



IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON THE TRAINING OF SYSTEMS ENGINEERING STUDENTS AT THE UNIVERSIDAD CATÓLICA LOS ANGELES DE CHIMBOTE

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ABSTRACT

Information and Communication Technologies (ICT) occupy a major place in everyday life for people. In the new millennium, the COVID-19 pandemic demanded the empowerment of ICTs in all areas of life, in student, work and social spaces. The Systems Engineering career at the Universidad Católica Los Angeles de Chimbote had to resort to virtuality in order not to lose the development of the teaching process. The purpose of this research is to evaluate the impact of information and communication technologies on the training of Systems Engineering students at the Universidad Católica Los Angeles de Chimbote during the COVID-2019 pandemic. Through four focus groups, thirty-five students from the School of Systems Engineering were interviewed, who raised advantages and disadvantages of the use of ICT. Techniques such as the Pareto Diagram and the AHP Saaty were used to determine the most influential advantages at this time and establish a hierarchy. In general, the impact of ICT on the students interviewed was adequate, pleasant, and positive in the study stage.

Keywords: Information and Communication Technologies, Systems Engineering, Universidad Católica Los Angeles de Chimbote, COVID-19

INTRODUCTION

Communication has been an essential element for the development of humanity. Since ancient times it has allowed the transmission of information between people, which can be from verbal, written, visual communication, mostly. Sensations, feelings, and emotions can also communicate moods between individuals.

The development of computer science, which could be said in a summarized way that is the transfer of information in digital format, has allowed communication to reach other spaces that could not be done in previous decades. For this, it is necessary to use computers that optimize the time of productive, scientific and social activities, through the development and implementation of computer programs, which can be used by people from work software, games, applications, social networks, among others. The automation of processes at various scales allows the achievement of greater productivity at work.

Serna (2009) states that it is currently important to analyze computing as a collection of services, with the use of computer applications. It also states that, in the same way as the natural evolution of species, in the computer world those systems that have a broader vision survive. Technologies in industry enhance benefits, always linked to the development of computer science.

Technologies can facilitate both the development of communication and information. That is why at present the development of information and communication technologies (ICT) have an unparalleled performance. These

technologies that facilitate relationships between people every day are perfected and help the better functioning of society. (Cisneros Zúñiga, Jiménez Martínez & Andrade Santamaría, 2023).

In his keynote address at the first phase of the World Summit on the Information Society held in Geneva in 2003, Kofi Annan, then Secretary-General of the United Nations, spoke of the importance of information and communication technologies that can improve the lives of all the world's inhabitants. For his part, Belloch (2012) reflected that ICT are those technologies for the storage, retrieval, processing and communication of information. Its social dimension becomes evident when there is a constant interaction between technology and society, which is bidirectional and around it, new professions and jobs will emerge, or current professions will be readjusted. ICT leads to new situations and projects, through research and its results, which allows decisions to be made to achieve the society you want to build.

ICTs are developed in several aspects such as computing, internet and telecommunications, in general. Representative characteristics of ICT according to Cabero (1998) in the case of the internet are multimedia information, interactivity, interconnection, immateriality, greater influence on processes than on products, instantaneity, digitalization, penetration in all sectors (cultural, economic, educational, industrial, etc.), innovation and the trend towards automation.

Marqués (2012) refers that ICT is not only the development of computing and its associated technologies, telematics and the world of multimedia, but in the same way the media: social media and traditional interpersonal media with technological support.

ICTs impact all sectors of society. In the educational field, the promotion and development of these is fundamental. It allows the socialization of knowledge between teachers and students, as well as the optimization of time and increase in student productivity, through innovative pedagogical strategies that change, transform educational models and prioritize the teaching-learning process (Belloch, 2012; Cruz et al., 2019; Gómez et al., 2016; Lévy, 2018; Marquis, 2012; Prieto et al., 2011; Real et al., 2015; Valverde and Garrido, 1999).

Education seeks new ways to adapt to the new needs imposed by today's society. In university education, more work is sometimes done on the transmission of information than on the logical construction of knowledge. ICT is proposed as pedagogical tools that raise the quality of the teaching-learning process with an increase in their effectiveness, through the integration of disciplines such as pedagogy and psychology of learning. (Real et al, 2015)

Good practices in incorporating ICT into university education include:

- The ease of accessing information and the variety of information available.
- The high reliability parameters and the speed of information and data processing.
- The variety of communication channels they offer.
- The elimination of space-time barriers.
- The possibilities of feedback and great interactivity that they offer.
- The development of flexible spaces for learning.
- The empowerment of personal autonomy and the development of collaborative work.
- The optimization of the organization and development of teaching and research activities.
- They streamline administrative and management activities, as well as allowing their relocation from the immediate context. (Baelo and Canton, 2009, p.4)

The incorporation of ICT in university education does not occur in the same way in students and teachers. Students have experience in technological and digital matters. Teachers, especially those with more years of experience, have been learning and incorporating ICT into their daily work, to be in line with the change in the educational process with the new digital facilities. (Gomez et al, 2016)

Access to pages and social networks such as Facebook, Twitter, Zoom, WhatsApp, in addition to participation in blogs, collaborative curation platforms, Moodle, forums, wikis, emails, among others, favor communication and information management between members of the training process in the university community, students, professors and academic institutions (Díaz and Gairín, 2018; Lévy, 2018; Prieto et al, 2011). The use of ICT in the school environment is due to infrastructure, training, attitudes, support from the management team, among others; among which, the interest and training of teachers, both instrumental and pedagogical level is fundamental. (Belloch, 2012)

Among the functions of ICT in education, the following could be highlighted (Marqués, 2012; Prieto et al, 2011):

- Source of continuous information.
- Channel of interpersonal communication and for collaborative work and for the exchange of information and ideas.
- Means of expression and for the creation of both students and teachers.
- Instrument for knowledge management and information processing.

- Instrument for school management.
- Didactic resource for learning.
- Means of entertainment and for psychomotor and cognitive development.

At the Universidad Católica Los Ángeles de Chimbote, Systems Engineering is one of the most accepted careers by students. This career allows the future professional to be able to develop integral solutions of computing and communications and to process information automatically. It applies scientific, humanistic and spiritual knowledge, with ethical, social and civic responsibility. In addition, the graduate has the professional skills to formulate projects related to ICT, demonstrate soft skills for guidance and advice on ICT issues, use information technologies properly and pertinently in the context of their profession, complying with norms and standards, evaluate the situation of information technology and communication technology projects, through research, propose development and innovation in the field of action of their profession, among others. (Universidad Católica Los Angeles de Chimbote, 2023)

Serna (2009, p.1) states that systems engineering is strengthened by "the evolution and complexity of information systems in the midst of the knowledge society, with very complex demands and expectations, also determine the need for this specialization". The most important purpose of systems engineering is not only the use of computer devices, but the treatment that is made to information from computer solutions. (Star, 2010; Parra, 2010)

At the end of 2019, the world did not know that it would face one of the most difficult times with the appearance of the new coronavirus, SARS-CoV-2, which causes COVID-19. The following years have been very hard for people. It was necessary to isolate themselves from the world, to establish new ways of living and working to avoid contagion, which in many cases caused the death of infected people.

The Catholic University Los Angeles de Chimbote had to resort to the use of ICT to be able to develop the classes, since the face-to-face in the classrooms was affected by the physical isolation to which it was necessary to go to preserve health. The Systems Engineering career also had to resort to this teaching modality, in which students and teachers had to create new educational spaces to continue with the teaching process. In this career that uses computer devices at all times, because it needs them to process and transmit information, students needed a greater individual effort to receive classes and study. For this reason, the objective of this research is to evaluate the impact of information and communication technologies in the training of Systems Engineering students at the Universidad Católica Los Ángeles de Chimbote during the COVID-19 pandemic.

MATERIALS AND METHODS

The study carried out has a qualitative design, is descriptive, non-experimental, cross-sectional. The methods used in qualitative research are inductive-deductive and analytical-synthetic.

For the study they were participants in the research 35 students from the School of Systems Engineering of the Catholic University Los Angeles de Chimbote, who showed their willingness to participate in the research and were enrolled during the COVID-2019 pandemic. Four focus groups were held, which allowed the collection of information. A focus group or focus group, are those group interviews, with groups of three to ten people, in which the people who interact talk about one or several topics in a relaxed and informal environment, under the guidance of an expert. (Hernández Sampieri et al., 2006)

Subsequently, a Pareto Chart was developed to determine the most important aspects detailed by students to identify the impact of ICT on their training during the pandemic. This technique analyzes the problem and is used to present data, drawing attention to the causes of greater incidence in the problem in question. Its purpose is to determine the 20% of the sources that cause 80% of the problems, "the vital few the trivial many". (Alteco, 2020)

Next, a Hierarchical Analytical Process (AHP) was applied, proposed by Thomas Saaty, recognized in the academic world known as AHP Saaty, is used for decision making, it is a multicriteria procedure. It helps to identify the best alternative according to the resources allocated, it can be social, economic among others.

The Saaty Methodology and the valuation scale (verbal judgment rate) that is proposed through the prioritization of the elements of the hierarchical model, the binary comparison of the elements, the evaluation of the elements through the assignment of weights, the ranking of the alternatives according to the given weights and the synthesis and analysis of sensitivity, It is evidenced as follows:

- 9 Extremely preferred
- 7 Very powerfully preferred
- 5 Powerfully Most Preferred
- 3 Moderately more preferred
- 1 Equally preferred

Saaty (2008) presents the methodology to be used for all selected criteria, which is performed as follows:

- for each line of the pairwise comparison matrix, perform a weighted sum based on the sum of the product of each cell by the priority of each corresponding alternative or criterion;
- for each line, divide its weighted sum by the priority of its corresponding alternative or criterion;
- determine the mean λ_{max} of the result of the previous stage;
- calculate the consistency index (CI) for each alternative or criterion:

$$IC = \frac{\lambda_{max} - m}{m - 1} \quad (1)$$

where m is the number of alternatives;

- determine the random index (IA) in Table 1, and
- determine the consistency quotient index (the ratio of the consistency index to the random index).

Table 1. Random index for the calculation of the consistency coefficient

| Number of alternatives for decision n | Random index | Number of alternatives for decision n | Random index |
|---------------------------------------|--------------|---------------------------------------|--------------|
| 3 | 0,58 | 7 | 1,32 |
| 4 | 0,9 | 8 | 1,41 |
| 5 | 1,12 | 10 | 1,49 |
| 6 | 1,24 | | |

Source: (Saaty, 2008)

RESULTS AND DISCUSSION

The research developed allowed the application of focus groups to 35 students of the Systems Engineering career, who gave their approval to participate. Due to the number of students, four focus groups were developed, regardless of sex, age, skin color, or year of study. In the four groups created, students were asked to raise the main advantages they had with the learning process during the COVID-19 pandemic. There is agreement with what was raised by the students.

The main advantages that students relate are summarized below:

- Students could study whenever they could
- Greater interaction between students through the virtual route
- Direct communication between students and teachers
- Use of more digital bibliography
- Greater organization for individual study
- Use of virtual platforms to obtain information, such as Moodle
- Increased use of social media
- Increased readiness with computing devices
- Didactic methods for learning by teachers
- Increased student prominence

The Pareto technique was applied to these elements to determine those that concentrate 80% of the main advantages. Figure 1 shows the result of the application of this technique. This shows that the teaching-learning method used was in accordance with the needs of the students. The students established, where possible, joint study schedules, which allowed for greater interaction between them. Social networks such as WhatsApp, Facebook, Twitter facilitated interaction between students.

The interpersonal relationships between teachers and students improved because for the most timid it was a space that led to them interacting from their homes. The teachers of the various subjects carried out innovative strategies, which motivated the students to study.

The use of university platforms allowed students access to an extensive digital bibliography, which sometimes did not give the required importance to being in the classroom and receiving the subjects directly with the teacher. Resume subjects from previous courses and study some concerns that improve the current study.

The adequacy for the study depended on the family strategies drawn up for economic sustenance, since many families needed to rearrange their schedules and activities in order to survive. In this way students could sometimes contribute to the family economy.

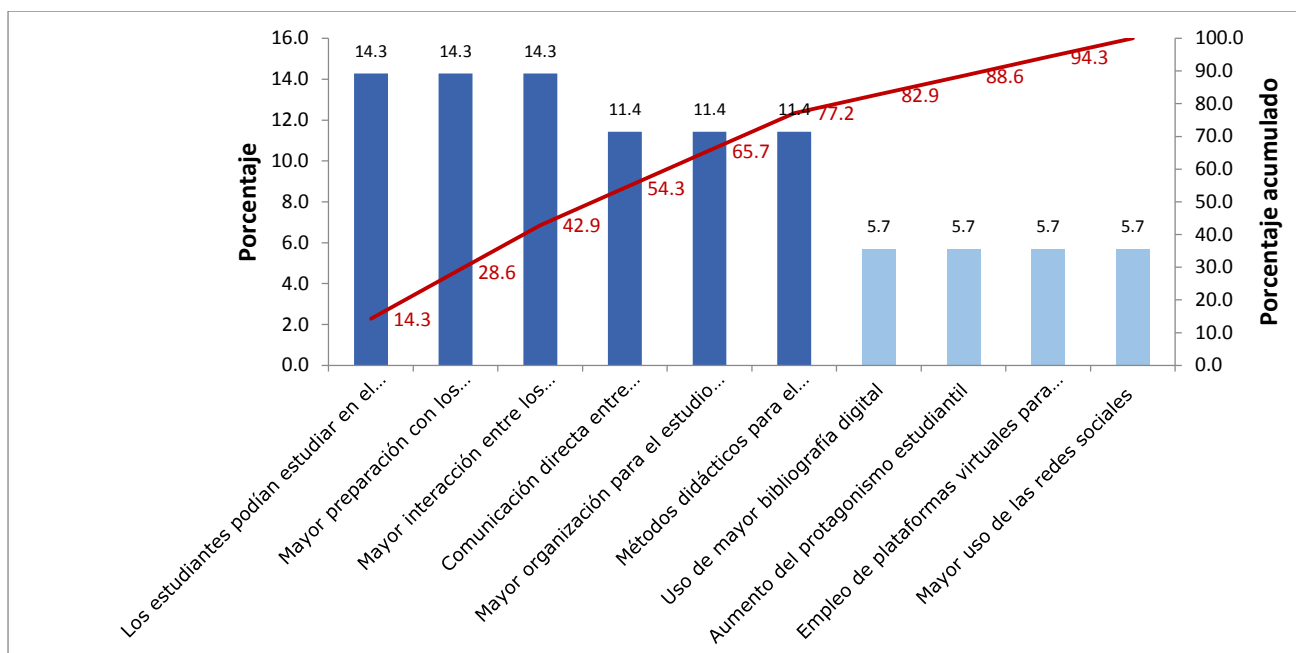


Figure 1. Pareto chart. Source: Authors.

Subsequently, the AHP Saaty is applied to the advantages that concentrate 80% of them: students could study whenever they could, greater preparation with computer devices, greater interaction between students by virtual means, direct communication between students and teachers, greater organization for individual study and didactic methods for learning by teachers. (See Tables 2 and 3)

Table 2. Standardized matrix AHP Saaty.

| Elements | Students could study whenever they could | Increased readiness with computing devices | Greater interaction between students through the virtual route | Direct communication between students and teachers | Greater organization for individual study | Didactic methods for learning by teachers |
|--|--|--|--|--|---|---|
| Students could study whenever they could | 1 | 3 | 3 | 5 | 7 | 5 |
| Increased readiness with computing devices | 0.33333333 | 1 | 5 | 5 | 3 | 5 |
| Greater interaction between students through the virtual route | 0.33333333 | 0.2 | 1 | 5 | 3 | 3 |
| Direct communication between students and teachers | 0.2 | 0.2 | 0.2 | 1 | 3 | 1 |
| Greater organization for individual study | 0.142857143 | 0.33333333 | 0.33333333 | 0.33333333 | 1 | 1 |
| Didactic | 0.2 | 0.2 | 0.33333333 | 1 | 1 | 1 |

| | | | | | | | |
|----------------------------------|--|--|--|--|--|--|--|
| methods for learning by teachers | | | | | | | |
|----------------------------------|--|--|--|--|--|--|--|

Source: Authors.

Table 3. Determination of weights of the criteria applying AHP Saaty method.

| Elements | Students could study whenever they could | Increased readiness with computing devices | Greater interaction between students through the virtual route | Direct communication between students and teachers | Greater organization for individual study | Didactic methods for learning by teachers | WEIG HT | W x Weight | Eigenvalues approx. |
|--|--|--|--|--|---|---|---------|------------|---------------------|
| Students could study whenever they could | 0.45 | 0.61 | 0.30 | 0.29 | 0.39 | 0.31 | 0.392 | 2.68 | 6.8213 |
| Increased readiness with computing devices | 0.15 | 0.20 | 0.51 | 0.29 | 0.17 | 0.31 | 0.271 | 1.98 | 7.3058 |
| Greater interaction between students through the virtual route | 0.15 | 0.04 | 0.10 | 0.29 | 0.17 | 0.19 | 0.156 | 1.03 | 6.5945 |
| Direct communication between students and teachers | 0.09 | 0.04 | 0.02 | 0.06 | 0.17 | 0.06 | 0.073 | 0.45 | 6.0984 |
| Greater organization for individual study | 0.06 | 0.07 | 0.03 | 0.02 | 0.06 | 0.06 | 0.051 | 0.33 | 6.5308 |
| Didactic methods for learning by teachers | 0.09 | 0.04 | 0.03 | 0.06 | 0.06 | 0.06 | 0.057 | 0.37 | 6.4311 |

Source: Authors.

When performing the consistency analysis, according to the proposed method, an own value of 6.5381 was obtained, the consistency index was $CI=0.13$, the random index is 1.24 with six advantages and is assumed from Table 1, and the consistency quotient index or consistency ratio is $RC=0.10$, which allows us to affirm that the exercise was performed correctly.

The degree of hierarchy is correct and demands of both teachers and the institution, a recognition to students for inserting themselves in the new modalities and learning and apprehending using their own strategies and those of the teachers. Their lives changed, fear and uncertainty took hold of each one, this pandemic had no precedent in the new millennium and the conditions were not created, in times of economic crises worldwide and specifically in the area of Latin America. The transition to virtual mode of all subjects demanded extra interest and motivation on the part of the students, in addition to the socioeconomic conditions they live.

The undergraduate students of the Catholic University Los Angeles de Chimbote, used information and communication technologies for the development of their training in this difficult stage. Although research cannot be generalized, having only 35 marks a before and after in the use of ICT and indicates a way forward in this technological and information area. These technologies impacted their learning, daily work and interpersonal relationships. The internet led to virtuality assuming the preponderant role in these times of physical isolation, but not social, because it allowed interaction between people from different spaces, which collaborated in their academic growth, students and teachers.

Special recognition is given to teachers, because at times that were not expected, it was necessary in a short time to create the conditions so as not to lose the academic years and students could continue their training, in this career that demands both computer devices and software. Creating strategies that motivated students was critical. Technological innovation

was present and allowed courses to be optimized by semesters. As the school year progressed, educational methods were perfected. The adaptation to new information technologies was not only for students, but for teachers, especially for those with more experience in teaching, who are older. The videoconferences provided interpenetrated students and teachers, as well as those responsible for ensuring connectivity in academic spaces or wherever professors indicated.

Through social networks, the links between the students were strengthened, activities were planned to clarify doubts, searches for methods to improve the study. The university promoted the virtual campus so that teaching activity was not lost. This led future professionals to obtain tools and create others that would allow them to better perform their functions, now students and later work.

While there are good practices there are also difficulties in this virtual way of developing classes. The disadvantages posed by the students were dependent on the socioeconomic level of the students and are the following:

- Sometimes the computer devices they have are not compatible with the software of the classes
- The connectivity to participate in meetings, virtual consultations was not the best. The application of the exams depended on the internet connection
- Carrying out other extracurricular activities, for the support of the family
- Contagion with the coronavirus
- When there were doubts with working with software, it was difficult to understand virtuality.

These difficulties must be taken into account for the next one, in the process of continuous improvement of the teaching-learning process that takes place at the Catholic University Los Angeles de Chimbote. A continuous preparation of both students and teachers in the new technologies of information and communications must be carried out on a monthly basis. University programmers must receive pedagogical preparation so that they are able to educate students and teachers in these technologies.

CONCLUSIONS

Information and communication technologies became much-needed tools in this stage of the COVID-19 pandemic that paralyzed the world. The Catholic University Los Angeles de Chimbote resorted to new strategies to maintain undergraduate and graduate teaching. However, for the training of university students it was necessary to establish technological resources that were not previously used to maintain communication and management of information and knowledge with them.

The use of ICT had a positive impact on students. It promoted individual study, interpersonal relationships between students and teachers, the use of computer devices, social networks, educational platforms, among others. The determination of the advantages by the 35 students interviewed, which, although it cannot be generalized, is an indicator of where one can work for a higher level of learning in circumstances in which virtuality is the teaching space.

The application of the Pareto Chart was successful. According to the Pareto Chart, students could study at the time chosen by them, greater preparation with computer devices, greater interaction between students by virtual means, direct communication between students and teachers, greater organization for individual study and didactic methods for learning by teachers. The rest of the advantages that were not selected when applying Pareto must be taken into account by the institution and teachers. The AHP Saaty technique perfected what was shown in the Pareto. In order of importance, the students placed the advantages in the hierarchical order stated above.

The difficulties expressed by students must be analyzed, as they affect their academic performance. These disadvantages, although they are not usually part of the infrastructure of the academic institution, but of the socioeconomic environment that the student lives, affect their performance.

ICTs must be promoted in all areas, student, labor and social. In the current moments that have returned to the classrooms, they must continue to interact digitally for the optimization of study time. Although it is always more feasible to learn directly with the teacher in the classroom.

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