back to Brazil, at the end of 2000, author1
returned to teaching English and two years late started working as an ICT facilitator.

Since the middle of 2002, he has worked as an ICT facilitator at ESB School (Franco & Lopes 2005; Franco, Cruz & Lopes, 2006). He has shared with other educators, students and researchers the digital/web-based knowledge developed through learning and teaching actions such as the ones described on this chapter. For instance, the first learning action related to using web-based technology at ESB School was a collaborative and interdisciplinary learning experience among him and a 4th grade primary educator and her 40 students for creating a chess board 3DVE.

The small scale interactive learning experience was mediated through presenting an author1’s VRML 3DVE to the educator and her students. The chess board 3DVE designed using VRML had as reference author1’s Musiquarium 2000 project, which was modeled in proprietary software during his master course (Franco, 2001b). After that, author1 and students created a small scale 3DVE applying low cost tools for representing the game culture and Brazilian carnival, which students were investigating. They also simulated a prototype home page using HTML scripts. Both the chess board and the home page were developed using a text editor (Notepad™) in a computer (Compaq™) 133MHz and 16RAM and visualized in a VRML viewer such as Cortona™ and Cosmo Player™ Figure 1.

Again, there was not Internet connection available in the school’s computers lab, but author1’s technical skills acquired during the master course and his lifelong learning attitudes supported to learn how to install a 3D web browser (Cosmo Player™) suitable to run the experiment and visualize the chess board simulation and develop a learning situation of sharing web-based knowledge with the 4th grade educator and her students.

An interesting result of this collaborative learning experience is that six months later when asked about the importance of it for the class development, the 4th grade educator said that she observed that the development of the web-based learning experience brought about increasing students’ confidence, collaborative work and engagement on learning attitudes (in Franco & Lopes, 2004).

After this informal talk, in 2003, the school computers lab configuration was upgraded. Twen-

Figure 1. On the left, author1’s interactive 3DVE used for presenting web-based technologies to a 4th grade educator and her students. On the right, a sample of the chess board prototype developed during the learning experience.
ty-one Computers Pentium III, 900MHz and 128 RAM with Internet connection were installed. So, since the first semester of 2003, autor1 has invited and shared the developed knowledge with students and educators, bringing about to build the work that has been carried out and results described on this chapter (Franco, Cruz & Lopes, 2006; Franco, Cruz & Lopes, 2006; Franco, Mariz, Lopes, Cruz, Franco & Delacroix, 2007a; Franco, Ficheman, Venâncio, Moreno, Freitas, Leite, Franco, Matias & Lopes, 2008c).

BACKGROUND

In this section we will describe some technical tools and projects that have supported researches and initiatives of creating and using advanced technologies in education.

Over the last three decades there have been several research and initiatives of creating and using interactive contemporary and advanced technology on individuals’ education as a way of inspiring and improving learning and teaching practices. It includes a tendency of using 3D advanced technologies.

With the growth and expansion of web-based technologies such as HTML (Zakour, Foust, & Kerven, 1997), VRML (Ames, Nadeu, & Moreland, 1997) and (Java and Java3d API™, 2008) and their interoperations (Roehl, Couch, Reed-Ballereich, Rohaly, & Brown, 1997), diverse collaborative, interdisciplinary, creative work and references have been developed and shared on the Internet ((Franco, Ficheman, Venâncio, Moreno, Freitas, Leite, Franco, Matias & Lopes 2008c; Mitchell, 1999; Perlin, 2008; Virtual Dundee, 2008; VRML sourcebook 2.0 on-line, 2008; Web3D consortium, 2008).

For instance, these and other related technologies have allowed using the state-of-the-art of 3D graphics and computer modeling to produce interactive museums exhibitions for introducing visitors to relevant ideas related to sciences, art, culture and technology (Colson, 2007; Wands, 2006) that help to explain complex ecosystems but also economic markets, immune systems, and even traffic jams (Ficheman & Lopes, 2008; Resnick, Strimpel & Galyean, 2008; Tan, Lewis, Avis & Withers, 2008).

TECHNICAL TOOLS DEFINITIONS

The main technical tools we have used to carry out this work are web-based and low cost ones. Most web documents are structured based on a markup language. According to Stanek (1996), these documents can be simple and/or complex structures described in terms of plain text. It ensures the widest distribution to any type of computer and presents the formatting in a human-readable form called markup. As demonstrated in the motivation section, “because the markup contains standard characters, this also means anyone can create documents in a markup language without needing special software” (Stanek, 1996, p. 17).

Having the school curriculum development in mind, by using a digital/web-based platform for supporting it, individuals have acquired and developed technical knowledge to create electronic documents similar to some traditional publications such as comics and comic books, magazines, books, newsletters, newspapers. Individuals’ technical knowledge acquired has also been applied for producing their own 2D and 3D simulations beyond the school (Franco, Ficheman, Venâncio, Moreno, Freitas, Leite, Franco, Matias & Lopes 2008c).

This way, through using scripts related to web-based standard markup languages we have contributed for developing individuals’ reading, writing, researching and communicating skills, as well as reducing the problem of digital divide.

Hypertext Markup Language – HTML is the predominant markup language for Web pages. It provides a means to describe the structure of
text-based information in a document — by denoting certain text as links, headings, paragraphs, lists, and so on — and to supplement that text with interactive forms, embedded images, and other objects such as video and audio (HTML Wikipedia definition, 2008; Murugesan, 2008; Rossi, Pastor, Schwabe & Olsina, 2008; Zakour, Foust & Kerven, 1997).

Virtual Reality Modeling Language- VRML is a standard file format for representing 3-dimensional (3D) interactive vector graphics, designed particularly with the World Wide Web in mind. It is a text file format where, e.g., vertices and edges for a 3D polygon can be specified along with the surface color, UV mapped textures, shininess, transparency, and so on. URLs can be associated with graphical components so that a web browser might fetch a web-page or a new VRML file from the Internet when the user clicks on the specific graphical component. Animations, sounds, lighting, and other aspects of the virtual world can interact with the user or may be triggered by external events such as timers (Ames, Nadeu & Moreland, 1997; VRML Wikipedia definition, 2008).

Virtual reality (VR) is a technology, which allows a user to interact with a computer-simulated environment, be it a real or imaginary one. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Users can interact with a virtual environment or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus boom arm, and omnidirectional treadmill. The simulated environment can be similar to the real world, for example, simulations for pilot or combat training, or it can differ significantly from reality, as in VR games (Wikipedia Virtual Reality definition, 2008).

According to Ronald Azuma’s definition, Augmented Reality – AR is an environment that includes both virtual reality and real-world elements. For instance, an AR user might wear translucent goggles; through these, he could see the real world, as well as computer-generated images projected on top of that world. Azuma defines an augmented reality system as one that combines real and virtual, is interactive in real-time, is registered in three dimensions (in Wikipedia Augmented Reality definition, 2008). Azuma’s definition is a classical view of AR that is focused on “grafting” 3D virtual objects onto the real world (in Bowman, Kruijff, LaViola & Poupyrev, 2005). Augmented reality (AR) is a relatively mature technology, but so far it remains largely undiscovered by schools as a means of enhancing traditional lesson delivery. The advantage of AR is its ability to overlay information on real physical objects as viewed on a LCD projector or interactive white board (Lewis, Avis & Withers, 2008).

Blog is another tool that is applied, attempting to stimulate individuals for using digital and web based technologies. The term blog (a contraction of the term “Web log”) is a Web site, usually maintained by an individual, with regular entries of commentary, descriptions of events, or other material such as graphics or video (in Blog Wikipedia definition, 2008).

**TECHNICAL TOOLS FOR SUPPORTING THE WORK**

The tools we have used for running this work are low cost third-party and free software such as Paint™, Notepad™ and GIMP™ (2008), Blender™ (2008) as well as accessible standard languages from WEB such as (Hypertext Markup Language – HTML, Virtual Reality Modeling Language – VRML, JavaScript) and their templates (Zakour, Foust, & Kerven, 1997; Ames,
Recently, we have also applied blog as a platform for supporting students to publish their work and develop the culture of using better digital/web resources.

Individuals have used the school computers lab Intranet and the Internet for researching and developing off-line and on-line projects. The Internet browsers that ones have applied to visualize information and interact with are Cortona VRML client™, and Internet Explorer™ (Franco, Ficheman, Venâncio, Moreno, Freitas, Leite, Franco, Matias & Lopes 2008c).

Other multimedia resources employed for researching as well as creating content have been the school's library and computers labs, as well as multimedia instruments such as video cameras, webcams, TV capture card - PlayTV MPG-2™, tape recorder, microphones and the XO Laptop version B2 and B4 related to one to one learning model (Ficheman, Saul, Assis, Correa, Franco, Tori & Lopes, 2008b; Franco, Ficheman, Lopes, Ferreira, Santos, Ferreira, Araújo & Moreno 2008).

Some students have reported that at home they use Windows™ operating system for practicing with HTML and VRML, but some of them have asked about the possibility of using Linux™. It would be excellent that non-technical individuals could install easier a browser able to read wrl files in a Linux™ system. We did tests with Linux Ubuntu™ operation system in combination with FreeWRL™ (2008) browser and the combination worked well with native wrl files without movie textures. So, individuals would benefit from the XO B4 laptops which run under Linux, Fedora™ operating system to develop 3D computer graphics skills and curriculum content.

**UNDERSTANDING SOME LEARNING AND ECONOMIC CONCEPTS AND APPROACHES**

Here learning as well as economic concepts and approaches that have supported educational and economic systems development and can serve for guiding this work improvement and sustainability are described.

The solidarity economy is often considered part of the social economy, forming what might be termed the “social and solidarity economy” (from the French “économies sociale et solidaire”). The concepts are still under development and the difference between the two terms is gradually being clarified. An organization seeing itself as part of the solidarity economy generally goes beyond achieving purely social aims: it aims to put right an injustice by expressing solidarity. For example, a local sports club has a social aim and so can be considered part of the social economy, but would not normally be considered part of the solidarity economy except in special circumstances (e.g. a township sports club in South Africa in the days of apartheid (in Wikipedia solidarity economy, 2008). For some theorists of the movement, solidarity economy begins with a redefinition of economic space itself. The dominant neoclassical story paints the economy as a singular space in which market actors (firms or individuals) seek to maximize their gain in a context of scarce resources. These actors play out their profit-seeking dramas on a stage wholly defined by the dynamics of the market and the state. Countering this narrow approach, solidarity economics embraces a plural and cultural view of the economy as a complex space of social relationship in which individuals, communities, and organizations generate livelihoods through many different means and with many different motivations and aspirations -- not just the maximization of individual gain. The economic activity validated by neoclassical economists represents, in this view, only a tiny fraction of human efforts to meet needs and fulfill desires (in Miller, 2006).

According to Wing (2006) the concept of computational thinking represents a universally applicable attitude and skill set everyone, not just computer scientists, would be eager to learn and use. To reading, writing, and arithmetic,
we should add computational thinking to every child’s analytical ability. Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science. Computational thinking includes a range of mental tools that reflect the breadth of the field of computer science. Some computational thinking characteristics are conceptualizing, not programming; fundamental, not rote skill; a way that humans, not computers, think; complements and combines mathematical and engineering thinking; ideas, not artifacts; and for everyone, everywhere.

System dynamics is a powerful methodology and computer simulation modeling technique for framing, understanding, and discussing complex issues and problems. It deals with internal feedback loops and time delays that affect the behavior of the entire system. What makes using system dynamics different from other approaches to studying complex systems is the use of feedback loops and stocks and flows. These elements help describe how even seemingly simple systems display baffling nonlinearity. The basis of the method is the recognition that the structure of any system — the many circular, interlocking, sometimes time-delayed relationships among its components — is often just as important in determining its behavior as the individual components themselves. Examples are chaos theory and social dynamics (Wikipedia System dynamics, 2008).

According to Forrester (1992) system dynamics can provide that dynamic framework to give meaning to detailed facts. Such a dynamic framework provides a common foundation beneath mathematics, physical science, social studies, biology, history, and even literature:

*In spite of the potential power of system dynamics, it could well be ineffective if introduced alone into a traditional educational setting in which students passively receive lectures. System dynamics can not be acquired as a spectator sport any more than one can become a good basketball player by merely watching games. Active participation instills the dynamic paradigm. Hands-on involvement is essential to internalizing the ideas and establishing them in one’s own mental models. But traditional class rooms lack the intense involvement so essential for deep learning.* (Forrester, 1992)

Ambient Intelligence - AmI is “a set of properties of an environment that IST Advisory Group is in the process of creating”. It is not necessary to more tightly define the term Ambient Intelligence. Most importantly, AmI remains a principal focus for information and communication technology. But it is important to appreciate that AmI remains an ‘emerging property’ and that future scenario building and iterations of the vision should treat AmI as an ‘imagined concept’ and not as a set of specified requirements. While AmI should not be promoted as a panacea for social problems, it does represent a new paradigm for how people can work and live together. AmI enables and facilitates participation by the individual - in society, in a multiplicity of social and business communities, and in the administration and management of all aspects of their lives, from entertainment to governance. Radical social transformations are likely to result from the implementation of the AmI vision (ISTAG Working Group, 2003; ISTAG Working Group, 2004)

According to Ficheman & Lopes (2008a) the concept of Digital Learning Ecosystems - DLE has its development inspired on nature ecosystems, consisting of species, populations and communities interacting with each other and with the environment. As in nature ecosystems, a DLE is the set of all relationships between biotic factors and between biotic and abiotic factors. Biotic factors are two major communities: the community of actors and the community of content. Actors are individuals that interact with digital technologies. Actors can be learners, teachers, parents, tutors, content creators, engineers or support technicians. Content is any kind of digital educational content
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i.e. learning tools, authoring tools, educational games, browsers, simulators and educational information. Actors and content can be viewed as two communities of biotic factors. They consider hardware technologies, software technologies and network technologies abiotic factors that compose the environment. In nature, a group of communities interacting with each other and acting on or suffering the action of abiotic factors constitute an ecosystem. A Digital Learning Ecosystem consists of communities of actors and content (biotic) interacting with each other and supported by their environment: hardware, software and network technologies (abiotic).

RELATED WORK EDUCATIONAL PROJECTS BASED ON CONTEMPORARY TECHNOLOGIES

In this section we keep developing the background showing related work that has involved the use of the contemporary and advanced technologies presented on the section of technical tools definition and can be used in combination with the learning as well as economic concepts and approaches named on this chapter.

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 (Johnson, Roussos, Leigh, Vasilakis, Barnes & Moher, 1999). The goal of NICE project is to construct a testbed for the exploration of virtual reality as a learning medium within the context of the primary educational reform themes of the past three decades. The project’s focus is on informal education and domains with social content, embracing the constructivist approach to learning, collaboration, and narrative development. The project has been extended to non-immersive users through on line connection. It has been used an interface based on VRML allowing participation of children using their personal computers. Children have access to the garden and also can write stories associating text and characters of NICE’s garden. Although the project was designing for children, adults have also experienced the garden environment (Roussos, Johnson, Leigh, Vasilakis, Barnes & Moher, 1997).

Following the world tendency for developing applications that can improve children education, the NIMIS project also applies the state of the art of computer graphics, artificial intelligence and intelligent agent technologies to reach its pedagogical and technological objectives. The NIMIS project is a distributed collaborative project evolving universities from several countries such as England, Portugal and Germany. The researches use intelligent agents as base for interactive learning in the project. For example, using agents as active components in virtual game-oriented environments that support school-beginners learning to read and write, particularly for reading through writing, and applications for revising and publishing kids’ own stories with integrated multimedia features, including writing conferences. By using these tools children gain notions of how to develop a narrative. The project structure also takes care about the right size of the equipment in terms of ergonomics, providing robust hardware, simple software and multimedia interfaces suitable for young children, balancing this way the use of best that technology can offer. Respecting grown pedagogical traditions and class-room procedures, the project has put into practice a specific classroom environment for early learning with general tools and specific applications supporting literacy-related activities. Based on an integrated desktop environment for young children, three
Applications have been developed in the NIMIS project: “T’rrific Tales” (CBLU, Leeds) aims at supporting collaborative story telling in a cartoon format. A second application, “Teatrix” (INESC, Lisbon), aims at promoting collaborative acting in 3D scenarios. The third application, “Today’s Talking Typewriter” (T³) provides a phonics-based learning environment for the acquisition of initial reading and writing skills by enabling children to freely and flexibly compose their own words. All NIMIS applications are embedded in distributed classroom activities, i.e. they are not designed as stand-alone tools but as customisable and user-adaptive tools in a collaborative setting (NIMIS, 2008).

Project LISTEN (Literacy Innovation that Speech Technology ENables) is an inter-disciplinary research project at Carnegie Mellon University to develop a novel tool to improve literacy -- an automated Reading Tutor that displays stories on a computer screen, and listens to children read aloud to provide a pleasant, authentic experience in assisted reading. The Reading Tutor lets the child choose from a menu of high-interest stories from Weekly Reader and other sources -- including user-authored stories. The Reading Tutor adapts Carnegie Mellon’s Sphinx-II speech recognizer to analyze the student’s oral reading. The Reading Tutor intervenes when the reader makes mistakes, gets stuck, clicks for help, or is likely to encounter difficulty. The Reading Tutor responds with assistance modeled in part after expert reading teachers, but adapted to the capabilities and limitations of the technology. The current version runs under Windows(TM) 2000 or XP on an ordinary personal computer. Though not (yet) a commercial product, the Reading Tutor has been used daily by hundreds of children, as part of studies to test its effectiveness. Thousands of hours of usage logged at multiple levels of detail, including millions of words read aloud, provide unique opportunities for educational data mining (Project Listen, 2008; Wikipedia Data mining, 2008). The Reading Tutor aims for the zone of proximal development - ZPD. It has a system for scaffolding children reading. By explaining unfamiliar words and concepts in context, it can remediate deficits in vocabulary and background knowledge. It provides spoken and graphical assistance when it notices the student click for help, hesitate, get stuck, skip a word, make a mistake, or encounter a word likely to be misread. Its “visual speech” uses talking-mouth videoclips of phonemes to scaffold phonemic awareness (Mostow, 2006) and supports knowledge transfer’s investigation, for instance, if a certain practice on one skill improves another skill (Zhang, Mostow, & Beck, 2007).

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 (Cook, 1998).

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 (Winkler, Reimann, Herczeg, & Hopel, 2003).

The project Rapunzel, (Flanagan, M. & Perlin, 2008) develops a software environment for real time, applied programming for underrepresented students’ early literacy (RAPUNZEL). The project addresses the critical shortage of women in
technology related careers and degree programs by empowering them to create with computer programming. For the researchers children who can learn how to program computers will have more opportunities for authorship and creativity afforded them, as well as more options in schooling and career paths.

The X3D Earth Working Group (Web3D working group, 2008) uses the Web architecture, XML languages, and open protocols to build a standards-based X3D Earth specification usable by governments, industry, scientists, academia, and the general public. The Group project supports individuals’ know, understand, use, and disseminate Web3D technology anywhere, anytime.

The Computer Clubhouses is a collaborative project that provides young people with the opportunity to become digitally fluent. The Massachusetts Institute of Technology (MIT) Media Lab and the Boston Museum of Science have established a network of learning centres in economically disadvantaged communities. At these centres, young people become designers and creators with new digital technologies. Clubhouse members use leading-edge software to create their own artwork, animations, simulations, multimedia presentations, musical compositions, websites, and robotic constructions (Computer Clubhouse, 2008; Resnick, 2002, Resnick, 2006).

According to Billinghurst (2008) the Human Interface Technology Laboratory New Zealand (HIT Lab NZ) conducts research with new emerging technologies such as augmented reality, next generation video conferencing, immersive visualization and perceptual user interfaces. Interaction design techniques are used to adapt these technologies to the needs of end users and solve real world problems. At HilLabNZ several augmented reality evolutionary projects have been developed following hardware and software improvements and accessibility to general public. The end goal is to improve the user experience with technology. The HIT Lab NZ’s projects go through designing of a mixed-reality book (Grasset, D’unser, & Billinghurst, 2008); supporting low ability readers with interactive augmented reality book (Dünser, 2008); blending art and mixed reality for merging between virtual and real, as well as investigating Maori’s cultural heritage (Grasset, Woods & Billinghurst, 2007); and researching and adapting contemporary interfaces for tabletop and mobile devices including their usability related to human factors and architectural design (Na, Billinghurst, & Woo, 2008; Schnabel, Wang, Seichter & Kvan, 2008).

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 author1 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 (Franco & Lopes, 2002; Meninos do Morumbi, 2008).

The Virtual Harlem is a collaborative VR tour of Harlem in which participants can travel back 80 years to see historical figures, and hear speeches and music from that period. The Virtual Harlem
project is an effort to create a learning environment that can enrich students understanding of the Harlem Renaissance, bringing about individuals’ approximation from Afro-American cultural heritage. The VR prototype enables students to become more than passive receptors of information, which is so common in many literature courses. The project goal is to develop rich, interactive, and narrative learning experiences to augment classroom activities (Park, Leigh, Johnson, Carter, Brody & Sosnoski, 2001).

The Human Interface Technology Laboratory’s (HIT Lab) Learning Center has been providing students with the opportunity to construct their own virtual environments since 1990, by working through special programs such as the Pacific Science Center’s Technology Camp, and through other educational environments. Starting in 1995, the Learning Center created the Virtual Reality Roving Vehicle (VRRV) program, which allowed students to take a more active role in the entire virtual development process by taking the technology directly into the classroom (Osberg, Winn, Rose, Hollander, Hoffman, & Char, 1997c). For instance, in her work Virtual Reality and Education Osberg (1993) analyses the advantages and disadvantages of using VR on children’s education based on empirical seven weeks camp experience with children aged 8 to 18 in the Pacific Science Center (PSC) Creative Technology Camp held in Seattle. Osberg’s investigation (1997d) compares the educational value of constructivist pedagogy as applied through the design, development and experience of 3-D interactive virtual learning environments to a traditional classroom approach and to a no instruction control. The constructivist treatment provided students with access to their choice of source content, 3-D modeling tools and instruction in virtual world development to assist in developing visual, auditory and interactive signs and symbols in the virtual environment. Traditional instruction included a biology textbook, worksheets and teacher-led discussions. The work is expand to educators’ training

Mario Schenberg Spaceship is a collaborative interactive installation at Parque CienTec (2008) that aims to reach out young visitors and awaken their interest for science, physics and astronomy through a space trip simulation. The Spaceship is designed to offer learning and entertaining environment, so a group of young learners can experience an adventure in space within an interactive and educational environment and game simulator. The environment design and construction is conducted by researchers from the Laboratory of Integrated Systems of the University of São Paulo (Globo Video, 2009; Fichemann & Lopes, 2008a; FEBRACE, 2008).

The Virtual Fishtank is an innovative new museum exhibit, developed by a collaborative work among the Boston Museum of Science, the MIT Media Lab, and NearLife Inc., with generous support from the National Science Foundation. Museum visitors can: create their own artificial fish; design behaviors for their fish; play with their fish in the giant fishtank; observe their fish interact with other fish analyze the ecological patterns that emerge (Resnick, Strimpel & Galyean, 2008).

Alice is an evolutionary (Conway, 1997) and innovative 3D programming environment that makes it easy to create an animation for telling a story, playing an interactive game, or a video to share on the web. Alice is a freely available teaching tool designed to be a student’s first exposure to object-oriented programming. It allows students to learn fundamental programming concepts in the context of creating animated movies and simple video games. In Alice, 3-D objects (e.g., people, animals, and vehicles) populate a virtual world and students create a program to animate the objects. In Alice’s interactive interface, students drag and drop graphic tiles to create a program, where the instructions correspond to standard statements in a production oriented programming language, such as Java, C++, and C#. Alice allows students to immediately see how their animation programs run, enabling them to easily understand the relationship between the programming statements
and the behavior of objects in their animation. By manipulating the objects in their virtual world, students gain experience with all the programming constructs typically taught in an introductory programming course (Alice org, 2008). The evolutionary 3D programming environment has supported student’s at risk (Moskal, B., Lurie, D., Cooper, S., n.d.) developing computer science skills by reducing the complexity of details that the novice programmer must overcome; providing a design first approach to objects and visualizing objects in a meaningful context. And according to Kelleher (2006) storytelling for engaging woman in computer science through motivating middle school girls to learn computer programming and choose to pursue computer science.

Tan (2008) presents a study related to the effects of using blogs for stimulating high education students to create content. The research attempts to understand students’ perceptions of learning and sharing based on investigating their blog using experience. Although, they are referent to a small group sample of a more general population, his conclusions highlight potential students’ ICT skills development, as well as reading, writing, communication abilities improvements. The conclusions also indicate a tendency of improving students’ personal conduct, stimulating knowledge sharing and promoting active informal learning and lifelong learning.

**METHODOLOGY**

We have presented to individuals digital and web-based knowledge through providing to them diverse learning situations and activities for direct manipulating virtual reality, information visualization techniques and other contemporary and advanced technologies (Franco & Lopes, 2005a; Franco, Cruz & Lopes, 2006; Franco, Fichman, Assis, Zuffio, Lopes, Moreno & Freitas, 2008; Franco & Lopes, 2008).

The interactive experiential learning and teaching actions have been related to ones’ exposure and experience the named technologies similar to the work (in Osberg, 1993). The learning and teaching actions have happened inside a municipal public school, as described in the introduction section. However, the learning actions that have been carried out are non restrictive to the municipal school learning environment.

Over the time, the learning/teaching strategies have benefited the surrounding community and beyond not just related to exposure and experience. We have achieved individuals’ cognition improvements, bringing about ones’ technical and practical skills enhancements to support knowledge transfer that is “clearly central to innovation process” (Powell & Grodal, 2006).

The approach have consisted in mediating ones’ education, by offering to students, educators and other people formal and informal learning/teaching situations, in which they can know, direct manipulate and understand the diverse technologies suggested for increasing ones’ knowledge building process, with support of spiral and incremental work (Pressman, 2006).

There has been a combination of theory and practice, for instance, of diverse and well known learning theories and methodologies such as Piaget’s constructivism and Papert’s constructionism. Such approaches can enhance individuals’ understanding about how people learn and grow, providing better support for designing teaching and learning materials and environments (Ackerman, n.d.; Papert & Harel, 1991).

We have also integrated the concept of scaffolding and/or software scaffolding use in education, which is a process that requires direct teaching and monitoring by an adult. It should be noted that one of the distinguishing feature of scaffolding is the role of dialogue between teacher and student. In addition, we have used 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 (Henry, 2002; Johnson, Roussos, Leigh, Vasilakis, Barnes & Moher, 1999; Luckin, Boulay, Yuill, Kerawalla, Pearce & Harris, 2003; Vigotski, 2007).

In addition, we have employed in our project development the Experiential Learning concept that has supported school community’s inside and outside learning interactions (Maier & Warren, 2000; ELT, 2008). Affective aspects have also been relevant to the student’s learning experience success. Our consideration on affective aspects has been inspired 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 in order they have become more practical and inclusive based on a horizontal relationship among educators and pupils, as well as supported by love, humility, hope, faith, confidence and respect for the freedom of expression (Freire, 2004; Gadotti, 1994). We include in this list the word “empathy” that can define successful communication in human relationship as suggested (in Peters, 2001).

Te’eni, Carey & Zhang (2007, p. 111) state that new psychological basis of Human Computer Interaction - HCI that balances and integrates affective and cognition aspects is rapidly gaining popularity. These researchers highlight that there is a necessity of “models that explain how feelings affect function, what limitations on feelings are, and how feelings impact behavior and performance in order to design HCI that considers the affective, including the cognitive aspects of human behavior”.

For instance:

in today’s competitive market of computer systems and the Internet, attitudes towards the systems determine whether customers will use and revisit systems, because many instances of use are discretionary. Understanding discretionary use, especially when the user is a client rather than an employee of the organization, is rapidly becoming one of the most important issues in HCI. (Te’eni, Carey & Zhang, 2007, p. 111).

Our learning/teaching experiences have showed that the logic stated above is applicable to support educators and students’ awareness about the relevance of using contemporary technologies on citizens’ everyday life. Individuals’ understanding the importance of applying computers, information systems and the Internet in synergy with human’s scaffolding as media learning resources inside and outside the school environment, and as communication facilitators has encompassed the integration between affective and cognitive aspects in HCI.

Schramm’s field of experience model, and model of communication feedback (1954) in (Tannenbaum, 1998) reinforce the importance of the communication process for both the sender and the receiver. Then, whether interpersonal or mass, the sender and the receiver decode, interpret, and encode messages. The message received is decoded and passed to the brain in form of “sign,” and the interpretation process is initiated:

If the receiver has learned the sign previously, then the receiver has learned that certain responses to it are possible. The responses are the meaning that the sign has to the receiver. The sign is always interpreted on the basis of both prior experience and the present context. (Tannenbaum, 1998, p. 263-264)

Tannenbaum (1998) states that communicators are constantly decoding signs, interpreting them, and encoding responses and he highlights such statement with a Schramm’s thought. “We can think of communication as passing through us – changed to be sure, by our interpretations, our habits, our abilities, and capabilities, but the input still being reflected in the output” (Schramm, 19954, p.8) (in Tannenbaum, 1998, p.264. For Schramm without an overlap in their field of experience, two people could not communicate.
For example, paraphrasing Tannenbaum (1998) two people who have a common language can communicate because both have overlapping fields of experience. Hence, a student who is new to a discipline, say computer science, mass communication or computer graphics, may have a difficult time understanding the concepts commonly used in that subject, because the students’ field of experience does not overlap extensively with those already in the discipline.

When the student attempts to communicate with a professor, the communication may be difficult because of the differences in the experience and the technical language that the student has yet to master. If the professor is to communicate successfully, he or she will have to work within only the symbol system and the experiences that both have in common. The professor may need to use examples or analogies for further explanation. That is, the professor must use a “sign system” that is shared with the student. (Tannenbaum, 1998, p. 264)

In the case study section development we will identify the concept of overlap of the fields of experience for helping the communication among students and educators and as an excellent guide that supports the application of multimedia and contemporary technologies in the communication process, as well as its affective influence for the success of the interactive learning and teaching actions.

For example, Doman (2009) demonstrates the power of the process of communication and its affective influence on individuals’ learning/teaching attitudes in Facilitated Communication that is a method, in which the parent provides the physical and emotional support that enables the child to express himself.

While the result of facilitated communication is profound, the technique itself is simple. The parent merely supports the child’s hand so the child can point to letters on a board, typewriter, or computer in order to spell out words, sentences, and paragraphs. The parent stabilizes the child’s movement so the child can effectively point, and through the experience of trial and error the parent learns the exact support the child needs to “write” his message. (Doman, Janet, 2009)

Relevant theoretical and practical works that have reinforced the idea of more horizontal relationship related to supporting individuals’ knowledge construction and interactive learning and teaching for improving education using low cost interactive and advanced contemporary technologies are Doman and Doman (2007) with the book How to Multiply Your Baby’s Intelligence and their work at (The Institutes for the Achievement of Human Potential, 2009) through stimulating children’s vision, auditory and tactile competence (Doman, 2009).

This kind of teaching/learning action has supported increasing the development of the competence of the brain of children who have sustained a brain injury and accelerated neurological development of normal children (Wikipedia Institutes for Achievement of Human Potential, 2009) by using Doman’s bit of intelligence BOI concept (Encyclopedic Knowledge, 2009). Gardner (2001) also does reference to the work of Glenn Doman at The Institutes for the Achievement of Human Potential. In addition, Gardner (2001) describes the educational artwork developed at the projects Zero (2009) and Spectrum (2009) for improving individuals’ intelligence by using a methodology similar to Doman’s BOI in combination with interactive contemporary technologies.

Paraphrasing, Osberg (1993), through the work that has been carried out, the idea is empowering individuals’ cognition and skills by maximizing the opportunity for learning, creating environments, materials, and processes to make learning fun and effective for everyone and in everywhere.
So, supervised, unsupervised and reinforcement learning actions are applicable to this work development (Luger, 2002; Russell & Norvig, 2003). This strategy has tended to contribute for scaling individuals’ knowledge on how to use information, and information systems effectively by supporting individuals’ ability to apply all their perceptual senses, yet be able to discriminate what is necessary and what is not, essentially through higher-level thinking skills as states Dede:

In a world where data increases exponentially each year, a major challenge for schools is to prepare students to access and use information effectively... This requires a refocusing of current uses of multimedia in the curriculum, from engines for transmitting massive amounts of data to tools for structured inquiry based on higher-order thinking (...) Reconceptualizing multi-media now is important because, over the next decade, the fusion of computers and telecommunications will lead to the development of highly realistic virtual environments that are collaborative and interactive. The evolution of this “meta-medium” will enable artificial realities that immerse students in information-laden virtual worlds. Such learning environments risk overwhelming their users unless they incorporate tools that help students and teachers to master the cognitive skills essential to synthesizing knowledge from data. (Dede, 1992, p. 54, in Osberg, 1993)

This work strategy has been supported by practicing how to model a 3D object and develop VRML worlds using a common text editor and other trademark software as much as we can, having in mind to foment and support individuals’ collaborative and interdisciplinary work based on computer graphics principles, accessible and low cost multimedia and ICT.

Paraphrasing Cunningham (2007, p.xxiii), the use of computer graphics and multimedia in the problem-solving process has been based on the development cycle of identifying the problem; addressing the problem by building a model that represents it and allows it to be considered more abstractly; finding a way to represent the problem geometrically; creating an image from that geometry so that the problem can be seen; using the image to understand the problem or the model and try to grasp a possible solution.

Hence, in recent research Lajoie & Nakamura (2006) highlight the necessity of increasing the degree of educational interactivity with more varied types of media. Teaching and learning using computer graphics and multimedia tools requires more scaffolding of learners, more attention to assisting learners self-regulation, and perhaps media that serves in a pedagogical manner through coaching, pedagogical agents, mobile devices, and realistic and imaginary environments that include virtual reality and even augmented reality dimensions (Ficheman, Saul, Assis, Correa, Franco, Tori & Lopes, 2008b; Lajoie & Nakamura, 2006; Na, Billinghurst, & Woo, 2008).

Our learning experiences inside and outside school have showed that this work strategy of using computer graphics, virtual reality and multimedia tools and techniques in several learning situations in context (Cunningham, 2008) as problem solving tools can be an exciting undertaking and can be one to be widely shared. Yet, as Osberg (1993) states, it is important to give yourself a break if things don’t go exactly according to the plan. Enjoy yourself and your students during this creative process!

According to Osberg (1997d) it is important make sure that everyone in your near vicinity knows what you are up to, and what it is going to take to be successful. This can include peers, administrative individuals, school boards, partners and your own children. And can be a key point in achieving environment scaffolding support.

There is evidence that school community’s awareness relate to the work that has been carried out is a key point, and has been relevant for this work to become sustainable. At ESB School, principal, pedagogic coordinators, educators and
students’ awareness about contemporary technology relevance for the educational environment has been a key point for developing a digital/web-based interdisciplinary and collaborative work inside school and expand it to individuals’ home.

For instance, the community’s awareness about technology existence allowed ICT facilitators’ to undertake collaborative work during 2003 to 2005. This collaborative work also supported some flexibility in classes schedule in order to develop an interdisciplinary work related to the learning and teaching of measuring systems and cartography in the first semester of 2005 (Franco, Cruz & Lopes 2006).

This work was extended to the surrounding community via community public library’s coordinator awareness and involvement about what was carried out in terms of pedagogic and technology work at ESB School. This kind of partnership work was collaboratively designed attempting to improve students’ reading, writing, researching and communication knowledge within active practice, as well as empowering community library’s services to individuals. For instance, students created a prototype of the community library home page with HTML scripts and using their VRML knowledge they modeled in 3D some spaces of the community’s library (in Franco, Cruz & Lopes 2006).

This kind of work methodology has brought about individuals’ awareness enhancements related to technology existence and its applications for promoting innovation’s sustainability in the learning environment. It includes stimulating individuals’ lifelong learning attitudes through spiral, incremental and evolutionary work, in which individuals have as their technical and development companion tools, among others, web-based and other contemporary and advanced technologies as will be showed in the case study section that follows (Brutzman & Daly 2007; Franco & Lopes, 2005b; Franco & Lopes, 2005c; Franco, Cruz & Lopes, 2006; Pressman, 2006; Franco, Ficheman, Lopes, Ferreira, Santos, Ferreira, Araújo & Moreno 2008).

**CASE STUDY**

In this section we provide examples of interactive formal and informal learning situations we have carried out with diverse individuals. These learning situations have been based on providing individuals’ experience with contemporary and advanced technologies, bringing about stimulating ones’ lifelong learning attitudes through spiral, incremental and evolutionary work.

**Case Study 1: Working with Educators**

Following a previous interdisciplinary and collaborative work presented on the SIGGRAPH 2006 conference (in Franco, Cruz & Lopes 2006), on September 2006, during an educators training time at ESB school, it was carried out a brainstorm about the work presented on the conference for educators that did not followed the interactive digital and web-based work carried out during 2005 (Franco & Lopes, 2005b).

A school pedagogic coordinator, four 5th to 8th grade level educators (2 Math, 1 Portuguese, 1 ICT facilitator) and a primary educator were in the workshop. After the brainstorm, we shared with them how to develop an application for teaching a curriculum subject through using some web-based technologies described on the background section. We discussed possibilities of improving individuals’ English language, writing, reading, researching, communicating and digital skills within an interdisciplinary vision involving arts and culture.

Author1 constructed an hybrid interface based on the combination and interoperability of 2D HTML and 3D VRML including to that MPEG, WAV and JPG as a dynamic and interactive way of teaching English attempting to improve
The hybrid 2D and 3D virtual interface was constructed using the following features:

- **Menu:** Initial Page, Introduction, Reading, Writing, Listening, Vocabulary, Grammar, Gallery, Practicing, Bibliography;
- **Objectives:** Improving socio-cultural interactions - via web-based technology (e-mail, Okurt, voice, video, letters (also more traditional ways and so on)); supporting individuals’ developing programming skills, which can make students increase other sciences, arts and communication abilities; stimulating creative writing through storytelling for constructing digital visual media content; understanding cultural trends and perspectives - related to diverse societies, cultures, genres; increasing individuals’ research possibilities related to the global on-line database - (the Web) such as in the related work (Flanagan & Perlin, 2008) and in (Colson, 2007; Chun, 2006).
- **Culture and Art:** We chose as a culture, art, science and technology support the theme ‘peace and society’ and developed it by using, reusing and constructing multimedia files related to pictures researched on the Internet and audio and visual material from authors’ personal collection. The theme inspiration came from the book Visual Arts and Communication – Unit 1 (Rueda & D’Angelo, 1999), which is designed to support English teaching, however, within an interdisciplinary vision.
- **Information Visualization:** Following the book suggestion for comparing images such as (“The Meninas”, Velazquez; “Metamorphosis of Narcissus” Dali, “The sunflowers” Van Gogh, “Guerinca” Picasso, and “Marilyn” Warhol) a 3D interface was designed for providing individuals navigating and reflecting about human’s problems such as war and lifestyle over the time.

The interactive workshop went on through direct manipulating the HTML code and page components (video, audio and text) and their use in context. For instance, the video and text were related to Marvin Gaye’s artwork – ‘What is going on’. The meaning of Gaye’s lyric seems to complete the pictures of the virtual gallery (in Franco, Ficheman, Alves, Venâncio, Lopes, Cruz, Santiago, Teles, & Aquino, 2007).

This workshop was a good opportunity to produce and presenting material related to teach English language and active learning and teaching possibilities referent to improve individuals’ digital literacy. The workshop also served as way of reflecting about general technology knowledge development, within enough flexibility to be adapted to the learning and teaching of other subjects such as Geography, History, Arts, Sciences, Mathematics, Physical Education and Portuguese.

The web-based and low cost technology application visualized and directed manipulated on a desktop personal computer, brought about individuals’ awareness on how to built a virtual reality environment and have the possibility of modifying it according to his/her ideas based on the procedural literacy concept as follows:

*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. Without an understanding of how code operates as an expressive medium, new media scholars are forced to treat the operation of the media artifacts they study as a black box, losing the crucial relationship between authorship, code, and audience reception. Code is a kind of writing; just as literary scholars wouldn’t dream of reading translated glosses of work instead of reading the full work in its original language, so new media scholars must read code, not just at the simple level of primitive operations and control flow, but at the level of the procedural rhetoric, aesthetics and poetics encoded in a work. (Mateas, 2005)

Similar 90 minutes workshop was carried out with international educators during the (ICEL, 2008) 11th International Conference on Experiential Learning through hands on experience of dealing with web-based technologies (Franco & Lopes, 2008), proceeding interactive learning and sharing knowledge actions from the code to the information visualization under author1’s supervision.

Educators constructed a small scale 3D digital environment evolving WRL, WAV, JEPG and MPEG files. Although educators were not used to deal with 3D technologies, at the end of that section they were satisfied with the interactions and technologies possibilities for improving individuals’ intelligence and communication through lifelong learning. Due to children natural tendency of being attracted and dominating contemporary technology (Miller, 2004), educators’ evaluation, related to using such technologies for improving children’s digital, math, spatial, imaginary and creative thinking skills, was considered effective.

An Australian educator from The Foundation for Young Australians (FYA, 2009) suggested for author1 using a software called (Scratch, 2009) with less literate children and educators for starting the technical work. She also indicated (Kahootz, 2009) a 3D modeling and digital audio software designed for supporting primary and secondary school students’ learning through active actions during curriculum development related to arts, math, language, environmental and social studies. Her words sent to author1’s e-mail:

(... ) take a look at scratch - http://scratch.mit.edu/. > This is a free animation software that is brilliant to use > with students using a simple programming language. I > really do believe it is easier to start with a simple > program like this with your staff compared to the one you > showed us. The one you showed us is brilliant for more > experienced ICT users but is complicated for most teachers. > I have worked in the area of ICT in Education for many years > and have found working with any programming language a > challenge for many teachers. If you begin with something > more achievable for them then you will have more of them > using it with their students. They can then progress to the > one you are using” (...)

December 13, 2008

Author1 replayed to her keeping the knowledge sharing after the workshop.

(... ) I think as a researcher it may interest you http://www.processing.org/learning/3d/texture1. html. And following the VRML stuff there is an evolution called X3D format that is Java Based and is free http://www.web3d.org/x3d/. And may be for native English speakers can be easier for using. (Author1, December, 2008)

Another educator from the Faculty of Mechanical and Manufacturing Engineering, of The University Tun Hussein Onn Malaysia (UTHM,
2009) said that the web-based technology would a
great way of attempting to stimulate his 12 years
son to become a digital content developer instead
of just a video game consumer. The educator kept
talking with author1 about one hour more after
the schedule time of the workshop doing hands
on exercises, taking notes, visiting VRML sites
and tutorials on the Internet.

Case Study 2: Individuals’
Technical Skills Development
and Lifelong Learning

Our approach of providing individuals’ exposure
and experience with 2D and 3d graphics through
developing small scale VE under supervised
learning has been effective to attracting students’
attention. It has brought about students’ lifelong
and independent learning attitudes with support
of web-based technology as companion.

For instance, after observing a previous inter-
disciplinary and collaborative work involving
Geography, Math, Geometry, English language
and ICT for supporting students learn scale, metric
measure system and cartography concepts, includ-
ing how to research, read, write and communicate
using ICT (Franco & Lopes, 2005b; Franco, Cruz
& Lopes, 2006) a student that was in the 3rd grade
level in 2005 asked the author1 to teach how to
develop a 3D model using the same techniques
that other students from 7th and 8th grade level had
applied to build their virtual worlds.

The learner was oriented within an interactive
workshop experience of 30 minutes. The student
created a red box by developing a VRML file. He
direct manipulated Notepad text editor to produce
the virtual and visualize it by using a browser
called Cosmo player 2.1™, what brought about
learning bits of computer graphics principles and
stimulating him to keep investigating further the
production of 3D worlds.

At the end of interactions the learner seemed
to be satisfied. He was smiling and telling his
mother he had understood the experience while
he was also holding a piece of paper with his
notes highlighting the references of X, Y and
Z axes related to the computer monitor in order
he could comprehend and use that (Franco &
Lopes, 2005c).

According to his mother (author9), he car-
ried out exercises at home, and the red box was
transformed in a room with other objects. Further
than that, the family and social interactions were
improved through digital/web-based knowledge
shared with his father, mother and brother who
was at the 2nd grade at the same school.

Although, the student’s mother was one of
the ESB School ICT facilitators and worked in
the school computers lab till the end of 2005, it is
relevant to highlight that the student’s independ-
ent learning attitude for developing programming
and information and communication technology
skills was his initiative.

His learning attitudes and creative knowledge
development are relevant evidences that indicate
the added value of using web-based and informa-
tion visualisation technologies on individuals’
education as lifelong learning companion tools.

He has improved his technical skills, designed
and produced work, which was shared with us through
his mother. She sent an e-mail to author1 in April
2007 with a 3D VRML model that was designed
having as a reference his home 2D blueprint (in
Franco, Cruz, Aquino, Teles, Gianevecchio, Franco,
Ficheman, & Lopes, 2007b).

Her e-mail demonstrates that the technical
domain of contemporary tools such as web-based
technology can be very useful in terms of sup-
porting individuals’ cognitive skills improvements
and lifelong learning attitudes.

During these three years even without much con-
tact with new Cosmo tools (we used the browser
Cosmo player™for supporting the work at school
from 2002 to 2005. It means VRML tools) L (her
sun) keeps working at home. For instance, with
the construction of my house, he took the 2D
blueprint and transformed it in 3D. My husband
works in the construction market, due to that L has contact with some blueprints of his father’s clients. As he did with my house blueprint, he has developed similar 3D work with these clients’ blueprints. These clients have observed and appreciated my son’s work. Now my son’s objective is to introduce his work to an engineering that draws the blueprints of the houses in the region where I live (The city of Caieras). He wants she gave him an opportunity of working through using his 3D technical skills. But, he has not got to demonstrate the work to her yet. I believe that her great difficult in accepting it is that he is only twelve years old. (Author1’s translation)

Case Study 3: Sustaining the Use of Contemporary Technology at School

Our collaborative and interdisciplinary web-based work had good results in 2005 (in Franco, Cruz & Lopes, 2006) and these have been reverberating inside and outside school environment and on individuals’ collective intelligence, bringing about dynamic and high quality knowledge based on academic and social interactions as demonstrated in the case study 1 and 2 and will be discussed in the evaluation section.

On the other hand, the changes that policy makers did in law that rules the school computers lab in the beginning of 2006, when the text of ‘Portaria 303/98’ was changed to ‘Portaria nº 103’ on January 2006, and later on to ‘Portaria nº 3669’ on August 2006, decreased the times, spaces and human interactivity for the collaborative and interdisciplinary support for individuals’ learning and dominating digital technologies it was developed in the learning environment (Franco, Ficheman, Alves, Venâncio, Cruz, Gianevechio, Teles, Aquino & Lopes, 2007; SINPEEM, 2007).

As said before, due to the changes in law, one of the ICT facilitators (author9) had to leave the ESB School in the beginning of 2006. Also, the computers lab class schedule was changed for activities before or after students’ regular classes. This action dramatic decreased the possibility of developing collaborative and interdisciplinary work among educators and students. It also brought about great entropy in the school lab environment. The entropy came from having one ICT facilitator to thinking and acting to support 35 to 40 students, and manage 20 computer machines at once. For instance, you can imagine an educator and 40 first year primary students, age 6 and 7, in the school computers lab at once!

When the Portaria 303/98 was created the rule was that the ICT facilitator should work supporting other educators and students and curricular disciplines development. At the end of 2006, the Portaria nº3669 determined that the computers lab classes should be back to the regular classes’ schedule. But, the ICT facilitator should keep working isolated in the school computers lab not as a facilitator but as a teacher. This situation has not happened at ESB School, yet, because the school has a schedule of five classes in the period of 4 hours. But in the schools where there are six classes in 4 hours and 45 minutes it has occurred.

So, during 2006, it was difficult period of adaptation. We had some moments with educators as described in the case study 1. And the work with students and contemporary technologies was almost isolated. However, some students that saw and participated on the web-based project in 2005 and new students kept this work sustainable.

Due to the work with contemporary technologies and the good results in the diverse contextualized learning experiences, even without technical appropriation of the tools used for producing curriculum content, educators became aware about technology possibilities for supporting curriculum content improvements.

However, to be aware of technology by observing others doing projects was not enough to individuals to gain lifelong learning autonomy to create digital content. For instance, an arts teacher Glaucia (author8) and a math teacher
Marlene (author6) asked how to create content using VRML because they were directly involved in the development of the diverse web-based technologies and interdisciplinary projects. So, we did some small scale workshops.

On the other hand, even with educators demonstrating will to develop technical skills, the school dynamics as well as educators’ busy time and space schedule created difficulties for educators researching and dominating with autonomy how to create content direct manipulating web-based technology and multimedia tools.

Nevertheless, contemporary technologies applications generated students’ interest in keep researching and producing content inside and beyond the school computers lab activities.

Based on the previous work developed in 2005 when he was in the 7th grade, a student kept developing his VRML world at home. Through his lifelong learning attitudes, he got enough expertise for supporting his and other students’ creative design and productive processes. For instance, from supervised learning in the previous year, he got an unsupervised stage of knowledge development by deconstructing a hybrid 2D HTML and 3D VRML interface related to the Cosmo Player™ fish tank example. He reused the fish’s VRML code into the building of his 3D VE outside living room. In his living room environment the student created diverse virtual objects based on his real home furniture.

An example of new student’s engagement on developing knowledge related to digital/web technology and computer graphics principles due to the accessibility to the tools provided in the school computers lab comes from a student that was in 5th grade adult education in 2006. The adult education classes used to happen in the evenings from 7 to 11 pm until the end of 2007.

The student was 53 years old at that time and had a good knowledge on hardware. He visited the school computers’ lab seeking for improving his computers technical skills related to software and digital content production. Author1 offered and reflected with him about learning VRML stuff for developing his cognitive abilities such as memory, attention, perception, planning (in Benyon, Turner & Turner, 2005; Preece, Sharp & Rogers, 2007). He was introduced to the 8th grade student and his artwork in Figure 5a we referred in the above example and they exchanged some ideas.

After that, he was told to install the necessary software at home, and after some installing troubles and three weeks for breaking his initial learning curve he started producing VRML files with autonomy. In general, at that time autor1 was used to meet the students twice a week, 1 hour and 30 minutes on Mondays and Tuesdays. The 5th grade student went seven times to the lab between September and November, 2006.

When he was asked about his feelings related to the 3D programming experience, the 5th grade student, Sir Germal said that at the beginning he was having problems for concentrating because the younger students’ noise in the school computers lab. On the other hand, at home he had Internet access and could follow the VRML Sourcebook V2.0 on-line examples (2008) and VRML Portuguese tutorials (Manssour, 2008; Barros, 2004). Sir Germal reported that he developed a 3D environment at home using his grandchild picture to training VRML texture mapping features. These facts brought about to him confidence to have unsupervised learning attitudes to do transformations in the VRML code, including adding animation to an object, playing with background colors, changing the transform and material parameters, developing textures with Paint™ program.

On the middle of the second semester 2006, students and educators’ technology awareness and appropriation led us to designing a prototype game project called ‘Uma Aventura no Espaço’/‘An Adventure in Space’. The idea was to share their 3D knowledge with other students and educators at school and surrounding community and participate in the projects selection of FEBRACE 2007. It included to stimulating other students to engage
further in their learning process through using interactive technologies as support for developing the diverse curriculum content subjects.

Although, it was not possible to pass on FEBRACE selection, students and educators’ improved their research, communication, traditional and digital literacy, and other cognitive skills such as writing and reading.

The initial game designing was based on the game ‘Jogo do Dinossauro do Spectrum’ – ‘Dinosaur Game from Spectrum’ project that is related to math curriculum development and supported by Gardner’s multiple types of intelligence theory (in Chen, Isberg & Krechevesky, 2001; Franco, Cruz & Lopes, 2006).

The project development idea was to construct a game for supporting teaching and learning the concept of positive and negative numbers in math, by creating both virtual and real versions of the game. The real prototype was not so difficult to design and implement. For the virtual version the plan was using VRML and HTML features related to hyperlinks and interoperation of multimedia files and modeling 2D and 3D VE.

Students designed the interface in several ways and learned how much work is necessary for producing digital content of quality. The work addressed the problem of learning to design simple and complex 3D interfaces by applying theory and practice. Ones used desktop virtual reality features to simulate, or adapt from the real physical world as investigated (in Bowman, Kruijff, LaViola & Poupyrev, 2005).

The work development supported the concept of problem solving as a form of learning to think, assuming that thinking is the primary mechanism for human understanding and improving the world. It includes expanding this idea for interactive forms of problem solving that depend on the behavior of the world rather than on a priori human beliefs (Wenger & Goldin, 2006).

Based on such concept, we attempted to carry out interdisciplinary and collaborative work by inviting math and arts educators (authors 6 and 8), including a former school’s student, who left school at the end of 2005, but kept researching with us and participating on other school projects development in 2006 to contribute with the school development.

Due to our lack of programming skills, we could not complete the project ‘An Adventure in Space’ with the quality and usability that we wished.

On the other hand, during our game prototype experience with advanced technology resources we got support outside the school environment for solving an interface design problem that was to produce a virtual dice for compounding the virtual game interface. The support came during the project implementation through the arts’ educator (author 8). She asked her brother in law, who had programming skills deeper than us to develop a virtual dice interface in a way we could use the virtual dice to complete the game interface.

He developed the dice interface quickly using the Visual Basic language. Unfortunately, because of languages incompatibility and our lack of programming abilities, we could not integrate the virtual dice in the HTML and VRML game interface. Nevertheless, due to JavaScript language compatibility with HTML and VRML, we asked him to develop the dice interface using JavaScript, but it was not possible for him to achieve that.

However, across the development of this interactive learning and teaching process, author 8 reported that her brother in law said that he had not seem a kind of work like this before applying virtual reality technology inside a primary school, and that this type of learning/teaching methodology should be continued.

Case Study 4: Intensifying the Use of Contemporary Technology at School

In 2007, after adapting to the scholar system changes as described in the case study 3, we got an increase in the quantity and quality of interactive, collaborative and interdisciplinary work
supported by contemporary technology, what brought about to energize students and educators’ interactions, as well as lifelong learning and education quality and opportunities as attempted in the work described (in Fullan, 2008).

The increment in the use of digital/web based tools in combination with curriculum content development approximated individuals from the diverse sciences, art, culture and technology as investigated and demonstrated (in Colson, 2007; Wands, 2006), impacting in democratizing digital/web based and general knowledge inside the school. It also improved ones’ communication skills in terms of dominating and using techniques and concepts related to information visualization, computer graphics, web-based technology and multimedia low cost resources to design and produce content, with support of the concept of overlap of fields of experience (in Tannenbaum, 1998).

Individuals direct manipulated these technologies to produce digital content at school and expanded the knowledge developed to informal home meetings and other learning environments in diverse communities (Franco, Cruz & Lopes, 2006; Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008), contributing for forming diverse, interoperable, high quality, dynamic and interactive digital learning ecosystems (Ficheman & Lopes, 2008; Forrester, 1992).

We believe that a great support for keeping this work sustainable over the past six years has come from the local community engagement in the interactive learning process. Students and educators’ interactive work and outcomes have gained visibility and served as a reference inside and outside the learning environment ecosystem. For some reason, perhaps the collective intelligence (Lévy, 1993), the community’s work has been extended to individuals the challenge of keeping the learning environment in continuous development for pushing the next generation of students. From this kind of work, the new generation of students has kept involved psychologically in improving their knowledge and confidence for enhancing the learning ecosystem, within a never ending spiral and incremental learning cycle.

For instance, through a middle term virtual reality technology appropriation, an 8th grade student (M1) in 2007 developed an interesting research work and web-based 3D presentation related to Charles Chaplin’ artwork.

M1’s technology background is related to his visit to the school computers lab when he asked to author1 to teach him how to develop a 3DVE in 2006. M1 had heard about the creation of 3DVE at home across (M2) his brother’s comments about the 2D and 3D web-based learning actions in 2003 and 2004. M2 studied at ESB School until the end of 2004. Other relevant reference that influenced M1 curiosity is that he observed other students’ work using VRML at school computers lab in 2005.

Franco, Mariz, Lopes, Cruz, Franco & Delacroix (2007a) state that M2 was one of the ESB School’s former students that supported the initial author1’s informal investigation (2003) related to the use of contemporary and advanced technologies on primary education for stimulating students’ knowledge development. This interactive and dynamic educational process has brought about a collaborative knowledge based partnership with the Laboratory of Integrated Systems from The University of São Paulo, in which educators and students have been achieved protagonist participation during the Feira Brasileira de Ciências e Engenharia – (Brazilian Fair of Sciences and Engineering) - FEBRACE 2004 and 2009 (in Franco, 2005; Franco, Cruz & Lopes, 2006; Imprensa Jovem, 2009; Portal Aprendiz, 2009).

Under supervision of author1, M1 developed an interactive 3D virtual museum environment about Charles Chaplin’s artwork based on VRML features such as video and still bitmap texture. The 3DVE was composed by content that he researched on the Internet. The work presentation was watched by his Portuguese teacher and student’s classmates.
The work was considered excellent by the Portuguese language teacher who had asked a research about Chaplin’s life. She also congratulated the student at the moment she knew that the 3DVE was developed by him.

It was a collaborative and interactive work, in which author11 provided the film Morden Times to be edited according to the student’s research on the site (YouTube, 2009). After that, similar to the combination of advanced technologies to support artistic and cultural heritage work developed (in Park, Leigh, Johnson, Carter, Brody & Sosnoski, 2001; Roussos, Johnson, Leigh, Vasilakis, Barnes & Moher, 1997), M1’s 3D VRML model was reused by author1 and 11 for supporting information visualization of author11’s investigation related to Afro Brazilian cultural heritage and the visibility of Negroes’ artists.

The work happened through combining in the 8th grade student’s virtual museum gallery a research related to negroes Brazilian musicians’ record cover illustrations. The record covers’ illustrations were referent to Pixinguinha, Paulinho da Viola, João Nogueira, Trio Mocotó and Clementina de Jesus artwork. The gallery was completed with a recent video related to Tony Tornado’s artistic life showed on channel Globo in the program ‘Estrelas’ (in YouTube Estrelas, 2009).

In the beginning of August, 2007, M1 saw and said that he enjoyed seeing the artwork he did, adapted and reused by the authors1 and 11. In sequence, M1 was asked to share his work with Professor Marcelo Zuffo (author 2) from the LSI. The Professor was visiting the ESB School computers lab. Professor Zuffo is an expert in web-based technology, virtual reality, scientific visualization, computer graphics and digital TV technology (Zuffo, 2001; in Globo Videos, 2009).

In Case Study 5: 2008, More Possibilities of Sharing Web-Based Knowledge

At the beginning of 2008, inspired on the water pollution museum project and based on Brazilian national curriculum parameter (PCN Matemática 5ª A 8ª series, 1998) related to math teaching we attempted to support one hundred and fifty 6th grade level students’ understanding how measure systems function and influence everyday life. This educational process also involved approximating interventions from author1. Through this and other examples showed through this chapter development, we infer that contemporary technologies can be used as ‘common ground’ or ‘common language’ for enhancing students and educators’ communication as highlighted (in Laurel, 1993), as well as impacting the development of knowledge of individuals under risk situation lifelong.

In the second semester of 2007, from September to November M1 contributed for modelling a 3DVE related to a scientific research that was presented to the school audience in November 2007. The scientific research was referent to the problem of water pollution and was developed with support of school educators and students’ interdisciplinary work. Under the school ICT facilitator and a Science educator (author5)’s collaboration and supervision, and using contemporary technologies as a common ground, fifth and sixth grade students investigated, formatted and presented the work through using digital/web-based 2D and 3D information visualization and low cost multimedia tools.

M1 shared his 3D knowledge with 5th and 6th grade students designing with their research support a 3DVE. The virtual environment was constructed by integrating GIF, JPG and MPEG files as textures, and WAV files for auditory enhancements through using Virtual Reality Modeling Language – VRML (in Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008a).
educators and students from visual the culture (Barbosa, 2006; Hernández, 2000; Project Zero, 2008), visual arts as suggested (in PCN 5ª a 8ª Séries Arte, 1998), and digital technologies in a way that individuals could dominate and use web-based ICT as companion and with autonomy within a lifelong learning process.

We carried out the work through doing small scale workshops during educators’ training time once a week. With students, the process was developed during their classroom time once a week and three research classes divided in three different sections of forty-five minutes each (Wednesday, Thursday and Friday) inside the school computers lab.

The idea of using web-based 3D technologies for understanding measuring concepts came from an informal talk between author1 and 10, at the beginning of 2008. During the talk they reflected about how to improve the way of teaching math in a more active mood and also associate it with the domains of 2D and 3D web-based technology, information visualization and computer graphics principles and tools.

Through informal way, author10 has followed author1’s research since 2005. Author10 was doing his third year undergraduate course on math. Author10 has background in drawing and CAD systems.

This collaborative learning experience proposal was a way of investigating the validity of providing to a undergraduate student experience with digital/web-based standard languages and technology and the real world school environment within its everyday learning and teaching challenges as described in (Franco, 2001; Franco, Cruz & Lopes, 2006).

The idea of the measuring project was shared with math and science educators at school. Both had experienced web-based 3DVE projects before during 2005, 2006 and 2007. They read the proposal, considered that interesting and started applying it on March 2008.

The actions of developing and sharing knowledge involved a mass collaboration process that Tapscott & Williams (2006) call collaborative science, which is based on the Web features related to increase individuals’ abilities of self-organize into large-scale networks, bringing about rapid diffusion of best scientific practices, stimulating new technological hybrids and recombination, availability of just in time expertise and increasingly powerful tools for conducting research with innovation within horizontal and distributed models, including greater openness of scientific knowledge, tools and networks.

The measuring learning project proposal was related to decrease the problem that students showed for understanding measure systems. The idea was to challenge the students to create their own measuring systems using as reference, for example, an eraser, a pen, or any other object they wish. From that the next step was to measure a wall.

In this case, it was measuring a classroom wall using the measure system that the group of students created. After that, students were asked to simulate the wall through creating a 3D virtual environment using a combination of web-based and desktop virtual reality technologies. The wall’s simulation also involved creating a design for wall tile and setting tiles in the wall. At the end of the process it was expected that students would be able to grasp measuring systems (in Brazil, the most used measuring system is the metric one) and improve their contemporary technology knowledge.

Math educators started working with students presenting the project proposal of developing work in collaboration with the ICT facilitator. The actions for achieving the proposal goal were carried out and redirect according to students’ needs, educators’ reflections about the teaching and learning experiences, and school’s schedule related to classes time and space.

During the learning process development and educators’ reflections, through informal and
formal meetings, math educators reported that the idea was well accepted by students. This means that the hands-on workshop with educators demonstrating and reflecting about the usability of digital technologies for supporting their work was effective.

Although, it is difficult for educators to have time for dominating and using technology with autonomy, the fact of direct manipulating it helped them understanding its value. Educators’ lack of time for dominating technology comes from too many classes per week, going to two up to four different schools during the week. Hence, for ones’ self investing in learning contemporary and advanced technologies is expensive. The average cost of advanced technology courses is higher than 30% of educators’ remuneration.

In the pre-work preparation workshop we also involved more two math and arts educators, both were introduced to VRML scripts and 3D technology. The educators initially said that students would have to type VRML code and this action could difficult students focus on understanding how a measure system works. But, in sequence, they were told about copy and paste techniques, contextualized through the VRML graphic pieces’ transformations such as (translation, diffuseColor, imageTexture).

The techniques used to share knowledge with the arts’ educator were researching one of the pictures “Aquarelas” painted by Lasar Segal (in Museu Segal, 2008) and apply it as texture on a Cylinder in real time. We also demonstrated to and reflected with them about concepts such as how to reuse the content created and to integrate diverse interdisciplinary content through applying copy and paste techniques on a 3DVE file’s construction and transformations Figure 2.

At the beginning of the experience the math educator who had programmed in Fortran language before, by mentally comparing Fortran (in Miller, 2002) and VRML code said that it would be difficult to students using VRML to produce their work. On the other hand, after experiencing how to save and visualize a file employing VRML ‘code’ or ‘scripts’, she agreed that it would be possible to apply VRML language for supporting individuals’ computational thinking and learning math’s concepts Figure 2.

We did further reflections at the end of the workshop. For instance, that this kind of interactive teaching and learning experience allows educators’ approximating from and reflecting with students about the importance of reading and writing words in a correct way. For example, because VRML is case sensitive, with reference to upper and lower cases. This makes ‘geometry Box’ different form ‘Geometry Box’. And it is a way of working individuals’ cognitive abilities related to attention and perception (Benyon, Turner & Turner, 2005; Preece, Sharp & Rogers, 2007).

Hence, we can make an analogy with real life in which ones’ writing and reading with effectiveness as well as developing skills for dealing with contemporary technology can bring about to them better communication skills and lifetime opportunities for self development. For instance, such as the opportunity that author1 had when he conquered the scholarship for doing his master course as described in the motivation section.

So, through these ones’ interactive horizontal proximity within learning and teaching processes, it is possible to achieve the necessary awareness about the whys, what for and how we should read, write, research and communicate with effectiveness. For example, for producing simple and/or complex content and organize it adequately in order to storytelling in a virtual environment it is necessary to research, read, think, understand, plan and write how the diverse narrative agents will interact with each other (Franco, 2001b, Laurel, 1993).

Paraphrasing Juul (2005p.15), this interactive learning process development uses the concept of “narrative as the primary way in which we make sense of and structure the world”. Across this interactive learning process we constructed a narrative structure that enabled us to support
Figure 2. First, on the left, author’s 1 visual representation of the VRML script that follows below the image and on the right. The reader can experience with this piece of code and visualize the figure above. For achieving that, download and install a VRML viewer (for instance Cortona™). After that, open a text editor (notepad) and write the code. Save the file as “bookexample.wrl” (Type – Text document). The (.wrl) is important to visualize the 3D world above. Then go to the folder where you saved the file and double click on it.
students’ grasping math measuring systems and its relations with real world, including preparing educators and students to deal with advanced and contemporary technologies.

Laurel (1993, pp.32, 33) states that “designing human computer experience isn’t about building a better desktop. It is about creating imaginary worlds that have special relationship with reality-worlds in which they can extend, amplify, and enrich our own capacities to feel, think, and act”.

While individuals write VRML scripts and concentrate on the action of visualizing the scripts, they can improve their higher order thinking, mental models and spatial literacy skills (McCullough, 2004), as well as organize themselves in order to understand the complexity that an enlargeable work in development such as this one can become.

The building of an enlargeable work like this implicates in developing diverse individuals’ cognitive and technical skills such as:

- Individuals’ technical skills development in computer literacy
- Review and learn math’s operations such as fraction and decimal number concepts
- How to calculate a wall area, simulate and setting tiles on it
- Dominating a measure system concept
- Learning to work cooperatively and collaboratively
- Improving students and educators’ visual arts domain
- Learning how to manipulate image processing programs
- Imagining and designing new products such as wall tiles textures
- Learning how to research
- Stimulating the learning of a second language (English), due to in Brazil the first one is Portuguese
- Improving spatial literacy
- Using, comparing and transforming the diverse existing measure units
- Developing Portuguese language reading, writing and communication skills

Real world examples of using Portuguese language related to learning math were students’ reports, in which they describe the initial process of creating their own measuring parameter and comparing it with the metric system. One of the math educators asked to her 70 students from the 6th grade level reports about the measuring activity they did. Author1 also read some of these reports.

During an informal talk between the ESB School ICT facilitator and one of the math educators, the math educator said that she was satisfied with the initial results of the project because students’ reports showed that they understood the proceedings they did and the math operations they executed.

After that, educators also discussed about the digital implementation of the project, which was carried out with good students acceptance according to the math educator observations and oral survey developed with students.

Despite of students’ engagement on the work carried out in the classroom, there were difficulties for educators supporting students’ technical skills development for finishing the digital work. Such problems happened because of difficulties related to the great average of number of students for one School ICT facilitator and due to school dynamics. Then, it was not possible to support students with deepen VRML technical foundations and regular frequency to the school computers lab.

On the other hand, the initial plan that was related to improve math teaching and learning became a collaborative, incremental and interdisciplinary research. During one of the meetings in the computers lab, the students were told to designing their own wall tile textures. This action approximated students from arts and history knowledge. In order to gaining more reference to
designing wall tiles, they were asked to research on the Internet diverse images of wall tiles. They also had access to a cultural and historic video that tells a story about Portuguese’s wall tile influence in Brazilian Culture (Jornal da Gazeta, 2008).

Similar to the case study 1, the interactive project development brought about educators’ hands-on experience on contemporary technologies and as consequence a math educator (author 6) changed her way of teaching and proposing learning activities. Based on the interactive skills developed during the measuring project, she guided her students for creating real world interactive games for understanding math concepts such as fraction Figure 3.

We think that by observing and supporting previous collaborative and interdisciplinary learning projects based on contemporary and advanced technology (Franco, Mariz, Lopes, Cruz, Franco & Delacroix, 2007a) as in the case study 3, author7’s interactive attitudes used for teaching math demonstrate that is possible to developed a feeling of understanding a problem within a certain situation (for instance, students’ learning needs) and transfer knowledge to solve it.

She applied her developed knowledge for solving problems with advanced and contemporary technology in appropriate way by transferring it to the use of more traditional materials to solve the problem of students grasping the concept of fraction. It seems that her understanding related to a problem solving and attitudes to reduce it go beyond the cognitive reasoning. It goes deeper to the state of developed wisdom. And the state of developed wisdom comes from processes of learning and experiencing through the time and space.

Senge, Scharmer, Jaworski & Flowers (2007, pp. 87) state that this kind of wisdom comes from ones internal feelings in combination with logical reasoning. For instance, as a good race driver a person does not act by deduction. She/he uses internal feelings while is going through the pitch lane.

Inspired on the math project with 6th grade level students, the ESB School ICT facilitator talked with and introduced the advanced and contemporary technologies that have been discussed during this chapter to 7th and 8th grade students.

We reflected that individuals’ domain on technology could bring about autonomy to use it lifelong to support the learning of diverse subjects such as Math, Portuguese, Arts, as well as individuals’ entrepreneurship and that there is no magic for achieving such performance. The key for improving performance is hard work.

It is necessary to study, learn to be patient to deal with problems that come with the intensive use of technology, to be persistent to learn technologies’ complexity and create complex 3DVE. It is a process that can support students and educators’ understanding the bottom-up culture where, for example, gamers use sharing and open-source techniques to existing products of the mainstream practices of the cultural industries (Raessens, 2006, pp. 382).

One of the problems of an educator attempting to do such action alone at the school computers lab is that with 35 up to 40 students inside, it is a great challenge for the educator to support physically and mentally students’ assistance needs to understand and do the technical exercises.
Then, one approach that has been used to decrease this problem is to ask the students who understand the process of creating, saving and visualizing VRML files to collaborate with the other students for achieving the goal established. Indeed, some of the goals of this work have been learning how to raise individuals’ spirit of collaboration and sharing knowledge.

Fortunately, these goals have been achieved through a long term and persistent work. Collaborative work and sharing knowledge have become common practices and part of the learning environment’s collective intelligence with support of digital/web-based and advanced technologies. It includes stimulating the excellence of human resources that have been developed over the past years inside the school environment.

The combination among collective intelligence, technical skills and individuals’ confidence and excellence has been a key point for recalling and sustaining the 3D web-based work. Furthermore, some students have developed their own web-based work and inviting other ones to joining in their learning process. In particular, one of them has investigated, shared and used deepen contemporary and advanced technology and his artwork has served as a relevant local reference to other ones inside and outside the school environment as we will describe in the evaluation section (Reportagem 1, 2008; Wellington, 2009).

We introduced 3D web-based principles through developing a small scale 3D environment using VRML nodes such as illumination, viewpoint, texture and transform, at the end of April 2008. Hence, in November 2008 we observed that the principles of that work were still on students’ mind.

During September and October we carried out a work in which students from 7th and 8th grade levels were asked to designing a 2D blueprint of a house with eight environments and calculating the individual area of each environment and the total house area (Area Wikipedia, 2008). So, after the blueprint design to be ready, the ICT facilitator proposed that they developed a 3D representation of the blueprint by coding it using VRML.

At the beginning the students were a bit resistant to do that task, and asked how to do that. But when the ICT facilitator explained and demonstrated how to do that, recalling students’ memory to the previous 3D web-based technology experience in the first semester of 2008, they understood that they were able to do the task and started to work, and some students achieved the objective.

Because the work novelty related to improve individuals’ technical skills domain, in terms of stimulating students’ production, the best results came from doing practical work for about 80 minutes. It was the time for them observing, discovering, inventing and producing their digital content following Dewey’s learning cycle proposal (in Senge, Scharmer, Jaworski & Flowers, 2007).

This learning/teaching experience was another real world example of using this work methodology to developed classroom content through learning and practicing math concepts, stimulating individuals’ communication, digital technical skills and spatial abilities improvements, by applying computer graphics and multimedia tools in context for solving problems and enhancing individuals’ cognition (Cunningham, 2008; Franco, Ficheman, Venâncio, Moreno, Freitas, Leite, Franco, Matias & Lopes, 2008c; Franco & Lopes, 2008; Kaufmann, 2004; Kaufmann & Meyer, 2008; Miller, 2004).

Paraphrasing, Miller, (2004) we have carried out work, in which interactive, advanced and contemporary technologies have been vehicles to teach, and the packing of educational content that is both entertaining and interactive. “Furthermore, this unique hybrid is an effective way of engage adult learners as well children. It has been put to work for everything from teaching basic math and reading skills to training sophisticated leadership techniques to business professionals”. (Miller, 2004, p. 137)
Enhancing Individuals’ Cognition, Intelligence and Sharing Digital/Web-Based Knowledge

EVALUATION

Computers and emerging, interactive, advanced and contemporary technologies such as VR and video games have had a psychological appeal on individuals’ mind as well as behavior (Dede, Salzman, Loftin & Ash, 1997; Franco, 2001; Merch, 1999; Miller, 2004). Due to that, we believe that these technologies can serve as problem solving tools related to improve Brazilian individuals’ low level of alphabetization that is a fact, which directly influences the low level of literacy related to ones’ reading, writing, math and science skills. Due to these structural problems, individuals lack of quality of knowledge to access and use arts, technology and culture with effectiveness according to recent surveys (in INAF, 2005; PISA, 2006).

Obviously, if people can not read and write well, probably they will have problems for accessing, understanding and benefiting from the technical, artistic and cultural artifacts that contemporary society has offered to citizens.

On the other hand, we believe that it is possible to enhance individuals’ digital and traditional literacy, including science, cultural, artistic and technology silks since the primary education with support of advanced and contemporary technology. Our work described through this chapter, mainly in the case study section, has showed the effectiveness of such proposal in practice via applying low cost tools for achieving that.

Within the related work section we presented many more experiences that demonstrate evidence that children have benefited from the support of the combination of teachers, their peers, the specific hardware and the use of both side by side, including networked collaboration to write electronic stories. For example, with the T’rrific Tales software within the NIMIS project (Brna & Cooper, 2003). The design and implementation of the NIMIS classroom is reasonably successful but this is due to a complex mix of factors that mainly complement each other (Brna & Cooper, 2003).

Similar to NIMIS project, our work has achieved reasonably successful and its effectiveness has been increased, mainly, due to educators and students’ awareness of technology existence and the raising on their understanding of what for, and how to use it for solving problems. This individuals’ comprehension has also supported the development of their technical skills.

Individuals direct manipulating digital, advanced and contemporary technologies has conducted ones to human computer interactions HCI, collaborative and interdisciplinary work and to the training of the human’s cognitive abilities (Dede, 2000; Franco, Cruz & Lopes, 2005a; Rusk, Resnick, Berg & Pezalla-Granlund, 2008).

Through the development of a long term work, this educational experience has attempted to support individuals’ cognition abilities improvements related to attention; perception and recognition; memory, learning, reading, speaking and listening; problem-solving, planning, reasoning, decision making and language by using contemporary technologies as demonstrated in the case studies one to five and investigated (in Benyon, Turner & Turner, 2005; Preece, Sharp & Rogers, 2007).

This educational experience has benefited individuals with the convergence among interactive technologies, education and human knowledge of excellence. This convergence has brought about individuals to access and develop content that engages humans’ multiple senses and offers several ways of ones acquire information and develop new skills – via hearing, reading, viewing moving and still images, and by manipulating and producing digital content and communicating in a variety of ways (Miller, 2004).

Across ones’ direct manipulating (Preece, Rogers, Sharp, Benyon, Holland, & Carey, 1994) digital/web-based technologies and low cost multimedia tools synergy we have addressed the problem of using “computers not simply as information machines, but also as a new medium for
creative design and expression” as states Resnick (2006) through actions that can stimulate a culture of classrooms focusing on supporting students’ cognitive abilities development as creative thinkers (Resnick, 2007).

CONNECTING BIOLOGY, LEARNING AND TECHNOLOGY

These students’ cognitive abilities can be encapsulated within a simplified model, which represents the human information processing HIP paradigm to be visualized and that support ones’ better understanding the process of brain function and that direct affects ones’ thinking and acting for building intelligence. According to Benyon, Turner & Turner (2005), this HIP model is composed by “‘blocks’ or subsystems: (a) a sensory input subsystem, (b) a central information processing subsystem, and (c) a motor output subsystem” (p.101).

It is not the scope of this chapter to do a detailed investigation about brain function. However, the biological influence of brain function has gained, among others, neuroscience, artificial intelligence and educators researchers’ attention for grasping how the human brain learns and develops knowledge (Churchland, 2004; Del Nero, 1997, Doman e Doman, 2007; Reilly & Munakata, 2000; Outras Palavras, 2009).

The human beings’ biologic nature provides to them equal possibilities of brain development if the brain is stimulated within an appropriate way. So, to be conscious that the brain grows dramatic through its use during the first six years of children’s lives and that we can do the brain grow if we want, it is a ‘key information’ for parents and educators (Doman e Doman, 2007, p.129; Child brain development, 2009).

Due to children’s brain development openness until the age of six, providing them quality and quantity information within a systemic and flexible way across precise ‘with adequate details’; discrete ‘only one item’; and not ambiguous ‘with a name that can be interpreted only in one way’ ‘bit of intelligence’ as said (in Doman and Doman, 2007, 244 - 245) is relevant. For example, the quality and quantity of visual stimulation changes the neural networks of the brain and changes the quality of output from the left brain as it develops (Accelerated Learning Methods, 2009).

According to Yamamoto (2009) in a recent research published in the Neurological Research magazine, auditory and tactile stimulation developed by learning how to play piano influenced and supported better learning outcomes, since music-making nurtures the intellect and produces long-term improvements. For instance, the children who were learning piano once a week scored 34% higher than the other groups on tests designed to measure spatial-temporal reasoning skills - those required for mathematics, chess, science and engineering.

Interestingly, the computer kids scored no higher than the group who received no special instruction. (…) “The high proportion of children who evidenced dramatic improvement in spatial-temporal reasoning as a result of music training should be of great interest to parents, scientists and educators,” added Dr. Shaw.

Paraphrasing Yamamoto (2009) this study shows that interactive and high quality learning experiences early in life can determine which brain cells (neurons) will connect with other brain cells, and which ones will die away. Because neural connections are responsible for all types of intelligence, a child’s brain develops to its full potential only with exposure to the necessary enriching experiences in early childhood:

What Drs. Rauscher and Shaw have emphasized has been the causal relationship between early music training and the development of the neural circuitry that governs spatial intelligence. Their studies indicate that music training generates the neural connections used for abstract reason-
The neural connections are related to the biologic processes called synapses. Synapses are functional connections between neurons, or between neurons and other types of cells. The synapse is the junction between the sending neuron’s axon and the receive neuron’s dendrite. The end of the axon that enters into the synapse is called the axon terminal or button (Reilly & Munakata, 2000, p. 30; Churchland, 2004, p. 209):

A typical neuron gives rise to several thousand synapses, although there are some types that make far fewer. Most synapses connect axons to dendrites, but there are also other types of connections, including axon-to-cell-body, axon-to-axon, and dendrite-to-dendrite. Synapses are generally too small to be recognizable using a light microscope except as points where the membranes of two cells appear to touch, but their cellular elements can be visualized clearly using an electron microscope. Chemical synapses pass information directionally from a presynaptic cell to a postsynaptic cell and are therefore asymmetric in structure and function. The presynaptic terminal, or synaptic button, is a specialized area within the axon of the presynaptic cell that contains neurotransmitters enclosed in small membrane-bound spheres called synaptic vesicles. Synaptic vesicles are docked at the presynaptic plasma membrane at regions called active zones (AZ). (Wikipedia Synapse, 2009)

Back to the case of piano classes (in Yamamoto, 2009), even without having to much detail about the learning process, it seems that good learning experience’s achievements are related to the way that the piano lessons and practices were developed and supported by human expertise, meaning also good emotional influence on students’ knowledge development.

We do not know what kind of tasks were developed using computers in that experience. Although, that interactive technologies and computers attract children’s attention (Miller, 2004), obviously, nobody can guarantee that they will support individuals’ intelligence improvements without adequate learning situations and activities able to stimulate ones’ learning attitudes and engagement for knowledge development. There has been the necessity of combining human’s excellence, hardware and software scaffolding in order to achieve individuals’ good knowledge development (Franco, Cruz & Lopes, 2006; Harrison & Hood, 2008; IINN-ELS, 2009; Luckin, Boulay, Yuill, Kerawalla, Pearce & Harris, 2003; Warner-Rogers & Reed, 2008).

On the other hand, paraphrasing Del Nero (1997), it seems that the piano experience achieved the objective of stimulating individuals’ mental operations through developing language and manual sensory-motor competence without overloading the brain, since there was only one piano’s class per week.

According to Del Nero (2007) it is necessary to preserve the brain from cognitive overload in a way it can operate within a good flow and with effectiveness. The nature, across biologic pressure or influence has conducted the human evolution to decrease the cognitive overload not necessary to the brain function. For him, one of the learning functions related to the invention of the writing and reading culture is to decrease brain’s functions that can be done by other means/media. For instance, let’s think about the writing function. On the one hand, we were born without dominating the writing skill and we can survive without learning to do it.

On the other hand, we have means/media of learning and automating the writing skill in a way it can be transformed in a concrete brain’s department (or virtually concrete). The mind allows establishing relations between the brain and the world. From these relations can result concrete departments and even virtual ones outside the body that are allocated in the culture, in the science and in the technology.
Due to that, it is not necessary to have all the information recorded in the brain. The information can be transmitted in diverse ways, abolishing the direct experience. However, as a condition for all these processes happen, it is necessary to separate volunteer and non-volunteer will or automatic. It is necessary that individuals act within attitudes of will. (Del Nero, 1997, p. 120).

So, the idea of representing based on mental operations is fundamental. In a certain way, more than symbols, representations are scenarios on which individuals set up diverse degrees of uncertainty. The manipulation of these representations-scenarios through logical rules or other related models is one of the mental life’s centers that formatted by the language in adequate way, formulates heuristics (proximity of general solutions) on scenarios with several degrees of uncertainty. Del Nero (1997, p. 121) illustrates the thoughts above by stating that “the mind could be a result of interactions among language, will, thinking and emotion. All of them are running on the conscience stage. The language is able to establish a link with the natural and cultural world. The mental operations would be the ones that results from the neural groups’ synchronization and they would serve as a base for constituting ‘atoms’ of conscience”.

**MENTAL OPERATIONS, CONTEMPORARY TECHNOLOGY, HUMAN DEVELOPMENT**

We have carried out work for influencing individuals’ cognition abilities improvements and stimulating ones’ learning attitudes for using and reusing the contemporary technologies. This influence and positive results have brought about to consider the effectiveness of this kind of flexible, dynamic and exploratory work for stimulating individuals’ mental operations and developing human’s intelligence.

It is important to have in mind that human’s intelligence improvements seems to be linked with good learning opportunities supported by adequate human and technical infrastructure in an educational environment, such as in the concept of ambient intelligence (ISTAG, 2003) within the logic of inspiring individuals’ achieving the highest level of cognitive progress that is enhanced wisdom (Flynn, 2007). According to Flynn (2007 p. 159), “Wisdom is knowledge of how to live a good life and, if one is fortunate enough to understand other peoples and their histories as well, it is knowledge of how to make a better world”.

At some extent to make a better world depends on developing everyone’s knowledge and capabilitie as key factors for achieving individuals’ freedom. Sen (2000) explains freedom as a primordial resource for individuals’ development. It is a social state in which individuals develop capabilities that make them able to avoid, for example, bad life situations such as starving. Further than that, individuals are able to live freedom associated with acquired capabilities of knowing how to read, write, calculate, and participate on policy decisions with freedom of expression.

This vision of freedom is based on enhancing human’s life. In this kind of scenario an individual is always conscious about his/her social and political rights and is prepared for using them or not according to his/her will. It is the possibility of ones being able to participate in the socio-technical decisions as investigates and suggests (Levy, 1993) and is discussed later in this section.

We believe and our practical learning/teaching experiences have showed that a vision such as The Moving Picture Experts Group’s one - MPEG-21 of enabling individuals’ access to any multimedia content supports the idea of improving ones’ development as freedom. The idea of providing individuals’ access to any multimedia content can be expanded further and effectively within the information society (Burnett, Pereira, Walle, & Koenen, 2006) since the primary education.
The MPEG-21’s vision has been transformed into action by inspiring common citizens to access and produce content through knowing and direct manipulating ‘digital objects’ of diverse multimedia formats such as (MPEG, JPEG, HTML, WRL, XML, WAV, MP3). This kind of practice when is carried out within collaborative learning actions and reflections can lead individuals to enhanced wisdom and participation on society’s socio-technical decisions.

Fortunately, due to the internet culture, which has been built based on the “techno-meritocracy of science and technological excellence that comes from the big science and the academic world” (Castells, 2003), the MPEG-21’s vision and related learning/teaching practices are among the reasons why it is so relevant to influence individuals to develop technical skills lifelong learning.

So, based on Lévy’s investigations and reflections (1993), to support individuals’ knowing, understanding, dominating and using digital technologies addresses the problem of allowing citizens to be aware and to take part of the socio-technical decisions, which despite we have lived in a democracy, in everyday life, rarely, have been taken with collective reflection. Lévy (1993) states that is necessary individuals retake mental appropriation of the technical phenomenon related to the human development before the industrial revolution.

This reflection is based on his concerns about the contemporary media influence in everyday life. “There is no more socio-technical ground, but the scene of media. The foundations of social behavior and cognitive activities have been transformed in great speed that everyone can notice immediately” (Lévy, 1993, p. 8). He presents a historical and cultural reflection about the relevance of information and communication technologies ICT (digital and emerging technologies) for the building of communities’ culture and intelligence. Also, Lévy highlights the relevance of using ICT for supporting ones’ knowledge construction process and a progressive building of a sustainable techno-democracy.

An important reason for these thoughts is that ICT encompass through advanced informational devices and emerging technologies such as computers, hypertext and simulation techniques diverse possibilities of stimulating human’s knowledge and cognitive abilities related to writing, reading, communicating, researching, vision, hearing, creativity, and learning (Dede & Palumbo, 1991; Lévi, 1993; Osberg, 1995; Franco, Cruz & Lopes, 2006). In the related work within the background section we showed diverse examples of projects that apply contemporary, emerging and advanced technologies for building educational applications, attempting to improve individuals’ knowledge acquisition and cognitive abilities.

This ongoing work have contributed to create and transform individuals’ habit, mental models and culture of using digital, contemporary and emerging technologies for ones’ researching and learning to think based on developing programming skills, using procedural literacy and computer graphics techniques since the primary education as demonstrated, investigated and recommend in (Flanagan & Perlin, 2008; Franco, 2000; Franco, Cruz and Lopes, 2006; Franco, Mariz, Lopes, Cruz, Franco & Delacroix, 2007a; Mateas, 2005; Osberg, 1995; Siggraph Education Report, 2007).

Empirical investigations and practices such as the ones in the case study section have showed that even non-technical individuals can develop programming skills through direct manipulating scripting languages (Franco & Lopes, 2005d). These possibilities of developing individuals’ computer skills have improved the way that ones think influencing better and constant mental activity, bringing about brain’s neuronal connections development. According to Piazzi’s investigation (2007) some of the current good professionals in the computing area had their intelligence stimulated while they were learning how to program, which is an activity that influ-
ences brain's neuronal connections development. This kind of learning process has support of the logic that an individual that is intelligent is also curious, so, he/she will have constant interest in learning and accepting challenges and so forth (Piazzi, 2007).

Satinover’s investigation (2007) related to increasing fractal dimensions in the human’s brain cortex when it is stimulated in adequate way reinforces the logic of exposing individuals to complex information such as classical music and other forms of complex music. However, as stated before, learning how to program is also a complex task and can influence brain development. So, we believe that it is relevant to stimulate brain through active learning processes related to developing ones’ programming skills supported by contemporary and advanced technologies since the early school days such as in the project (IINN-ELS, 2009; Nicolelis, 2008) and suggested (in Mateas, 2005).

We illustrate the above statement through describing an informal and prototyping learning/teaching experience, in which author1 produced and used an web–based hybrid interactive 3D virtual environment VE developed and visualized with digital resources using a combination of VRML, still JPEG, and moving MPEG, textures, including audio and text files (Franco, 2005). During the experience, the code of the 3D digital environment was direct manipulated first by an educator who has worked in the alphabetization process, and after that by a 1st grade level student. Under author1 scaffolding the 1st year student modified the code to input his video related to a ‘parlenda’ in the 3D VE for understanding the importance of writing and reading well, including accessing to innovative digital knowledge (in Franco J., Mariz, Lopes, Cruz, Franco N. & Delacroix, 2007a).

Although it was a prototype learning experience, the 1st year primary educator considered that it was interesting due to the possibility of building and experiencing learning and teaching within a VRML adaptive hybrid interface (in Franco, 2005). Through the 3DVE adaptive hybrid interface it was possible to combine natural, cultural, and virtual worlds with learning situations within a way that connected sensory-motor experience (auditory, vision, tactile) with conscious brain operations ruled by thinking, emotion and will as (in Del Nero, 1997).

It was possible to apply Doman and Doman’ s (2007) ‘bit of intelligence’ concept by learning how to virtually interoperate on mind diverse ‘bits of intelligence’ across real world physical operations such as recording audio and video files, modifying text files, spatial navigation in a 3DVE, including human to human communication and human computer interactions. It seems that these learning/teaching actions brought about ones’ brain neural network simple and complex operations and learning through stimulating several synaptic activities.

We used ‘parlenda’ that is a type of children’s game genre that combine text, speech and body expression as a base to support the learning experiment because educators are used to apply this genre to develop children’s reading and writing skills related to their alphabetization process. The logic of using ‘parlenda’ in the teaching and learning processes is alphabetizing children through stimulating them to associate the sounds of the words that they already know and memorize when they pronounce while they are playing with the written representation.

Hence, it was a way of connecting indoor (video games) and outdoor games as tools for personal and group developing with primary school adequacy in terms of improving children’s cognitive reasoning abilities and physical skills (Bartunk, Martin & Martinová, 2007).

This kind of learning practice involved stimulating individuals’ perceptual and cognitive development. It seems to be a good strategy that can be used for improving educators, students and surround community’s traditional and digital alphabetization, including literacy skills related
to arts, technology and culture in a collaborative mood by adapting and using the synergy between the real world content and the digital one in a mixed reality experience as explains (Milgram & Colquhoun, 1999) and shows the interactive work carried out (in Franco, 2005; Franco J., Mariz, Lopes, Cruz, Franco N. & Delacroix, 2007a).

The use of digital tools in combination with curriculum content and human development has approximated individuals from the diverse sciences and technology. It has also improved ones’ communication skills in terms of dominating, using and sharing techniques and concepts related to information visualization, computer graphics, web-based technology and low cost multimedia resources (Franco & Lopes 2005; Franco & Lopes, 2008). Individuals have direct manipulated these technologies to produce digital content at school and expanded the knowledge developed to informal home meetings and other learning environments in diverse communities such as demonstrated in case study 2.

Here, we show more two examples that highlight how this work has been expanded to other learning communities.

First, the ICT facilitator (author 9) who left Ernani School at the beginning of 2006, because of the law changes as explained before, used her VRML knowledge for supporting her math teaching with secondary education students. In 2007, her knowledge referent to VRML supported her math’s teaching in a state public school in the city of Caieras, which is located in the surrounding of São Paulo city.

As results of her work, author 9 reported that even with the school computers lab environment under low level of technical conditions and great number of students per computer (about eight computers for forty students), by introducing to high school students of the city of Caieras VRML examples of the work she did at Ernani School. She got students’ interest in learning math concepts by challenging them to deal with computer graphics principles, desktop virtual reality, and information visualization tools and techniques.

She also reported that students enjoyed the interactive learning and teaching actions and shared knowledge to develop the tasks. They also asked her if that kind of digital tool would allow them to produce their own games. The fact that 7th and 8th grade level students from ESB created 3D virtual worlds also served as challenge for her students in Caieras to keep developing their math learning and 3D work. Unfortunately, she could not finish all the technical and visual work planed because she was pregnant and had a medical license before the end of the year (in Franco, Cruz, Franco & Lopes, 2007c). Recently, March of 2009, due to this chapter development process that she shared with her colleagues at school, she reported by e-mail to author1 that there have been from other high school educators and the principal of the school interest in doing a workshop and developing knowledge in VRML.

Second, the collaborative knowledge sharing and constant exposure and reflection about digital technologies has improved author 11’s digital skills through direct manipulating contemporary technologies and producing digital content. For example, authors 1 and 11 as attempted to improve their digital knowledge exchanging interdisciplinary knowledge related to use the art/education concept in combination with advanced and contemporary technologies (Barbosa, 2006; Mitchell, 1999) by experiencing with the fusion among photography, art and computer graphics such as the work carried out (in Parrish, 2002).

They developed a 3D web-based application for investigating cultural heritage related to the City of Carapicuiba, an action that stimulated individuals’ traditional and digital literacy skills through researching in books and on the Internet, and mixing real and virtual realities in practice. The walkthrough 3DVE artwork developed by authors 1 and 11 served as their self-training for exploring and understanding how to integrate diverse digital technologies to produce content.
related to school curriculum development. The authors and 11’s artwork also showed the possibility of developing qualitative 3DVE with low cost tools. It is a mixed reality environment showing a composition of real pictures from the city of Carapicuiba, a Historical City, with little flags textured on the floor with inspiration on Alfredo Volpi’s artwork. The VE is a simulation that demonstrates how Carapicuiba could be if the houses of the central village were designed with inspiration on Volpi’s artwork (in Franco, Stori, Lopes & Franco, 2005; Franco, Cruz, Franco & Lopes, 2007c).

Author11 used further his digital skills at home to support his daughter, who was in the 6th grade level in 2007. He scaffold his daughter develop content related to produce a film of 8 minutes about Rita Lee’s life using low cost multimedia tools. In this film it was also included artistic, cultural and political facts from the sixties. Later on, author1 presented the film as an example to students inside the school computers lab inside the ESB School aiming to inspire them to do their own productions. This expectative was transformed into reality during the development of the science project related to the ‘water pollution’ in case study 4 and in (Franco, Ficheman, Assis, Zuffo, Lopes, Moreno & Freitas, 2008a).

Author11 has also applied his digital knowledge and skills to prepare classroom material and conduct his History teaching at a public school in the city of Carapicuiba that is in the east of São Paulo metropolitan area. Step by step he has influenced his students to develop their digital skills through guiding students how to use better the Internet and computer resources to understand History by investigating and accessing to arts and culture. Author11 has used low cost software and capture card (TV capture card - PlayTV/MPEG-2™) for capturing and editing movies through compounding collages that illustrate his speech during the classes and also improve students’ knowledge in art and culture. Author11 has said that students use to look after him to get information about the film productions beyond the collages they saw in the classroom and many of the students have watched the films at home.

Author11 has thought that for using digital and emerging technologies with effectiveness, it is necessary that educators keep studying and researching lifelong. His conclusion is because to select the images that are used to produce the learning material need to be researched and previous contextualized on educators’ mind. His argument has been that when an individual is working with information visualization, computer graphics, the Internet, and multimedia tools, he/she is opening the material and subject researched to interdisciplinary and transdisciplinary work that can involve concepts such as ethics, values, and inference and interference from other diverse disciplines.

The diverse examples in the related work, through the case study section and implications in the evaluation section are according to the logic that supports the use of digital/web-based and advanced information visualization tools on students’ learning and educators’ training to stimulate ones’ interactive learning and knowledge based on sensorial and perception (visual, auditory, tactile, mental) development (Reilly & Munakata, 2000).

The learning/teaching actions have contributed to reverse the idea of “black box” that many non-technical individuals have about possibilities of producing two-dimensional 2D and tri-dimensional 3D virtual environments VE by using computer graphics principles (Foley, Dam, Feiner & Hughes, 1993) and related technologies as problem solving tools through several learning situations.

According to Del Nero’s investigations (1997), during the learning experiences and lifelong, it is important for understanding and using with effectiveness the combination among technology, sciences, culture and arts to take in consideration forms and media to be linked with individuals’ education. It is also relevant to consider collabora-
tive, dialogic, interdisciplinary and lifelong learning education as key-point to society development. Del Nero (1997) recommends developing students’ knowledge and capabilities with diverse learning experiences that go from math to drama, from language studies to reading daily journals, from sports to the intensive use of computers. Computers should be used in practical aspects via individuals’ direct manipulating software programs and programming languages, and related to theory ones should learn about languages, logic and electronic fundamentals.

Churchland (1998) demonstrates the importance of applying high level programming languages through scripts that allows one’s dominate and control information processing in computers. For instance, scripting languages such as HTML, DHTML, VRML, and Java Script enable designers’ programming to create hypertext (Dabbagh, 2008; Wikipedia Scripting languages, 2008).

This can be a powerful way of stimulating and improving individuals’ with low literacy abilities (functional analfabetism) through integrating and interoperating several technologies related to drawing, modeling, writing, programming, researching, reading and communicating. Furthermore, paraphrasing Pietraß (2007) researchers on cognitive psychology state that the combination of text and picture induces to increase students’ mental representation and operation than mere text according to (Blömeke 2003, Issing 1997) in (Pietraß, 2007).

Del Nero states that “education is the great tool to execute corrections in the brain-mind” (Del Nero, 1997, p. 439). He reflects about form and media and their relation with world’s transformations and the education field. The reflection is that besides the traditional disciplines, there are new areas emerging that have blended with the old ones and beyond. Another reflection is that computers have taken human’s place in tasks where the rules are well defined. His inference related to these reflections highlights the necessity of changing the old traditional way of expositive classes and classical schooling subjects.

According to Del Nero (1997) it is time for new ways of teaching and learning that develop rapidly an interface among the disciplines (opacity zones of intersection, which will take long to be executed by computers). Furthermore, it is necessary to stimulate individuals’ desire (will) to develop new knowledge and persistence to study lifelong. Hence, school environments should have well trained educators, as well as no more than 20 students per class at k-12 education.

A better average of students per educator seems to be essential to stimulate sustainable interactivity and better individuals’ communication inside the classroom under applying the concept of overlap of fields of experience, which is considered an excellent guide for supporting the use of multimedia and contemporary technology within a critical way (in Tannenbaum, 1998).

Using the modular features of web-based technology has enabled individuals to understand and practice how to construct simulations with support of the synergy among web-based 2D and 3D technology, desktop VR techniques and information visualization tools for visual communication (Cunningham, 2007), within simple and complex operations. Due to the features of modularity of these technologies, one can use these contemporary technologies as ‘bits of intelligence’ as (in Doman and Doman, 2007) for supporting brain neural development with respect to the biological processes related to the synapses; reducing brain overload due to the existing on-line/off-line libraries and templates and the ones to be created referent to the mentioned technologies.

Despite of ICT complexity when it is viewed as a whole for non-technical people, ICT, in this case, referent to web-based technology, is composed by many modular features which have brought about support from electrical engineering processes for building web-based learning environments (Pressman, 2006). The web-based modular features have allowed the construction of
flexible, knowledgeable and rich media learning environments with great potential for supporting collective intelligence’s technical development. This support has come from the development of individuals’ cognitive and technical abilities, as well as intelligence related to the concept of modularity and its uses within the different disciplinary contexts ‘of modular thinking’. Callebaut and Gutman, (2005) state that modularity:

(...) the attempt to understand systems as integrations partially independent and interacting units – is today a dominant theme in the life science, cognitive science, and computer science. The concept goes back at least implicitly to the Scientific (or Copernican) Revolution, and can be found behind later theories of phrenology, physiology, and genetics; moreover, art, engineering, and mathematics relay on modular design principles(...) (Callebaut & Gutman, 2005, back cover).

Then, it is relevant individuals’ understanding, learning, dominating, using and producing simple and complex systems applying the concept of modularity to support brain-mind development.

We believe that the concept of modularity is compatible with the synergy between “modular thinking” and the HIP model described within the connecting biology, learning and technology on this evaluation section. This compatibility can bring about modularity to be a useful support for knowledge transferring between diverse fields and impact as a useful consequence of this knowledge transfer, on the development of individuals’ cognitive abilities.

Using web-based technology as communication tool, knowledge development and digital content production instrument supported by the developmental psychology (Kassin, 1995; Miller, 2004) in combination with the concept of modularity and its relation with a developmental process that involves transformation and self-organized hierarchical systems reinforce the base for this work technical implementation in diverse contexts. Self-organization is supported by a mass of interactions between the smallest entities (subsystems), which basically consists of either collaborative or competitive relations with a wide range of nonlinear interactions, spatiotemporal scales, recurring commonly in natural systems as studied in biology, physics, and economics (Buscalioni, Iglesia, Buscalioni & Dejoan, 2005).

We have achieved the described results in this chapter, by learning to develop research and simulations using contemporary and advanced technology. As Dede states:

Simulation and visualisation tools help students recognise patterns, reason qualitatively about physical processes, translate among frames of reference, and envision dynamic models. These curricular approaches improve success for all types of learners and may differentially enhance the performance of at-risk students. (Dede, 1999)

Dede’s statement (Dede, Salzman, Loftin & Ash, 1997) supports Teixeira’s investigations and reflections (1977) about democracy and universal k-12 education. Teixeira’s reflections address the necessity of providing excellence of learning and teaching in k-12 education for forming students’ knowledge, mind and capabilities within high quality. The argument we sustain to claiming for an excellent technical and pedagogical infrastructure in learning environments is that educators and students, in particular the individuals at risk situation, are already at schools and can benefit from high quality and dynamic education (in Forrester, 1992; Franco, 2001; Franco, Cruz and Lopes, 2006; Wikipedia System dynamics, 2008).

Providing excellence on education in terms of combining adequate learning environments and or ecosystems (Ficheman and Lopes, 2008a), high quality tools and good human expertise may promote individuals’ active preparation and participation within a solidarity and democratic economy. Adequate learning ecosystems can contribute to improve the current bad situation of too
many citizens who are under economic and social vulnerability, bringing about lifetime opportunities to these individuals and enhancing society commonwealth (IINN-ELS, 2009; Miller, 2006; Nicolelis, 2008; Sen, 2000, Singer, 2002a).

Learning ecosystems and schools which have planned to work within good work quality and stimulate individuals’ development of excellence in a ethical way (Gardner, Csikszentmihalyi & Damon, 2004), should inspire individuals learning in practice the importance of lifelong education in the current time of constant changes in economy and technology (Senge, 2002b).

One school’s paradigm for achieving such goal is what has been called ‘democratic school’. The hypothesis that has been worked in the ‘democratic schools’ is that human beings are naturally curious and desire to learn all the time without someone else force these attitudes.

Paraphrasing Senge (2002c) in these schools students learn, play, interact with mates and adults and also develop a great sense of responsibility and conscience. When they left these schools they know more than the ones who went to conventional schools. Hence, students have left democratic schools with their spirit and intellect prepared to be critical and conduct these individuals with more autonomy through life.

We believe that this kind of citizens’ preparation has been adequate to the type of society that the concept and practice of solidarity economy has attempted to reinvent all the time within the little opportunities that the capitalism has opened to it.

TECHNOLOGY SUPPORTING DEMOCRATIC INTERACTIONS INSIDE AND OUTSIDE SCHOOL

Due to the collaborative and interactive work inside and outside ESB school environment, as we said before, we have achieved good work quality results even when students have left school. It is thought that through using scripting languages and exposing students to diverse 3D environments as well as supporting students dominate contemporary technology, we have sustained students’ curiosity to learn how to use more sophisticated digital tools. This way they have improved their computational thinking within systemic, flexible, spiral, incremental and experiential learning actions.

For instance, in 2007, the 8th grade student who supported the ‘water pollution’ project in case study 4 has benefit from the 2D and 3D computer graphics technical skills he started developing at ESB School (Garrido, 2009). During his visits to the school computers lab, accordingly to the development of his evolutionary web design skills and curiosity to create more realistic 2D and 3D digital content he was introduced to tools such as GIMP™ and Blender™.

Although, the 8th grade student finished his studies at Ernani School in the end of 2007, due to the good quality of the human to human and human computer interactions he has shared his knowledge in computer graphics with other individuals and developed a Blog since 2007 showing his drawing artwork (Garrido, 2009).

Hence, the horizontal dialog between him and the ESB ICT facilitator has been developed based on digital/web-based technology knowledge, which has been applied as a ‘common ground’- (language/medium) (in Laurel, 1993), including as a form of overlapping the student and educator fields of experience (in Tannenbaum, 1998). For example, in February 2008, at the gate of the school, during an informal talk, the student expressed to the ICT facilitator that he had difficulties for installing a VRML browser (Cortona™) in his computer at home. He described the diverse proceedings he had carried out for installing the browser, but it did not work.

Then, both went to the student’s home where they installed the VRML browser. In student’s home they carried out one and half hour of interactive VRML workshop discussing and prac-
ticing how to develop animation, understanding English terms and 3D modeling possibilities. In sequence, they developed more fifty minutes of interactive workshop for understanding how to do animations in Photoshop™, comparing those proceedings with the ones necessary to develop animations in the Gimp™ software.

During the informal talk at student’s home, his brother a former student from Ernani School and his mother also participated. The 8th grade student’s brother was one of the first students to participate in the interactive digital and emerging technologies investigation during the beginning of this work development from 2003 to 2004 (Franco & Lopes, 2004; Franco, Mariz, Lopes, Cruz, Franco & Delacroix, 2007a).

According to the informal talks and formal lessons, we observed that the work carried out has influenced the student’s cognition and intelligence leading him to enhanced knowledge, which can be related to wisdom as described in (Flynn, 2007). This thought is because, the student has shared his web-based knowledge with other mates at his current technical course, in which he has learned how to fix the hardware of computers and web design. He also is doing a secondary education course.

His autonomy for dealing with web-based technology as lifelong learning companion has been improved. A proof of that is the interactive 3DVE he designed after that meeting at his home and on March 02/08 he sent by mail to the ICT facilitator. The student developed a nice house and a beautiful garden. The 3DVE was compounded by diverse still images as textures, VRML animation features for opening and closing the door at the entrance of the house. He worked with VRML material proprieties using transparency and coloring the 3DVE within a balanced way.

Later on during May 2008, he sent more examples of his artwork in design that reflected his deepen efforts in learning and using Blender™ software.

In another human computer interaction including human to human interaction based on contemporary technology knowledge, at the end of April 2008, during the students’ research time within the school computers lab, one of the 7th grade level students reported that he talked with his father that he was learning HTML and VRML at school. He said that his father approved the idea of students’ access to advanced technology at school. At the beginning his father was afraid about installing a VRML browser in the family machine. But after two weeks, in May 2008, the student got enough knowledge to manipulate VRML files and installed a browser.

He reported to the ICT facilitator that he installed a browser in the computer at home and he was sharing knowledge with another colleague from the 7th grade level that had also developed VRML abilities in the school computers lab. This situation is evidence that the individuals’ digital knowledge acquired and developed at school computers lab has been a common ground that has influenced communication between individuals from the school environment and the surround community, as well as inspired students’ collaborative and independent learning attitudes (Franco, 2001).

At the end of 2008, the student said he had difficulties for keeping developing 3D worlds because he had not understood some VRML syntax rules. On the other hand, he asked information about how to develop drawings using (Gimp™, 2008) because his friends from the Okurt™ were processing images using Gimp™ software. So, we did a workshop. His latest interest was to design a web page, so he was guided to do some HTML exercises through using a tutorial.

After sometime, in March 2009, when informally asked about how was the development of his digital skills, the student reported that he had stopped training because his colleagues also stopped, and that he was a bit lazy to think about how to develop 2D and 3DVE interfaces. However, the student did not point or link the dif-
Enhancing Individuals’ Cognition, Intelligence and Sharing Digital/Web-Based Knowledge

Ficulties in direct manipulating the contemporary technologies that we presented to him as the main reasons to his decision of stopping the practical learning process.

Although, we think it is necessary further investigation for understanding the whys, we have observed similar problem related to other students’ lack of will and consequent attitudes to think for solving problems in other school curriculum subjects. Our observations have been confirmed through informal talks with other educators from the ESB School.

We are aware that has been difficult to transform the current school environment in a learning space that can include all the forms of interest-based activities and/or experiential learning opportunities that people voluntary participate in, often with great personal engagement and use of time when they are in leisure time (Illeris, 2007).

On the other hand, through carrying out this work supported by digital/web-based technology, low cost information visualization tools, and free software, students and educators have engaged and improved their digital knowledge and technical skills. It includes that they have applied knowledge and technical skills in practice with great personal engagement in school and beyond, anytime and anywhere, as it has been demonstrated in this chapter. So, as Illeris (2007, p.233) states “e-learning can constitute an appropriate supplement in many contexts, but it presupposes that the relevant multi-aspect programs are available and – to an even greater extent than other learning – that the participants have considerable motivation.”

An example that reinforces the relevance of developing multi-aspects programs and individuals’ digital knowledge and supports our arguments and actions for using web-based technology, low cost and free software tools in ones’ education process beyond the proprietary ones comes from Professor Brutzman’s speech during his presentation related to the X3D standard and The Extensible 3D (X3D) Earth project (in Forum X3D, 2008) at Polytechnic school, University of São Paulo.

The example that happened in a developed country is referent to a student from secondary education. The professor said that a young student from the region of the Naval Postgraduate School, USA, got an opportunity for studying modeling in a University in Stanford. He learned modeling using Maya™ software. But when the student came back home, he could not afford to buy the tool. The student asked support for solving that problem and keeping his modeling practices. It was offered a free X3D software environment that is an XML based format and extends VRML functionalities (WEB3D consortium, 2008; X3D Earth Implementation Workshop, 2008).

Due to situations like that, it is fundamental that educational systems can provide to educators from primary to higher education technical fluency and pedagogical skills to present and support students new possibilities of using high quality and low cost contemporary technologies to develop individuals’ cognition abilities and intelligence far beyond industry ‘office’ packages, and ‘mechanic like games’ on the Internet (Franco, Cruz & Lopes, 2005; Resnick, 2002; Resnick, 2007).

It seems that educational systems have kept ‘failing or lacking’ in providing educators’ technical skills improvements to use contemporary technology to support students’ learning and curriculum content development. Then due to this bad situation only a small number of students will have the opportunity of deciding with awareness how they will use digital and emerging technologies effectively after the school days:

“When people are introduced to computers today, they are typically taught how to look up information on the Web, how to use a word processor, how to send e-mail. But they don’t become fluent with the technology. (Resnick, 2002)"

For ameliorating this problem, it is thought that in every educational space designed for children,
youth children and adults’ education development around the world, policy makers should support the creation of pedagogical and technical infrastructure suitable for forming dynamic and high quality digital learning scenario. That is why having a graduate student such as author10 participation in the development of a learning math project like in the case study 5 is relevant. Author10 participation is an opportunity of approximating a graduate student from the dynamics of real world learning environments and feel how innovative ideas in combination with contemporary technology can scaffold individuals’ learning.

The learning environments ecosystems could be based on investigations, concepts and learning paradigms such as the ‘ambient intelligence’ – AmI in (Ambient Intelligence Org, 2008) and projects such as the New Media Consortium (NMC)’s Horizon Project (2008) that investigates and suggests pedagogical tendencies related to the use of emerging technologies in education and their influence to develop, for instance, collective intelligence. According to (NMC, 2008), due to hardware and software improvements and decreasing costs, it has been increased the tendency of using virtual and augmented reality as learning tools.

An example of this tendency related to the ESB School is the experimental work carried out by LSI researches. They used virtual and augmented reality techniques in combination with low cost mobile computers to create an interactive, interdisciplinary learning and teaching experience. “Religions of the world” was the main theme that involved subjects like history, geography, Portuguese, math and art in individual and collaborative activities. The application was developed using the ARToolkit for fast prototyping and its purpose was to prove the concept of using different mobile tools and technologies to verify how learners transition and alternate from one tool to another (Ficheman, Saul, Assis, Correa, Franco, Tori & Lopes, 2008b).

In times of constant society and technological changes, this work initial motivation has increased and encompassed the perception that is necessary that we as educators learn and use contemporary and advanced technologies as a ‘common ground’ (language/medium) to support educators and students overlapping their learning fields of experience and interactions with effectiveness.

Achieving a common ground or communication state based on the concept of overlap of fields of experience can bring about individuals’ commitment, confidence, and psychological empowerment to engage themselves and keep attracting other ones (students, educators and community) in a persistent citizens’ knowledge and intelligence development work that involves diverse combinations such as pedagogy, technology and management, theory and practice, traditional and open learning.

PSYCHOLOGICAL, PEDAGOGIC, TECHNICAL AND HUMAN SUSTAINABILITY

The psychological, pedagogic, technical and human sustainability of this digital/web-based knowledge work has also been supported by learning theories concepts such as Piaget’s constructivism and Papert’s constructionism in (Cavallo, 2000; Johnson, Roussos, Leigh, Vasilakis, Barnes & Moher, 1999), including the motivation that people have got as a result of the “agency” concept, which is the pleasure of taking meaningful actions and seeing the results of our decisions (Murray, 2003). For example, accessible web-based standard languages such as HTML and VRML combined with 2D and 3D interactive computer graphics and virtual reality techniques, as well as multimedia tools and files can bring about “agency” when individuals can see the tangible results of their programming such as the example in Figure 2.
These actions, techniques, psychological and pedagogic combination address the grasping and the designing of human-centered interactive systems involving people, activities, contexts and technologies (Benyon, Turner & Turner 2005), including sensory perceptions (vision, audition, touch) and their implications for designing, as well as how to apply the combined knowledge of cognitive psychology and information technology to the design of artifacts (Te’eni, Carey & Zhang, 2007).

The thought is in constant dialogic relation with the external world. By the perception phenomenon, the external world talks with individuals through their feelings. After that a message arrives in our psycho where each individual will do a personal reading. This reading can be constituted of a current content or the current content can take individuals to a parallel reading (Revista Mente, Cérebro & Filosofia, 2007).

For example, it is possible to imagine a tree that was born in the ground of the Estação Primeira de Mangueira Samba School. For the ones that will visit the School by the first time, it will be a simple fruit tree. On the other hand, for the individuals who know deeper the history of Estação Primeira de Mangueira, the tree is a symbol of the Samba School. The reflection is the phenomenon of this parallel reading, when the perceptions of ones’ living with the object transcend the perception of the object that was seen (Revista Mente, Cérebro & Filosofia, 2007).

It is thought that it is through an interactive exercise of perception and reflection as in the example related to Mangueira Samba School that we have found affective, engaging and effective ways of conducting the digital/web-based learning and teaching experiences, as well as stimulating individuals’ computational thinking skills and attitudes.

Some alternatives to conduct the learning experiences are: to make a previous view of the content to be seen by asking a research on the Internet; developing curriculum content in combination with interactive and digital tools, including technologies from the Internet such as using web browsers as Internet Explorer™, FireFox™, Cortona™ and Cosmo Player™, as well as a low cost text editor for content creation and visualization in 3D.

There is coherence of the examples that were described in the case study section and the use of contemporary technology as a ‘common ground or language’ in combination with ‘the concept of overlap of fields of experience’ to support psycho studies related to children’ behavior that have been based on Wallon and Lacan’s theories in (Bastos, 2003). According to Bastos’ investigation (2003) both authors grasp the individual as an individual social inserted in the culture and in the language.

We believe and have showed through this chapter several examples that the use of web-based and digital technology as a ‘common ground or language’ to support individuals learning process, it is something that children understand very well and can be a relevant mean/media of scaffolding and approximating educators and students, children and parents, and friends in the contexts of school and home in everyday life.

Through interactive actions supported by digital/web-based knowledge individuals can become aware of the changes in art, science, technology and cultural practices, including social values encompassed in the contemporary technologies and digital/virtual environments that influence citizens’ everyday lives (Coslson, 2007; Paul, 2008; Pietraß, 2007; Popper, 2007). For instance, through the creation of simple and complex digital environment content that has involved diverse proceedings, knowledge, and languages to compound it, such as the animated documentary Waltz with Bashir (in Wikipedia Waltz with Bashir, 2009).

According to (Murray, 2003) digital environments are procedural, encyclopedic, participative and spatial. These properties make digital environments powerful tools for simple and complex liter-
ary creation. These properties allow constructing flexible learning environments based on the concept of scaffolding and/or software scaffolding use in education such as the Listen Tutor project example in the related work section (in Chang, Beck, Mostow & Corbett, 2006). Scaffolding 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 (Henry, 2002; Luckin, Boulay, Yuill, Kerawalla, Pearce & Harris, 2003). Scaffolding is related to Vygotsky’s theory, which he called the zone of proximal development - ZPD. The ZPD is the difference between the children’s capacity to solving problems on his own, and his/her capacity to solve them with assistance (Vigotski, 2007).

**COLLABORATIVE WORK REINFORCING INDIVIDUALS’ INTERACTIVE TECHNOLOGIES DOMAIN**

The collaborative work developed inside the school environment and the surrounding community has also been integrated to the academic educational research related to the – Núcleo de Aprendizagem, Trabalho e Entretenimento - NATE – ‘Nucleo of Learning Work and Entertainment’ from the Laboratory of Integrated Systems LSI from the University of São Paulo since 2004 (Franco & Lopes, 2004; Franco, Mariz, Lopes, Cruz, Franco & Delacroix, 2007a; Franco, Cruz & Lopes, 2006; NATE, 2009).

This collaborative and cooperative work has allowed to school individuals engage in the latest processes of educational researching and using contemporary and advanced technologies in learning and teaching. This collaborative process between primary and higher education has also addressed the necessity of sustain individuals’ motivation for developing digital technical knowledge and e-learning skills with support of multi-aspect programs as proposed (in Illeris, 2007, p. 233).

For instance, researchers from the Laboratory of Integrated Systems - LSI from the University of São Paulo constructed an interactive visual application for supporting a learning and teaching experience which combines diverse tools and devices such as augmented reality and low cost mobile platforms inserted in an educational context.

The interactive visual application was constructed on the top of the ARToolkit software, which is designed for fast prototyping. The learning experience purpose was to investigate the concept of using different mobile tools and technologies to verify how learners adapt and alternate the transition from one tool to another.

The tests were performed at ESB School. The initial application brought about to conclude that even if some mobile platforms have limited computational power, the use of augmented reality combined with other tools can present a new form of representation and interaction and can be an innovative way of using technology in the classroom to improve students’ knowledge (Ficheman, Saul, Assis, Correa, Franco, Tori & Lopes, 2008b).

The lifelong learning/teaching collaborative experiences that have been carried out with researchers from LSI have approximated the ESB School and surrounding community from lifetime opportunities such as to participate in a prototype educational experience related to the one-to-one learning model proposal (OLPC Wiki, 2008; Franco, Cruz, Aquino, Teles, Gianevechio, Franco, Ficheman, Camargo & Lopes, 2007; Lopes, 2007; Franco, Ficheman, Lopes, Ferreira, Santos, Ferreira, Araújo & Moreno 2008b). Since April 2007, educators and students from ESB School and researchers from the Laboratory of Integrated Systems have trained with and used the XO laptop related to the one-to-one model in diverse learning/teaching and entertaining contexts.
Enhancing Individuals’ Cognition, Intelligence and Sharing Digital/Web-Based Knowledge

Due to school community involvement with digital technologies (Franco, Cruz & Lopes, 2006) and its participation in the one-to-one learning model, in 19 April 2007, Nicholas Negroponte and OLPC team visited the school. During their visit they first interacted with primary students from a 2nd grade level class (in Silveira, 2007).

After that, at school computers lab, the OLPC team met other educators and students from 6th to 8th grade levels and talked about the one-to-one learning model project. The common ground for the human to human and human computers interactions was the laptop XO (Yahoo News, 2007).

Later on, August 2007, Professor and researcher Mitchel Resnick visited the school to see the one-to-one learning experience and interacted with students from 7th and 8th grade levels, including author1 at school computers lab. The common ground for this meeting was based on XO laptop and the Squeak (2008) software installed on the machine interface.

The collaborative work between Ernani School and LSI has provided interdisciplinary work references for educators and students, bringing about individuals’ better understanding on how electronic engineering resources have influenced arts, culture, education and the entertaining industry (Colson, 2007; LSI, 2009; Paul, 2008; Wands, 2006).

The school and university partnership has allowed school community to visit diverse, scientific, cultural and digital art exhibitions such as Mario Schenberg Spaceship, a collaborative interactive installation at park CienTec that aims to reach out young visitors and awaken their interest for science, physics and astronomy: through a space trip simulation. The Spaceship is designed to offer learning and entertaining environment, so a group of young learners can experience an adventure in space within an interactive and educational game simulator. Students from ESB School visited the Mario Schenberg Spaceship project at the end of 2007.

Scientific, artistic, cultural interactions and learning experiences such as this one are always on students’ mind. For instance, a 7th grade level student, at the end of 2008, said that she enjoyed her visit to the Parque CienTec, in 2007, and asked to author1 if there would be a new visit to the Mario Schenberg Spaceship (in Parque CienTec, 2008).

Beyond that, she made a lot of questions related to developing real and virtual simulations. During an informal talk she and other classmate proposed to design a school simulation with focus on saving rain water. They said that as public buildings, schools should be the best example for children of how to proceed to save water.

Students were encouraged to do that. However, the idea was not implemented by her and classmate. They talked to another student from the 8th grade level.

The student is the one we cited during the case study 5. He has investigated, shared and used deepen contemporary and advanced technology. His artwork has served as a relevant local reference to other individuals inside and outside the school environment (Reportagem 1, 2008; Wellington, 2009).

One important feature that the student has developed is that he has always invited somebody else to share his technical knowledge developed in computer graphics. For instance, he supported a post graduate student from LSI to learn VRML and build a 3DVE interface related to the Golden Material as we will see later on.

From a basic VRML introduction and reflection about computer graphics applications developed at his classroom, passing by hands-on interactions during his classroom schedule and in the students’ research time at school computers lab, as well as carrying out work across using and reusing a 3D virtual world code presented by author1, the 8th grade student improved his knowledge on contemporary technologies and transformed himself in protagonist in several learning/teaching situations. For instance, by merit, his artwork
led him to participate with other school students from an international education event called ‘I Seminário WEB Curriculum’ (2008). During this event the student could improve his writing and communication skills by writing a report about the 3D project he participated at school (Aprende Brasil, 2008). He also talked to the audience, demonstrating the technical skills he developed in real time.

The 8th grade level student shared his web-based knowledge with educational agents from São Paulo Municipal Secretary of Education. They did not know how to use VRML technology. So, the student and author1 developed a workshop of fifteen minutes discussing the technology and its pedagogic potential. At the end of the workshop the educational agents were satisfied with the presentation and congratulated both speakers by the work. Beyond that they asked further information about how to use technology and the possibility of disseminating that for the municipal school network.

During the workshop the student was the main protagonist. He explained to the agents why author1 developed that kind of work with students. Part of the student’s work is published (in Aprende Brasil, 2008; Wellington 2009):

Professor Jorge introduced this tool for all my classmates (...) He wishes that this tool can support the diverse curricular disciplines (...) to do the classes more enjoyable (...) a cool way of understanding math, arts, geography, history, Portuguese, English (...) he would like to show a bit of what computers can do (...) due to currently adolescents only want chatting (...). Student (in Aprende Brasil, 2008)

He also reported that he shared knowledge at home with his sister. He was attempting to do that by using pure VRML language but she found difficult. Then, later on, by suggestion of a researcher from the NATE-LSI, we downloaded the Internet Space Builder™ software (ISB, 2009). After that, he reported that she was more interested in developing digital knowledge in computer graphics.

As in the case study 2, with the knowledge sharing example between authors1 and 11 and other real world examples highlighted on this chapter, the computer graphics knowledge shared within the 8th grade student’s home environment have engaged the family in diverse interesting ways as the interaction model described in (Franco, 2001a).

Contemporary and advanced technologies have been designed in a way they can integrate easier than few years ago. They also have become affordable for ordinary people. These facts have brought about more possibilities for decreasing the problem of ‘digital divide’ anytime and anywhere. For instance, in the present days linking computers and TV features and concepts allows amplifying the possibilities of sharing, analyzing and creating visual information of excellent quality at low cost (Figure 4).

Back to the 8th grade level student’s work, due to the presence of researchers from the LSI at Ernani School environment, because the one-to-one learning model project, the student’s work was shared with them. So, at the end of 2008 author1 asked to the 8th grade student to support the development of one of the post graduate student, (author3)’s knowledge in VRML. She has worked as math educator in primary education and at that moment, she was doing a study for implementing the Golden Material in 3D.

The 8th grade student accepted the challenge. Then, we organize a workshop of 90 minutes within of the interactive style described in the methodology section, with the 8th grade student acting as protagonist to conduct the workshop and minor author1’s interventions. After that meeting, she returned once more to ESB School to enhance her VRML knowledge and reinforce her cycle of improving digital and computer graphics knowledge. In sequence we kept scaffolding her by e-mail Figure 5.
The result of the workshops for sharing digital knowledge with her can be considered successful. The collaborative efforts to support technical knowledge transference and her 3DVE Golden Material work developed worth it. A proof of the great value of the work is that her paper describing the work related to the virtual Golden Material and the learning of math concepts will be presented in a conference 2009 (Venâncio, Franco, Correa, Zuffo & Lopes, 2009).

This real world example of sharing and transferring knowledge can support the philosophical thoughts and practical work related to provide horizontal education to individuals (in Freire, 2004), inspire the building of democratic schools (Senge, 2002, b-c), including develop ones’ computational thinking skills (in Wing, 2006). These are individuals and society states possible to achieve if everyone will have lifelong opportunities of developing their knowledge and capabilities with respect to the concept of ‘development as freedom’ (in Sen, 2000) a concept that we discussed before during this section construction.

We are aware that there are much work for doing in terms of scaling to more individuals the achievements of ESB School learning environment and its community. Fortunately, the basic tools for keeping developing the work have been improved and blessed through meritocracy, which has increased the degree of educational interactivity with more varied types of media for teaching and learning (Lajoie & Nakamura, 2006).

That is the case of ESB School and community participation in the one-to-one learning model prototype project. The ESB participation has increased the number of computers at school and Internet access anytime and anywhere across...
installing wireless connection, bringing about involvement and support from human and technical knowledge of excellence, resulting in access to new projects and devices, and stimulating individuals and institutions collaborative and cooperative work.

Students and educators from the school have learned robotics principles through supporting the interactive experiments of prototypes of new learning devices and influencing their final design, as well as presenting the final industrial product to the public. For instance, students and educators form the ESB tested and showed a new product called “WE DO™” as protagonists on the educational event ‘O Brasil que Nós Queremos’ from Lego™, in August 2008 and ‘I Seminário Web Curriculum’, in September 2008. For participating in both events individuals designed an interactive visual narrative in which they were storytelling about some important places related to the city of São Paulo, and compared pictures referent to the Artwork of Tarsila do Amaral and Cândido Portinari with the real ESB School surrounding place Figure 6.

The collaborative work developed for participating in the diverse events resulted in a Lego™’s donation of 39 kits ‘WE DO™’ that can be shared and support diverse interactive learning situations at ESB School learning ecosystem.

The XO mobile computers have been used by educators and students in order to do research on the Internet (Lopes, 2007). It has also been applied as a common ground that has supported knowledge and empathy development among educators, students and families.

The idea has been to approximate the school actions from the families through students’ mediation. The strategy has been allowing students from one or two classes per weekend to take the mobile computers home and share digital knowledge with surrounding community. In general, the educational activities at home are developed using video, text and the diverse software installed on the equipment. It would be very useful if the XO capabilities were applied to the development of small scale simulations and scientific visualizations. Still, there is no Internet connection outside school, neither the XO mesh network is functioning. These are the challenges to be solved in a future project.

Some former students have come back to school and through a volunteer work support students from the school that are new monitors to develop their digital skills and organize the laptops logistic Figure 7.

By exchanging ideas with a former student that has kept supporting the laptop logistic organization we investigated and reflected about some solutions for decreasing management problems such as easier access to storage and recover data because of the sharing of the mobile computers has become difficult to find the files. The quantity of laptops available does not allow one-to-one computer paradigm all the time. It is about 900 students for sharing about 160 machines. On the other hand, having a powerful Internet connection, enough for supporting school network operations can be a solution for using a tool such as Google Docs™. By using Google docs™ we can have access to a spreadsheet not available in the software that originally came
in the XO. Google’s web solution can provide space for saving the information on-line, so it is possible individuals to store, publish and access information anytime and anywhere through using web/data warehousing (2009) and information visualization resources.

Another solution we have applied referent to use the web to story data since 2007, it is that we have developed the cultural practice of supporting students and educators developing and maintaining their own Blogs, through feeding the Blogs with curricular and entertaining information developed at classroom, school computers lab and home (Beatriz, 2009; Garrido, 2009; Marlene, 2009; Nunes, 2009, Simone, 2009; Wellington, 2009).

CONCLUSION

Through this empirical work supported by mediated learning experience (in Fonseca, 1998), qualitative research (2009) and participant observation (2009) we have addressed how to systematize and stimulate non expert individuals to develop interest by science and technology through integrating and interoperating them with arts, culture, sciences and education.

This work has followed expert researchers’ contribution to the understanding of the development and evolution of natural and complex systems using the combination among technology, sciences, culture and arts such as demonstrated in the essays modularity in arts (Jablan, 2005), modularity at boundary between the art and science (Buscalioni, Iglesia, Buscalioni & Dejoan, 2005), and modularity of mind and culture (Callebaut & Gutman, 2005), which is based on Fodor’s essay modularity of mind (Fodor wikipedia, 2009; Jerry Fodor on mental architecture, 2009; Modularity on mind, 2009; Visual modularity, 2009).

In order to demystify VR and digital technology “black box” problems to non-technical individuals, to reduce the “digital divide” and to improve individuals’ traditional and computers literacy, we have systematized and carried out collaborative, interdisciplinary and transdisciplinary work inside and outside the school environment.

For the context of this work development, contemporary and advanced technologies have been the answer for achieving a ‘common ground’ (Laurel, 1993). For both, a common ground for enhancing teaching/learning classroom experiences with support of the concept of the overlap

Figure 7. A former student using the XO laptop connected on the Internet. The former student did a workshop to novice (monitors).
of the fields of experience. And common ground for contributing to diffuse the art of stimulating ones’ cultural technology appropriation and educational changes within long term educational actions through engaging students, educators and surrounding community (citizens) in persistent spiral and incremental movements of developing and sharing knowledge through lifelong learning experiences (Franco, 2001; Franco & Lopes, 2005; Franco, Cruz & Lopes, 2006; Franco, Ficheman, Lopes, Ferreira, Santos, Ferreira, Santos &Moreno, 2008a; Pressman, 2006).

The school internal and external examples of using contemporary technologies to develop digital content have created relevant local references, including covered how to use e-learning as an appropriate supplement in many contexts, through relevant multi-aspect programs available and – “to an even greater extent than other learning – that the participants have considerable motivation” Illeris (2007, p.233). These actions have brought about sustainability to this work development and leading everyone engaged in this process to diverse cognitive and technical abilities enhancements. Among them cognitive abilities for understanding and using new and multiple alphabetization possibilities related to learning how to deal with digital/web-based information, visualization tools, which can contribute for achieving individuals’ digital fluency (Demo, 2008b; Demo, 2009; Franco, Cruz & Lopes; 2006).

This kind of work has also brought about creating several references of learning and teaching the diverse curriculum subjects within a balanced support related to the combination of arts, culture, sciences and technology (Franco, Cruz & Lopes, 2006; Popper, 2007) for improving individuals’ minds for the future as demonstrates Gardner’ investigation and reflections (2007).

His investigation and reflections have covered the interrelation among the disciplined mind that takes information, understands and evaluates it objectively within cognitive and reasoning processes; the synthesizing mind that receives and organizes ideas from diverse resources; the creative mind that acts based on the synthesized knowledge to solve problems and evoke innovative ways of thinking; the respectful mind covers the respect to the diversity among human beings; and the ethic mind address ones’ responsibility as workers and citizens beyond their own needs (Gardner, 2007).

We have observed that there are several ways for stimulating and developing writing, reading, researching and communicating skills from children to adults through using digital and interactive graphics tools. This work has provided individuals’ access and knowledge acquisition related to contemporary and advanced technologies for building 2D and 3D virtual environments plus improving teaching/learning activities. The strategy adopted has been based on creating learning situations in which individuals can reflect and share knowledge across using interactive technologies tools for enhancing their literacy skills.

We have also focused on improving individuals’ awareness about the possibilities of producing digital content of excellent quality making use of open standards, even without high-end machines and/or specific software. The experiments carried out have showed that technical and non-technical educators and students from diverse cultural backgrounds are able to interact with 3D interfaces and construct small-scale examples in real time adapting them to diverse pedagogical and informal contexts (Franco & Lopes, 2005d).

For achieving these goals within an easier way, we believe that educators should not have their cognitive and physical performances overloaded. Hence, such thought is reinforced in Lajoie & Nakamura (2006)'s research, which highlights the necessity of increasing the degree of educational interactivity with more varied types of media. Teaching and learning using computer graphics and multimedia tools requires more scaffolding of learners, more attention to assisting learners
self-regulation, and perhaps media that serves in a pedagogical manner through coaching, pedagogical agents, mobile devices, and realistic and imaginary environments that include virtual reality and even augmented reality dimensions (Ficheman, Saul, Assis, Correa, Franco, Tori & Lopes, 2008b; Lajoie & Nakamura, 2006; Na, Billinghurst, & Woo, 2008).

Conversely, educators have worked with too many children at once, as well as long periods of time in order to survive economically. It can be included on these concerns educators’ necessity of being up to date with society changes and education transformation needs such as the ones supported by the combination of contemporary advanced technologies and neuroscience (in IINN-ELS, 2009; Nicolelis, 2008).

Within a learning economy that currently points to individuals’ lifelong learning attitudes for adapting themselves to world changes such as move away from manufacturing to a services economy, with the emergence of the knowledge economy and the decline of many traditional institutions which has been requiring individuals to become more active in managing their lives as states John Field (2006) (in Wikipedia Lifelong Learning, 2009), policy makers should provide less overwhelming school environmental conditions to educators and students.

Accordingly to the real world examples described during this chapter, it seems that such positive policy makers’ action could influence the raising of sustainable and qualitative learning environments, as well as learning and teaching interactions, bringing about improvements on individuals’ knowledge and cognition development. These kinds of qualitative learning opportunities could reverse the current logic of more and more quantity of time that individuals have stayed at school. Perhaps, due to the current overwhelming situation to individuals’ mind and body, the great amount of time that ones have stayed at schools has not been transformed into ones’ knowledge development of quality.

Demo (2009b) reinforces the above criticism, when he reflects that increasing the quantity of individuals’ time at a school learning ecosystem has not resulted in better individuals’ learning achievements than before. He suggests less guided or passive learning and teaching practices that have been based on learning manuals designed for someone outside the local learning ecosystem. He also recommends that educators have their abilities of learning to learn enhanced in order to improve their minds for thinking deeper about the complexities that involves the act of learning and teaching. Within a scenario of good work conditions, it seems that educators would be able to learn how to use the contemporary and advanced technologies and tools available, and then stimulate and support individuals’ lifelong learning with effectiveness.

There is recognition that constant social changes and digital/web-based technologies are elements that have added a rich layer of complexity to learning environments. Then we infer that policy makers’ educational initiatives should improve and support intensive, high quality learning opportunities not only in schools, but also at home, parks, community centers, museums, and workplaces (Blikstein & Cavallo, 2002; Blikstein & Zuffo, 2003; Franco, Cruz & Lopes, 2006; Resnick, 2002; Nicolelis, 2008). For instance, the good results of the collaborative and cooperative work carried out between the primary and high education that have been presented on this chapter are other real world evidences that benefiting and improving children and other individuals’ knowledge and cognition development lifelong within high quality, interactive, and dynamic learning ecosystems worth it.

Within a cognitive society (Fonseca, 1998) using the synergy among psychology, neuropsychology and technology in schools as support of high quality on individuals’ education, in intensive way, keeps a challenge. Although, “even within the neuroscience understanding how the
brain work is still far from complete” (Harrison & Hood, 2008).

According to recognized learning concepts and projects (in Doman & Doman, 2007; Gardner, 1994) as well as the theory and practice carried out on this work, the synergy between neuroscience and education including its potential to support educators’ better educational actions can not be denied. For instance, neuropsychologists could support education through contributing in discussions related to the right type of learning ecosystem structure (best size of school, size of the class, level and type of extra help), modifications in the curriculum taught, thinking ways of using technology and accommodations such as computers, diaries, and so on (Harrison & Hood, 2008).

This chapter development has showed that is relevant to provide an educational policy that enables to broke the paradigm of passive education and transform it in an active learner’s centered and knowledge based approach (Bertoline & Laxer, 2006; Freire, 2004; NAC, 2005; Osberg, 1997; Resnick 2007). The research and practical examples have proved that is possible to achieve such goal through applying interactive computer graphics, information and visualization tools and techniques to support educational actions.

The educational actions we have highlighted during this work have supported ordinary users routinely tailor applications to their own use and use this power to invent new applications based on their understanding of their own domains. Users, with their deeper knowledge of their own knowledge domains can increasingly be important sources of new applications at the expense of generic systems programmers (with systems expertise but low domain expertise) (in Wikipedia Human-computer-interaction, 2009).

Due to this work good result, we believe that is relevant to keep learning actions based on dialogic human-to-human interactions with great influence from human computer interactions. However, with interactions stimulating citizens’ knowledge and cognition development within a scientific rigor (Freire, 2004), and with support of contemporary and advanced technologies. The idea is to sustain teaching and lifelong learning situations as well as the practice of science with the spirit of supporting citizens’ cognitive abilities and intelligence improvements, leading them to the state of enhanced wisdom (Flynn, 2007; Senge, Jaworski, Scharmer & Flowers, 2007).

Finally, enhancing individuals’ cognition, intelligence and technical skills development through sharing digital/web-based knowledge by using desktop virtual reality and information visualization techniques and tools within K-12 education, has proved to be relevant, and has the potential of supporting individuals’ spiral and incremental lifelong learning cycles that can impact on democratizing the society.

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REFERENCES


Milgran, P., & Colquhoun, H., Jr. (1999). A taxonomy of real and virtual world display integra-
Enhancing Individuals’ Cognition, Intelligence and Sharing Digital/Web-Based Knowledge


Murugesan, S. (2008). Web application development: Challenges and the role of Web engineer-


