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Journal Computer Technology

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The works must be unpublished and refer to topics of Data Management, Establishment of Computer Networks, Design of Database Systems, Software Design, Computer Science, Software, Computer Technology with Services, Business Process Outsourcing, Hardware and other topics related to Engineering and Technology.

Presentation of content

In volume four, issue twelve, as the first article we present, *Educational elements of instructional design to enhance the construction of virtual learning environments,* by URIBE-OLIVARES, Nadia Sarahi, SIORDIA-MEDINA, Paul Rafael and ZEA-VERDÍN, Aldo A., with secondment at the Universidad Autónoma de Nayarit, as a second article we present, *Analysis of usability evaluation according to the quality standards*, by AHUMADA-CERVANTES, María de los Ángeles, MELO-MORÍN, Julia Patricia and ÁLVAREZ-BALTIERRA, Eric, with an appointment at Instituto Tecnológico Superior de Pánuco, as a third article we present, *Design of a fuzzy controller for open architecture quadrotor*, by CHARRE-IBARRA, Saida, VALDOVINOS-JIMENEZ, Thonatiu, ALCALA-RODRIGUEZ, Janeth and GUDIÑO-LAU, Jorge, with secondment at the Universidad de Colima, as fourth article we present, *A diagnostic about using educational technology and learning environments in the bachelor's degree program in Computational Sciences at Universidad Autónoma del Estado de Hidalgo*, by MARTÍNEZ-LAZCANO, Verónica, ALONSO-LAVERNIA, María de los Ángeles, MUÑOZ-SÁNCHEZ, Yira and CASTILLO-PÉREZ, Iliana, with secondment Universidad Autónoma del Estado de Hidalgo and Escuela Superior de Ciudad Sahagún.

Content

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Educational elements of instructional design to enhance the construction of virtual learning environments

Elementos pedagógicos del diseño instruccional para potenciar la construcción de ambientes virtuales de aprendizaje

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Abstract

From the perspective of experts in instructional design, what pedagogical elements favor the construction of virtual learning environments? It is the question that guides the present investigation. Education has had significant changes in recent decades, so institutions would be expected to transform. The management of educational change must be carried out from within the institutions themselves, who, through the operability of their educational model, foster the learning of their students. The innovation elements of an institution involve the entire educational community. The pedagogical foundations must permeate the management team, teachers and administrative staff to achieve true educational quality in any educational modality. This research focuses on the particularities of the virtual modality. It aims to analyze the different perspectives of instructional designers of institutions of higher and higher education regarding what pedagogical elements are necessary in offering virtual education. It also analyzes the professional profile of those who exercise the role of instructional designer in the different institutions.

Instructional, pedagogical, virtuality

Resumen

Desde la perspectiva de expertos en diseño instruccional ¿Qué elementos pedagógicos favorecen la construcción de ambientes virtuales de aprendizaje? Es la pregunta que guía la presente investigación. La educación ha tenido cambios significativos en las últimas décadas por lo que se esperaría que las instituciones se transformen. La gestión del cambio educativo debe de realizarse desde el interior de las propias instituciones, quienes a través de la operatividad de su modelo educativo propician el aprendizaje de sus estudiantes. Los elementos de innovación de una institución involucran a la totalidad de la comunidad educativa. Los fundamentos pedagógicos deben permear al equipo directivo, a los docentes y al personal administrativo para lograr una verdadera calidad educativa en cualquier modalidad educativa. La presente investigación centra su atención en las particularidades de la modalidad virtual. Tiene como objetivo analizar las diferentes perspectivas de diseñadores instruccionales de instituciones de educación superior y media superior respecto a qué elementos pedagógicos son necesarios en la ofrecer educación virtual. Asimismo, analiza el perfil profesional de quien ejerce el rol de diseñador instruccional en las diferentes instituciones.

Instruccional, pedagógicos, virtualidad

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Introduction

Knowledge is ubiquitous, therefore teaching has to leave the classroom. Formal educational structures cannot respond to the needs of progressive adaptation in a world of change and growing demand in education. Education in non-school modalities has had an important development. The current agreement 11/18/18 of the Ministry of Public Education (SEP) establishes the following definition:

It is characterized because the development of the teaching-learning process is carried out through an educational technology platform, electronic media or through autonomous learning processes and / or with didactic supports. The learning activities must reflect the use of the Educational Technology Platform or identify the suggested resources for autonomous learning processes (SEP, 2017).

In this sense, the depth of the process of social change that is currently taking place falls on those who assume responsibility for training the new generations (Aretio, Corbella and Figaredo, 2007). The new educational processes require the participation of various actors: teachers, administrators, researchers, designers, pedagogues. Who from different professional roles contribute to this transformation.

The transformation of the learning experience must be an experiential experience. The emergence of new roles within the training processes is necessary. It is not enough to incorporate educational technologies into institutions to achieve innovation in learning processes. Virtual education is nourished by inter and multidisciplinary work that is complemented and enriched with information and communication technologies (ICT) as well as emerging technologies.

Currently, 15% of people study through distance and online education (OECD, 2019). However, the quality of these programs raises concern, there are no longer established criteria for their evaluation and accreditation, at least in Mexico.

Virtual education has posed new challenges since it has a large number of different components than face-to-face education. The differences range, from the management of space and time to the resources with which the construction of knowledge is promoted. An essential component in virtual education is Instructional Design (DI) (Aretio, 2017).

ID is a distinctive pedagogical tool in this modality, which, in general, consists of a written plan that stipulates the content to be developed in a learning unit, what are the learning objects to use, how will the distribution of tasks and how the students will be organized.

In addition, it indicates the times in which the materials must be visible on a certain platform and when the work of the student body must be received. The general characteristics of instructional design have been studied since 1963 with the Dick and Carey Model. Its study has evolved in such a way that in recent decades models have emerged that allow us to analyze the importance of ID in teaching-learning processes.

Virtual education as a dynamic process in universities

The process of variation that educational institutions have faced is characterized around globalization, the knowledge society and postmodern organization (Colado, 2002). Faced with these social changes, institutions would be expected to transform. Educational institutions face the challenge and social responsibility of making educational changes that allow their community to adopt the most valued skills and abilities. Guzmán and Escudero (2016) point out that it is not enough to incorporate educational technology in institutions to achieve educational innovation, they point out that it is necessary for institutions to carry out optimal, controlled and reproducible transformations in order to promote and control the production processes of intangible capital in education.

The integration of information technologies and the constant demand towards bending physical limits and taking advantage of time generates new educational modalities. Educating the population through conventional means, meeting the multiple training demands of society, is practically unfeasible today.

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García (1999) expresses that classical institutions are not relevant for all the needs of those who require training. He points out the need to combine education and work in order to adapt, without having to abandon one or the other. It is visualized that this demand could be covered through the emergence of new educational modalities. Currently, virtual education has components or basic elements that are integrated into the processes to generate teaching-learning. García (1994) indicates that the classic structure of education in this modality is made up of the student, teacher, materials and communication channels and the organizational infrastructure.

For the institutions that offer education in an out-of-school modality, the instructional design in the educational field must facilitate the meaningful processing of information and learning; therefore, they must be able to teach knowledge in an organized manner (Merril, Li & Jones, 1990).

Teaching at a distance encourages careful consideration of instruction in order to achieve an environment that facilitates learning. Martínez (2009) expresses that the role of instructional design in virtual education requires good planning. In general terms, planning means foreseeing goals to be achieved and making a project a reality, considering, of course, the means to achieve it.

Virtual education is taking advantage of face-to-face formats, however the analysis of its components is still not enough. According to Aretio, (2017) the studies carried out focus on verifying the effectiveness of distance systems, as well as the innovations and technologies that accompany digital learning, not the training processes in the modality itself.

Among the elements that have been analyzed in virtual education are established what summarizes the pedagogical-didactic part, the technical part and the follow-up of the course. It also indicates the analysis of the digital skills of the teachers who teach it and the technological infrastructure necessary for the modality.

Pedagogical elements for virtuality: from the traditional didactic triad or virtual holistic models

The education-technology binomial has to be insoluble at all times with regard to virtual education. Failure to reproduce face-to-face education processes should be a priority in the institutions that offer this modality. Respecting the characteristics of the population and the training processes of the students.

In recent decades, with the evolution of technologies, the behavior of society has undergone a modification, the most noticeable being the way in which communication processes are carried out. What is automatically related to changes in population training needs.

The evolution in the educational system is taken up from the proposal of Echevarría (cited by Aretio, Corbella and Figaredo, 2007) where a gradual change is established. These could be specified as: natural, urban and telematic; each one has been the result of the ideology of the moment and the technological advances put into practice.

In this sense, technological advances have caused a radical transformation in the way in which education is understood and developed. Therefore, it is necessary to establish the difference between two concepts that are often used synonymously: distance education and virtual education.

Distance education involves physical separation. The not necessarily coincide in time and space. That is, not a synchronous interaction in the same place between students and teachers. Arancibia and Montecino (2013).

The need to combine education with virtuality has modified the concept of teacher and student. It also transforms how the teaching-learning process is conceived. Which happens to not be something tangible but virtual. So it is related to new ways of acquiring knowledge, introducing the term eLearning.

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Virtual education has been the modality that from its birth has shown a greater predisposition to assume technological innovation (Aretio, Corbella and Figaredo, 2007). Therefore, the introduction of new information and communication technologies justify the development of new structures for training and knowledge acquisition.

Generating learning is one of the main challenges of education in any modality. Within virtual education there is the planning of its design for implementation on a platform. The incorporation of information and communication technologies in training processes in a formal and recognized way as an educational modality presents a challenge for institutions that take on the challenge of adding it to their educational offer (Alba, Carballo, Pons, Labra, Moreno and Rio, 2005).

Analyzing the development of a virtual environment supposes the knowledge of a methodology that gives foundation to the actions selected to carry out the achievement of the objective of the course. Martínez and Quincha (2012) mention that before the rise of information and communication technologies, it is necessary to modify the traditional schemes of design and planning of courses, therefore, thinking about recognizing pedagogical elements to facilitate the teaching processes-learning in virtuality leads to analyzing the different models that are used for the construction of virtual environments.

The 21st century society has expressed the need for new spaces for its educational processes. The use of the internet in education sets a standard to host these spaces. A Web-based educational system comments Mendoza and Galvis (1999) is not simply digitizing educational texts or making electronic books.

In this sense, the notion of designing courses in a non-face-to-face modality implies the awareness of identifying the environments where the learning process will be generated. In virtual education the concepts used to name these spaces are virtual learning environments (VLE).

A learning environment is the place where students and teachers converge to interact psychologically in relation to certain contents, using previously established methods and techniques with the intention of acquiring knowledge, developing skills, attitudes and in general, increasing some type of capacity. or competition (Enrique and Alzugaray, 2013).

Díaz-Barriga (2013) describes a learning environment as the result of establishing didactic sequences that offer an ordering of actions to be carried out, not necessarily in a unique way.

Another element considered important is interaction. Perrenoud (2012) expresses that the interaction is conceived as an exchange activity between the student's thinking and knowledge, between teachers and students through various exchanges, between each actor in education and an internal resource. Therefore, when talking about the environment, reference is made to a globalized whole, where spaces, objectives, knowledge and human beings establish relationships with a purpose, thus generating a fabric of interactions associated with the solution of needs that they require, every day with greater force, the creation of artificial structures by man to be achieved (Belloch, 2017).

In virtual education, it is necessary to establish theoretical foundations that guide practice and interactions. In this sense, constructivism is considered as a reference. For the constructivist model to be carried out, it is vitally important to emphasize collective work. In this way, generate debate and exchange of knowledge among the members of a group, share doubts and propose joint solutions, considering different points of view that can expand knowledge.

Methodology

The phenomenological-hermeneutical method is the axis through which the research is carried out. Phenomenological human science is the study of lived or existential meanings. Under this approach, the relationship of the perspectives of instructional designers will be explored in order to give meaning to the universe in which they develop. Van Manen (2003) expresses that phenomenological-hermeneutical research is a search for fulfillment, through explaining the world as it is.

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Therefore, it focuses on the description of the phenomenon as it is found in reality. From the experience and expressions of the participants. The interpretation of the results will be based on hermeneutics, which tries to understand the nature of the lived experience.

In order to know the reality from perspectives, the voices of ten instructional designers were taken, who based on their experience gave guidelines to generate a discourse of both national and international institutions.

Based on his discourse, he deconstructs educational reality in relation to the proposal of the traditional didactic triad, recognizing that virtual education has specific elements that it has to visualize to generate satisfactory teaching-learning processes.

Results

The pedagogical elements identified in the discourse of the participants of this research allow enriching this initial proposal with new elements typical of virtuality. For its construction, the macro categories and their respective codes were considered in order to have a graphic representation of the pedagogical elements to promote the construction of virtual learning environments.

Although the didactic triad is taken as a guiding figure, when analyzing the results obtained, a fourth vertex is integrated, where the instructional design is recognized as part of the learning process within the VLE.

The modification of the content vertex by learning object was carried out with the purpose of recognizing the set of digital resources where different activities, resources and functions are reflected to generate learning situations. Wiley (2000) expresses that a learning resource is "any digital resource that can be reused as a support for learning".

It is proposed that the four edges of the proposed diagram (learning objects, student, teacher and instructional design) act in a constant process of interaction.

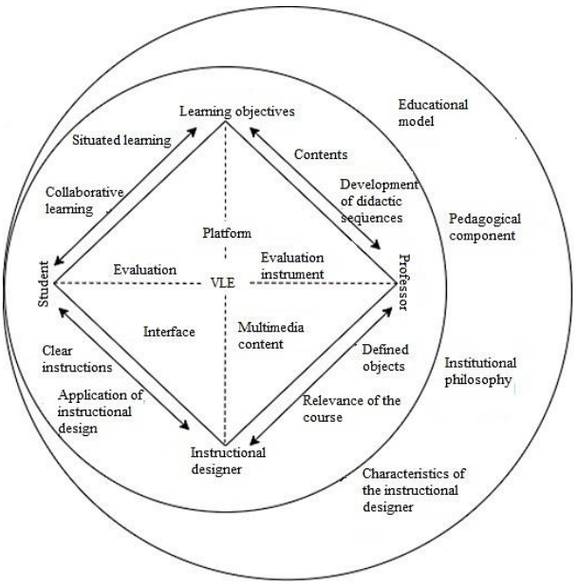

Figure 1 Holistic model for the virtual Uribe-Olivares

Conclusions

In conclusion and regarding the holistic model for virtuality, it explains the pedagogical elements, in the first circle the macro category educational model, pedagogical component, institutional philosophy and characteristics of the instructional designer are established. Recognizing the importance of the educational model within the institutions will allow influencing: institutional philosophy, pedagogical component and instructional design model, which are a frame of reference for the teaching-learning process.

Within the second circle, the actors considered within the teaching-learning process are established. In each of the vertices are the elements of the didactic triad; However, the limitation gave way to integrating a new vertex that is the instructional design since this determines the planning of the course, manages the technological resources, as well as implies the selection of the way in which the content is presented and the strategies so that the student can access it (Avilés and Avilés, 2002).

Within the same graph (figure 1) the pedagogical elements for learning are identified, depending on the relationship of each of the vertices. All based on the categories and codes found in the participating sample's discourse.

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Integrating the pedagogical elements found here to this new proposal of Diagram for virtual education facilitates understanding the needs that virtual education requires. It allows us to see that it is not possible to try to imitate the face-to-face education process on a platform.

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Analysis of usability evaluation according to the quality standards

Análisis de evaluación de usabilidad de acuerdo con las normas de calidad

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Abstract

This research provides a study of usability as a quality attribute of Web pages, using as a benchmark the requirements that must be followed under the International Organization for Standardization / International Electrotechnical Commission 25000. The methods used to carry out this process are studied, as well as the description of the aspects to be considered for evaluation thereof. It carried out a review of the literature on software tools for measuring the usability of Web pages and disadvantages. The methodology that can be used is determined to perform the corresponding evaluation process and the results are established using a practical case.

Usability, web page, Quality, Evaluation

Resumen

La presente investigación proporciona un estudio de la usabilidad como atributo de calidad de las Páginas Web, tomando como punto de referencia las características que deben de cumplir conforme al estándar de la norma Organización Internacional de Normalización/Comisión Electrotécnica Internacional 25000. Se estudian los métodos que se utilizan para llevar a cabo dicho proceso, así como, se describen los aspectos que se van a considerar para realizar la evaluación de estos. Se lleva a cabo una revisión de la literatura sobre las herramientas de software para la medición de la usabilidad de las Páginas Web y los inconvenientes. Se determina la metodología que puede ser utilizada para realizar el proceso de evaluación correspondiente y se establecen los resultados mediante la utilización de un caso práctico.

Usabilidad, Páginas web, Calidad, Evaluación

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Introduction

Currently, the acquisition of software from desktop, web, mobile or service applications is largely dependent on the level of quality achieved by each of them, for this reason all types of industries that want to be highly competitive in the field. National and international markets have increased the level of quality in their processes (Villegas, 2009). Software quality is the degree to which the software has certain attributes that it must meet. Specifically in the Software industry, several attributes have been defined when specifying the quality of a product. Which are: usability, reliability, security, performance, always looking for customer satisfaction (Kan, 2002). Among the quality attributes, one of those considered important is usability, which indicates the ease with which a user can use a Web Page (Enriquez, 2013).

Usability is a quality attribute which refers to the ease for the user to do a certain task, which adapts to the needs and satisfaction of the same (Len Bass, 2003). The usability evaluation process could yield results that lead to improvements in web page production. The usability evaluation is for the purpose of modifying and optimizing some aspects of web pages that are poorly designed.

There are organizations that have worked on the standardization of quality aspects in software such as the ISO (International Organization for Standardization), the IEEE (Institute of Electrical and Electronics Engineers, Inc.) and the IEC (International Electrotechnical Commission). These standards coincide in specifying usability as an attribute of quality, which is important for the user, making the software product attractive, learned, used under certain conditions and contexts of use. To achieve this objective, the ISO / IEC 25000 Standard was taken as a reference for the evaluation of this quality attribute.

The existing software tools for the evaluation of usability do not specifically consider the evaluation of this quality attribute. They evaluate the user interface considering only some aspects of usability but do not specifically focus on a quality standard.

In recent years the use of web pages to develop daily activities within companies has been increasing, it is necessary to create criteria that allow the evaluation of usability as a quality attribute of the same. Considering the end user as the main actor in the use of web pages.

This work focuses in a general way on establishing the criteria that must be considered to carry out the usability evaluation. It is carried out as follows: In section I. Introduction, it provides an induction to the subject. In section II. Usability, in which the meaning is described considering the opinion of various authors. Section III. ISO / IEC 25000 Quality Standards, which makes an analysis of the points that will be taken to measure usability as a quality attribute. Section IV. It analyzes the evaluation methods that various authors have used in their research for the evaluation of usability. In section V. Provides a study of the existing tools for the evaluation of usability and their drawbacks. Section VI. It establishes a methodology to carry out the Evaluation of the usability of the Web Pages. In section VII the results are established and finally in VIII. Conclusions and future work are established.

Usability

The International Organization for Standardization proposes two definitions regarding the usability of software:

- ISO / IEC 9126 establishes that “Usability refers to the ability of a software to be understood, learned, used and be attractive to the user under specific conditions of use”.

- ISO / IEC 9241 mentions that "Usability is the effectiveness, efficiency and satisfaction with which a product allows specific objectives to be achieved by specific users in a specific context of use".

Jakob Nielsen defines usability in terms of five attributes: ease of learning, efficiency, memorability, errors, and satisfaction. Nielsen mentions that the importance of these attributes varies depending on the context and the end users (Enriquez, 2013).

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Usability can be defined according to ISO 25000 as the ability of the Software to be understood, learned, used and attractive to the user when used under certain conditions. For which the standard divides these characteristics into sub-characteristics such as:

- Ability to recognize its adequacy.
- Learning capacity.
- Ability to be used.
- Protection against user errors.
- User interface aesthetics.
- Accessibility.

In conclusion, it can be defined that usability is the ease of use that an object or artifact has for a certain user, with respect to the environment in which it operates (Standardization, 2020). This concept is applied to different environments and objects to measure the process that is carried out. In this case, it will be used to evaluate the usability of the web pages.

Regarding the usability of the software, it constitutes a quality attribute that is essential for its success, as determined by the International Quality Standards ISO / IEC 25000 that are mentioned in the following section.

ISO / IEC 25000 quality standard

A. Quality. One of the important factors currently in Software development is the quality of the product as mentioned in the standards together with the quality of the process.

The quality of a software product is the set of qualities that characterize it and determine its usefulness and existence against standards. An adequate balance should be proposed in factors such as efficiency, reliability, satisfaction, among others, which can be defined under two aspects (Heck, 2010):

1. Internal quality: Measurable from internal characteristics, such as source code.
2. External quality: Measurable in the behavior of the product evaluated by the end user, which is what will be considered for this study.

B. Standard 25000

In recent times the ISO / IEC 25000 family of standards has emerged, which establishes a manual for the use of a series of international standards called Software Product Quality Requirements and Evaluation (SQuaRE - System and Software Quality Requirements and Evaluation) (Standardization, 2020).

The ISO / IEC 25000 standard establishes a series of guides that are based on ISO / IEC 9126 and ISO / IEC 14598. Its main functionality is to guide software development by specifying the requirements that must be met as well as evaluating quality attributes.

The ISO 25000 standard establishes three views in the quality study of a product; the internal view, the wedge considers the size, complexity of the code and that it complies with the established norms according to the object-oriented development methodology. On the other hand, the external view, analyzes the performance of a web page, the memory usage of a web application or the uptime. The one to be considered in this study is the view in use, which is responsible for making measurements regarding the efficiency and use of the end-user software, so that the software is productive when performing the tasks assigned.

One of the important quality factors mentioned is usability, since it is what determines the degree of user satisfaction and on this depends whether the software is used efficiently or not.

To carry out the evaluation, it is necessary to analyze the methods used to evaluate usability and determine which ones are going to be considered for carrying it out.

Usability evaluation methods

Methods are the steps used to measure the usability of a product such as web pages. They help the evaluator to perform the work more efficiently, because researchers have used them over the years and have obtained favorable results in this process.

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The usability assessment methods can be divided into: inspection, inquiry, test (Mohd Naz'ri Mahrin, 2009), Semi-cognitive model and the Eye Tracking Technique.

Inspection: They are a set of methods based on the examination of the user interface of an application by experts. In this method, each evaluator performs a diagnosis of the interface based on a heuristic checklist created for this purpose. Later they meet to discuss the elements found in the interface, finally a report of the aspects found is prepared in a qualitative way.

The methods are the following: Heuristic evaluation, plural usability tour and cognitive tour, standards inspection.

Inquiry: It consists of analyzing the tastes of the users, dislikes, needs and identification of requirements. Which can be: Field observation, guided discussion groups, interviews and recording of uses.

Test: In this method, users work on tasks using the system or its prototype and evaluators analyze the results to see how the interface supports users with their tasks. Which can be: performance measures, thinking aloud (Thinking Aloud), constructive interaction, retrospective test, driver's method (Giraldo, 2011).

These are methods that focus on evaluating the efficiency and effectiveness of the system, that is, they evaluate the usability objectively.

Semi-cognitive model: This evaluation method understands the interface as a communication mechanism between the designer and the user. There are two models, the designer model, which is the creator's mental image of what he wants to build and how it should work, and the user model that explains how the system works (Scolari, 2001).

Eye tracking: It is a novel technique that allows to have proof of what point of the information system the user has been looking at at all times. This technique provides information on the difficulty of finding specific aspects of the interface and the time or number of elements analyzed before finding the appropriate element (Juan-Miguel López Gil, 2010).

To determine a tool that serves as a support to measure Usability as a quality attribute under the ISO / IEC 25000 Standard, it is necessary to make an analysis of the different software that performs this process. This study will allow to know the criteria that must be evaluated in order to serve as support so that companies can validate the level of usability of web pages.

Software tools for evaluating website usability

The selection of several tools that are used to carry out the usability evaluation was carried out, which are described below:

- WebSAT: Static Web analyzer tool, is a prototype tool that inspects the HTML composition of web pages to detect usability problems.

- WebXm: is the main risk solution in order to verify the problems that impact the efficiency and compliance with the user of the websites. It is developed by an IBM company, called WatchFire (Benavides & Aros, 2012). Automate the detection of some page defects such as: broken links, spelling errors, slow loading pages, the way of navigation, to help improve the usability of the website. Its main function is to evaluate the quality of websites from the perspective of usability, but it does not evaluate the quality of use.

- Drum (Diagnostic Recorder for Usability Measurement) is a software tool that enables computer-aided analysis. Helps video recording methods in task analysis. Automatically calculates work time (Macleod & Rengger, 1998).

- PROKUS. System to measure usability taking into consideration the ergonomic design of the user interface (Gert Zülch, 2000).

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- CrazyEgg: It is an online computer program that tracks the clicks that users make on each component, this tool makes heat maps, identifying distracting elements, relevant areas or places that do not contain links where users interacting with the page clicked. The data is exported to Excel or database. Although clicks are tracked on a single page, they do not monitor the entire session, so it does not analyze the behavior of visits between various pages of the web application or at different times.

- Page Analytics: It is used as a google browser extension, it uses metrics to analyze the web page to be studied, it results in what users see when they click on the different elements of the web page, providing which parts are most used by For its users, it is found on the internet for free, although it sometimes allows analysis of complete sessions to be carried out, the information it provides can be a bit confusing. Therefore, it is important when using it to define well the objectives you want to achieve, as well as the metrics that are going to be used, otherwise it can cause a lot of work in this regard.

- UxCheck: It is based on the 10 principles of Heuristic evaluation of Jacob Nielsen (Nielsen, 1994). This is installed in the browser and in this way the user can interact with the page and see what elements do not comply with the principles, it also allows adding notes, taking screenshots. It is free and easy to use, it focuses mainly on web design, it does not allow to establish new evaluation criteria.

- Site Checker: Its evaluation is based on the W3C Web Content Accessibility Guidelines (WCAG). Valid Html code, as well as it can evaluate other content such as dead links, hidden files, Java scripts, CSS, additional comments in the HTML code and the text relationship code on a Web Page (Macho, 2013).

Disadvantages of usability evaluation tools

Some disadvantages of the aforementioned tools can be observed, which are:

- WebSat: Does not evaluate dynamic pages.

- WebMX: Evaluates the usability and accessibility of a web page. However, in the accessibility assessment you can only assess the contrasting text and background color.

- DRUM AND PROKUS: These tools cannot find dead links and additional comments in the code in the internal quality assessment.

- CrazyEgg: This tool does not provide the results automatically, it transports them to a spreadsheet, where they will be interpreted by usability experts.

- Page Analytics: It does an analysis of the entire sessions, however, the great variety of data it produces is confusing.

- UxCheck: It only uses heuristics to evaluate usability.

- Site Checker: Evaluates internal quality and external quality only focuses on user accessibility.

As can be seen, most of the works cited above focus on evaluating usability in terms of content, accessibility of web interfaces. Other tools only evaluate the heuristics established by Nielsen for usability evaluation. None of them specifically focuses on measuring usability according to the Quality Standards of the ISO / IEC 25000 Norms specifically. The following section establishes the Methodology to be used to carry out this process.

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Methodology to carry out the usability evaluation

To carry out the evaluation of usability as an attribute of quality, the criteria must be established, as well as the attributes that allow assessing each one of them so that the web pages allow compliance with International Standards as established by the Norm ISO / IEC 25000 in its section 25010 in addition to the ISO / IEC 25022-2016 Standard) that measures the quality in use in the usability section, which is derived from the ISO 9241-11 Standard, which contemplates the efficiency criteria , satisfaction and ease of use, as quality criteria that must be considered to evaluate software products such as web pages.

The evaluation will be carried out through the following steps:

The inspection method will be used in which it will be carried out by five usability experts according to the studies carried out by Nielsen (Nielsen, 1994), on the grounds that a greater number of evaluators reduces the benefit considerably, in addition to You should take into account that it is from different disciplines, such as three experts in Web page design and two people from the IT area specialized in graphic design and programming:

The measurement instrument will be through the evaluation of the characteristics, which will include the following aspects to be evaluated.

Communication: Measures the degree of interaction between the Web interface and the end user (CCOM).

Ease of Use: Measures the degree of User Satisfaction with the Web Interface (CFUSO).

Aesthetics: This criterion measures the aesthetic design of the user interface (CFES).

Operability: Measures the ability of the User Interface to fulfill a certain function (CO).

Ease of Understanding: Measures the ability of the User Interface to use its resources in particular tasks and conditions of use (CFCOM).

Efficiency: Measures the time taken to complete a task in the Web Interface (CEF).

Fault Tolerance: Measures the ability of the Web Interface to prevent errors and set error messages appropriately (CTF).

Documentation and help: Measures the ease offered by the Web Interface to provide help to the user when interacting with the Web Page (CDYA).

For each criterion, a series of attributes will be established, which are the ones that the evaluator will use to give a weight to each criterion.

It is proposed to create an automated tool that evaluates all types of Web Pages according to the 8 criteria established by the ISO / IEC Standard, as well as the metrics that correspond to each criterion to evaluate the usability of the same.

Once the Methodology of this research has been determined, the results obtained from the usability evaluation analysis are established.

Results

To carry out the application of the usability evaluation criteria, a case study was used, the page of the Higher Technological Institute of Pánuco, the quantification of the criteria was determined based on a liker scale from 0 to 5, where The Value Judgment found in Table 1, goes from a total compliance to a Non-compliance.

Criterion	Assigned value
Fully complies	5
Acceptably Compliant	4 a 4.9
Comply regularly	3 a 3.9
Satisfactorily complies	1 a 2.9
Fails	0.0 a 0.9

Table 1 Rating scale
Source: Self made

Subsequently, the total usability value of the Web Interfaces is obtained, which corresponds to the result of the sum of the scores of all the criteria as shown in equation 1 and equation 2.

Criterion = Σ (Attribute value) / Non-total. (1)

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Equation 2:

Usability level = (CCOM + CFUSO + CFE + COP + CFCOM + CEF + CTF + CDOC) / Total Criteria
(2)

A rating will be determined on a scale from 0 to 100% as shown in Table 2.

Criterion	Abbreviation	Valuation%
Communication (content)	CCOM	12.0%
Easy to use	CFUSO	15.0%
Operability	COP	13.5%
Aesthetic factors	CFE	12.0%
Ease of Understanding	CFCOM	12.0 %
Efficiency	CEF	12.5%
Fault tolerance	CTF	12.5%
Documentation and help	CDYA	10.5%

Table 2 Weighting of the Usability Evaluation Factors for web pages
Source: Self-made

The following equation 3 will be used, in which the value of the criterion will be determined, adding the value of each attribute established by the evaluator, between the total number, multiplied by the weighting of the factor.

Criterion = Σ (attributes) / Non-total * weighting. (3)

Finally, to determine the usability rating, the sum of the 8 criteria is carried out by the weighting established for each criterion. In this way, the usability value granted to the evaluated web pages is obtained.

The technologies used for the development of the software for the evaluation of the usability of web pages that considers quality standards and evaluates each of the established criteria, is shown in Figure 1 below:

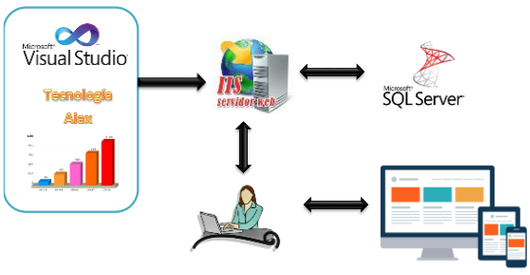

Figure 1 Evaluation Software Architecture
Source: Self-made

It should be mentioned that the most objective result is presented by evaluation criteria, as shown in Figure 2, since it allows a clearer view of the evaluation results. The Software tool allows evaluating each of the 8 criteria. In this case, the operation of the web page to be studied is presented:

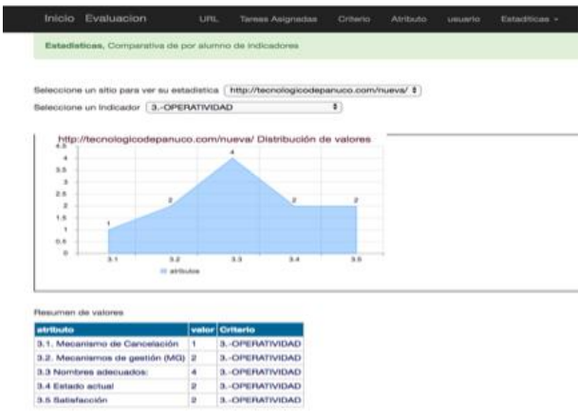

Figure 2 Operability
Source: Self-made

Regarding the results obtained in the operational criterion, it is observed in Figure 2 that point 3.1 management mechanisms, cancellation mechanisms, satisfaction, are below the average, because in the first instance the home page it does not allow you to configure the environment where you work and also according to the results it does not provide user satisfaction. In this way, the results of the 8 criteria established to evaluate the usability of the web pages are obtained, from communication to documentation and help of the web page.

Conclusions

The present research provides a study that serves to determine the criteria to carry out the usability evaluation as a quality attribute, taking the ISO / IEC 25000 standard to find aspects of the interface that are poorly designed and propose improvements to the web pages so that the end user achieves efficiency and satisfaction in using it. The growing need for companies to have web pages that are usable and comply with the quality standards established by international standards, makes it necessary to evaluate usability as a quality principle, in such a way that it allows software developers to realize account of what they must modify in the design of the web pages to improve their usability, as well as save time in maintenance, which translates into a cost reduction in coding hours.

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As work in the future, it is intended to carry out an evaluation model of the usability of the Web Pages that includes an experimental group in which the results are analyzed using the software tool and the Eye tracking technique that allow obtaining the preferences of the users. users.

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Design of a fuzzy controller for open architecture quadrotor

Diseño de un controlador fuzzy para cuadrirrotor en arquitectura abierta

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Abstract

The use of quadrotor helicopters has now increased, especially in civilian applications such as maintenance tasks related to power line or large construction status control, surveillance, crop control in agriculture, work processes in the logistics sector, among others. One of the main problems with some of the conventional designs is the lack of stability. This paper presents the design of a controller using an intelligent control technique to achieve the stability of a quadrotor, to experiment an open architecture quadcopter helicopter was developed, the controller was programmed using LabVIEW software and the data acquisition system is based on the NI PCI 6251 card.

Fuzzy controller, Quadrotor, Fuzzy rules

Resumen

El uso de helicópteros cuadrirrotores se ha incrementado en la actualidad, especialmente en aplicaciones civiles tales como tareas de mantenimiento relacionadas con el control de estado de líneas eléctricas o grandes construcciones, vigilancia, control de cultivos en la agricultura, en los procesos de trabajo en el sector logístico, entre otros. Uno de los principales problemas que presentan algunos de los diseños convencionales es la falta de estabilidad. En el presente trabajo se presenta el diseño de un controlador utilizando una técnica de control inteligente para lograr la estabilidad de un cuadrirrotor, para experimentar se elaboró un helicóptero cuadrirrotor en arquitectura abierta, el controlador se programó utilizando el software LabVIEW y el sistema de adquisición de datos se basa en la tarjeta NI PCI 6251.

Controlador difuso, Cuadrirrotor, Reglas difusasd

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Introduction

Intelligent control techniques that emulate the characteristics of biological systems offer opportunities and advantages to create control systems with new capabilities. The intelligent control is designed to provide a level of intelligence and autonomy in the control decision that allows to improve the performance of a system. It has different tools to emulate the biological behavior that a human being could use to solve a problem; one of them is fuzzy logic or Fuzzy Logic, a branch of AI (Artificial Intelligence) that is capable of handling vague concepts such as "tall" or "young" allowing to build devices that estimate information that is difficult to define. Fuzzy systems have rules determined by the people who directly manipulate the system to be controlled and the mathematical model of the system is not required, unlike conventional control where the system is analytically modeled through a set of equations (Ponce & Ramírez, 2010) (Wang, 1997).

The modern study of fuzzy logic and partial contradictions has its origins in the 20th century, when Bertrand Russell took up an ancient Greek paradox whose solution could not be found with classical logic.

The concept of fuzzy logic was conceived thanks to the research of engineer Lofty A. Zadeh from the University of Berkeley (California), Lofty introduced the concept around the mid-sixties, at first, I did not name this logic as fuzzy logic if I do not call it the principle of incompatibility. Lofty A. Zadeh described this principle as: "As the complexity of a system increases, our ability to be precise and construct instructions about its behavior decreases to the threshold beyond which precision and meaning are exclusive characteristics" (Guzmán & Castaño, 2009).

In 1965 Lotfi A. Zadeh published Fuzzy Sets. This article describes the mathematics of fuzzy sets and by extension of fuzzy logic, this work gave the field its name. Applying Lukasiewiez's logic he created a complete algebra for fuzzy sets (Zadeh, 1965).

Fuzzy logic was applied in the mid-1970s by Ebrahim H. Mamdani at Queen Mary College in London. Mamdani designed a fuzzy controller for a steam engine. Since then, the term fuzzy logic is synonymous with any mathematical or computational system that reasons with fuzzy logic (Castillo, 2015).

At present, fuzzy logic is quite common and has great industrial application in different areas related to technology, such as electronics, control and robotics, among others. For example, in the automotive industry it has also been taken advantage of, Nissan has had an anti-lock braking system since 1997 that detects wheel speed, conditions and driving pattern, and diffuse ABS determines the braking action, with slip control (Von, 1994).

Since 1988, Hitachi has delivered the control of the Sendai metro to a diffuse system and has reduced errors in acceleration and braking by 70% (Ponce & Ramírez, 2010).

Applications in simpler systems have also been demonstrated, such as an environment regulator that is used to release hot air when the temperature is low and close it when the temperature is very high (Castaño, 2009).

A quadrotor helicopter or more commonly known as a drone, is an unmanned aerial vehicle that has four rotors, generally placed at the extremities of a cross. Control of vehicle movement is achieved by varying the relative speed of each rotor to change the thrust and torque produced by each of them (figure 1).

Figure 1 Dron cuadrirrotor Mavic Pro Platinum
Source: (DirectINDUSTRY)

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The use of drones is increasingly common within society, and the subject of drones continues to be investigated in different areas, such as the case of research aimed at the implementation of neural algorithms for stabilizing the flight of a drone carried out by students of the National Polytechnic Institute (Medina, 2017), the development of works to control the height of the AR.Drone 2.0 quadrotor using fuzzy logic (Campos etal, 2019), the design and construction of an unmanned aerial vehicle type quadcopter applying the law control based on sliding modes (Lara et al., 2017), and the application of diffuse systems applied to unmanned aerial vehicles for the monitoring of green areas (Balanza et al., 2016).

In this work, the design of an intelligent controller based on fuzzy logic for a Quadcopter built in open architecture is presented, it begins with the presentation of the prototype and later the design and programming of the fuzzy controller is carried out in LabVIEW software, presenting in an interface graphical trajectories followed by the prototype to achieve stabilization.

Design and implementation of the quadcopter in open architecture

A test bench was built to place the prototype and be able to experiment with it safely. The test bench had to withstand the loads and vibrations of the quadrotor.

Before manufacturing, it was designed in a CAD program (Computer Aided Design), the final result was the design shown in Figure 2, with dimensions at the base of 30 cm long by 2.5 cm wide, for the Side supports, pieces of the same material were used with measures of 20 cm high with the same width and a separation between each support of 15 cm. ¼ inch PTR was used for its physical construction.

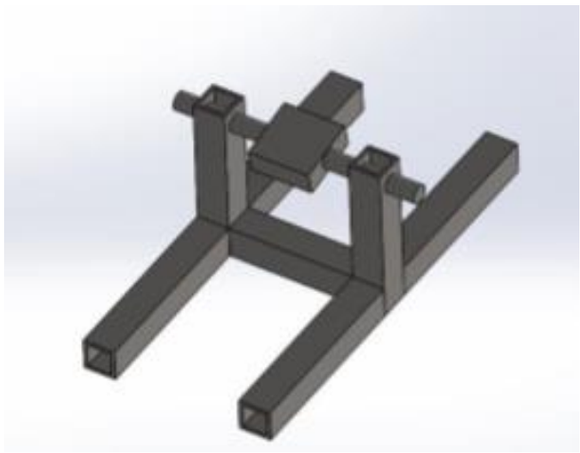

Figure 2 Testing bench
Source: Self-made

Figure 3 shows the result of the physical construction of the bench to place the quadrotor, in the lateral supports of the structure holes were made for the placement of a transverse axis, with the function of providing movement, in the same way I implement a wooden base with 4 holes for fastening with 2-inch screws.

Figure 3 Testing bench
Source: Self-made

For the base of the quadrotor where the circuits are mounted as well as the motors with their respective propellers, a frame designed with rigid plastic material was used for a quadrotor of the DJI brand model f450 resistant to shocks and vibrations, with mounting dimensions in the engines suitable for those required (Figure 4).

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Figure 4 Quadcopter frame f450
Source: (DJI)

Using the SolidWorks software, the scale model of the structure was made with the measurements corresponding to those of the physical frame (Figure 5), in the center of the structure there are two clamping plates, the lower plate is made copper coated with non-conductive paint, this is responsible for the connection with the battery and also the connection of the motors for its power supply, the upper plate is the base where the controller plate is located, providing accessibility to the circuits for adjusting values or settings in the program.

Figure 5 Scale Modeling of the Quadcopter Helicopter in SolidWorks
Source: Self-made

Figure 6 shows the quadcopter mounted on the test bench, as well as some of its components.

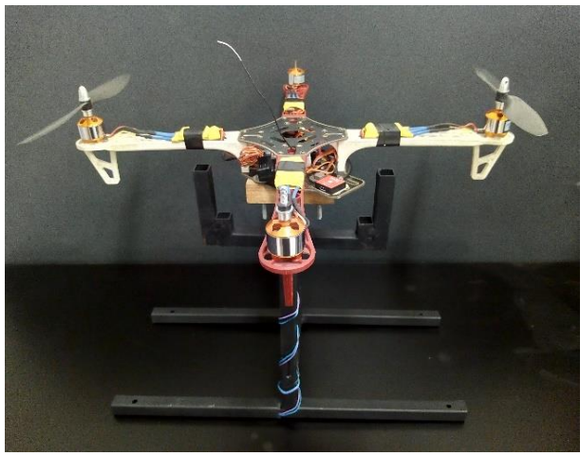

Figure 6 Quadrotor mounted on test bench
Source: Self-made

The main parts and devices that make up the prototype designed and developed entirely by the authors of the project are described below:

Brushless Motor A2212 / 13T 1000KV. Brushless or brushless motor controlled by PWM. Ideal for Quadcopter type flight systems. They are also used in fixed wing aerial vehicles. The motor supports up to 12A and it is recommended to use a 30A ESC controller, Figure 7.

Figure 7 Brushless motor
Source: (HETPRO)

This motor shows much higher performance than a brushed DC motor. When calculating the thrust with respect to the weight of the device, it was concluded that the kilovolts (kv) factor of these motors is sufficient to be able to lift. The "kv" factor in a brushless motor, normally appears next to the number of turns of the motor's winding, and what it indicates is the number of revolutions per minute at which it can turn for each volt of electricity applied to it.

Considering that the weight of the device is 1.2 kg with a consumption of 9.3 A, the force of a motor is 620 gr which is 6.076 N, there are 4 motors, so with a current of 37.2 A we have a vertical force of 24,304 N.

According to Newton's second law

$$F = m\,a$$
(1)

Where F is Force

m is mass.

a is acceleration.

Using (1) and taking into account that the mass is 1.2 kg, and the force is 24.304 N, the acceleration would be:

$$a = \frac{24.304\ N}{1.2\ kg} = 20.25\ m/s^2$$

And subtracting the acceleration from gravity:

$$a = 20.25\frac{m}{s^2} - 9.81\ \frac{m}{s^2} = 10.44\ \frac{m}{s^2}$$

So it is feasible to use the selected engines.

ESC (Electronic Speed Controller). Electronic device used to control the speed of the brushless motor through a Pulse Width Modulation (PWM) signal of 50 Hz and depending on the length of the pulse width, it will deliver more or less power to the motor (Figure 8).

Figure 8 Electronic Speed Controller
Source: (HETPRO)

Propellers They are implanted in the motors and are of the utmost importance since they oversee making the rotation of the motors produce a vertical force that pushes the air and can make the quadrotor take off from the ground and keep it there until the power of the motors is decreased by the user in control (Figure 9).

Figure 9 Propellers
Source: (HETPRO)

Li-Po battery. It is a type of rechargeable battery that is usually used in electronic radio control systems mainly in airplanes, helicopters and quadrotors, these batteries are usually small and light thus avoiding being a burden for the drone, since exceeding the weight they support can cause wear or failure of the engines (Figure 10).

Figure 10 Bateria Li-Po
Fuente: (DJI)

Data acquisition card (DAQ). The main component of the data acquisition system is the DAQ measurement hardware, which allows a computer to communicate with a physical process and interact with it, performing control tasks, recording signals, among others. The NI PCI-6251 card, M Series high-speed multifunction card, is used in this system (Figure 11).

Figure 11 NI PCI 6251 card
Source: (National Instruments)

To carry out a safe handling of signals in the quadrotor, a circuit was designed to isolate the PWM that is sent to the prototype, in this way, the PCI card used in the data acquisition system is protected.

The circuit that was designed for the PWM signals uses optocouplers for the separation of the PCI card with respect to the speed regulators of the brushless motors, in Figure 12 the circuit diagram is presented.

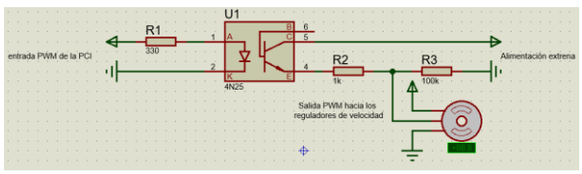

Figure 12 Protection circuit diagram
Source: Self-made

Figure 13 shows the electronic protection circuit developed.

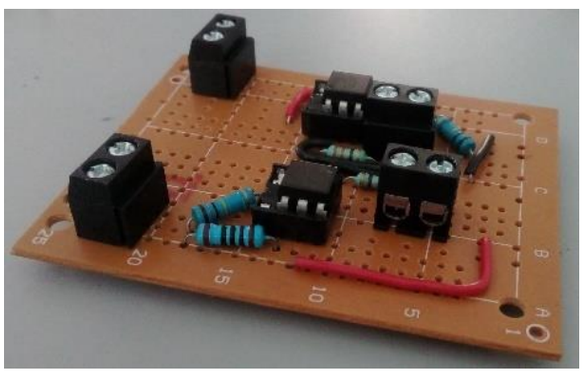

Figure 13 Protection circuit
Source: Self-made

On the other hand, a box was designed that would allow the battery that powers the quadcopter to remain fixed in the prototype and could be disconnected when recharging was necessary. The Solidworks program was used, which made it possible to design a plate that could be assembled to the quadrotor structure in a precise way.Once the plate model had been made, the 3D printing was continued, as shown in Figure 14.

Figure 14 Battery base
Source: Self-made

In Figure 15 you can see the equipment developed to experiment control techniques focused on handling quadrotors.

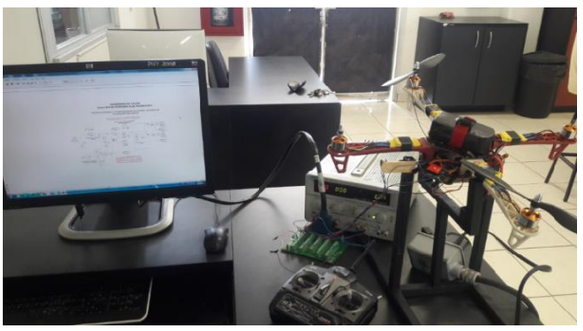

Figure 15 Experimental equipment
Source: Self-made

Fuzzy controller design

Figure 16 shows a block diagram of the control system, the reference value is the desired tilt value (0 ° value to keep the drone in a stable position), the fuzzy controller adjusts the rotational speed of the motors by means of the PWM signal so that these take the quadrotor to the desired position.

Within the process, the quadrotor may be subject to disturbances, which are reflected in its inclination. The drone's position generates a voltage variation through a potentiometer and the process is repeated until the desired position is reached (Figure 16).

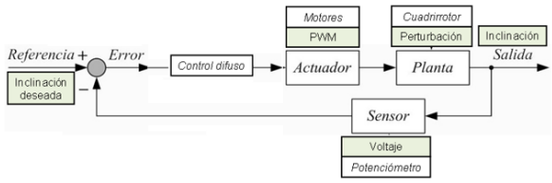

Figure 16 Closed loop control system diagram
Source: Self-made

Figure 17 shows the devices and equipment that make up the control loop and the connection between them, it is observed how the PWM signal generated by the fuzzy controller programmed in the computer is sent from the NI PCI 6251 acquisition card to the regulators speed, which are responsible for controlling the speed of the motors, responsible for modifying the position of the quadcopter. The drone inclination is read by the acquisition card through the voltage variation that is created in the potentiometer placed on the axis of the quadcopter base.

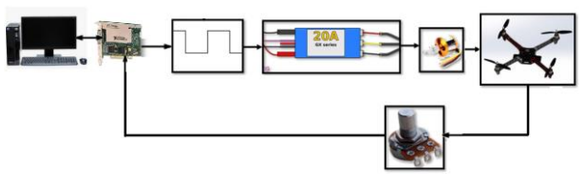

Figure 17 Components in the closed loop control system
Source: Self-made

The graphical interface and the programming of the controller was carried out in the LabVIEW graphical programming software, Figure 18 shows the block diagram of the program for reading the potentiometer that provides the inclination present in the drone.

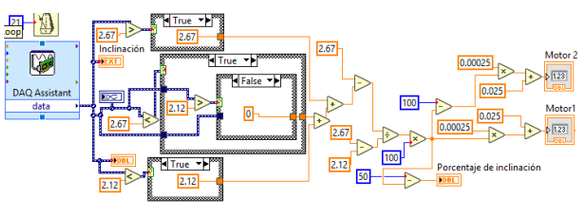

Figure 18 Program for reading the position of the drone
Source: Self-made

The variables involved in the fuzzy controller are the following:

- Inclination (given as a percentage, 100% corresponds to the incline fully to the right and 0% to the incline completely to the left).

- Input velocity (given in a range from -3.5 to 3.5, the sign el determines the direction of the velocity).

- Output speed (given in percentage, for later conversion to a duty cycle value).

They are listed in table 1 with the corresponding labels.

Angular tilt (percentage)		Relative angular velocity		Engine speed	
FI	Left End	MI	Very Fast Left	IV	Minimum speed
SI	Semifinal Left	RI	Fast Left	DL	Too slow
LI	Left side	PI	Little Fast Left	ML	Very slow
PI	Little Left	SV	No speed	LL	Slow
MI	Minimum Left	PD	Very Fast Right	PL	Little slow
CP	Center position	RD	Quick Right	NL	Nothing slow
MD	Minimum Right	MD	Little Quick Right	ME	Less than Normal
PD	Little Right			VM	Average speed
LD	Right side			MA	More than Normal
SD	Semifinal Right			NR	Nothing fast
FD	Right End			PR	Little fast
				RR	Quick
				MR	Very fast
				DR	Too quickly
				AV	Maximum speed

Table 1 Variable labels
Source: Self-made

Table 2 presents the rules programmed in the fuzzy controller to achieve stabilization of the drone.

Velocity \ Angular Tilt	FI	SI	LI	PI	MI	CP	MD	PD	LD	SD	FD
MI	AV / IV	AV	DL	AV	ML	AV	PL	AV	ME	AV	VM	RR	VM	PR	VM	NR	VM	MA	VM	VM	VM
RI	AV	DL	AV	ML	AV	ME	MR	VM	RR	VM	RR	VM	NR	VM	MA	VM	VM	VM	MA	VM	MA
PI	AV	ML	AV	ME	MR	VM	PR	VM	NR	VM	MA	VM	VM	VM	VM	MA	VM	NR	VM	PR	VM	RR
SV	AV	PL	MR	NL	PR	ME	NR	ME	MA	VM	VM	VM	VM	MA	ME	NR	ME	PR	NL	MR	PL	AV
PD	RR	VM	PR	VM	NR	VM	MA	VM	VM	VM	MA	VM	NR	VM	PR	VM	MR	ME	AV	ML	AV
RD	MA	VM	MA	VM	VM	VM	VM	MA	VM	NR	VM	RR	VM	RR	VM	MR	ME	AV	ML	AV	DL	AV
MD	VM	VM	VM	MA	VM	NR	VM	PR	VM	RR	VM	AV	ME	AV	PL	AV	ML	AV	DL	AV	IV	AV

Left engine / Right engine

Table 2 Fuzzy controller rules
Source: Self-made

The fuzzy controller was programmed using the Labview "Fuzzy System Designer" library. Figure 19 shows the membership functions of each of the variables used.

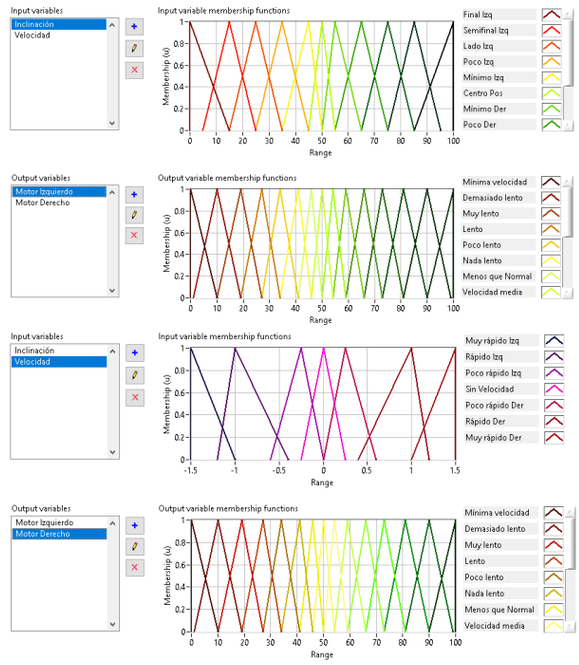

Figure 19 Membership features
Source: Self-made

To observe the transient response of the drone, an interface was designed, where some parameters necessary to interact with the prototype can be established, Figure 20.

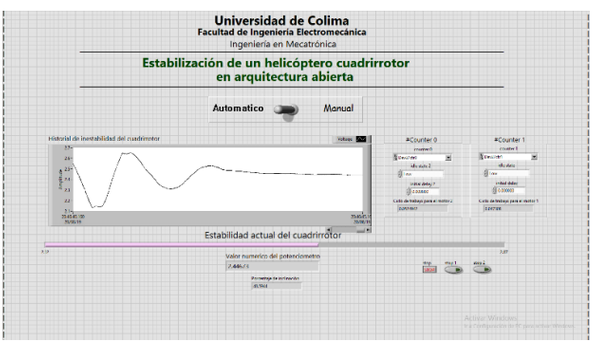

Figure 20 Graphic interface
Source: Self-made

Results

Different tests were carried out to observe the stabilization in the central position of the drone after experiencing a significant disturbance caused by a sudden change in the inclination and speed in it, Figure 21.

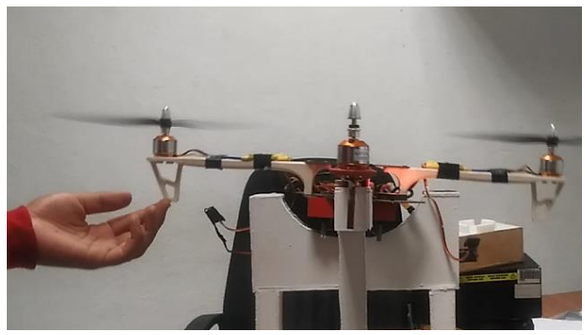

Figure 21 Drone subjected to a disturbance
Source: Self-made

The results of the tests are presented in Figure 22. The approximate time for the quadrotor to stabilize (0-degree tilt) after a disturbance is 7 seconds.

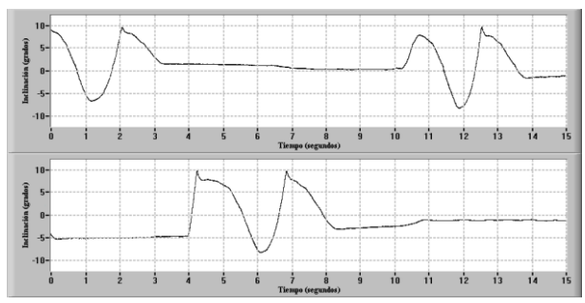

Figure 22 Graphs of the stabilization behavior of the quadrotor subjected to disturbances
Source: Self-made

Another test carried out was to bring the drone to the corresponding position of zero degrees starting from a state of rest. In this test, the drone was located on each side of the test bench structure, in Figure 23 it started from an initial position of -10 degrees and in Figure 24 from 10 degrees, in both cases it managed to be located at zero degrees in approximately 4 seconds.

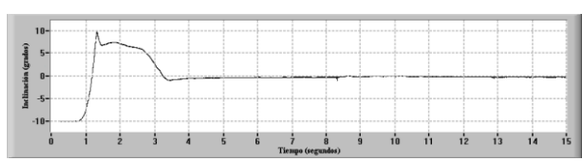

Figure 23 Quadcopter stabilization graph starting from a -10-degree tilt
Source: Self-made

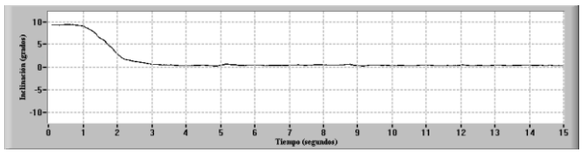

Figure 24 Quadrotor stabilization graph starting from a 10-degree tilt
Source: Self-made

Conclusions

With the development of this work, the usefulness of the implementation of a fuzzy system for the control of multirotor helicopters was demonstrated, the fuzzy control design does not require the mathematical model of the process, since it bases its operation on the knowledge of an expert, obtained with experience, and incorporates the common language to the design of the control system, adapting better to the real world as it works and understands our own expressions. For the controller design it was necessary to experiment with the drone through an interface, where the effects of the voltage variations received by the brushless motors could be observed.

The transfer to the control system of the specialized information regarding the form of control of the variables occurs in the construction of the rules, a very important and delicate stage, where several alternatives were considered, observing that with the greatest number of rules and functions of membership achieved a shorter stabilization time and a smoother transient response.

The importance of stabilizing drones today is extremely important, as they are currently used in many important tasks, such as sending packages and information through pre-programmed drones, the analysis of optimal terrain for construction through aerial captures, search and rescue tasks. Therefore, it is important to ensure stability during your flight, as there are many factors or disturbances that can intervene in it.

The stabilization objective of a drone was achieved with an intelligent control technique, applying tests with disturbances; as well as the quadrotor was able to return to a stable position and stay there from any initial position.

The prototype of the quadrotor built in open architecture will allow to continue experimenting with different control techniques for the development of future research works.

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To the Faculty of Electromechanical Engineering of the Universidad de Colima.

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A diagnostic about using educational technology and learning environments in the bachelor's degree program in Computational Sciences at Universidad Autónoma del Estado de Hidalgo

Diagnóstico del uso de tecnología instruccional y ambientes de aprendizaje en la Licenciatura en Ciencias Computacionales de la Universidad Autónoma del Estado de Hidalgo

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Abstract

Instructional Technologies and Educational Environments are tools that together improve academic performance and facilitate student learning, favorably impacting the ability to instruct without the presence of a teacher. However, these potentialities are not always taken advantage of maximum to achieve an effective learning process. In this article, a diagnostic evaluation of a Bachelor's educational program is presented, based on an evaluation instrument that was developed to evaluate the quality of an online educational program. The phenomenological method guided this research because it explored how teachers perceive the educational program in the aspects of instructional technology and learning environments. The purpose is to identify the strengths and weaknesses that the educational program shows because it is a program designed for face-to-face modality. Most of the findings found are weaknesses and it is attributed to the fact that the program was designed for face-to-face modality, which implies that work should be deal with the indicators that have been weak to improve their quality. The use of the results will be of great importance to make decisions and improve the quality of the program to be taught in virtual mode.

Learning environments, Diagnostic evaluation, Instructional technology

Resumen

Las Tecnologías de Instrucción y los Ambientes Educativos son herramientas que en conjunto mejoran el desempeño académico y facilitan el aprendizaje de los estudiantes, impactando favorablemente la capacidad de instruir sin la presencia de un maestro. Sin embargo, estas potencialidades no siempre se aprovechan al máximo para lograr un proceso de aprendizaje eficaz. En este artículo se presenta una evaluación diagnóstica de un programa educativo de Licenciatura, a partir de un instrumento de evaluación que fue desarrollado para evaluar la calidad de un programa educativo en línea. El método fenomenológico guió esta investigación porque exploró cómo los maestros perciben el programa educativo en los aspectos de tecnología instruccional y entornos de aprendizaje. El propósito es identificar las fortalezas y debilidades que muestra el programa educativo por ser un programa diseñado para la modalidad presencial. La mayoría de los hallazgos encontrados son debilidades y se atribuye a que el programa fue diseñado para modalidad presencial, lo que implica que se debe trabajar con los indicadores que han sido débiles para mejorar su calidad. El aprovechamiento de los resultados será de gran importancia para la toma de decisiones y mejorar la calidad del programa que se impartirá en modalidad virtual.

Ambientes de aprendizaje, Evaluación diagnóstica, Tecnología instruccional

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Introduction

The COVID-19 pandemic has had a considerable impact on the work of the human being, in the social, economic, political and academic aspects. In the latter, due to the radical change in the way in which students enrolled in face-to-face programs have had to receive their distance classes in this contingency period, regardless of academic level or school type (public or private). Such a situation, therefore, has forced the use of Information and Communication Technologies (ICT), considering or not, their intention in the instruction, which may result in learning with a lower quality than expected, since it is only to make use of technology, but the instructional design of the course and the skills and competencies that the teacher has in the use of Instructional Technology (IT) and Learning Environments (EA) is also important, to properly impart the teaching and so that students can acquire knowledge according to the learning objectives established in educational programs (COMIE, 2020).

Instructional technology is defined by the Association for Communications and Educational Technology (AECT, for its acronym in English) cited by Camacho and Benitez (2011, p. 5), as “the theory and practice of design, development, use, administration and evaluation of processes and resources for learning” while Camacho and Benitez (2011) define it as the use of appropriate technological resources for instructional purposes to facilitate learning and improve the academic performance of students. The Educational Environments or Learning Environments, Duarte (2003) defines them as the scenario where favorable learning conditions exist and develop. In these scenarios, there are participants such as students and teachers who develop capacities, competencies, skills and values. EA are designed to align the necessary elements and produce the expected results, technology being one of those elements that allow achieving the desired results. Using technology, educational materials can be created, the instructional design of the subject can be developed, an instructional system is created, that is, any product that improves academic performance and facilitates student learning (Groff, 2013).

Distance education supposes a transformation and innovation of the methodological strategies to teach classes (Verdezoto Rodríguez & Chávez Vaca, 2018) and leads to significant changes in the work of both the teacher and the student, seeking from the latter a greater participation in the educational process with the purpose of obtaining a meaningful and collaborative learning (Rojo Domínguez & Arregui Mena, 2017). However, not all teachers are prepared for such renewal and, consequently, these purposes are often not achieved.

This virtual modality has been on the rise in educational institutions. However, the quality assessment instruments for this modality type focused on the course design and not on the actions of the teacher who taught the course. However, both the course design and the skills and competencies of the teacher to handle technology as a tool to transmit knowledge are important, since a committed teacher can be successful in teaching a course despite poor instructional design and vice versa, a failure may occur in the course, despite a good instructional design, which means that the quality of the teacher is decisive for the quality of the course (Piña & Bohn, 2014).

The definition of quality in education is ambiguous and inconsistent for some authors, given that education is intangible, Bates (2015) cited by Lenert and Janes (2017) defines quality as: "... teaching methods that successfully help learners develop the knowledge and skills they will require in a digital age" (p. 2). Rubrics and various quality instruments have been used for years as quality measures of the educational program, the online course, the teacher's work, and the student's learning, among other aspects. The authors Newhouse, Buckley, Grant, and Idzik (2013); Parscal and Riemer (2010); Piña and Bohn (2014), and Roehrs, Wang and Kendrick (2013) cited by Lenert and Janes (2017) used the Quality Matters rubric which was designed between 2006 and 2007 to measure quality in the design of online courses, A few years later Shelton (2010) with the support of the Online Learning Consortium built an instrument for higher-level educational institutions to measure the quality of their online programs.

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In this context, there is a need to measure the quality of an educational program of any level, which is why evaluation or self-evaluation is used to diagnose the state in which it is. In this evaluation, different indicators are integrated that impact in some way on the use of IT and LE, such as infrastructure, instructional design and support of different kinds. As a result of the diagnosis, the strengths and weaknesses of the program will be detected, the latter aspects being the ones that must be addressed to improve the quality of the program. For these, strategies must be established, as well as planning and executing the corresponding actions to guarantee the continuous improvement necessary in the educational program.

The diagnostic evaluation of an educational program must be carried out by choosing an appropriate instrument, that is, one that has been designed with the objective of measuring aspects related to the combined use of IT and LE, in order that the results are adequate and according to the objective, and in the case of online or distance courses, the evaluation instrument must establish and implement more rigorous metrics to measure their quality (Wendler, et al., 2012).

In this article, a diagnostic evaluation of a higher-level educational program designed for face-to-face modality is carried out, which due to the COVID-19 contingency has had to change to virtual or online modality and it is required to know if the program meets the necessary elements in terms of instructional technology and educational environments to be taught in this last modality, for this reason a diagnostic evaluation instrument has been chosen for a higher-level educational program in virtual or online modality, whose indicators are related to IT and LE, and which is also a scorecard with very rigorous metrics to measure the quality of online courses in higher education, called "Quality scorecard for the administration of online education programs: a Delphi study" (Shelton, 2010).

The objective of this study is to identify the strengths and weaknesses in instructional technology and learning environments in the Bachelor´s degree program in Computational Sciences at Universidad Autónoma del Estado de Hidalgo (UAEH) through a diagnostic evaluation instrument in IT and LE. The problem detected is that it is unknown whether the BSC has elements at a satisfactory level in IT and LE aspects to be taught in virtual or remote mode, preserving or without impairing its quality.

Material and methods

The research design is cross-sectional, that is, a non-experimental method to collect and analyze data at a given time or period. The foregoing, due to the fact that a single application will be made to a teaching group and several variables will be investigated, being oriented to the design and implementation of an instrument to assess its results (Hernández, Fernández, & Baptista, 2014).

Studies with this type of design offer more descriptive results than experimental ones, which is ultimately what is sought since their objective is aimed at identifying the strengths and weaknesses of the use of instructional technology and learning environments in the educational program in particular.

On the other hand, it has a quantitative approach because the results are obtained from a diagnostic evaluation. As mentioned above, the evaluation instrument used was based on the work "Quality scorecard for the administration of online education programs: a Delphi study" (Shelton, 2010), because it is an instrument that was developed to evaluate the quality of an online or distance educational program, whose indicators are related to instructional technology and learning environments. Table 1 shows the 50 selected indicators, the indicator number, description and category to which it belongs are observed, according to the author's instrument.

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Indicator No.	Description	Category
10	Faculty, staff, and students are supported in the development and use of new technologies and skills.	Technological support
11	The minimum standards guidelines are used for course development, design, and delivery of online instruction.	Course development and instructional design
12	Technology is used as a tool to achieve learning outcomes in the delivery of course content.	Course development and instructional design
13	Instructional materials, course syllabus, and learning outcomes are periodically reviewed to ensure they meet program standards.	Course development and instructional design
14	The courses are designed for students to develop the knowledge and skills necessary to meet the learning objectives at the course and program level. These can include participation through analysis, synthesis and evaluation.	Course development and instructional design
15	Learning objectives describe outcomes that are measurable	Course development and instructional design
16	Selected assessments measure the learning objectives of the course and are appropriate for an online learning environment.	Course development and instructional design
17	Student-centered instruction is considered during the course development process.	Course development and instructional design
18	There is consistency in the development of the course for retention and quality of the student.	Course development and instructional design
19	The design of the course encourages the participation of teachers and students.	Course development and instructional design
20	Current and emerging technologies are evaluated and recommended for online teaching and learning.	Course development and instructional design
21	An instructional design is provided for creating an effective pedagogy for synchronous and asynchronous class sessions.	Course development and instructional design
23	The online course site includes a schedule that describes course objectives, learning outcomes, assessment methods, textbook information, and other related course information, making the course requirements transparent to the user. time of registration.	Course structure
24	The institution ensures that all distance education students, regardless of where they are located, have access to appropriate library / learning resources to support the courses they are taking (SACS statement).	Course structure
25	Expectations for student assignment completion, grading policy, and faculty response are clearly provided in the course syllabus.	Course structure
26	Links or explanations of technical support are available in the course.	Course structure
27	The instructional materials are easily accessible and usable for the student.	Course structure
28	The course adequately addresses the special needs of students with disabilities through alternative instructional strategies and / or referrals to special institutional resources.	Course structure
29	They provide opportunities / tools to encourage student-student collaboration (i.e. web conferencing, instant messaging, etc.).	Course structure
30	The documents attached to the modules are in a format that can be easily accessed with multiple operating systems and productivity software (PDF, for example).	Course structure
31	Student-to-student interaction and teacher-to-student interaction are essential features and are facilitated in a number of ways.	Teaching and learning
32	Feedback on student assignments and questions is constructive and provided in a timely manner.	Teaching and learning
33	Students learn appropriate methods for effective investigation, including assessment of the validity of resources and the ability to master resources in an online environment.	Teaching and learning
34	Students have access to library professionals and resources to help them cope with the overwhelming amount of resources online.	Teaching and learning
35	Instructors use specific strategies to create a presence in the course.	Teaching and learning
36	Students must be provided a way to interact with other students in an online community.	Social and student commitment
37	Technical assistance is provided in course development and assistance with the transition to online teaching [for faculty].	Teacher support

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38	Instructors are prepared to deliver distance education courses and the institution ensures that faculty receive training, assistance, and support at all times during course development and delivery.	Teacher support
39	Teachers receive training and materials related to fair use, plagiarism, and other relevant legal and ethical concepts.	Teacher support
40	Teachers receive ongoing professional development related to online teaching and learning.	Teacher support
41	Clear standards are set for teacher engagement and expectations around online teaching.	Teacher support
42	Workshops are held for teachers to inform them about emerging technologies and the selection and use of these tools.	Teacher support
43	Before starting an online program, students are counseled on the program to determine whether they possess self-motivation and a commitment to distance learning.	Student support
44	Before starting an online program, students are advised on the program to determine if they have access to the minimum technology required by the course design.	Student support
45	Students receive (or have access to) program information, including admission requirements, tuition and fees, books and supplies, technical and supervisory requirements, and student support services prior to admission and course registration.	Student support
46	Students have access to the training and information they will need to secure the required materials through electronic databases, interlibrary loans, government archives, new services, and other sources.	Student support
47	Throughout the duration of the course / program, students have access to appropriate technical assistance and technical support personnel.	Student support
48	Student support staff is available to address student questions, problems, bug reports, and complaints.	Student support
49	Students have access to effective academic, personal, and career counseling.	Student support
50	Minimum technology standards are established and made available to students.	Student support
51	Student support services are provided outside of the classroom, such as academic advising, financial assistance, peer support, etc.	Student support
53	Students receive relevant information: ISBN numbers, providers, etc. and modes of delivery for all the required; Instructional materials: digital format, electronic packages, print format, etc. to ensure easy access.	Student support
54	The program demonstrates a student-centered approach rather than trying to tailor the distance education student service to the student services on campus.	Student support
56	Students are instructed in appropriate ways to communicate with faculty and students.	Student support
57	The institution provides guidance to both students and faculty in the use of all forms of technologies used for the delivery of the course.	Student support
58	Tutoring is available as a learning resource.	Student support
59	Students are instructed on the appropriate ways to get help from the program.	Student support
62	The expected learning outcomes at the course and syllabus level are regularly reviewed to ensure clarity, usefulness, and appropriateness.	Evaluation and assessment
64	The retention of courses and programs is evaluated. The results of the course assessments are used as part of the teacher / instructor performance assessments.	Evaluation and assessment
67	Course evaluations are examined in relation to teacher performance evaluations.	Evaluation and assessment

Table 1 Indicators for the diagnostic evaluation of the bachelor's degree program in Computational Sciences
Source: (Shelton, 2010)

Then, having defined the indicators to be evaluated, a questionnaire was used as a means to carry out the diagnostic evaluation, which is the most used instrument to collect the data.

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This questionnaire consisted of a set of 50 questions related to eight categories, distributed as follows: 1 indicator from the Technological Support category, 11 indicators from the Course Development and instructional design category, 8 indicators from the Course structure category, 5 indicators from the Teaching and learning category, 1 indicator from the Social and student commitment category, 6 indicators from the Teacher support category, 15 indicators from the Student support category, and 3 indicators from the Evaluation and assessment category .

The questions are closed and contain categories or response options that have been previously delimited, for which the Likert-type scale was used, with four response options, which are: Fully compliant, Moderate use, Insufficiently observed and Not observed. Each indicator is worth up to three points, with the following values:

- Not observed. It refers to the fact that no presence of the indicator to be evaluated is observed, so its score is 0 points.

- Insufficiently observed. It refers to the fact that a slight existence of the indicator has been found, however, it needs to improve in this area, so its score is 1 point.

- Moderate use. It corresponds to the fact that a moderate use of the quality indicator has been found, however, some improvement is needed in this area, so its score is 2 points.

- Fully compliant. It refers to the fact that the quality standard is being fully implemented and does not require improvement in this area, so its score is 3 points.

This way of working the questions has the purpose of facilitating the coding of the results and, consequently, their analysis.

Once the means to obtain the information of interest has been defined, the population to be studied is defined and the results are to be generalized over. The population, that is, the number of teachers who teach at the BSC is 90, however, due to the COVID-19 contingency, 36 teachers were contacted through email and / or cell phone number, to whom it was the invitation to answer the questionnaire. Therefore, the size of the universe of 36 teachers was considered, the margin of error was estimated at 10% and the confidence level was 90%, with these data the size of the sample that is calculated is 24 teachers, the calculation is obtained through the use of online sample calculators (Asesoría Económica & Marketing, 2009; netquest, 2020). The instrument was applied to 36 teachers, and 25 answered, which represents 69.4%.

Finally, making a summary of the steps of the methodological design, the following phases were carried out:

- Selection of indicators in Instructional Technology and Learning Environments of the diagnostic evaluation instrument (Shelton, 2010).

- Creation of the evaluation instrument in Google Forms (Google, 2020).

- Organization of results.

- Analysis and discussion of results.

Evaluation application results

Once the diagnostic evaluation instrument was applied to the teachers of the BSC educational program, the results that are presented below were grouped by category in order to promote a discussion of the aspects that could be improved to achieve an educational quality in the remote mode. The data of each category were managed by graphs of two types:

- Categories with a single indicator: Percentage of the teachers number in each of the possible answers (level of development of the category).

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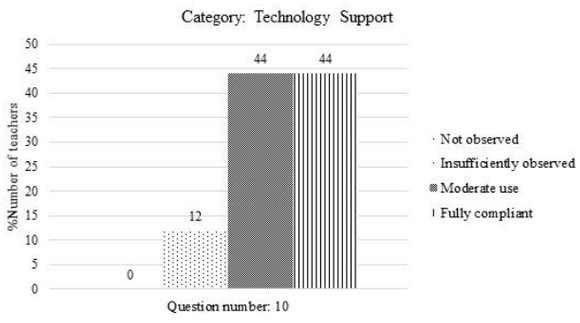
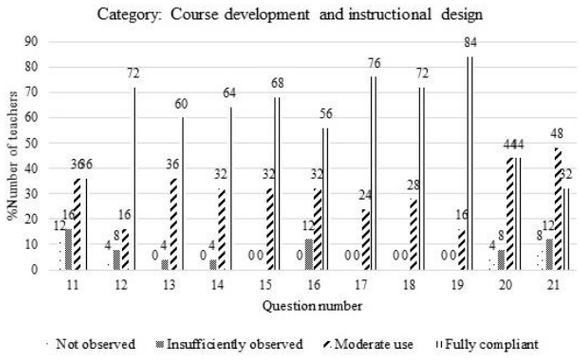
- Categories with more than one indicator: Percentage of the teachers number by the indicator number evaluated in that category, each line indicates one of the possible responses (level of development of the category).

The results obtained in the diagnostic evaluation by categories of the Shelton instrument (2010) are presented below. Graphic 1 shows the percentage of the number of teachers who evaluated the only indicator of the Technological Support category; In Graphic 2, the results obtained in 11 indicators of the category Course development and instructional design can be observed (questions from number 11 to 21).

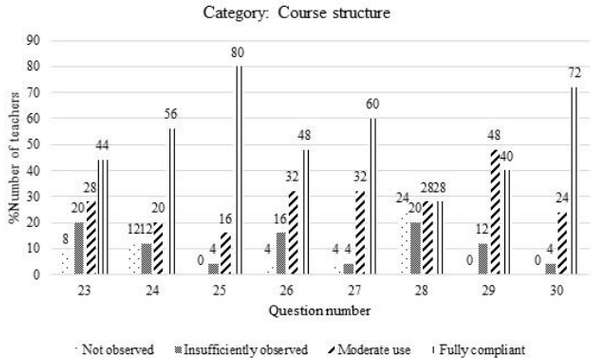
In Graphic 3, we can see the results obtained in the eight indicators of the course structure category (questions 23 to 30); Graphic 4 shows the results of five indicators in the Teaching and learning category (questions 31 to 35); As well as in Graphic 5, the results obtained in the indicator corresponding to the category Social and student commitment are shown (question 36).



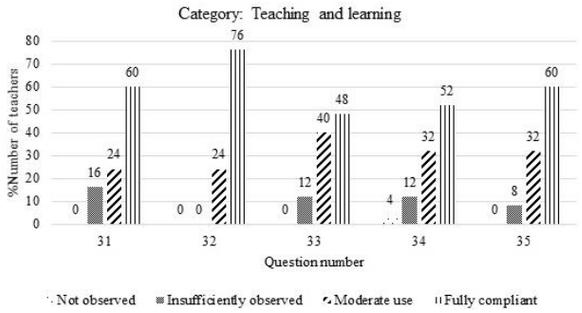
Graphic 1 Results obtained in the Technological Support category



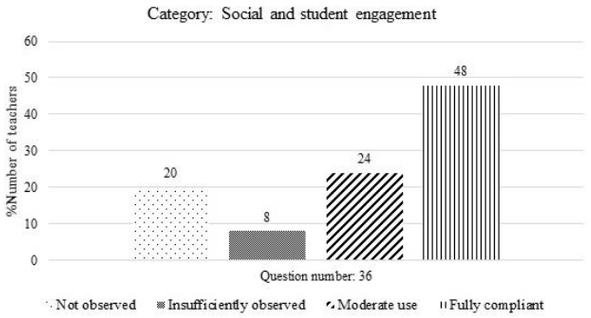
Graphic 2 Results obtained in the category of Course development and instructional design



Graphic 3 Results obtained in the Course structure category

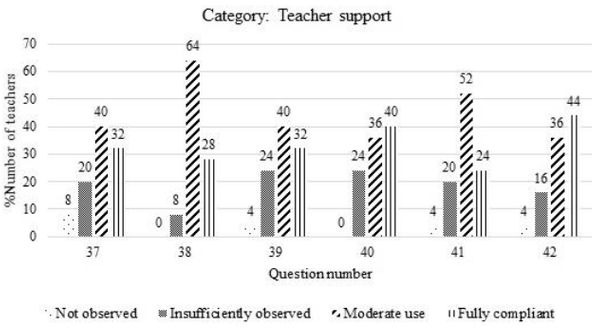


Graphic 4 Results obtained in the Teaching and learning category

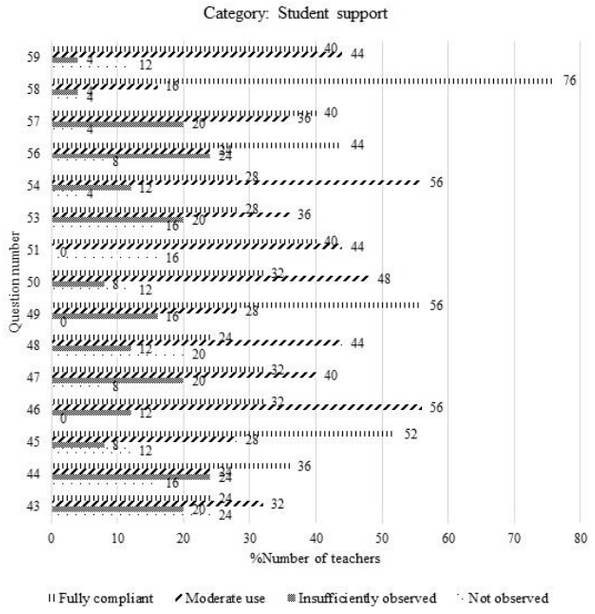


Graphic 5 Results obtained in the category of Social and student commitment

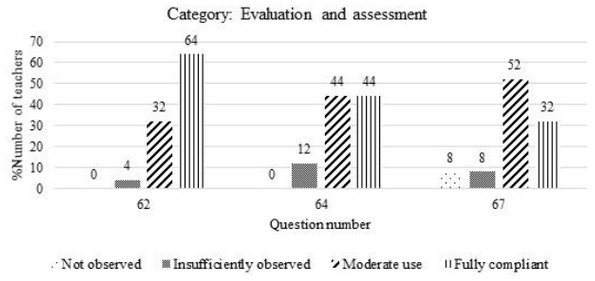
In Graphic 6, the results obtained in the six indicators of the Teacher support category are presented (questions 37 to 42); In Graphic 7, the results obtained in 15 indicators of the Student support category can be observed (questions from 43 to 51, questions 53 and 54, and questions from 56 to 59), and finally, in Graphic 8, the results obtained in the three indicators of the Evaluation and assessment category (questions 62, 64 and 67) are shown.



Graphic 6 Results obtained in the Teacher support category



Graphic 7 Results obtained in the Student support category



Graphic 8 Results obtained in the Evaluation and assessment category

Discussion and analysis of results

For the analysis of the results, it has been considered that an indicator is a weakness if any of the options Insufficiently observed and Not observed has been selected by any of the respondents, therefore, it is evaluated as a strength if none of these options has been selected.

Under this criterion, the results have identified some strengths in two categories, being the same: Course development and instructional design (indicators 15, 17, 18 and 19), and the Teaching and learning indicator (indicator 32), in the rest of the categories weaknesses were identified. Each specific category is discussed below.

The categories of Technological support, and Social and student commitment have a single indicator, in which it is shown that teachers are dissatisfied with these services, having evaluated them with 12% and 28%, in the options of Insufficiently observed and Not observed respectively (See Graphic 1 and Graphic 5). From what can be seen that faculty, staff and students do not receive sufficient support in the development and use of new technologies and skills.

In the category of Course development and instructional design, there are seven of the 11 indicators with at least one dissatisfied teacher (See Graphic 2), which implies that in this category, the BSC educational program does not comply with aspects such as: minimum standards for course development, design and delivery of online instruction, use of technology to achieve learning outcomes, periodic review of instructional materials, and having an instructional design for synchronous and asynchronous classroom sessions, in other aspects. It should be mentioned that instructional design is a very important part in the integration of technologies in the teaching-learning process (Moranchel Pocaterra, Morales Franco, & Quiñónez Salcido, 2017), since it is where knowledge is planned and organized, didactic materials, activities, evaluations and the sequence of contents, among other educational resources, all this favors meaningful learning of students (Molina & Molina, 2002; Zapata, 2013), so it is important to establish actions and follow up to improve the aspects of this category in the program.

In the Course structure category, the eight indicators (from 23 to 30) are considered weaknesses, since at least one teacher has evaluated them as Insufficiently observed, and in five of the eight indicators (23, 24, 26, 27 and 28), in addition, they evaluated it in the category of Not observed (See Graphic 3).

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This situation reveals that the educational program lacks most of the indications included in this category, which are: the information that must be included on the course website, such as the program that describes the objectives, learning outcomes, evaluation methods and bibliography, among others; that the institution guarantee access to library/learning resources for distance education students; that technical support links or explanations are available in the course; that instructional materials are accessible and usable for the student; in other aspects.

In the Teaching and learning and Evaluation and assessment categories, although most of their indicators were evaluated as Insufficiently observed, they only have one indicator evaluated as Not observed (See Graphic 4 and Graphic 8).

From the evaluation in the Teaching and learning category, it can be seen that some of the teachers consider that there is little interaction from student to student and from teacher to student; they also point out that students learn little about appropriate methods for effective research, including evaluating the validity of resources and the ability to master resources in an online environment; similarly, some teachers state that they lack specific strategies to make students perceive their presence in the course. Finally, at least one teacher believes that students do not have access to library professionals and resources to help them cope with the overwhelming amount of online resources.

Regarding the category of Evaluation and assessment, it can be observed that some teachers consider that the learning results expected at the course and program level are not regularly reviewed to guarantee clarity, usefulness and appropriateness; nor are the results of the evaluations carried out on the course used as part of the teacher's performance evaluations; and, at least one teacher believes that course evaluations are not tested in relation to teacher performance evaluations.

In the Teacher support category, although all the indicators were evaluated as Insufficiently observed, in four of these, at least one teacher also evaluated it as Not observed (See Graphic 6).

This finding allows us to perceive that teachers feel dissatisfied in aspects such as technical assistance in the development of the course and support in the transition from online teaching, in training and materials related to plagiarism and other legal and ethical concepts, as well as, in training on the selection and use of emerging technologies, among others.

In the Student support category, 12 of the 15 indicators were evaluated as Not observed, so this category is one of the greatest weaknesses that the program has, since teachers consider that it lacks the services that it should include (See Graphic 7), which are: before starting an online program, students are advised about the program to determine if they have self-motivation and a commitment to distance learning; students are advised on the program to determine if they have access to the minimum technology required by the course design; student support staff is available to answer questions, problems, bug reports and complaints from students; student support services are provided outside of the classroom, such as academic counseling and financial assistance; students receive relevant information such as ISBN numbers, providers, among others; students receive instructional materials in digital format, electronic packages, and print formats, among others, to ensure easy access; students are instructed in appropriate ways to communicate with faculty and students; and tutoring is available as a learning resource; in other aspects.

Conclusions

The results achieved in this study have made it possible to punctually identify the aspects that must be addressed in the educational program to provide quality training in the virtual modality. It is noteworthy that some of the categories such as institutional support, teacher support and student support are currently being worked on by the university management, in response to the situations presented during the COVID-19 contingency, where all the educational programs of the institution abruptly went from face-to-face to virtual mode. For the remaining categories, an improvement plan has been developed where specific strategies have been defined in order to work on the identified weaknesses.

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Two extremely important aspects stand out in this study that favorably affected the scope of the research objective, the first, referring to the instrument selected as the basis, which has been improved over the years by its authors in order to deeply examine the aspects that affect the quality of an educational program in terms of instructional technology and learning environments. As a second aspect, but of equal relevance, the objective participation of teachers that allowed us to have an X-ray of the current state of the program.

The work carried out represents one more effort, of all those who have been endeavouring to enrich the distance modality, especially in raising awareness of all its actors so that they can contribute individually and collectively to evolve towards a quality virtual educational process.

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† Researcher contributing as first author.

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General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

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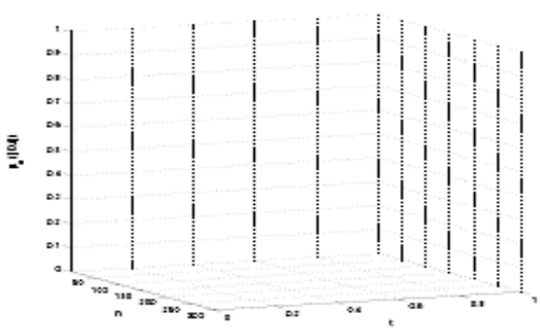

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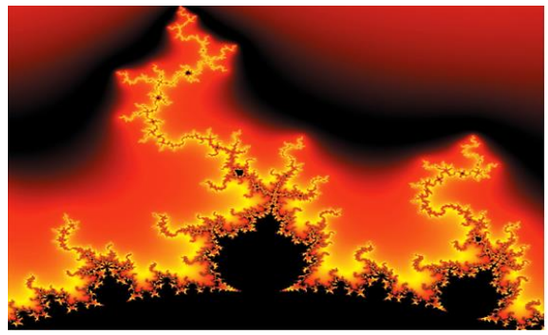

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Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources

Thanks

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Conclusions

Explain clearly the results and possibilities of improvement.

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