Approach to professional practice from simulators and virtual laboratories

C J Peña, L Vargas and J C Murcia

Corporación Universitaria Minuto de Dios, Vicerrectoría Regional Bogotá Sur, Departamento de Investigaciones, Unidad de Ingenierías y Unidad de Ciencias empresariales, Calle 1 # 9-50, Bogotá – Colombia.

cjpena@uniminuto.edu

Abstract. The professional practice and student experimentation have undergone changes in the mode of the instruction processes, which has had an impact not only on the adaptation of business processes but also in the reorientation of academic dynamics around the use of simulators, due to the development of new learning technologies and their high influence in educational environments. Therefore, higher education institutions are responsible for designing complementary learning situations to the future professionals’ training of the disciplinary area through qualified practices. That is why, through this research and the use of mixed methods, the perception of students and teachers of the support that new technologies have been providing just as a teaching resource for the transfer of knowledge, boosting the experimental classroom and its implementation in the professional practice; Simulators and virtual reality have allowed the improvement of science as an active part of academic processes and business development. The results highlight the importance of continuing to work on the implementation and familiarization with these tools.

1. Introduction

New information and communication technologies (ICT) have allowed higher education institutions to implement differentiating technological tools in their teaching-learning environments. [1] Virtual laboratories represent a creative, modern and cheap option for universities. Not only non-face, but also face-to-face educations require these spaces within their training processes. Consequently, classes will accomplish two didactic objectives simultaneously: a) carry out practices related to the subject by expanding the availability of laboratories and b) training students in the use of ICT.

Engineering education, is one of the fields of greatest theoretical-practical development, seeks that engineers can gain the necessary skills by applying their knowledge in practical experiences, specifically in those situations that, due to their high costs, it is not possible to implement through a traditional laboratory, which generates a window for the implementation of virtual laboratories. The huge transformations that we experience today in highly changing professional contexts are typical of globalization. The prevailing paradigms on professional learning in universities indicate that in today's world the real question must be whether students receive at universities is according to the needs of the environment. Therefore, students can solve or tackle real problems in the future. Then is almost an obligation for future professionals and its preparation in this field not only a personal
commitment on the part of the student but also that the educational infrastructure should gradually foster its development. Implementation of these elements as a preface to the exercise and professional practice is essential for students. This incursion develop skills at the technological level in the various fields of application according to the basic training, which will allow not only a change in the teaching thought and pedagogical instruction, but will also provide different tools in students during the process of their professional practice. Those previous abilities associated with the globalization components they face during their first approach to the work life that will set an important guideline for their professional development.

Many academics considered that conventional or traditional classrooms, that means face-to-face education have been the only spaces where students can develop practices and do direct experimentation with reality, it is a space where their interactivity allows the student to observe what happens in their experiments, which help with the development of their cognitive abilities [2]. However, it must be consider that face-to-face method entails high costs of infrastructure investment, adaptation, support and that in some cases they carry great risks of not being able to achieve completely the learning objectives because it is not possible to do a certain amount of experimentation either. Most of the time it is due to the impossibility of accessing materials such as those that are considered dangerous, or due to the limited use times of these. However, the link between private companies and study institutes have managed in many of these cases to be able to solve, through sponsorship, the demand for their use and benefit different zones that expect results and advances in fields such as research.

A virtual laboratory or simulator is computer software that allows experimentation from a computer of different situations in almost any field of engineering, whereby manipulating different environments, variables, parameters, and input constants. As seen in figure 1 and figure 2 as an example of experimentation with these, both in software and hardware. It is allowed to run a model in which is usually based on mathematical algorithms to obtain output data. One of the advantages of this type of program is that it allows almost immediately obtaining mathematical, logical, and statistical results and data, which in face-to-face method would take a little longer to obtain. Other advantages are that a greater number of students can have simultaneous access to the experimental processes while improving the self-learning processes, as well as allowing the repetition of the experimental situations in a very short time and with fewer potential risks that could have reality; however, this practice does not replace real experimentation in any case.
2. Related Works (Literature)
For engineering education, throughout history, it has been evolving in the didactics used for the teaching-learning process, taking into account the dynamics of the markets and the inclusion of ICT in the various fields of engineering action. Likewise, the learning methods developed by new generations, which have grown with a greater link to technology and self-learning processes, require that educational institutions provide them with diverse and innovative tools for these processes.

As a consequence, the inclusion of tools such as LV and LR in the teaching of some of the topics of the subjects related to engineering programs have been increasingly nowadays, offering students different alternatives for facing problems on subjects as mathematics, physics, chemistry, robotics, electronics, programming, soil studies, among many other engineering applications. This innovation allows that the theoretical concepts acquired be used in such a way that future engineers not only keep the memorial exercise of theories but also can apply them through the development of laboratories.

For example in The University of Alicante (Spain), particularly for the teaching of robotics in which a virtual laboratory was designed, allows simulating the handling of a robot arm, and also the teleoperation of the equivalent real arm by several students through the Internet [3]. This practice generated as a result greater conservation and useful life of the arm by not executing erroneous commands that could damage it and also saving on Purchase of materials, time spent for practice and possibility of repetition of functions for clarity of the concepts used by students.

A similar application made at the Universidad Europea in Madrid, in which was used a remote laboratory based on internet for teaching control engineering: LABNET, assured the acceptance of the system by students. It dues to the experience acquired demonstrates that a remote experimentation environment is feasible and students adapt quickly to an educational setting that involves the use of remote laboratories [4].

On the other hand, a study with students of the IV semester of Electronic Engineering of the National University of Rosario (Argentina) in 2011 in relation to the use of the Remote Laboratory of Electronic Physics, evidenced the appropriation of this tool by the students. In addition to this, transcending the objectives of the study; meanwhile, the reports showed progress in the presentation of other tests that the students saw possible, resulting in a complementary use of the remote and traditional laboratories [5].

Talking about non-face-to-face engineering teaching, virtual and remote laboratories represented a significant role in theoretical-practical processes. For instance, in the study done at the University of Extremadura (Spain), whereby a simulator was developed for the study of hydraulic power networks, the students' found out that the user interface was easy to understand by most of students. Also, they considered better understanding the operation of hydraulic networks considering that many of them are not possible to develop in a traditional laboratory environment [6] (p. 66).

The available information on the internet related to applied cases of the use of virtual laboratories is quite robust. It allows us to infer that the application of these in engineering classrooms has generated a long history throughout history. Moreover they have become a tool of greater use in higher education institutions, which also leads to the presentation of various studies related to strategies for the development of virtual laboratories adapted to the needs of the courses, as well as others focused on the implementation of virtual laboratories of free access or licensed that acquire these institutions.

Another research done [7] at the University of the Coast (Colombia), the design of a model of a remote laboratory applied to the creation of microprocessor systems, in which fundamental stages such as the identification of requirements are established. The methodology for the project of the laboratory and its implementation, while [8] exposes in its research a compilation of outstanding resources on the web related to the area of Systems and Automation Engineering, categorizing them in automation and industrial instrumentation, architecture and computer networks, robotics, simulation and dynamics of systems, plants and software and other resources.

As mentioned [4], several projects have been deployed worldwide, some of them financed by the European Union, as CYBERLAB has culminated in the creation of a service provider for the integration of network laboratories. PEARL is a project focused on infrastructure development that
allows remote access to laboratory equipment and investigates its pedagogical impact to validate its development. MARVEL developed a mixed environment that combines remote and virtual laboratories on the website of the Spanish Committee Automatics. It presents a compilation of several virtual and/or remote laboratories related to the area of Systems Engineering such as robotics, computer vision, automation or automatic control (p. 19), which allows viewing a wide range of options for the implementation of this type of tools in engineering education.

The RV teacher [9] belonging to the National University of Colombia, in an interview as part of this research, argued that today many teachers are interested in knowing other teaching methods. He exposes some researches and among them the National Institute of Educational Technologies and Teacher Training (INTEF) of Spain, estimates that every year about 10,000 teachers seek training opportunities to acquire digital skills to be able to transfer these experiences to the students. There are currently technological advances by companies such as Hewlett-Packard-HP for Spanish classrooms such as some computers and monitors specially designed to convey this type of experience in educational environments. Another contribution is the improvement in the understanding of the curricular contents, remembering the knowledge in the short and long term and makes the students more attentive and cooperative, achieving a better personalization of the class.

The fact that direct work in a traditional laboratory is still the optimal method to train to learn in students should not be ruled out, noting that such work, complemented with practice in virtual laboratories, has a greater impact on the teaching-learning process. This is reflected in the study developed by [10], which concludes that the use of the simulator as a complement to the dictated topics helps the student to pose challenges and goals in the development of the practices; since the simulator there is always in capacity to show the final result and verification of the proposed workshop, while in practical work, the detection of the fault and the verification is not so immediate and effective. Likewise, it was shown that by working in a combined way the simulator and physical assemblies, the level of drop out of the subject by the students was reduced to 10%, associated with teamwork, due to the distribution of functions and activities among the participating students.

3. Theoretical framework
The simulation of processes has evolved in parallel with computers and electronic devices. In the past with the entrance of the first machines there was a computer program for each process; however, as these were improving and other elements such as graphic interfaces, audio, multimedia, the development of more complex algorithms, object-oriented programming and complementary programming languages such as Java, Dreamweaver, Flash, among others, it was then possible to create general purpose tools with which different processes of reality can be simulated.

Simulation is one of the most powerful tools available to decision makers, design and operation of a system regardless of its complexity. Nowadays engineers, designers, analysts, administrators, among other professions make use of this resource because it allows the study, analysis and evaluation of situations and phenomena that would not otherwise be possible to analyse in a short time [11]. In several of these cases, the use of pre-decision simulation tends to be a factor to be taken into account as a requirement because the risk of making a bad decision decreases.

Since a simulator and a virtual laboratory are based on mathematical models that run on computers, their configuration and commissioning are much simpler than the configuration and commissioning of real laboratories. Also, they have a much higher degree of robustness and security since there are no real devices that cannot cause problems in the environment [12], considering that the majority of these experimental cases arise in ideal scenarios free of affectations and external factors outside the experimentation presented in the real world.

In relation to this [13], they express the advantages and disadvantages that arise with the implementation of virtual laboratories. Emphasizing positive aspects such as a greater number of students experiencing asynchronously, with flexible schedules for their practice, and the possibility of experiencing freely until understanding the concepts in a clearer way, promoting self-learning environments, as well as breaking the space-time barriers in the use of traditional laboratories.
Despite all the advantages offered by new technologies, simulators and virtual laboratories, these can also have their disadvantages, as is the fact that to be successful the experimentation processes, prior training of both the teacher is required as of the student that allows the development of skills in their management. Another aspect is that the simulation needs many highly reliable input data, so the acquisition of this data can be very expensive in time and money and if you do not have control over it. The simulation can never compensate for the poor quality of the data input and its results will then be very different from what is necessary. Since the input data is wrong then the output data will also be wrong, or if the proposed model is not well described, the output will not be adjusted to reality, so that a bad model can lead to wrong decisions in reality [11].

In the LV there is also the risk that the student will be totally abstracted from reality and tend to behave like a simple spectator, so that the instructional design of the educational experiences, must contemplate that the activities in the LV are accompanied by guides instructions that allow the student to be an active part of the experimental process. They must contain clear learning goals that allow one or another way to assess the competence in the subject. Not everything should be simulable, some experiences must be done in the real world so as not to lose the complete vision of reality, which implies that it is the teacher who must determine and analyse the relevance of the issues that should be simulated and which not [two]. In addition to all previous information, we must add the fact that we must tend to break the resistance that may exist among teachers regarding the inclusion of ICTs in their classes. For that reason, it is necessary to change the thinking in teaching methodologies by the teacher, since Students leave the classroom and be supported by autonomous student practices as the main input to independent work [14-15], as well as the need for support staff for the resolution of aspects related to technical support, software development and installation.

Another aspect that has been opening up spaces in the field of experimentation is the simulation based on the WWW or online simulation, which are considered as an effective means for the distribution and unification of criteria regarding the simulation process. In which the simulation process progresses continuously and dynamically, obtaining the results of the simulated time in each period of sampling in the form of a continuous flow of numerical values or graphs evolving in a sustained way; however these types of simulators depend exclusively of being connected to the network all the time [16]. Therefore, you can limit its effectiveness and use to the presence of the connection, however one of its advantages is that you will not have to have powerful computer equipment or servers to its operation, which implies a considerable reduction in operating costs as well as allowing access to your information from any Place of the world.

Virtual tools can be found on the internet and can be classified in other denominations. As proposed [17] in: blogging, chat tools, charts & graphs, file sharing and mashups, microblogging, notebooks and notation tools, online office suite, Online presentation , personal web portals, photo editing / sharing, search engines, social bookmarking, social network, survey and polling tools, task and group management, video chat, video editing / sharing, website creation, wikis and finally group template page. Some of them are available for free to the teacher.

4. Approach and Methodological Design

This research is exploratory and a mixed methodology used, between interpretative and praxeological. From the interpretative point of view the hermeneutic that the different social actors make of their “reality”, this means studying it from people and emphasizing the process of understanding on the part of researchers to try to discover the meaning of their Actions. From the view of phenomenology that allows us to distinguish the form of things from how people think it is a reality [18].

4.1. Population and Sample

4.1.1. Target population of the study. Students of the Engineering Faculty from Minuto de Dios University Corporation of South branch of Bogotá, enrolled in the first semester of 2018 (380 students, which corresponds to 100% of the potential students), belonging to the Informatics Technology
programs, Electronics Technology, SR Management Technology, Logistics Technology, Network Technology and IT security. Like 35 teachers belonging to the different programs mentioned above.

4.1.2. Sample design. The sample design is probabilistic, in two stages, stratified in the first stage, the selection method is Simple Random Sampling (MAS) in the two stages. First sampling stage selection. They are selected by the program according to the different semesters obtained from each program. The stratification criteria considered is semester, for which six semesters and number of students registered for each semester were formed. In this first stage, 6 programs distributed in 20 semesters were selected. In the second stage of sampling, students over 18 were selected with a minimum of 20% of students per program.

4.1.3. Sample size. Total population 380 students, Total students surveyed, qualified (sample): 191
Total respondents who expressed and signed the consent to use data: 191.
For a total population of 380 and a margin of error of 5%, the sample should be 191 people.

4.1.4. Sample distribution. Regional South branch of Bogotá, “San Camilo headquarters”, disaggregation into six technology programs: IT, Electronics, Market Management, Network Security, Business Logistics.

4.2. Methodological Design
4.2.1. Sample frames. Registration of enrolled students given by the Regional Information System Coordination of Regional South branch of Bogotá.
Collection date: from May 28 to June 5, 2018.
The number of pollsters: 4 pollsters, 1 field supervisor.
The margin of error: the error is 5%, with a confidence level of 95%, and heterogeneity of 50% is assumed.
4.2.2. Collection technique. A virtual survey format, applied face-to-face in classrooms assistants.
4.2.3. Instruments for collecting information. The instruments in research in the semi-structured interview and surveys, to make a diagnosis of what is known by learning with augmented reality in both students and teachers. And what is marketed in the market on resources or virtual devices for learning, for this purpose, questionnaires are used, according to [19] “The questionnaire is a set of questions designed to generate the necessary data, in order to achieve the objectives of the research project”, This is why this instrument is chosen, to reach one of the objectives of the research, these instruments are chosen, to reach one of the objectives of the research.

5. Results
According to the information collected in the research through interviews with teachers and surveys of students from different academic engineering programs, it is evident that using virtual laboratories, simulators and virtual reality in the classroom, allow traveling and experimenting without leaving class. Students can meet, visit and study without leaving the place, enriching their learning in a fun and practical way, while removing economic and geographical barriers; some institutions of higher education, due to lack of spaces to rehearse or build, activities or workshops cannot be easily developed, so these pedagogical resources become an alternative to direct the classes and facilitate teaching. The usage of this technology allows they can implement for example laboratories, as mentioned throughout this article, recreating scenarios for the student to explore and interact with knowledge.

From the teaching perspective, it is expressed that these resources become an appropriate tool to create new educational environments, diversifying the options and allowing the teacher to meet the needs of each student without neglecting the group dynamics. Neuroeducation experts argue that this technology, due to its ability to create scenarios within the classroom, allows for more vivid and emotional experiences. That is why accessing digital resources can benefit the educational experience.
for both students and educators, although it is not an essential requirement to be a teacher at present, including the transformed learning in higher education institutions, which seek the preparation of its students within a digital environment to develop their disciplinary skills.

For the interviews, analysis categories were taken into account, such as: knowledge and interaction with simulation technology, virtual laboratories, and virtual reality, their use in education and devices such as VR, for the respective analysis.

On the other hand, intervention was made with the students of first semesters through surveys, whose categories to analyse were: emerging competencies, virtual laboratories, simulators and virtual reality in education, virtual spaces, in order to analyse the perception regarding, the use and relevance of these in class and the skills they have with this technology, so they were asked the following questions:

Figure 3. What is your level of knowledge about simulators and virtual reality technology in your laboratories or practices.

The answers to this question were: 42.9% basic, that means, that commercially recognize the devices and through internet consultations; 31.4% average, at some point they have identified programs or devices but without thoroughly exploring their operation; 11.4% very basic, only the specificity of what is worked on in some classes and nothing; more and 8.6% advanced, some students who have been interested in investigating this technology remain a very small population that knows it and 5.7% null (blue segment), do not recognize these neither experience nor by literary review, which represents little interest in this area. In the face of being a generation that has grown hand in hand with technology, they have little management and knowledge of these tools, they recognize it through online consultations and videos, they do not know that it can be used for their learning; they only identify it for use of training.

Therefore, it is important to relate the question about frequency in the use of virtual reality simulators and devices, with the answers on the level of knowledge to contrast them and verify if they have been curious to perform exploration with them beyond the technical review and documentary film.
According to the answers, it was found that 21.4% at least once they have used these resources, which may represent that they were once interested in knowing, but without generating greater impact that induces them to deepen this technology; 46.4% two to five times, which means that they are students who have used them occasionally for academic or entertainment use; 17.9% have used it 6 to 10 times, indicating that they are students who are interested in technology and finally 14.3% have used it more than 10 times become fans of technology and discovering new applications, making them research on new trends in versions of devices and software.

Finally, within the questions asked, the inquiry about hardware devices that students have frequently used and how they have been implemented in their classroom and laboratory processes is highlighted.

Virtual reality (VR) devices that you know or have used

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Virtual reality (VR) devices that you know or have used
It is identified that in 18% Samsung Gea VR is the most used for virtual glasses; 13% use Sony Play Station; 6% Oculus Rift; 5% Google Cardboard and 3% HTC Vive. The factors that are into account when selecting a device are costs and technical specifications of the same; for example: the peripherals Samsung Gea VR facilitate immersion with cell phones; Sony Playstation VR is for exclusive use on PS4 console, which makes it a game element and allows a high immersive experience for video game fans.

As evidenced by the VR regardless of the devices and software used, they are used for entertainment. According to survey results, students are unaware of the application of this technology in the academic subject; but it is important as a teacher to know what they handle. Students have digital skills, in this way the teacher characterizes the study groups, selects the virtual investment devices and software, as well as the preparation of the curricular contents for the implementation of laboratories in classes.

When consulting teachers about the use of resources in the classroom as simulators or virtual laboratories in cases such as laboratory practices in electronics, computer science, logistics processes among others, there is a clear trend towards the frequent use of these resources.

![Figure 6](image)

**Figure 6.** As a teacher he has made use of simulators and virtual reality devices in his laboratory practices in the last 6 months

The great majority affirm that they are very practical to be able to advance in the achievement of learning objectives or goals; most recurrent themes are for the development of Computational Algorithms, circuit simulation, computer network simulation, computer security, logistic models, study of physical and chemical phenomena, as well as study of the operation of systems and machines.

Both teachers and students were asked to evaluate their experience with the use of simulators, virtual reality elements and the implementation of virtual laboratories, and the vast majority as seen in Figure 7 expresses that their experience it was very satisfying.
6. Conclusions and future work

There are some elements to be considered in the implementation of virtual laboratories in the teaching-learning process of Engineering: for choosing or development should be based on aspects associated with resources, the installed capacity, the intentionality of the laboratory, the skills to be developed, the branch of knowledge, language, among many others that can generate both positive and negative results in the use of these tools. Therefore, the importance of constantly monitoring the impact that generates in students the implementation of virtual laboratories in the Engineering chairs.

It is important to highlight that Virtual Reality is in full evolution in the world [20] uses the immersion technique, where the user immerses himself through a viewfinder or other device to another reality or different space from the one he is in, being in a mode of "Teleportation", to interact with virtual elements in environments that can be laboratories, museums, universe among others; Virtual reality is a form of learning in which interacting with a computer, a virtual space is created where tasks are developed, test theories or live simulated experiences. This technology has two challenges to get into the academic and work environment, for example, the skills gap represents difficulties within education organizations and institutions to have enough technological experts to manage the digital transformation and another challenge is ensure that the institutional changes highlight the importance of integrating new technologies into their assets.

The proposal to implement virtual laboratories in the classroom becomes a useful tool for education because it improves attention in students, due to it is an experience in which they get in touch with the senses [21], allowing the assimilation of the concepts efficiently and recreating a real context reducing learning times, since "living" the situation directly, understanding what happens and solving the problems; It is a more dynamic process. Remember that the main instrument in the case of virtual reality glasses is the image, this is the format to which digital natives and young students react better and use more in their study and leisure.

By using laboratories, students can experiment, rehearse, make mistakes and correct, without being exposed to risks or without exposing real resources to economic or physical losses. In this way, it is possible to contribute as a teacher to a development of life facing new changes to do less traumatic
and worked in advance in virtual environments. The RV helps the personalization of learning, because this technological application expands the resources to be used in classes, so that the preparation of future professionals is according to the real life where they are going to work. Like the case of architecture students or engineering when they can see their plans come true; the study of the land and the necessary rectifications, they visualize it prior to the execution and materialization, because a 3D recreation of the infrastructures is made and additionally they run them as if they were there, improving the effectiveness and quality of their works.

In the same way, in the case of artistic subjects and cultural management, virtual reality offers animated versions of museums and galleries in which you can tour and study an environment or a work of art and its context. Finally, as a demonstration from the need for virtual laboratories, in medical subjects, in the exploration with simulations students learn about the prevention of occupational hazards, dissections, identification of traumas or diseases, by virtual inspections. The theory to virtual scenarios enriches knowledge, more participation and teamwork is generated and what is learned in class is preserved in the short term, without achieving the objectives of the subject.

It is proposed as part of future work to deepen the issue of applications of hardware devices such as HDMI for laboratory practice processes, as well as deepening the different programs that are currently free of charge to improve processes of simulation in subjects of the area of physics, mathematics, general theory of systems as well as in the administration part of computer systems. While it is true that not everyone is competent implementing virtual laboratories, their study could lead to the development of other information technologies in support of curriculum development within the different academic programs.

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