

# *Educative use of simulators in free software for the education of the physics in the engineering programs*

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*Abstract* - See of the necessity that the education has of incorporating the technologies of the information and the communication TICs to the teaching-learning processes. The investigation group TICA: Technology, Investigation and science applied since for several years come developing projects of incorporation of TICs in the education.

One of these projects is the one that today is presented in this document and whose purpose has been to identify solutions of educational software: simulation systems, virtual educational environments, educational software, among the most outstanding. But with an added value that you/they should be developed standard first floor of free software that you/they guarantee their use, modification and execution without restrictions for the final user or the institution that he/she wants to use them.

Around this topic you beginning an investigation from the year 2007, which begin with the topic of pretenders developed in free software for physics, when going developing this topic was being identified all kinds of solutions of free software, making with it that in a parallel way you began to inventory these solutions.

Today per today they have been identified near 2500 solutions of free software among pretenders, learning environments and other solutions with educational use.

And seeing this great volume you design a repository of pretenders in free software which has been denominated Open Simulates Source. This portal has as purpose to index all development of free educational software.

*Keywords-component; e-learning and learning colaboratives environment, simulation, educational software, open source educational software.*

## I. INTRODUCTION

The free software has penetrated today per today all the areas of the knowledge and of the development of the society, its organization and development model has allowed him to be positioned like a true solution to the necessities and computer of the current world.

But little it is known about systems of free software for educational use, and it becomes necessary to study the evolution and the state of development of the free educational software.

Their main objective was to identify and to document the state of development of the topic in the current society and to transform this study in a repository or bank of digital resources initially conceived for pretenders that it stores the results of this study and it publishes them in the Internet by means of a place Web. And later on it includes all the types of educational software.

Defined this purpose the project gave beginning to the study on the topic and along this document the obtained results are exposed, categorizing and analyzing the low results certain variable ones.

It is presented studies by type of identified software, for type of language in that you/they were developed, for license type with the one that are distributed, for the operating system platform in that you/they are available and for the case of the physics that is the central topic for area of knowledge inside the physics.

This study takes to the reader from all over the world for projects from the local thing, projects in Colombia and going by United States, Canada, Argentina, Peru, Europe (Spain, Portugal, France, Italy, Germany, England) Asia (Japan, China, Taiwan) among the countries with identified projects. They were identified in total 50 projects of pretenders in free software, with a total of 2097 pretenders for physics. And as regards learning environments around 6, and another type of educational software to the moment d this article has been identified but of 15 projects.

Many of these projects of which an individual synthesis is made, for professors of the different universities is led, others for software communities sponsored by universities. And for the international community of free software.

## 1.1. Problem of Investigation

1. Do pretenders exist for educational use in the teaching-learning of the physics, developed in free software?
2. of existing these resources which the effect of the educational use of pretenders is developed in free software in the learning of the students of the class of Physics in programs of university pregrado?.

## 1.2. Objectives

To design, to develop and to evaluate, an on-line repository that contains material, documentation, sources and executable of simulation systems for physics laboratories developed in free software "open source" and a methodology pedagogic pilot to prove their use and implementation like educational material for pregrado courses.

### Specific objectives

- To identify the simulation systems for physics laboratories developed in free software, their characteristics, functionality, technical information and the code source and the executable ones.
- To define and to design the guide of implementation of a pretender like educational material in a real course.
- To design and to develop in tools of free software the repository on-line pilot that will contain the simulation systems for physics laboratories, their documentation, sources and executable.
- To validate in a course the use of one of the pretenders and the education methodology or defined pedagogic model to implement them in a course.
- To establish the diagnosis in front of the validation of the use of the pretenders and to identify the strengths, weaknesses and opportunities of improvement that allow to use in a more efficient way this type of materials in the classroom.

## 1.3. Justification.

When developing this work a database it is believed with the simulation resources to support processes of teaching-learning of the physics and developed low environments of free software, which is published through Internet in order to putting it to disposition of the educational community.

On the other hand the project after developing this informative source and of resources it allows to identify a

methodology for the use of these resources in order to validate and to diagnose the educational use of the same ones inside a real course of this area of the knowledge, settling down and identifying with it the strengths, weaknesses and opportunities of improvement that allow to make use in a more efficient way this type of materials in the classroom and to diagnose the disposition of the student community toward this type of resources.

Contributing with this to that you/they begin this type of works in the other areas of the knowledge, an advantage of this work is that as what is looked for it is free software, when being able to centralize the information of these solutions and the access to the same ones in a single place you can provide to the educational institutions of resources that improve the education and that they truly give solution to the social necessities that the education today per today it should satisfy.

When identifying the strengths, weaknesses and opportunities of improvement that the software pretenders get rid it contributes to the technological development of the education, besides reducing costs in the use of audiovisual resources for the educational ones, being that these resources are more economic than the use of specialized technical material of laboratory and in some cases they are gratuitous.

Also, you offers an opportunity to the educational community at all the levels to be added to the use of this innovative technology like strategy for the learning, breaking the paradigm of the use of traditional strategies.

## 2. IDENTIFICATION AND CLASSIFICATION OF THE SOFTWARE

The project left of two questions:

1. Does software exist (pretenders, operating systems, educational software, learning environments) for educational use in the teaching-learning of the physics, developed in free software?
2. Of existing these resources which it is the use and diffusion of the same ones inside the community?.

With this couple of queries beginning was given to the field work that consisted on to identify software of the mentioned characteristics and to document it in order to including them in a repository or bank of pretenders.

One works during long eleven months making searches in Internet, sending letters to universities and communities of free software in order to obtain sources of information on the topic.

Parallel to this work and linking an investigating youth, technologist in systems you beginning the design and development of the on-line repository that I eat in the initial project approached single pretenders you denominates Open source he/she Simulates.

## 4. PHASES OF DEVELOPMENT OF THE INVESTIGATION

For effects of organization of the information he/she was defined a categorization system, which I include the type language in the one that you development each software, the license type with which is distributed and for the physics the category to which belongs according to the thematic one.

These variables were used to classify the results.

### 3. ADVANTAGES OF THE USE OF FREE SOFTWARE

The derived advantages of using solutions (operating systems and programs) based on free software they are:

**Under cost.** It is the first motivation for the use of the free software the cost of acquisition of the software it can already be free or of very reduced cost.

**Total independence of any private sector or company.** This supposes not to be bound to the market conditions imposed by software companies that sometimes show monopoly situations.

**Security and privacy.** When having the code source, the internal operation will be known and they will be and they will correct the possible errors, shortcomings and holes of security. At the moment Linux is immune before the immense majority of virus computer specialist that affects to the systems almost exclusively Windows.

**Adaptability.** The modifications and corrections of possible errors are carried out in an immediate way. This way, the applications are in continuous improvement and evolution process.

**Quality.** The free software, to the domain being publishes, it is being continually used and purified by a great number of developers and users of the same one that add and they demand constantly new functionalities.

**Regarding the standards.** The use of free software and open systems facilitate the interoperability among different organizations.

**Predistribution.** Any change and improvement that it is introduced in programs lower it licenses free it should be included in later versions and added to the code source. The technological development is this way continuous and dynamic.

**There is not legal restriction of use.** There is not limitation in the number of licenses neither of copies inside the organization like it happens with the software he/she doesn't liberate where the payment settles down in function of users' number, size of the organization, etc.

**Continuity.** The right of any user is guaranteed to continue the development.

**Easiness.** They can begin new projects based on the code of a free program or to adapt it without necessity of requesting authorization in this respect.

### 4.1. Identification phase and documentation of software resources

In this phase you looks for and I identify the solutions of educational software of type pretender for physics laboratories developed in free software in the national and international environment. This stage or phase include that to each opposing solution and that it finds been developed in the last ten years he/she was identified their characteristics, functionality, technical information, the code source and the executable ones insofar as possible, or in their defect the place Web from which you can use.

These programs were selected previous analysis of the characteristics that should complete in terms of the topic that approach, the one which you development with base in the contents that become trained in the Physical I of the pregrado programs. Those which in particular should give computer treatment of the simulation of phenomena related with the topics.

At the same time, in this phase a revision of works was made on the didactic problem of the experimental learning of the Physics [1] and [2], with object of identifying the most important pedagogic aspects that it should complete a simulation system for the educational use (theoretical contents, virtual experiences [3], tasks of development of dexterities, activities have more than enough learning [4], methodologies for development are practiced supported in pretenders [5])

### 4.2. design phase and development of the repository of the software resources

Previous to the design and development you selects as tool of development of the repository the PHP 5. as language programming base for those additional functions that are required, and you uses for their design Web the environment Mambo or Joomla whose use license is LPG. As agent of databases MySQL, as servant Apache Web. To configure the place web cpanel use it was made.

In this phase use of the software engineering was made to design the solution Web that would serve as repository of the pretenders and its respective documentation. I design that include the integration inside the place Web a system administration of educational contents that is MOODLE for the project, since it is free software, compatible with MySQL, PHP and Apache.

Parallel to the design you proceeded to develop the solution Web and it is necessary to begin tests of the gathered pretenders, to validate their functionality and the access to the resources that each element of the repository provides.

### 4.3. Phase of identification of the educational methodology and the design of implementation guides.

This phase required him to be defined the educational methodology to use to validate the educational use of physics pretenders in a real course. You proceeded to define the population of the course, the level, and the educational modality.

Selected as group pilot the course of Physical I of the Technology in Civil Works from the Ability of Studies to Distance of the UPTC.

At the same time that you identifies this educational methodology of use, you elaborates the guide of implementation of the pretender like educational material in a real course, which should help the students to carry out in a practical way a series of experiences of Physics, using the pretender selected in order to validating the strengths, weaknesses and opportunities of improvement that allow to use in a more efficient way this type of materials in the superior education the classroom [6].

Of equal he/she is formed they defined in this phase the indicators that allow to diagnose the educational use of the pretenders and the impact of the same ones in the education.

#### 4.4 application phase

Once the educational methodology has been identified, they have been designed the implementation guide and one had available the pretenders and the system of administration of educational contents you proceeded to it incorporates these resources to the educational practice, as complementary tool in the programming of practical works of physics, in the first engineering course in programs of pregrade of superior education [7].

And you proceeds to validate the use of pretenders. You also looks for to analyze the influence of these computer applications, and of the complementary didactic materials, in the learning process that the students carry out through the laboratory experiences, evaluating the reports of the work sessions carried out with the software.

#### 4.5. Phase of I diagnose

This final phase as its name indicates it I look for to establish the diagnosis in front of the validation of the use of the pretenders in the education and to identify the strengths, weaknesses and opportunities of improvement that allow to use in a more efficient way this type of materials in the classroom.

### 5. IT FOCUSES METHODOLOGICAL

It is good to specify that the methodological focus of this investigation is to describe the current situation of the topic, identifying the projects and developments of pretenders, making this investigation of descriptive type, having as primordial purpose to establish the state of development of the topic educational use of pretenders developed in free software for physics. To have presents this consideration it is fundamental to understand the results that they are presented fruit of this investigation.

As one of the objective it is to create a bank of information that identifies and present the developments of software type pretender based on free software, he/she gave place to establish the characteristics of the analysis of information in front of the topic and defining the general mark for the investigation. The characteristics that have been defined for the identification of data, their treatment and analysis are:

Software type: characteristic centered under the types of free software or the conditions of a software to be denominated free software. Taking as concept that at least fulfills one of the freedoms that have been defined in the concept of free software.

It licenses under which the software is distributed, it became necessary to identify this characteristic for this way to present in a more solid way the results.

Programming language, this characteristic looks for to settle down which languages are those that lead the development of pretenders in free software.

Platform or Operating system, this characteristic looks for to settle down in that operating systems the identified software can be used

Area of the knowledge, although the project is defined for single physics, this science has multiple areas for its development, the fundamental areas of the physics were identified and you looks for to associate each result to one of these areas.

TABLE 1. VARIABLES OF INVESTIGATION

| CHARACTERISTIC       | VARIABLE                                      |
|----------------------|---|
| Software type        | Web o Applet                                  |
|                      | Application instalable                        |
|                      | Operating System                              |
|                      | Directory                                     |
|                      | Development Solution                          |
|                      | Learning Managent System                      |
| Programming language | C++   |
|                      | Java  |
|                      | Python  |
|                      | Perl  |
|                      | Swish / Flash                                 |
| Platform             | GNU/Linux                                     |
|                      | UNIX  |
|                      | Windows                                       |
|                      | Mac OS  |
| License type         | GNU GPL                                       |
|                      | Freeware                                      |
|                      | LGPL  |
|                      | Creative Commons                              |
|                      | Shareware                                     |
|                      | BSD. Berkeley Software Distribution) Licences |

### 6. ANALYSIS OF RESULTS.

For the process of documentation of the results the used instrument was a registration leaf, which you uses along the identification process and it allowed to analyze and to process the data obtained according to the necessities and objectives defined by the project.

In synthesis projects of educational software that are totally free software they are few, a good percentage of resources and projects identified in this study are partially since free software they don't fulfill the four freedoms required to be free software.

This work has allowed to establish three big categories of solutions of simulation software, of equal it forms as the physics it is a very wide science it became necessary to identify the area to which belongs each solution of identified simulation.

Finally this characterization of results taking as relating the existent types of free software and indexed in the numeral one 2 of this article and they are analyzed and they classify the results according to the types of licenses that belong to the free software.

It is important to recognize that you looks for to identify the language in which the solutions and identified projects were developed, being the language Java that of more use, followed by languages like C, C++ and Python among the most outstanding.

### 6.1. Identification of resources for software type.

This analysis allowed to determine the quantity and the percentage of pretenders for class of identified software, with the objective of knowing the tendency of the market in front of the software types.

TABLE 2: CLASSIFICATION PRETENDERS FOR TYPE OF SOFTWARE

| Software Type         | No. Projects | %    | No. Objets  | %    |
|-----------------------|--------------|------|-------------|------|
| Applet (Java /Flash)  | 22           | 44,0 | 2069        | 98,7 |
| Opetaring System      | 1            | 2,0  | 1           | 0,1  |
| Aplication Solution   | 15           | 30,0 | 15          | 0,7  |
| IDE                   | 5            | 10,0 | 5           | 0,2  |
| Directory             | 2            | 4,0  | 2           | 0,1  |
| LMS                   | 5            | 10,0 | 5           | 0,2  |
| <b>Total projects</b> | <b>50</b>    |      | <b>2097</b> |      |

Analyzing table 2 could settle down that the developments type Applet is the most common in the simulation in free software for physics. The cause of this result this in the portability of the applets, its easiness of being executed about the Internet, and the robustness for the mathematical handling of the languages used for these simulations is Java and Flash (Distributed the executable one gratuitously not the code source).

The Figure 1. Percentages of pretenders according to software type, it shows as the population of physics pretenders developed in software he/she gets rid they distribute according to the software type.

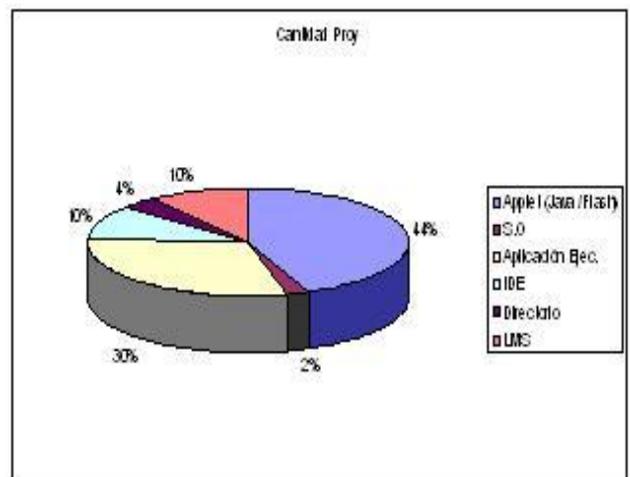


Figure 1. Percentages of pretenders according to software type

The pretenders identified type applet developed in language Java, allow to discharge the code source or binary and the execution files (. jar).

As regards applications executable type, it could settle down that they correspond in their great majority to applications to simulate graphic of high mathematical complexity.

Finally the environments of development type IDE for creation of simulations in free software is scarce but little by little they consolidate as the future of the pretenders in free software. In a numeral one later on are described with detail these solutions.

To level of directory Web or repositories of resources it was possible to identify two repositories of those more than 50 projects, these repositories are of type informative database.

And at level of operating systems of open code you identifies the operating system Ing-X that integrates the most robust and complex developments for simulation in their distribution. This project has its origins in the republic of the Argentina and it integrates more than 15 simulation solutions for multiple areas of the scientific knowledge.

### 6.2. Identification of resources according to the development language

Inside the investigation process and rising of the projects, to each project he/she is identified the programming language in which was developed, the object of this analysis it is to establish the tendency in programming languages for the development of pretenders and to identify the causes of their use.

TABLE 3: CLASSIFICATION PRETENDERS ACCORDING TO PROGRAMMING LANGUAGE

| Programming language | No. Projects | %    | No. Objets  | %    |
|----------------------|--------------|------|-------------|------|
| Java                 | 29           | 58,0 | 1880        | 89,7 |
| Python               | 6            | 12,0 | 7           | 0,3  |
| Flash                | 3            | 6,0  | 198         | 9,4  |
| C++                  | 10           | 20,0 | 10          | 0,5  |
| NA                   | 2            | 4,0  | 2           | 0,1  |
| <b>Total</b>         | <b>50</b>    |      | <b>2097</b> |      |

In a conclusive way this analysis hurtles that the language Java is the more used for the development of pretendes, followed by Flash, C++ and Python. This finishes language this being proven in the system SimPy = Simulation in Python, project that has created a solution based on this language to develop pretendes in free software, see you Figure 2 Percentages of pretendes according to programming language using.

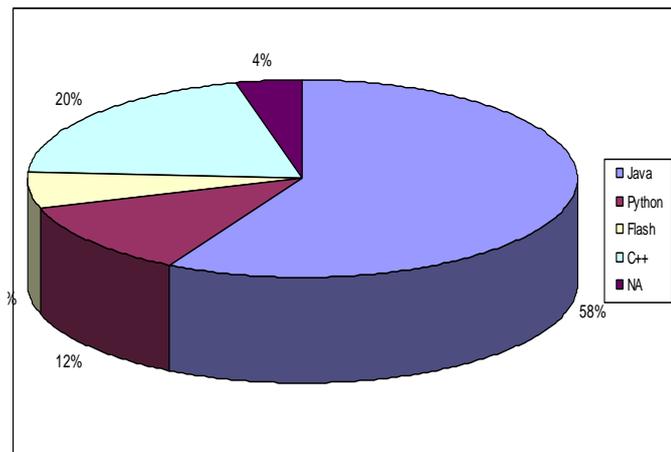


Figure 2 Percentages of pretendes according to programming language using

The reasons for those which the language Java is the more used in the development of pretendes for physics they are:

- Java is a language multiplatform that allows to develop from an independent way to the operating system the applications. Making completely portable and scalable all development in Java.
- Their packages and APIs for mathematical handling and graph in 2D AND 3D allow to integrate and to manage the complex operations and graphic that the physics requires to simulate the different events and study areas.
- Java is a language to modulate reutilizable that allows to create a development highly and then without many changes to translate it, reason that has made that in the market the pretendes type applet in java are available in multiple languages.

- On the other hand its robustness in advanced mathematical prosecution makes it very useful in the simulation topic in physics, the same as the packages of classes for handling of 2D and 3D and the graphic handling.
- On the other hand to the power to execute an applet on a navigator of Internet, he/she gives place to that their distribution and use you simple and work in practically all team of I compute.

Special case is the topic of pretendes developed in Flash, it is one of the systems of development of better graphic and very versatile prosecution when being integrated with the Internet, since these developments are guided the Web, contrary to alone Java it is possible to obtain in the great majority of the cases the executable one but not its code source, making it free in use but not in the other defined characteristics for the free software

The central difference of the developments in Java, C++ and Python in front of Flash this in that the developments under the first three languages offer the four established freedoms for the free software, while alone Flash grants the freedoms one and three, execution and distribution.

### 6.3. Identification of resources according to the type of distribution License

The object of including inside the characterization of the study this aspect was the one of identifying the tendency as regards licenses of the identified resources type pretender and the level of implementation of the commitments of the free software and according to the license of distribution of each resource or project.

The table 4 reflective the results of this study, when analyzing them one can do with clarity that the Freeware and knows to the software that is free as soon as I use and distribution not in permits to consent to the code source and to change it or to improve it leads for wide margin the results.

Leave with concern that in this topic the total freedoms of the free software should be approached and concerted in order to take advantage of the strengths of the development communities in the remarkable improvement of these resources.

TABLE 4: CLASSIFICATION PRETENDERS ACCORDING TO THE USO/DISTRIBUCIÓN LICENSES

| License type     | No. Projects | %    | No. Objets  | %    |
|------------------|--------------|------|-------------|------|
| GPL              | 16           | 32,7 | 120         | 5,7  |
| LGPL             | 1            | 2,0  | 1           | 0,0  |
| BSD              | 2            | 4,1  | 2           | 0,1  |
| Freeware         | 28           | 57,1 | 1867        | 89,0 |
| Creative Commons | 2            | 4,1  | 107         | 5,1  |
| <b>Total</b>     | <b>50</b>    |      | <b>2097</b> |      |

The analysis takes to conclude that the freeware in 57.1% is the form but common of to publish and to put to disposition of the I publish a software, and the disadvantage of the same one is that they don't fulfill the four freedoms settled down by the free software, leave equal it forms that the license LPG occupies the second place with 32.7%, see you the Figure 3. Percentages of pretenders according to type license with the one that is distributed.

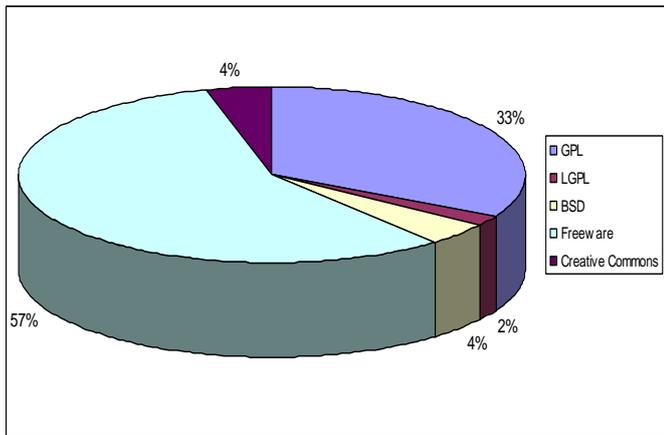


Figure 3 Percentages of pretenders according to type licenses with the one that is distributed

This takes to that thinks about the necessity to take place under oneself approach the form of transforming the freeware into license LPG to guarantee the 4 freedoms of the free software and potencialization the advantages that this development model offers.

#### 6.4. Identification of resources according to use platform

Necessarily to identify the platform or operating system on which the pretender can be used, it is fundamental. This assures the portability between one and another operating system.

TABLE 5: CLASSIFICATION PRETENDERS ACCORDING TO THE OPERATING SYSTEMS FOR THEIR USE

| Plataform       | No. Projects | %    | No. Objets  | %    |
|-----------------|--------------|------|-------------|------|
| GNU/Linux       | 8            | 16,0 | 8           | 0,4  |
| Windows         | 5            | 10,0 | 202         | 9,6  |
| Multiplataforma | 35           | 70,0 | 1885        | 89,9 |
| Mac OS          | 2            | 4,0  | 2           | 0,1  |
| <b>Total</b>    | <b>50</b>    |      | <b>2097</b> |      |

The results described in the table 5 in a conclusive way identify that the developments are in 70% multiplataforma assuring with it the use of the same point in GNU/Linux, like in Windows or even Mac OS. To see Figure 4. Percentages of

pretenders according to their readiness for Operating system.

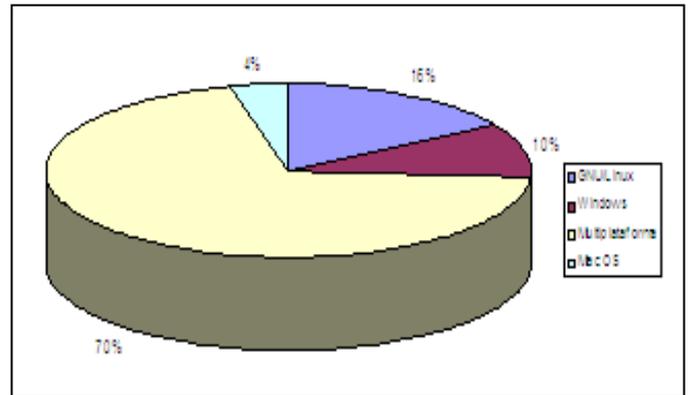


Figure 4 Percentages of pretenders according to their readiness for Operating system

This obeys to that the great majority of solutions is developed in java, and this language to be portable it allows that in a very simple way it can be used in multiple

The case of the operating systems GNU/Linux surprises to be so low, although when analyzing it with the fact of already belonging to the category multiplataforma it this being in GNU/Linux of for if.

## 7. CONCLUSIONS

### 7.1. Conclusions

In the work he/she intended to identify and to document the projects of educational software developed in free software by means of the development of an on-line repository, equally developed in free software.

It is of specifying that the results fruit of this stage of the project are satisfactory in quantity, you to identify around 2000 software solutions, each one documented and organized according to the application area.

Of this study you concludes that the educational software that you/they are hundred free percent is few hardly 42.4% in I number of identified projects and in I number of pretenders 11.4% of the total, situation that obeys the non identification of the authors with the models of licenciamiento of free software, situation that takes to conclude that in I present time the concept of free software under the principles that to this they not yet govern it they are clear for the development communities and the institutions.

Bigger effort is required on the part of the associations and foundations agents and promoters of the free software and the experts in the topic to clarify the concept.

On the other hand in their great majority these pretenders are personal initiatives and professors' of different institutions singular that moved by the desire of improving the education they have developed this type of resources and that for the necessity of the same ones they have been able to link to these initiatives to other colleagues.

It is required to lead in a more organized way and with approaches of quality of educational software and of the dynamics of systems this type of projects so that inside a community of developers a model of development of free educational software consolidates.

From the educational point of view several projects were identified that are very solid in the methodological and pedagogic that can be the courses to consolidate the educational use of pretenders inside the society.

## 7.2. Future works

Identified those more than 2000 software solutions developed in free software a very important future work would be given by the validation in educational terms of these resources and under the approaches of quality of the educational software. Investigation that would allow to have better elements when making use of these resources to the educational and educational organizations.

Of another part with the existence of integrated environments of development of free software should be carried out the analysis and study that it takes to define the methodology for the development of pretenders and free software using these systems and with their respective validation processes from the pedagogic thing, the instructional design and the theories of the learning that sustain the quality of these systems.

He/she thinks about the possibility to investigate this same topic enlarging it to other areas of the knowledge, since when developing this project it was possible to glimpse that there are pretenders for many other areas, but that of equal it forms they could be identified and by means of a repository to place them within reach of the community.

A later project to this he/she should take these pretenders and to validate them from approaches that measure the learning and their impact in the processes of development of knowledge.

## 8. GRATEFULNESS

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