

Evolution of Ecuadorian Educational Informatics: A Quarter of a Century Assisted by Computational Engineering

Evolución de la Informática Educativa Ecuatoriana: Un cuarto de siglo asistida por la Ingeniería Computacional

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ABSTRACT: Through a timeline, from 1998 and with intervals of 8 years, the Evolution of Educational Computing in Ecuador is revealed. It is then that, as an objective, the concepts of the Internet and university education at that time are ratified; using paid Microsoft programs and excluding Free Software. So much so, that multimedia tutorials are recognized as objective elements within user Computing. Therefore, as a result of the research and applying the qualitative method, starting with the period 1998-2006, the versions of Windows, the advance of the Internet and Google as a search engine are perceived. Apart from this, the beginning of Artificial Intelligence with high-level languages is outlined; muLISP case. Later, in 2007-2015, Natural Language Processing, Machine Translation and Linux are mentioned as bases for learning; revealing four distros applicable to higher education. Subsequently, between 2016-2024, the Semantic Web, online platforms with Artificial Intelligence and typographic quality are distinguished; Protégé case for ontological diagramming, Octave online for Exact Sciences and Overleaf for writing scientific article.

KEYWORDS: computing; education; engineering; history; technology.

RESUMEN: Mediante una línea de tiempo, desde 1998 y con intervalos de 8 años, se devela la Evolución de la Informática Educativa en Ecuador. Es entonces que, como objetivo, se ratifican los conceptos de Internet y la enseñanza universitaria en aquella época; utilizando programas pagados de Microsoft y excluyendo al Software Libre. Tanto cuanto, es así que se reconoce a los tutoriales multimedia como elementos objetivables dentro de la Informática de usuario. Por consiguiente, como resultado de la investigación y aplicando el método cualitativo, comenzando por el periodo 1998-2006, se percibe a las versiones de Windows, el avance de Internet y Google como buscador. Aparte de esto, se bosqueja el inicio de la Inteligencia Artificial con lenguajes de alto nivel; caso de muLISP. Más tarde, para 2007-2015], se menciona al Procesamiento del Lenguaje Natural, la Traducción Automática y a Linux como bases del aprendizaje; revelando cuatro distros aplicables a la educación superior. Posteriormente, entre 2016-2024], se distingue a la Web Semántica, las plataformas en línea con Inteligencia Artificial y la calidad tipográfica; caso Protégé para la diagramación ontológica, Octave online para las Ciencias Exactas y Overleaf para la redacción de artículos científicos.

PALABRAS CLAVE: informática; educación; ingeniería; historia; tecnología.

In 1879, practically, the modern era appeared. Since it shows the world with the light bulb and thus its manager, [Thomas Alva Edison], projects the beginning of the new century. Programming, 90 years later, in 1969 and with the auspices of the National Aeronautics and Space Administration (NASA), the emergence of the Internet. Then, briefly, it can be understood as "...a communication system that integrates computer networks in an indeterminate number and allows the exchange of all types of data; case of text, image and video" (Dhar et al., 2022, p. 6).

In addition to email and Chat, at the end of the previous century, the World Wide Web was an everyday occurrence. Virtuality even caused the context of social paradigms to change. Since then, we have dedicated ourselves to knowing the unknown and today, users are accustomed to looking at all types of information on the Internet; from showbiz to sports. But actually, we don't know how Artificial Intelligence (AI) works and the hidden things that Internet has inside. Therefore, it cannot be conceptualized in its entirety (Ayers et al., 2023; Wagner & Ertl-Wagner, 2024; Wang et al., 2023).

Technically, at a global level, the Internet had its peak in the 90s. However, quite late, it arrived in this country almost at the end of the previous millennium and it was thus that, in the interval 1998-2000, its benefits began to be known. However, when its overcrowding allowed, it had to be connected using a telephone line, an internal modem and its creaking notice as a connection warning. In terms of software, Internet Explorer (IE) was taking its first steps and the North American company America OnLine (AOL) was the queen of Intelligent Information Search on the Web; with Netscape as a browser and AOL Instant

Messenger as a Chat manager. Likewise, the Google search engine was born and Windows 98 was at its peak; the 2000 version was a precursor to the banking and business system. Unfortunately, free programs were totally unknown in this country and, therefore, Linux was an ignored technological paradigm.

The same thing happened on the academic subject. Since Ecuadorian university centers were in their infancy; above all, in terms of the concepts of the computational universe that was coming. He even made mistakes in basic notions of Computer Engineering terms. Likewise, economically, the cost of peripherals made their acquisition impossible. Since the purchase of PC (Personal Computer) devices was the weakness of most households; lacking cutting-edge technology. However, the exponential growth of users created the boom of cyber salons as flourishing businesses. The same ones that palpitated with the currency exchange; sucretization to dollarization in the government of Jamil Mahuad Witt in 1999.

However, "...from that moment, in higher education centers, the Internet went from being a tool dedicated to research to a dedicated leisure instrument for any age group; especially in young people between [12;18] years old" (Wang et al., 2021, p. 17); existing, voices of protest against the dependence on online games. In this way, the World Wide Web became entertainment and in return, for some professionals, it was the means to update their knowledge; case of teachers.

Thus, by presenting these mishaps and raising awareness, the National Polytechnic School (EPN) gave positive points of view in the interest of technological progress; much more, being a precursor to the creation of virtual communities. It

was then that, for this purpose, it was called “The megaproject of millennial globalization” and it is here, when a diversity of tools was applied to raise student awareness about the fruits of the network; the academic in first position.

Based on this, newspapers and magazines echoed the human-machine interaction. So much so, that the marketing of software tutorial packs began to boom; case of “Juanito's alphabet” (1996) and “Amazonas: A dream” (1997). Reiterating that, in those years, the Internet was an educational tool and to which advantages were attributed; also disadvantages, in the case of the nascent gaming.

Development

1998-2006: Computer Engineering and its relationship with the Internet

Around the first years of the new millennium, due to lack of knowledge in Ecuador, the Internet was conceptualized, only, as an interconnected and decentralized set of communication. Uselessly, in order for the student to learn new topics, irrelevant topics were touched on; case of the protocol for direct communication between TCP/IP (Transmission Control Protocol/Internet Protocol) networks. Adding that, in the subject “Generational history of computing”, the evolution of IT was made known and in this, there was a delay in teaching staff; case of the syllabus that was around 25-30 years old, e.g. Origins of ARPANET (Advanced Research Projects Agency Network).

What's more, the expectation was diminishing thanks to the disastrous knowledge of the pioneering Web protocol. Since there was even confusion between the most basic terms of Engineering; case of the PHP (Hypertext Pre-

Processor) programming language with HTML (HyperText Markup Language); as for the e-mail and Chat environments, these managers were studied as a subject; case Hotmail and MSN Messenger.

But in the following period, 2000-2002, knowledge in this nation improved somewhat. Since distance university centers began teaching refresher courses and Information and Communication Technologies (ICT), as a novelty, were among the most requested topics. Then, the Universidad Nacional Abierta y a Distancia (UNAD), originally from Colombia, was the precursor. The same one, which offered diplomas for continuing education and at that time, “...the most accepted areas of study were Technological Education Sciences (59%), Social Sciences (22%), Engineering Sciences (9%), Exact Sciences (7%) and others (3%)” (Wong-Ayoub et al., 2022, p. 62). However, as a contradiction, “...only 27% of those enrolled in the academic improvement courses completed the curriculum. The remaining percentage was allocated to desertion due to lack of commitment to their institution” (De Bortoli Cassiani et al., 2022, p. 7).

Then, based on the latest and falling into the same mistake as always, outdated topics were once again encountered. Such that, opting for the new Windows XP, the teaching of the Post Office Protocol (POP), Internet Message Access Protocol (IMAP) and Simple Mail Transfer Protocol (SMTP) was proposed. Obviously, these were useless topics for the sake of future Computer Engineers; due to its irrelevance in the transmission of knowledge. It even got to the point that, in an Ecuadorian university category «E», the process for downloading files, through FTP (File Transfer Protocol) and P2P (Peer to Peer), was

taught as a subject; having Napster as your tool.

However, in Ecuadorian Universities belonging to Category «A», in the case of the Pontificia Universidad Católica de Ecuador (PUCE), current topics aimed at telephone communication were taken up; case of Voice Over Internet Protocol (VoIP), Internet Protocol TV (IPTV) and electronic newsletters with the Network News Transport Protocol (NNTP). Without forgetting, Teletype Network (Telnet) as remote access to external machines.

Next, moving forward in time, by government decree and through the Ministerio de Educación y Cultura (MEC), at the end of 2004, the study of Free Software was revealed. At which time, the global boom of the Linux operating system was able to reach the Ecuadorian classroom universe. Unfortunately, due to lack of teacher training and total ignorance, it was not considered. However, it was resumed in 2006 with the Government's proposal; in the person of Rafael Correa Delgado and his projection towards free services for the culturalization of the population.

After that, the Universidad San Francisco de Quito (USFQ) was delegated to launch the reliable Debian GNU/Linux distribution and consequently, "...in mid-2006, free Software was ushered in the business world; something, which was rejected by the corporate community. Since ignorance in installation, operation and maintenance made things difficult" (Battaglia et al., 2022. p. 103); from that moment on, the country went backwards. Consequently, in the following months, the company International Business Machines (IBM), together with Microsoft, reveals the commercialization of the Windows structure as "Savior of the Homeland"; but without taking into account the licenses.

Changing the subject, naming instant messaging as a software application and in that period of 8 years, without a competitor, the king of Chat communication was Windows Live Messenger. So much so that, together with Hotmail as a star product, it was the benchmark for the computer monopoly by the multinational Microsoft Corporation; owned by Bill Gates. Therefore, said application served for direct communication between peers, friends and contacts; likewise, to share multimedia material. Which, a little later, gave a prelude to the operation of mobile phones; Nokia case.

Regarding the social aspect, in that period of time, it was possible to corroborate that the number of users in Ecuador was around a quarter of a million. It was then that, at the end of 2006, the English consulting firm Price Waterhouse Coopers (PwC), applying stochastic mathematical models, made the first projection of the advance of virtual communications in this country; resulting, among others, in the advancement of video games. Apart from that, the Live Communications Server (LCS) distro was intended for multitasking connections; being considered as a Streaming repository.

At the same time, the AOL (America Online) portal gave a good account on the American continent; not to mention in Ecuador. Since, in those years, it was the monopolist of all types of computer topics in the new world and with Netscape as a browser, it imposed authority. But the MSN Explorer was rising and Altavista, with its search engine, was approaching the top; until the Google monopoly arrived. Emphasizing that the Altavista search engine was taking its first steps in terminological classification. More than anything, relying on parametric rules to decipher the syntax

in Intelligent Information Search on the Web; this step is considered the beginning of Artificial Intelligence (AI). So, in later years, it is irrefutable that Google took advantage with its search engine; highlighting semantic theory and shape recognition. Consequently, from the first five years of the present millennium, electronic businesses were booming; eBay case. But the most surprising thing was that social networks appeared, little by little; Facebook on the front line.

Regarding programming, as a process of Computer Engineering, at that time, it could only be achieved through code written in proprietary software; case of languages: Pascal, Prolog and muLISP. As for visual coding, Microsoft Visual Basic was pioneered and mathematical programming was coded using GeoGebra. Reiterating, almost all of the programs described were paid and therefore, in Ecuador, computer piracy was emerging as an industry. At the same time, online portals, intended for code compilation, did not exist.

2007-2015: Linux, Semantic Web and online portals

Rafael Correa Delgado, winning socialist candidate in the 2006 electoral elections, promoted teacher training and at that time, it was mandatory for teachers, in any area and level, to have, at least, an Official Master's degree. However, based on this mandatory regulation, state organizations, such as the Consejo de Evaluación, Acreditación y Aseguramiento de la Calidad de la Educación Superior (CEAACES) and the Secretaría de Educación Superior, Ciencia, Tecnología e Innovación (SENESCYT), imposed the university teachers obtain a fourth level qualification.

But at that time, there was disagreement among every teaching professional. Since the refusal to resume postgraduate courses was emphatic and one of the reasons, surely the main one, was the advanced age of the Ecuadorian university professors (66 years). However, to improve educational institutions, the Ministerio de Gobierno (MG), together with the Ministerio de Relaciones Laborales (MRL), imposed early retirement; something that, socially, became chaos. However, somehow, the citizens endorsed it.

Likewise, international agreements were established with distance higher education centers; case of the Universidad Nacional de Educación a Distancia (UNED); located in Spain. Consequently, said study center came in favor of the teacher development and updating plan with Official Master's degrees in various areas. What's more, given the doctoral boom of 2007, scholarships were promoted. The same, which were established in the Ley Orgánica de Educación Superior (LOES) and regulated by the Instituto Ecuatoriano de Crédito Educativo (IECE).

Unfortunately, like everything in Ecuador, corruption in the aforementioned institution was evident. Since, the direct beneficiaries, for face-to-face studies in the US and Europe, were the relatives and friends of the politicians in power. For this reason, formal complaints, for bribery, reached the Defensoría del Pueblo and in the Asamblea Nacional Constituyente, there were many questions for non-compliance with the item intended for scholarship recipients; according to the written press, they had to be assisted by their families to alleviate their expenses in foreign nations.

Noting that, upon completing their studies, they launched new topics to be taught in Engineering; Computer Science as a ribbon. For example, the universe of Free Software framed in Berkeley Software Distribution (BSD) distros. Based on this, as a prototype, the Escuela Politécnica Nacional (EPN) launched the course called: «Linux and BSD: Freedom free in two steps». It is here that the benefits of the free programs were made known and among the attendees was the technical staff of Banco Pichincha (BP).

Consequently, referring to the new topic to be taught, it was presented at the national level; especially, in Ecuadorian university centers. Obviously, the most prestigious ones took the lead; for its computing infrastructure, cutting-edge technology and teaching immersed in doctoral degrees around the world. Going to the negative side, being novel in copy and paste, it was exposed in the new curricular framework of the Computer Engineering degree. With this, the name change occurred; case of «Computer Systems Engineering» to «Information and Communication Technologies Engineering». In a way, this caused a great impact on the student society. Since these denominations, apparently new, would carry prestige to get a better job in the future.

Regarding the study topics, modern content was proposed; case of teaching the Linux operating system. Choosing, for computer networks to Slackware, structured programming to Fedora and manipulation of Web services to CentOS. The outdated theme was abandoned and the dynamics of the nascent Web 2.0 was the projected image. Apart from that, Object Oriented Programming (OOP) was allocated to the queen

distro; Gentoo.

Consequently, the structured programming was recapitulated based on the most decisive points; from input instructions to graphs. For this, projecting didactics and pedagogy, the C++ language was applied; immersed in Linux for free. Since the GNU Compiler Collection (GCC) performed the compilation without problem and for Object Oriented Programming (OOP) JAVA was chosen; being an efficient language (Bodirsky, 2008; Moorey & Biase, 2020; Lin et al., 2021).

Therefore, "...objects, classes, and relationships were easy to encode. Since, the visual aids, together with examples, served to understand that new programming paradigm" (Nwokoro et al., 2021, p. 6). Even at that time, the Internet provided a sublime learning model through Webinars and they were so new that they were recommended for the achievement of a new academic culture. In addition to this, the Escuela Politécnica Nacional (EPN) supported research in other higher study centers; case of the Universidad de Otavalo (UO).

Next, the Universidad Técnica de Ambato (UTA), in the subject called «Artificial Intelligence», began teaching with the muLISP code and this, being a formal language, was directed, clearly, at the establishment of the elementary principles of Semantic Web; case of the Linguistic Corpus. At the same time, updating the teaching staff on the topic of Natural Language Processing (NLP) was difficult to achieve; since, there was ridicule when the topic to be studied was indicated. Since, the idea that the PLN studied the characteristics of the language to understand the functioning of search engines had to be explained; DuckDuckGo case and its polysemous semantics.

Likewise, speaking of the Semantic Web, we began with its definition. Indicating that, "Since the mid-90s, it has been considered a novel space on the topic of Artificial Intelligence (AI) and in this, semantic descriptors help to develop portals that contain Language Technology" (Guizzardi, 2020, p. 188). Thus, "...the Semantic Web is the part of Artificial Intelligence (AI) that investigates computational mechanisms to facilitate the interrelation between man and machine; all the time, which allows for more fluid communication" (Balbi et al., 2022, p. 3).

So much so that a person who is a participant in a dialogue combines words to form sentences and know meanings. Obviously, this method describes representations understandable to human beings and provides versatility to everyday tasks; in order to maintain the new Web 2.0. Based on this, several Ecuadorian teachers, having obtained the Diploma de Estudios Avanzados (DEA) and being the predecessor to the Doctoral Thesis, chose to renew didactic compendiums of the Engineering in Information and Communication Technologies curriculum. What's more, for some students, this served as a Trabajo de Fin de Grado (TFG) and at the beginning of 2015, it was proposed to carry out their professional internships in companies in the sector; one of them, International Business Machines (IBM). Therefore, being a North American multinational, it gave the green light to research projects in search of professional excellence; above all, giving way to work on ontological Web portals, Protégé case.

However, the user's needs for coding, validation and testing were also studied; due to its advantages, the software pack from the same firm was chosen. Since it had free access, it was

dedicated to the development of models with its own ontological domain and as a result, a research project could be obtained at the Universidad Politécnica Salesiana (UPS); Quito extension. This being an automatic translator in three languages programmed in JavaScript. At the same time, a lexicon was attached, in API (Application Programming Interface) libraries, of Ecuadorian terms to translate one-person sentences. Naming Spanish (49.6 %), English (38.5 %) and Portuguese (11.9 %); likewise, to the Spanish corpus (53 %), English (37 %) and Portuguese (10 %).

Noting that this information provided advantages to the curriculum of Information and Communication Technology Engineering and based on the massive information contained in the World Wide Web, its normalization was feasible. Adding that the Semantic Web is considered in the management of online platforms. So much so, that, within the interval 2010-2012, the use of virtual technology to support teaching was set as a standard; e.g. Mathematical programming with Octave online.

2016-2024: Cloud technology as a virtual tool for university teaching

Taking advantage of online education, it was an obligation, in every educational center, to opt for virtuality; reason for free. Indicating that "...a virtual platform, with Web support, has a simple and practical interface. Apart from that, it is ideal for having clear information and the simplicity it contains is the initial step to achieving collaborative work" (Eynon & Malmberg, 2021, p. 573).

Specifying that, at the Universidad Técnica Luis Vargas Torres de Esmeraldas (UTELVT),

being an Ecuadorian center of higher education category «E», at the beginning of 2016, the accreditation of university courses was attempted. For this, a laudable way was to opt for the so-called «Endorsement and Improvement Courses»; inducing trainers to begin readjusting the teacher's knowledge. But, unfortunately, putting this task into practice was extremely complicated; due to the poverty of physical infrastructure and the reluctance to learn on the part of the attendees.

Obviously, being a current topic, it began with learning about portals at the user level. Emphasizing the ease, operation and integration of ICT with the services provided to teachers. Likewise, simple Website concepts were made available and through examples, the practicality of the resources offered by the Google portal was explained; Forms case.

Regarding innovation, years ago in Ecuador and as a result of the doctoral boom, it was an obligation to carry out scientific research. However, at that time, there was a deficit in terms of production. However, in compliance with SENESCYT ordinances and in the middle of the last decade, the typographic process of scientific writing began using the «LaTeX» composition system.

Evidently, taking advantage of the studies of Ecuadorian professionals graduated abroad and emphasizing this composition system, teaching refresher courses for continuing education were taught at the Universidad Católica de Santiago de Guayaquil (UCSG). Consequently, being a prestigious educational center, it had first-class computing infrastructure and from that moment, the computer rooms were made available; for the convenience of attendees, in the LaTeX topic, the

Overleaf portal was chosen. That is to say, due to its ease and free use, this Website provided noble panels for writing, compiling and displaying plain text; apart from PDF compilation and collaborative learning. Next, with the syllabus presented and responding to the functional scheme, in this course scope metrics were applied and through diversified matrices, conclusive spaces were identified in the achievement of the planned competencies.

Then, the creation of Websites framed in Civil Engineering was proposed to the students; on the subject of roads, bridges and structural works in the building sector. Therefore, when applying virtual tools, there was a choice between two online portals: Wix and Calaméo; these, being friendly, helped in resolving doubts. Since the links, accompanying documentation and multimedia were easy to insert. For this reason, attendees were provided with resources for the development of collaborative tasks. Thus fulfilling the thought that "...a portal is a content center that provides the identification of processes to satisfy the user's needs" (Kim et al., 2022, p. 4). More specifically, with the help of the data service methodology, collaborative work was chosen and this is where the students gave opinions in achieving a joint task; the online conversation was a neuralgic point for its achievement. Even camaraderie was obtained with the contribution of ideas in a fused manner and group organization was a lightening factor; building a Blog as support.

Reasonably, as a social experiment and based on autonomous learning, groupness was valued; this was done without restricting leadership. For this reason, the councilors of Higher Education in Ecuador have proposed ICT as an academic advance; thus giving a push to

university academic excellence.

Conclusions

The slow progress of the Internet in Ecuador is not surprising and because of this, when undertaking this journey, we have summarized the most important sections of the Evolution of Educational Computing in Ecuador; without making the backwardness of some educational centers in this country seem plausible. However, the quarter of a century, projected as a timeline, proposed the influence of Computer Engineering within academic society. So much so that, in very few Ecuadorian universities and to a certain extent, there still exists the so-called technological illiteracy; obviously, this thought is ambiguous. Above all, with the help that the Internet provides to Higher Education and in this, the student universe gains ground; as the first canon of the pedagogical implementation of the new millennium. Since, the fact that Windows continues to reign demonstrates the ineffectiveness of third world education. However, it is easy to notice the poverty of concepts and agendas presented 25 years ago. However,

Consequently, in those years, the academic preparation of higher education students was low and we can clearly see that, with the passage of time, Ecuador has raised the level. But this depends on the teachers and more than anything, on the student; opting for free software tools with GNU/Linux distros obtained for free. At the same time, the main mistake, when the digital world appeared in Ecuador, was not putting emphasis on technological preparation. To do this, help yourself with innovative tools that promote appropriate didactics and that the student foresees, within a reasonable timeline,

acceptance; in this, teaching has a lot to do with it. Since there will always be rejection and ignorance with current issues. However, the procedure of updating, through multimedia platforms, is fair and necessary, in order not to have low quality at the educational level. The reason for this is that youth must adapt to changes quickly and not do so for the sake of novelty; since the future work environment will miss your professionalism.

Therefore, "We must take advantage of the fact that students have a mobile phone at hand. Such that ubiquitous teaching reduces costs, supports collaborative work, and its skills are projected into the future" (Louhichi et al., 2021, p. 53). As long as the rejection does not come from the paradigms of its misuse and poorly done virtual work; this will be an important point to abandon outdated environments. Considering that Ecuador must look to the future and not be tied to the past. To do this, special Linux distributions for education, such as Skolelinux, should be considered. The same one, which contains a variety of gaming applications. But the one that deserves emphasis is Edubuntu. Since it is a distribution intended for university students and includes applications that promote scientific research; case of Sagemath (Mathematical Sciences), McStas (Physical Sciences) and Chemtool (Chemical Sciences). Fortunately, students' interest in updating themselves and eradicating digital illiteracy are preponderant factors. Because of this, Free Software should be the starting point for the incorporation of ICTs in the university world and for student society to advance technologically. Much more so when collaborative work supports and includes virtual tools.

Finally, it is plausible to futurize the idea that Computational Engineering leads to success. So that it becomes a point of survival and enhances new knowledge; both educational and business. However, the impact that ICTs have within Ecuador is commendable and there is still a long way to go. Then, for this to be fulfilled, we must contribute ideas, generate collaborative work and absorb experiences from the best Universities on the planet; this, at least, as hope.

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Conflict of interests

The authors declare that there is no conflict of interest.

Authors' contribution

Williams Basantes-Valverde: Investigation and Project Management.

Katherine Tixi-Gallegos: Supervision.

Norma Allauca-Sandoval: Revision.