Alternatives and Reasons for using free software acquisition in the teaching practice of engineering

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Abstract

We are currently living during an educational modernization, which is reflected in the Vanguard Educational Models. Higher Education Institutions (HEI) propose a massive incorporation of Information Technology and Communication (ICT). They are intended to be used in all degree programs and especially in the classroom teaching. For this reason this proposal outlines and describes alternatives and reasons for using freely distributed and acquired software available for use in teaching and promotion of learning engineering in Mexico.

Based on the requirement of not only encouraging the widespread use of ICT, but also do so ethically and honestly in the teaching practice. It has been decided to promote the use of such tools. Considering the cost factor of proprietary software, if you do not have the financial resources it becomes difficult to legally acquire and thus motivates practices that contradict the ethical codes of professional performance.

Keywords: Free Software, Open Source Software, Teaching, Learning, Engineering.

Introduction

There exists within institutional initiatives an educational model of the National Polytechnic Institute which incorporates Informatics and Communication Technologies (ICT) in academic work in all levels of the institution's technologies, promoting the use of software in the classroom and teaching support, resulting in significant learning in students. With respect to the proposed educational model (ME) of the National Polytechnic Institute, it is noted that the IPN should be distinguished because their services are of the highest quality and meet the challenge of creating more educational opportunities for young people, focusing in six key objectives:

1. Centered Learning.
2. Flexibility and focus on the student
3. Integration of scientific, technological and humanistic
4. Internationalization and Multiculturalism
5. Autonomy of learning
6. Renewed conception of the link between the theoretical and the practical

Development

Focusing on ICT in the field of teaching, the use of software is becoming increasingly widespread. In the universities, and in particular in the subjects of engineering science and applied technology taught in the engineering curriculum, programs are frequently used that perform various calculations and represent functions. However, prices for licenses to use these these tools may limit its use in institutions and more so in the pupils. (A New Educational Model for IPN 2003)

Free software acquisition has claimed great importance at this time and more and more people using it. A few years ago perhaps this type of software was limited to computer fans. Today many have heard of or even used programs like *Firefox* or *Opera* web browsers etc. According to the definition presented by Rodriguez RM 2011.; a program is free software if the user has the following freedoms or rights:

1. The freedom to run the program, for any purpose.
2. The freedom to study the way the program works, and adapt it to your needs
3. The freedom to redistribute copies.
4. The freedom to improve the program and release the improvements to others, so that all the user community benefits.

There are several licenses that ensure the distribution of free software programs are maintained as such, the most common being the GPL. A program which licenses restrict the right to study, modify or redistribute the program are called proprietary software, the latter being by definition one in which a user has limited their ability to use, modify or redistribute it, and most of the time the license has a cost (RM Stallman. 2004).

As the ME of the IPN already mentioned, there is a call for new tools to achieve the six objectives listed above and for the use of different free software packages which allow the realization of these objectives in a simple, ethical and economical way for students and institutions. In this context the use of Free Software Applications, Software acquisition and free open source programs can decisively assist the pedagogical renewal that is included in the adaptation to the six key objectives listed above. Students will have available (for free and from home) the same tools as the teacher. This will make it much easier to engage in an active and creative (which is nothing little) teaching-learning subject process. And if at the same time we consider within a holistic focus, and thus integral in every respect, that as teachers not only convey scientific knowledge, technological skills and

knowledge, but also take care to carry out ethical and honesty-teaching practices. In this respect we would not only teach the students to work ethically in theory, but also in practice.

Atributes

With respect to the former considering the use of free software, additional features should also be mentioned:

Economic attributes Proprietary software tools or licenses must be purchased for use. For example, many college teachers use mathematical software for symbolic calculus (CAS) which needless to say are worth mentioning for the purpose of this investigation. These programs have a cost, and it is unlikely that a college or high school student can afford to pay for them if they intend to work with them at home. Recalling the saying that sums up the GNU ethics: "Free software is a matter of liberty, not price" (L. Bayon, JM Grau, JA Otero, MM Ruiz, PM Suárez 2011).

Legal attributes. A prerogative to use free software acquisition in teaching, is that we can legally distribute copies of the program to students. Using free programs aviods having to work with illegal copies. The free program license quintessentially authorizes us free distribution "If you employ software without autonomy to distribute copies, sooner or later you will be faced with a moral bind when a comrade tells you: The program that you have would be helpful to me. Can you give me a copy? "(Ibid).

Scientists attribute. A strong correlation between the use of free software and the Scientific Method is perceived. Indeed, in science the review of results is essential by other scientists thereby giving new results. Essentially the same is true in the world of free software. One can take the program from another user, change it, renew it, improve it, optimize it, and also use it as a basis to expand a new program or other application.

Training Features. When students are trained with specific bases in certain specific programs, there is a downside where the programs with the passage of time become archaic since they are constantly being upgraded. In addition, training students with this type of software is independent of a particular technology. The aim, therefore, is training based on fundamentals and not applications.

Philosophical attributes. If we start with the foundation that engineering education is not only to transfer a series of knowledge and technical skills or practices, but also seek to move positive social values, it is clear that the use of such software contributes to this purpose. Using free software programs in the classroom promotes values such as equality of opportunity, freedom, knowledge sharing, creativity, solidarity, and respect for the law. "A program that is free software may not perhaps be technically superior, but it will always be ethically superior "(Ibid).

It is crucial to understand that the concept of free software is not just talking about free software: free software can be sold if desired (and often there is someone interested in paying for it). In this sense, free software can also become "commercial software" and, in fact, part of the business model of some companies (eg, distribution of GNU / Linux like RedHat or SuSE) focuses on the sale of free software . Although those who purchase software should be aware that (due to the third freedom) they may redistribute it when they want and as they want, for example without asking for money in return without someone's permission.

It is also useful to distinguish free software from other concepts such as freeware (free software, but without freedom of study or modification) or shareware (software that can be evaluated for free but for a while to use or has limited features). On a practical level, we associate the concept of free software to "open source software" or "open source" (open source), since the only distinction is the approach that those who use it want to convey, which is much more pragmatic.

From the point of view of Ethics

In accordance to the dictionary of the Royal Academy of the Spanish language, Ethics is:

- The segment of philosophy concerning morality and the duties of man.
- The set of moral standards that protect human behavior.

It should be considered that ethics is the discipline that deals with the moral assessment of human acts, in addition to a set of moral principles and rules that governing human activities.

Ethics provides the theoretical and practical to use freedom well. According to Quispe-Otazu (2007) "No one can live well with only desire." We need to be clear about what it is to live well and then implement it. Good intentions are not enough.

Ethics is not to tastes, opinions or desires. It is not the same to behave the same in one way or another. It is an important part of the life of a man. Therefore, ethics is involved in the various issues affecting each of the human professions.

Hence, there is great importance to defining rules of behavior that guide correct actions.

Moreover computing is currently one of the areas of greatest cultural influence to such a degree that it has achieved to some extent influence our behaviors and the way we feel a part of society.

In this vein, and in context with the subject we can say that part of the problems linked to information and communication technologies can be due to:

- Internet Fraud.
- The problem of software and intellectual property: illegal copies of software, software failures.
- Data storage and invasion of privacy.

Piracy is best defined in the context as the sale and distribution of illegal copies of software. It is an evil that afflicts the global economy severely. Unfortunately this phenomenon is deeply rooted in developing economies, where there are cultural, legislative and economic factors that prevent this from happening. According to the Business Software Alliance (BSA by its acronym in English), the global average of pirated software installed in 2003 was 36%, representing a loss of $ 29 billion for the information technology industry. This rate is even higher in developing economies (Rodriguez AG, Glass Baron SB 2005).

Normally efforts around combating piracy focused on the formation of robust laws for the protection of intellectual work, as well as the development and implementation of mechanisms to ensure compliance. Additionally the most active agencies in the fight against piracy, such as BSA, have unions that are formed by the same companies that develop commercial software, who do not consider the promotion of free

software as a viable option. Occasionally, some marketing efforts focus on promoting ethical values, but is contrary to the expectations and give opposite results (ibid.)

It can , in a sense, be argued that the main reasons for piracy are those related to socio-economic factors of the regions. The lack of purchasing power, as well as having the need to remain competitive, prompts people to change their moral standards to justify a practice that is incorrect. Piracy campaigns have little effectiveness for its punitive nature, rather it is preventative. Note that for an effective campaign, one must not attack the causes and consequences of the problem. Thus, efforts for a more proactive and appropriate approach should focus on creating an entire organizational culture in schools, which mainly relate to us as engineering teachers. Generating schemes to make applications more accessible to end users, as well as the strengthening of values, are things that our country sorely needs. Among these values we can offer alternatives that during the early years and the first courses free software procurement, distribution, and use is encouraged, seeking indirectly to impact companies that sell proprietary software at lower prices to the general public. This creates fair competition and of course these facts occur in a market that will remain dominated by the law of supply and demand.

Sometimes due to the lack of indications by the coordination of courses in some schools, teachers do not change the tools that have been using since they graduated university. So sometimes they are "married to" or enchanted by a trademark of a particular software and hardly opt for something that is freely distributed unless there is carried out a reform to amend this act- software available to all students. Including the use of free software in plans and curricula would help a lot for this purpose.

In addition, you must provide the means necessary for centers of investigation, but even more to the centers of technological development which within its purposes are the development of free software. In this way to some extent the problem of illegal copies will be resolved and every nation that drives these initiatives will in some way be dependent on others regarding their IT development and at the same time cease to be identified as a country where corruption and impunity prevails in these crimes.

Similarly, in the creation and / or renovation of the plans and programs of study in engineering, the inclusion of subjects made expressly for a particular use of proprietary software should be avoided as far as possible, which happened in the past since the existence of freely

distributed software packages was null and even the variety of proprietary software for a specific topic in engineering practice was very limited. But now, except for some very specific activities, there are various free and commercial programs for teaching different engineering topics.

For these facts and to help find alternatives for engineering education using computer packages within everyone's reach, within the next segment free software will be presented with a short description of its origin and use according to their specific purposes.

Some alternatives

Software for free distribution in engineering education.

wxMaxima

According to Rodríguez Galván (2007), Maxima is a program whose purpose is to carry out both symbolic and numeric mathematical calculations. It is able to manipulate and matrix algebraic expressions, derived and integrated functions, and perform various types of graphics etc.

Its original name was Macsyma (MAC's Symbolic Manipulation System), where MAC, Machine Aided Cognition, was the name of the Laboratory for Computer Science at the Massachusetts Institute of Technology (MIT). During the initial phase of the project, Macsyma was developed in these laboratories in 1969 with funding from several U.S. government agencies (National Aeronautics and Space Administration, Office of Naval Research, U.S. Department of Energy and U.S. Air Force). The concept and the internal organization of the program is based on the thesis that Joel Moses developed at MIT on symbolic integration. According to Marvin Minsky, the director of this thesis aimed to automate Macsyma symbolic mathematical manipulations performed in order to understand the ability of computers to act intelligently. The year 1982 is key. MIT transferred a copy of the program to Symbolics Macsyma Inc. for economic exploitation, making their own code and another for the Department of Energy. This copy came to be known as DOE Macsyma. In 1992 the retail version of Macsyma was acquired by a company called Macsyma Inc, and the program would lose steam gradually before the market presence of other similar programs like Maple or Mathematica, both inspired originally by the Macsyma program. But there were two parallel stories. From 1982 until his death in 2001,

William Schelter of the University of Texas had a version of this program adapted to the standard Common Lisp based on DOE Macsyma, which is already known to differentiate with the name Maxima from the commercial version. Currently, the project is being maintained by a group of developers originating from various countries, assisted and helped by many others interested in Maxima. Since Max will be released under the GNU-GPL, so the source code and manuals are freely available through the project website http://maxima.sourceforge.net

Octave, Python and Ruby

A screenplay or script is a series of commands that are passed to an interpreter to be executed. They do not meet the definition of a program because they are not executable by themselves. A program communicates directly with the operating system while a script is done by an interpreter that in turn sends commands to the operating system. The most popular scripting languages are, in the case of general purpose languages, Java, Python and Ruby. Java's popularity is due to its nature of business and is very easy to manage, while Python and Ruby are free software of equal or better quality but without advertising. Python is a language based on the consistency that offers high productivity and versatility. Ruby is one of the newer languages, its popularity is increasing thanks to the Ruby on Rails application development-oriented websites. There is a wide variety of scripting languages oriented for mathematics. Matlab, Maple, Mathematica, Scilab, Octave, Euler, O-Matrix, R or S are scripting languages. The best known are Matlab, Mathematica and Maple. (Hernandez A. D. A. 2007).

Psim

According to Bargalló P. R.; Morón RJ Sust i Rossello J. (2009) PSIM is a simulation tool for electrical and computer electronics. The programming is simple and intuitive, as is done by means of a graphical interface that lets you draw diagrams of the circuits to be simulated, having a bar that besides elements includes generators and charges, all necessary to control elements (devices for measurement, control and estimation etc.). The company that markets Psim is Powersim, http://www.powersimtech.com/, where you can download a free version, but which is limited in

its capabilities. Powersim is dedicated to the development of tools for simulation and design of products such as power supplies, motor drives, power conversion and control systems. The idea is to increase customer efficiency and productivity, to reduce cost, and the time-to-market of new products.

FEMM

Finite Element Method Magnetics (FEMM) is a very versatile free software tool which can perform the following tasks:

- Analysis 2D (3D axisymmetric systems)
- Analysis magnetostatic, eddy current, electrostatic, DC and AC driving.
- Thermal analysis in permanent and transitional arrangements.
- Includes the effects of saturation and laminate material.
- Working with permanent magnets.
- No limit on the number of items.
- Working in batches. Own programming language (LUA)
- Post-process with powerful calculating quantities of interest (par, equivalent impedance, Joule losses and magnetic, etc..).
- Availability of an Internet discussion forum to solve both problems to propose extensions of the program.
- Link with other programs: MATLAB / OCTAVE, EXCEL, OptiY (ibid.)

OptiY

This software has a free version available, which is limited in the number of variables to optimize and is ideal for science, engineering and economy students and budding researchers. It is a multidisciplinary analysis and

optimization program that incorporates the latest techniques and the most advanced optimization strategies. It has the advantage that optimization models are considered as a black box with inputs and outputs. This allows the binding to simulation packages like MATLAB, FEMM, ANSYS and others. It allows a sensitivity analysis, trace curves and solution maps and data mining. The adaptation to a particular environment simulation is performed by the appropriate interfaces.

It helps automate part of the solution of the problems of engineering and science in the design and development process. The key therefore is to transform a problem into a series of tasks of analysis and optimization. Free versions of OptiY can be obtained from http://www.optiy.de.

PowerWorld Simulator

Its demo version, which is for educational purposes only, is freely distributed on the web. You can perform all the studies available in the original version but in systems of up to 12 buses or nodes. This is sufficient for purposes of learning and understanding in the simulation of power systems in case of power flow studies, short circuit fault and other related studies. It even displays the exchange of power between two areas of an interconnected system. This version can be obtained at the URL PowerWorld Corporation (http://www.powerworld.com).

PSCAD

The PSCAD stands for Power System, CAD means Computer Aided Design. This tool, based on the introduction of a wiring diagram, simulates its behavior and analyzes results, all in a graphical environment for easy and intuitive operation. It consequently integrated variables representing tools, gauges, control elements and models of electrical components. One of the strengths of PSCAD is its library of components that direct use in an electrical diagram of the most common components in power systems. This program is available free of charge on your student version with limited features, as well as manuals and application examples from the website: http: \ \ www.pscad.com.

Scilab

Scilab is a program that was developed for the solution of control systems, signal processing and other mathematical applications, and the philosophy of free software covered under the GPL license. Scilab was created to make numerical calculations but also offers the possibility to make some symbolic calculations as derivatives of polynomial and rational functions. It has hundreds of mathematical functions and the ability to integrate programs in major languages (Fortran, Java, C and C + +). Integration can be in two ways: for example, a program in Fortran Scilab use or vice versa. Scilab was made to be an open system where the user can define new data types and operations between them. Scilab comes with many tools: 2-D and 3-D animation, linear algebra, sparse matrices, polynomials and rational functions, Simulation: programs for solving systems of differential equations (explicit and implicit), Xcos: simulator diagrams block hybrid dynamical systems, classical control, robust LMI optimization, differentiable and nondifferentiable optimization, signal processing, graphs and networks, parallel Scilab using PVM, Stats, Creating GUIs, Interface with symbolic computation (Maple, MuPAD) Interface with TCL / TK. This program is available in https://www.scilab.org/.

Geogebra

It is a dynamic geometry system. Constructions can be made of points, vectors, segments, lines and conic sections as functions and then can be changed dynamically. It is a mathematical program developed by M. Hohenwarter and an international team of developers at the University of Salzburg and Atlantic University, Florida. The program includes geometry, algebra and calculus and is intended to be used in all levels of education. It is a free program developed under a Creative Commons license; You can copy, distribute and transmit the program for non-commercial purposes. It is a quality program that has won several international awards, such as the European Academic Software Award in 2002, the International Free Software Award in 2005, and the Tech Awards in Silicon Valley in 2009.

Gantt project

It is very complete when planning a project, allowing an absolute display of the same tool. Everything is under control of the program, from the

resources in personnel matters and holidays, to dividing the project into a tree of tasks and assigning each appropriate resources. Gantt project allows for dependencies of interrelated tasks, ie, a task cannot start until you complete the previous one. It exports the task on a JPG, PNG, PDF and HTML image. The program can be installed to be used from Windows, Linux, Mac or other systems, in which a version of the Java runtime environment (language platform on which it is developed) is available. The program is under GNU license which basically indicates that the program can run, copied, modified and distributed free of charge by all users, while maintaining the type of license itself, ie, that their copies or modifications not can be distributed prohibiting reproduction. It can be downloaded http://prdownloads.sourceforge.net/ganttproject/ganttproject-2.0.2.exe?downloadp.

Conclusions

There is little or no knowledge of the existence of free software for some members of the engineering faculty. With the recommendations they make to use commercial software for projects, tasks or duties, this leads students to acquire illegal copies and with it a flood of further problems including the growth of an illegal business for the demand of such products on the black market which can be avoided by offering alternatives such as those detailed in this paper.

Awareness of the how such an unlawful attitude could have on students, teachers cannot be guardians of the interests of a company nor promoters of malpractice, allowing students to conduct illegal activities such as copying software without the authors consent only to deliver homework. At the other extreme is the case of free software par excellence, which allows it to be installed on as many computers as possible and promotes teachers to share with students, with all the support of the law, the tools (perhaps accompanied by teaching materials), to use at home those same used in the working environment of the classroom. Moreover, by using a tool in the classroom that is freely licensed, teachers have additional advantages in the planning and development of the subject, derived from have a guarantee that the programs will be installed and used by students in their own homes and also can be installed and used by the teacher in as many computers as needed.

The free software license allows and indeed encourages the use of several tools at once which are complementary and able to interact with each other. Each have their strengths and weaknesses. Although the teacher will side with one of them, she can always offer students the possibility of enriching experience with others, to solve the same problem from different perspectives and to satiate the curiosity of those that have major concerns. Similarly this way of behaving (attitude) naturally permeates among the students, so it is necessary to promote good practice since the arrival of the new generation so that through the teachers there a veritable moral renewal that is so necessary in everyday life and not just in speeches.

It would also be very helpful, as mentioned in the research, that in the plans and engineering curricula subjects are not made expressly for the use of any specific commercial software , unless it gives competitive advantages to both students and the university because most of the time , rather than benefit the school, a technological dependence might be avoided by developing alternatives that could even come from the same research work in universities seeking therefore better technological development created in nations that do not have it.

Currently in first world economies, such as in Germany, UK, Spain France, there are programs that motivate both research and the development of free software for both the development of their websites, create pages and support teaching at major universities in these nations. In the case of Latin America, both Brazil and Colombia and Venezuela are betting heavily towards the use of free software.

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