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Presentation of content

In the first article we present, *The design of pedagogical technology and the staff formation as central elements in education, mediated by ICT*, by MARTÍNEZ-MÁRQUEZ, Marco Antonio, with adscription in the Universidad de Guadalajara, in the next article we present, *Design and prototyping of an automated didactic medicine* dispenser, by ECHANDI-PACHECO, Rodolfo, with adscription in the Universidad Fidélitas, in the next article we present, *Analysis of the use of the cell phone in the learning process of the students of The Superior Technique in Industrial Processes of the UTNA*, by VAZQUEZ-GUTIERREZ, Rosa Inés, with adscription in the Universidad Tecnológica del Norte de Aguascalientes, in the next article we present, SiO_2-PDMS as oil removal system, by GÓMEZ-LÓPEZ, Rosa Viridiana, SALAZAR-HERNÁNDEZ, Mercedes, MORENO-PALMERIN, Joel and SALAZAR-HERNÁNDEZ, Carmen, with adscription in the Instituto Politécnico Nacional and Universidad de Guanajuato.

Content

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The design of pedagogical technology and the staff formation as central elements in education, mediated by ICT

El diseño tecno-pedagógico y la formación docente como elementos centrales en la educación mediada por TIC

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Abstract

It is unquestionable that during the last decades the use of ICT has increased in the education field, this driven by the dictated policies through organizations such as UNESCO, that promote the importance of innovating the teaching process, improve learning, to democratize education and for students to acquire the skills that the actual and future workforce will demand from them; Nevertheless the health contingency caused by COVID-19 that forced schools to transition from in person instruction and a hybrid to an online model, it demonstrated several shortages and problems. For example, the lack of technological equipment, the limited connectivity to the internet, the training of faculty for the design and administration of virtual classrooms. With that said, the following article covers the design of pedagogical technology and staff formation, as central elements that allow the interests of an institution that decides to incorporate the use of technology to the education process and the results it obtains; Therefore, so looking for the vivid experience during the last two years, let it be the starting point to take advantage of a better manner the implicit potential that technology has to optimize the educational process.

Education, ICT, Use, Design of pedagogical technology, Staff formation

Resumen

Es incuestionable que durante las últimas décadas el uso de las TIC se ha incrementado en el ámbito educativo, esto, impulsado por políticas dictadas por organismos como la UNESCO, que promueven la importancia de innovar los procesos de enseñanza y mejorar los de aprendizaje, democratizar la educación y que los estudiantes adquieran las competencias que les demanda el mercado laboral actual y futuro; sin embargo, la contingencia sanitaria ocasionada por el COVID-19, que obligó a las escuelas a pasar de modalidades presenciales y mixtas a una modalidad en línea, evidenció diversas carencias y problemas, como la falta de equipamiento tecnológico, de conectividad a internet y de capacitación del profesorado para el diseño y administración de aulas virtuales; en este sentido, en el presente trabajo se habla del diseño tecno-pedagógico y la formación docente, como elementos centrales que permiten alinear los intereses de una institución que decide incorporar el uso de tecnologías a los procesos educativos y los resultados obtenidos; lo anterior, buscando que la experiencia vivida durante los dos últimos años, sea el punto de partida para aprovechar de una mejor manera el potencial implícito que tienen las tecnologías para optimizar los procesos escolares.

Educación, TIC, Uso, Diseño tecno-pedagógico, Formación docente

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Introduction

Today more than ever it is clear that information and communication technologies play a central and indispensable role in the development of society; they have modified the way in which people communicate, produce, share and access knowledge, work, and even spend leisure time; However, their incorporation and use in the educational environment has encountered a series of difficulties related to the lack of economic resources of schools, teachers and students to access them, keep updated, have internet connection, digital literacy and resistance to change, among others, This has been aggravated in the last year by the health contingency caused by COVID-19, which forced education systems to abruptly switch from face-to-face and mixed modalities to an online modality, and which has resulted in a greater impact on the most vulnerable, increasing dropout and failure rates.

In this sense, the document offers a referential framework for the construction of a techno-pedagogical design, understood as a set of technological tools made available to teachers and students, accompanied by an explicit, global and precise proposal on the best way to use them; and a comprehensive teacher training program that, under a collaborative model, considers the so-called categories of the knowledge base, understood as the common places that provide a basis for teachers to ensure success in the teaching-learning processes.

The proposal presented here is based on the policies and guidelines that UNESCO has been dictating since the end of the last century and that emphasize the importance of using ICT in education, to democratize access to schools, improve teaching-learning processes and prepare students for the labor market to which they are destined, but also, based on the impact caused by the health crisis we are experiencing, which puts at risk not only Sustainable Development Goal 4, related to quality education, but also the access to education as a fundamental human right and the exercise of other rights for which it is an enabler, threatening to become a generational catastrophe, by causing a setback in education worldwide.

Education and ICT

According to UNESCO (1998), information and communication technologies were the instruments that modified knowledge in society, making it possible to increase productivity and consequent economic development. This generated high expectations about what could be achieved with their incorporation into education, in addition to considering it as an unavoidable issue to innovate teaching processes and improve learning processes, democratize access to schools and ensure that students acquire the skills demanded by a new labor market, where technological tools play a predominant role.

In this sense, UNESCO has made multiple and constant efforts to influence the world's education systems, beginning with the World Declaration on Higher Education in the 21st Century (1998), based on questions such as: what kind of education do we want? and for what kind of society? whose objective was to establish the principles that should govern the reform of higher education systems. The declaration was based on the idea of the existence of a global, complex and changing society, where education must contribute to building peace, based on a process of development, equity, justice, solidarity and freedom.

The work of this Conference was organized into three areas and four debates in each, the first being: higher education and development; higher education, culture and society; and, new trends and innovations in the field of higher education, where, as can be seen, in the third area great importance was given to technology-mediated education, and the debates were on: higher education for a new society; from the traditional to the virtual; higher education and research; and, the contribution of higher education to the education system as a whole, determining that:

> At the dawn of the new century, there is an unprecedented demand for higher education, accompanied by a great diversification of it, and a greater awareness of the fundamental importance of this type of education for socio-cultural and economic development and for the construction of the future, for which the new generations must be prepared with new skills, knowledge and ideals (UNESCO; 1998: 19).

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In general terms, UNESCO proposed that countries modify their education systems and introduce policies to enable their schools to build networks and exchange experiences; create pedagogical environments capable of bridging distances, favoring social and economic progress; take advantage of ICTs for educational purposes; adapt technologies to national and local needs; facilitate the identification of objectives and interests of countries, as well as equitable access to technological infrastructure; follow the evolution of the knowledge society to ensure quality and equitable access rules; and, taking into account the potential of ICTs, consider that it is the schools that should use them to modernize their work, and not vice versa.

The World Declaration on Higher Education in the 21st Century was followed by various documents to guide academic work in the new century, including a planning guide on information and communication technologies in teacher training (UNESCO; 2004), which, although based on the idea that ICTs have had a profound impact on teaching and learning, transforming the way in which teachers and students access knowledge and training, at the same time recognizes that in order to effectively take advantage of the potential of new technological tools, essential conditions must be met, such as:

- Students and teachers must have sufficient access to digital technologies and the Internet in classrooms, schools and teacher training institutions.

- Students and teachers must have at their disposal educational content in digital format that is meaningful, of good quality and that takes into account cultural diversity.

- Teachers must have the necessary skills and knowledge to help students achieve high academic levels through the use of new digital resources and tools (UNESCO; 2004: 13).

The proposal thus highlights the importance of understanding the impact of technology on society and its repercussions on education, of considering the context for the integration of technologies in schools, of developing standards in teacher training, of following up on the stages of teacher development and the competencies they must acquire, and of generating student-centered learning environments (UNESCO; 2004).

In the same sense, the work Towards Knowledge Societies (UNESCO; 2005), insists on the leading role that technological innovations have played in society and their potential in the educational field, stating that:

> "The radical changes brought about by the third industrial revolution - that of the new technologies - have in fact created a new dynamic, because since the middle of the twentieth century the formation of individuals and groups, as well as scientific and technological advances and cultural expressions, have been in constant evolution, especially towards ever greater interdependence. (UNESCO; 2005: 5).

But, notwithstanding the change mentioned, the work also recognizes that achieving a public sphere of knowledge is still an unfulfilled ideal, where ICTs and the Internet seem to open new perspectives for the expansion of the public space of knowledge, questioning whether the means are already in place to allow equal and universal access to knowledge, as well as a shared use of it, as a human right, considering that: "This must be the touchstone of authentic knowledge societies, which are sources of human and sustainable development" (unesco; 2005: 17). (UNESCO; 2005: 17).

Finally, within the framework of the educational reform proposed by UNESCO since the end of the last century and in the first decade of the current one, which seeks to develop new skills in students, supporting their social and economic progress, the work called ICT competence standards for teachers (2008) stands out, with the following objectives:

- To develop a common set of guidelines that professional training providers can use to identify, develop or evaluate learning materials or teacher training programs for the use of ICT in teaching and learning.

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- Provide a core set of qualifications that enable teachers to integrate ICT into their teaching and learning activities in order to enhance student learning and optimize the performance of their other professional tasks.

- To expand the professional training of teachers to complement their skills in pedagogy, cooperation, leadership and innovative school development with the use of ICT.

- Harmonize the different ideas and vocabulary related to the use of ICT in teacher training (UNESCO; 2008: 4).

In this regard, it is important to mention that this document is a proposal addressed to decision makers in educational institutions, with the purpose of working both in the construction of curricula, or in their updating, to adapt them to reality, as well as in the offer of courses that allow teachers to prepare themselves for a new educational context, which will help their students to acquire the skills required for their professional training.

The above is part of the work carried out by UNESCO in the field of education and through which it aims to influence most countries to incorporate ICT into their education systems, and where progress is recognized, but also shortcomings and major challenges, having so far extremely varied results due to multiple factors, such as the economic capacity of schools, teachers and students to access updated and appropriate technological tools, digital literacy, availability of appropriate educational content, precise and concrete policies and guidelines on the objectives pursued and even the school culture and resistance of its actors to change, even more so, in the conditions we have been living in for almost two years, due to the health contingency caused by COVID-19, which has put schools around the world to the test, as discussed in the following section.

Education and COVID-19

While it is true that the world's education systems have recognized the importance of using ICTs in the teaching and learning processes, it is no less true that the health emergency we have been going through since the end of 2019 has shown that neither schools, nor teachers and students were prepared to move from face-to-face or mixed modalities to an online modality, as shown by studies conducted by the UN, UNESCO and ECLAC.

Education during and after COVID-19. United Nations Policy Brief.

According to the UN (2020), the health contingency caused by COVID-19 has caused the world's education systems the greatest disruption on record, leading schools to implement an online modality, affecting almost 1.6 billion students in more than 190 countries, aggravating pre-existing disparities by reducing opportunities for the most vulnerable. It also highlights that the losses in terms of learning may extend to the next generation, leaving behind the progress achieved in decades, as almost 24 million students are at risk of not having access to school or dropping out due to the economic problems caused by the disease.

This becomes relevant when we look at the differences between developed countries and those where their populations have barely enough to subsist.

A relatively small number of countries are tracking the actual extent and use of distance education modalities. However, projections show variable coverage: in high-income countries distance education reaches 80-85%, while that figure drops to less than 50% in low-income countries. This deficit can largely be attributed to the digital divide, given that the disadvantaged population has limited access to basic household services, such as electricity; a lack of technological infrastructure; and low levels of digital literacy among students, parents and teachers (UN 2020: 13, 14). (UN 2020: 13, 14).

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Notwithstanding the above, some positive aspects have been identified, which should be worked on with greater emphasis, recognizing that the current situation has stimulated innovation by resorting to various technological means in schools to maintain communication and develop distance education solutions, The essential role of teachers has been recalled, which is considered to be inseparable from quality education, without leaving behind the most vulnerable, which depends on students having an enabling environment and resources to access learning, as well as teachers having better training on the educational methods required today.

Thus, in the face of uncertainty about the return to face-to-face classes, and considering that the right to education is a fundamental human right, and at the same time enabling of others, the UN (2020) proposes the following:

- Reduce transmission of the virus and plan thoroughly for the reopening of schools.
- Protect education financing and coordinate to achieve results.
- Create resilient education systems for equitable and sustainable development.
- Respect education and accelerate change in teaching and learning.

The call is, then, to make education a priority, both for governments and for the world's education systems, to prevent the current crisis from becoming a generational catastrophe that puts at risk the human right of access to education, and other rights that depend on it, being necessary to work on proposals that contribute to the fulfillment of Sustainable Development Goal 4, called Quality Education.

Education in time of the COVID-19 pandemic. COVID-19 Report. ECLAC-UNESCO.

In the same sense as the UN, ECLAC and UNESCO, in their COVID-19 report (2020), state that the pandemic caused by the SARS-COV-2 coronavirus has provoked an unprecedented crisis, leading to the massive closure of schools, affecting more than 160 million students in Latin America and the Caribbean, This will increase the gap between those who can access distance education and those students from countries and regions with lower incomes, especially those living in rural areas, where indigenous people and migrants also tend to live.

The report also states that in the face of the crisis being faced, the main measures have been the suspension of classes; and, as a consequence: "the deployment of distance learning modalities...; the support and mobilization of educational personnel and communities, and attention to the health and well-being of students" (ECLAC-UNESCO; 2020:1).

In this order of ideas, the document in question focuses on two issues: on the one hand, to make visible the consequences that these measures will have, and on the other, to make recommendations to cope with the impact, projecting areas of opportunity to innovate education and improve learning.

As consequences, there is talk of a direct impact on the academic training of students, noting that while it is true that governments have made significant efforts to give continuity to educational processes through the use of ICTs, considering that they have access to multiple pedagogical and knowledge resources, it is no less true that the countries of Latin America and the Caribbean have made significant efforts to improve the quality of education through the use of ICTs, It is no less true that the countries of the region were unequally prepared to face the problem, since significant gaps persist in access to the digital world, both in schools whose resources are insufficient to keep them up to date, and in homes, where the main device for connecting to the network continues to be the mobile phone, with the limitations that its use in the school environment entails.

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However, as areas of opportunity to lessen the impact of the current crisis, the importance of adapting the evaluation processes is mentioned, which has to do with the monitoring of learning, evaluation and feedback, in order to know what has been the progress of students and, based on this, make decisions and carry out actions to improve for their benefit; It also refers to the need to support teachers and principals, who have played a central role, responding to emerging demands, re-planning and adapting teaching-learning processes, adjusting methodologies, reorganizing the curriculum and designing subjects and diversifying the means, formats and work platforms; finally, it also mentions the need to prioritize vulnerable groups, that is, to guarantee an inclusive, equitable and quality education, with learning opportunities for all and throughout their lives.

According to ECLAC and UNESCO, the crisis being experienced in all social spheres, and especially in schools, should be a turning point to:

> "rethink education, giving priority among the new contents to preparing students to understand reality, to live and act in times of crisis and uncertainty, to make decisions at the individual and family level, and to promote collective solutions to urgent challenges that contribute to the structural transformation of the world." (ECLAC-UNESCO; 2020:17).

Thus, taking into consideration the above-mentioned background, attention is now focused on the importance of techno-pedagogical design and teacher training as central elements in ICT-mediated education, considering that the current crisis should be the turning point that gives technological tools, in the educational field, the relevant role they should have had for many years.

Techno-pedagogical design and teacher training in ICT-mediated education

The purpose of this section is to present a proposal that contributes to achieve a better alignment between what educational institutions seek with the incorporation of ICT into teaching-learning processes and the results that are achieved, taking into account ideas such as the following:

> "The fundamental argument for continuing to maintain a high level of expectations in the educational potential of ICT... is... their taking into consideration as tools for thinking, feeling and acting alone and with others.... This argument is supported... by the unprecedented possibilities they offer for searching and accessing information, representing it, processing it, transmitting it and sharing it" (Coll et al; 2011:84).

In other words, it is unquestionable that technological tools have great potential in the educational field and can become instruments that allow students to think, feel and act alone and with others, thanks to the possibilities they offer to access the information that exists on the network, but for this to become effective, it is necessary that each educational system in general and each school in particular, work on two central aspects, which are a techno-pedagogical design and a teacher training program, taking into account the needs of the context to which they correspond. The following are reference frameworks that guide the work to be done.

Reference framework for building a techno-pedagogical design

To speak of a techno-pedagogical design is, first, to recognize that ICTs have become indispensable tools for the realization of the educational act, and that they have the potential to innovate teaching processes and improve learning processes; and second, to offer a proposal on the best way to use them. The concept is as follows:

> "Proposals for incorporating ICTs into formal and school education generally take the form of a techno-pedagogical design, i.e., a set of technological tools accompanied by a more or less explicit, global and precise proposal, depending on the case, on how to use them for the implementation and development of teaching and learning activities. In their more complex variants, these designs include three groups of elements: a proposal of contents, objectives and teaching and learning activities, as well as orientations and suggestions on how to approach and develop them; an offer of technological tools; and a series of suggestions and orientations on how to use these tools in the development of proposed teaching and learning activities (Coll et al; 2011: 99). (Coll et al; 2011: 99).

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In this order of ideas, there is no room for discussion on whether information and communication technologies should or should not be used in the educational field, especially taking into consideration that nowadays, and in the face of the health crisis caused by COVID-19, they have been the means that has allowed educational systems to stay on their feet and not stop the teaching-learning processes; However, what is subject to discussion, and should be addressed, is the lack of concrete proposals on how to do it, considering the particularities of each school, such as the academic model, the educational modality, the environment, the needs of teachers and students, and the culture that governs them.

This makes it necessary to take into consideration three issues:

First: The contents, objectives and teaching-learning activities, and the way to approach and develop them. This element is directly related to the role of teachers, and its importance lies in that it leads them to reflect on the place of a learning unit within the curriculum of the educational program to which it corresponds and how, or to what extent, it contributes to achieving the students' graduation profile; this implies a detailed study of the contents to be addressed, the objectives to be achieved and the most appropriate activities to achieve them; that is, knowledge of the discipline and mastery of teaching work strategies.

Second: Technological tools. This aspect, on the other hand, is related to the administrative decisions made by school authorities, and refers to the set of technologies offered to teachers to carry out activities; these tools must be designed according to the needs of the academic model, educational modality, context, teachers and students, international and national trends, and the challenges faced by ICTs themselves.

Third: Guidelines on how to use ICT in school activities. Once the first two elements have been covered, the institution should not forget to guide teachers on the most appropriate way to use technologies, an element that is related to the administrative authorities and the teacher training area, who are responsible for the design of policies and guidelines for the implementation of an online modality; these guidelines are essential to ensure the success of the work of teachers and students.

Based on this, it is essential for each institution to work on a comprehensive proposal that guides teachers in their school work, taking into account the context and the students as the center of attention.

Reference framework for the development of a teacher training program

Now, the best way to complement the technological infrastructure and Internet access that a school can have, is the training of teachers, through a comprehensive program that allows digital literacy, but also that it is reflected in a better use by students, this, considering that:

> Scientific and technical development, the rapid mutability of knowledge, new social attitudes, new professional challenges and the massive use of information technologies demand new ways of managing knowledge and new strategies for university teaching (Imbernón; 2008, in Cutti; 2012: 32). These demands for new strategies for university teaching focus attention on the figure of the academic and his or her pedagogical training, which is commonly conceptualized as teacher training (Cutti; 2012: 32).

According to the aforementioned authors, it has been the scientific and technological development of recent times, which has required new ways of managing knowledge, and with it, also other ways of promoting teaching and learning, especially at the higher level, focusing these changes in the figure of teachers, who are required to play a leading role inside and outside the classroom, since knowledge is no longer only produced in schools, but is part of other social dynamics, thanks to the use of various technological tools, such as smartphones.

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Thus, in view of the global scenario, a basic issue to improve teachers' practices, through the use of ICT, is precisely the development of a teacher training program, understood as: "a formal and informal process, of professional preparation for the exercise of pedagogical praxis" (Cutti; 2012: 32), where academics become the focus of attention, and their training, from a systemic perspective, enters into a dynamic and permanent process in which they acquire competencies in the disciplinary, pedagogical and technological areas, in addition to other areas, which give it an integral character. It is a matter of helping teachers to break with traditional work schemes, to move on to others that allow them to ensure the success of their work, taking into consideration the particular needs of the context, of the students and of themselves.

In view of the above, it is imperative to work on a proposal for teacher training that, being comprehensive, allows strengthening the role of teachers and obtaining satisfactory results in terms of student learning, thus being able to achieve indicators that focus more on learning outcomes than on content, making a student-centered pedagogical model a reality. The training program should minimally consider the two aspects discussed below:

The categories of the knowledge base.

The first issue to be addressed in order to specify a teacher training proposal is what Shulman (2005) calls the categories of the knowledge base, which he identifies as issues that underlie the understanding that the teacher must have, so that students can build knowledge, the common places that provide a basis to ensure the success of the teaching-learning processes.

> ... the ability to teach revolves around the following commonplaces of teaching... A teacher knows something that others do not understand, presumably the students. The teacher can transform the understanding, the skills to perform, the desired attitudes or values, into pedagogical representations and actions... Thus, the teaching process necessarily begins in a circumstance in which the teacher understands what is to be learned and how it is to be taught. It then proceeds through a series of activities during which students are given specific knowledge and opportunities to learn (Shulman; 2005: 9).

The knowledge base categories proposed by the author are as follows:

Content knowledge. It contemplates the professionalization of the discipline mastered by the teacher, through participation in academic events. It is the basis for teaching in any career.

General didactic knowledge: It considers the strategies of class management and organization that transcend the subject; it is the knowledge and application of different teaching-learning models.

Knowledge of the curriculum: It refers to the mastery of the materials and programs that serve as tools for the teacher's job; the purpose is that the teacher locates, within the curriculum of the career in which he/she develops his/her practice, the subject on which he/she works; it also has to do with his/her training for the design and development of new curricula.

Didactic knowledge of the content: It deals with the relationship between the subject to be developed and the pedagogy, between the knowledge of a subject and the way to approach it; it is also the knowledge of the academic model and the educational modality.

Knowledge of the students and their characteristics: It has to do with the knowledge of the students, since only on this basis will the teacher be able to make the best decisions regarding the work methodology; it is a fundamental issue to ensure the success of the teaching-learning process,

Knowledge of the educational contexts: It considers the characteristics of the group, the management of the authorities and the place where the school is located; in general terms, all the aspects that forge the culture of the institution and that influence the teacher's work.

Knowledge of the objectives, educational values and their philosophical and historical foundations: This refers to knowledge of the general educational system and of the policies and guidelines that govern education.

In addition to the aspects proposed by the aforementioned author, it is essential for teachers to have knowledge in other dimensions, such as:

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Knowledge of ICT: Initially contemplating digital literacy, but later understanding that these should be a means in the development of the teacher's work and not just an end.

Knowledge in research: In order to promote the analysis and transformation of their own practice, which will lead each teacher to enter into a process of continuous improvement, according to the needs of the school context.

Knowledge of tutoring: In order to be able to be a guide in the school environment, and to accompany the students' entry, trajectory and graduation.

It is important to point out that the categories of the knowledge base defined should not be considered or become a straitjacket for schools or their teachers; they are, as the author who proposes them refers, common places that it is convenient for teachers to know, master and apply, but each school must undergo a process of recognition of its needs and work on them.

A model for detecting training needs.

Now, regarding the way to detect training needs, it should be taken into account that a criticism of current educational systems is that most decisions are made at the central level, from where models created for other contexts are usually taken, and when implemented in places that have totally different conditions, they end up with unsatisfactory results.

Cutti (2012) states that an example of these policies is that educational institutions have forgotten about a transcendental activity such as the pedagogical training of teachers, giving priority to postgraduate studies; he adds that among the evidence of the lack of interest in the subject is: that training programs appear and disappear, teacher initiatives are subject to political and personal changes of those responsible for the programs, activities aimed at training are fragmented, repetitive and disconnected from the context, and there is no clarity in the vision pursued by each school, because while they promote teacher training, they do not demand it, value it and much less recognize it.

This background forces a paradigm shift, and to think about the existing models to detect training needs, which according to Font and Imbernón (2002), cited by Cutti (2012), are:

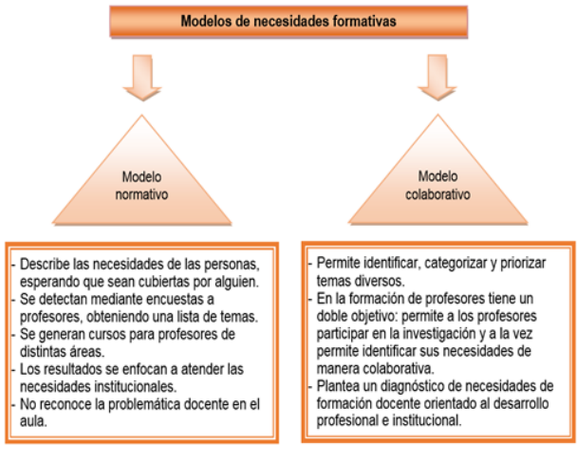

Figure 1 Training needs models, according to Font and Imbernón (2002), taken from Cutti (2012)

As can be seen in the diagram, while in the normative model the authorities of the institution are the ones who are considered to have the vision to discover the shortcomings of teachers and prescribe teacher training courses, in the collaborative model the starting point is the needs felt by teachers, since they are recognized for their ability to notice what they need to improve their practice, and they are allowed to create a map to identify shortcomings, relationships that exist between them and establish an order of priority to solve them.

From the above, it can be concluded that teacher training programs should be articulated from an inductive logic, starting from the identification of teachers' needs in each context, since they are the ones who can express what they really need to improve their daily work, as proposed by the collaborative model.

Conclusions

It is evident that the technological developments of recent decades have marked the course of modern society by considerably modifying production systems, but they have also generated large gaps between countries that have access to them and those that lack the most indispensable.

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In the field of education, and despite the efforts made by UNESCO since the end of the last century to incorporate ICTs into schools, the results have not been as expected, since there is still a considerable gap between what is expected by educational systems and what actually happens, and their presence in schools continues to be, as Cuban (1993) states, peripheral and marginal.

Proof of the failure that has been, in many cases, the incorporation of ICTs in schools, is that by moving from face-to-face and mixed modalities to an online modality, due to the health emergency caused by COVID-19, not only has Sustainable Development Goal 4 "Quality Education" been compromised, but even the access to education as a fundamental human right, especially in the population from vulnerable groups, where dropout and failure rates have increased considerably, threatening to become a generational catastrophe.

In this sense, the current crisis is called to be the breaking point that modifies school practices, that is, education must no longer be what it has been until now, the world's educational systems must change once and for all, making effective the potential of information and communication technologies, which in other social spaces has been widely exploited. Learning environments must be built, where the teacher acts as a mediator and the student constructs knowledge; according to Bartolomé (2004), we must move from content analysis to the acquisition of competencies, from directed work to self-regulated learning and from information consumption to information management.

But achieving the above implies working on central aspects such as the construction of techno-pedagogical designs according to each context, as a set of technological resources available for teachers and students, accompanied by a proposal to use them, which guarantees the innovation of teaching processes and improvement of learning processes; and, in a teacher training proposal that, from a collaborative model, provides teachers with the necessary skills to work in the new reality we are facing.

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Design and prototyping of an automated didactic medicine dispenser

Diseño y prototipado de dispensador didáctico automatizado de medicamentos

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Abstract

This project focuses on the principles of Arduino UNO, which is an open-source electronic platform that helps build a wide variety of projects without having expert programming knowledge. It is known that medicine, treatments and medications in general are constantly evolving thanks to the advancement of technology and science; therefore, this project has focused on that area through the construction of a medical dispenser that can contribute to the experience of the employees and the user. Each user will have an identification document with their predefined treatments and medications so that they can personally purchase all these products by simply placing their card near the dispenser, it will read the information and return the product. In short, having an Arduino as the brain of this project can facilitate any day-to-day task and help create devices that can regulate any dispensing process, reduce costs, and help people get their product without waiting too many hours in a hospital, primary reason for the construction of this project.

Arduino, NFC, Servo motor, Innovation, Medicine, Dispensing

Resumen

Este proyecto se centra en los principios de Arduino UNO, que es una plataforma electrónica de código abierto que ayuda a construir una amplia variedad de opciones de proyectos sin tener un conocimiento experto en programación. Se sabe que la medicina, los tratamientos y los medicamentos en general están en constante evolución gracias al avance de la tecnología y la ciencia; por tanto, este proyecto se ha centrado en esa área por medio de la construcción de un dispensador médico que pueda contribuir a la experiencia de los empleados y del usuario. Cada usuario dispondrá de un documento de identificación con sus tratamientos y medicamentos predefinidos para que pueda adquirir personalmente todos estos productos con tan solo colocar su tarjeta cerca del dispensador, este leerá la información y devolverá el producto. En definitiva, tener un Arduino como cerebro de este proyecto puede facilitar cualquier tarea del día a día y ayudar a crear dispositivos que pueden regular cualquier proceso de dispensado, reducir costos y ayudar a las personas a obtener su producto sin esperar demasiadas horas en un hospital, razón primordial de la construcción de este proyecto.

Arduino, NFC, Servo motor, Innovación, Medicina, Dispensador

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Introduction

This project is focused on the principles of the Arduino UNO platform for the creation of a prototype that can contribute to the work of some employees in the health area. It is known that medicine is constantly evolving thanks to the advancement of technology and science, so new treatments, cures, antibiotics and drugs in general have been created for the benefit and welfare of human beings.

For this reason, with the premise of making a contribution to these great advances, a prototype of a dispenser of medicines and medical products has been designed, so that people can have access through this device directly and thus obtain the medicines in a faster and more efficient way.

With this project we want to ensure that users have access only to the dose of medication detailed by the specialist, to ensure that the drugs are purchased responsibly.

Given the above, a literature search was conducted on the technologies aimed at improving the current processes, which basically depend on people, sometimes without adequate knowledge, so that the drug is supplied, giving space to the factor and human error comes into play and can cause, in some cases, undesirable effects on patients.

Based on the above, the need arises to design an automated dispenser in which only the specialist who prescribes the medication, the system and the patient intervene.

Theoretical Development

The dispenser was thought to be developed with a simple and accessible technology, this in order to seek efficiency and full functionality, that is why it was developed with the Arduino board. Next, aspects about its operation and some theoretical foundations relevant to the project will be discussed:

A. What is Arduino?

Arduino was born in 2005 at the Interactive Design Institute of Ivrea (Italy) and is a free design device, which began to attract attention in different fields due to the ease of working with it.

Arduino is a microcontroller on a board, fully programmable and simple to use. Arduino boards can read inputs and generate output signals such as, for example, a finger pressing a button and turn it into an output that will enable things like an LED (light emitting diode) or a motor to be activated.

As mentioned above, there is no doubt that Arduino is one of the best solutions to consider for educational projects. With the structure that the Arduino UNO platform has, it can be said that anyone can develop the programming of this, since it is not programmed in assembly language, as it was done with previous microcontrollers, but it works with C/C++, which is a much more understandable language for humans, being considered almost a high-level language.

B. Technical specifications of Arduino UNO

The Arduino microcontroller has a single USB port that allows its power supply, it is worth mentioning that it can also be powered from some other source such as a battery pack, since it has voltage regulators, as well as all the necessary circuitry to ensure optimal and safe operation.

It also has 14 pins, pins that can be used for both input and output, to which you can connect devices whose ability to transmit signals are between 0 to 5V.

The following table shows the Arduino specifications in a more summarized form:

Microcontroller	Atmega328
Operating voltage	5V
Recommended input voltage	7 – 12V
Input voltage limit	6 – 20V
Input pins - digital output	14 (6 can be PWM)
Analog input pins	6
Continuous current per IO pin	40 mA
DC current on pin 3.3V	50 mA
Flash memory	32 Kb
SRAM	2 Kb
EEPROM	1 Kb
Clock frequency	16 Mhz

Table 1 General characteristics of the Arduino
Source: Own elaboration

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In the case of the Arduino UNO model, it has two variants: Arduino UNO and ARDUINO UNO SMD, whose difference is that the ARDUINO UNO has the microcontroller of the Atmel brand and ARDUINO UNO SMD, as the name indicates, has it in SMD format (miniature microcontroller chip).

C. Advantages of using Arduino in educational projects

The capabilities of the Arduino have already been mentioned, and according to its functionalities, the following advantages can be mentioned:

1. Both the hardware and the software are open source, so there is a wide amount of options for projects to be developed.

2. Having basic programming knowledge, you can work with Arduino, thanks to its ease of use and low complexity of the code.

3. With very little money you can create projects that make any day-to-day task easier.

4. It is a very versatile platform since it has many variations of connecting components.

As indicated above, the use of Arduino can be complemented with multiple components such as buttons, LED diodes, and sensors among others, however, this range of components can increase according to the different needs that other developers try to solve, so we will explain below only the components that were used for the development of the automatic medicine dispenser.

D. Servo motors

This is a small electric motor highly used in electronics that allows to control and indicate the angle, position and speed of rotation of a device. It has a limitation of movement, since it has a range of 0 to 180º. However, it has a high degree of accuracy.

These motors allow a supply voltage between 4.8V to 7.2V, being 6V the most recommended value for its operation because with lower voltages, the motor has less force and speed. On the other hand, with voltages higher than 6.5V, the servos begin to oscillate more frequently, which makes them not very useful.

Regarding the operation of these devices, they are internally constituted by a DC motor, coupled to a speed editor and with the necessary electronics to control the position of this. Then it has a potentiometer next to the servo shaft that allows to identify the position of the shaft. All this information is then processed by an integrated controller that is responsible for adjusting the desired position.

Specifically in this project we used the Tower Pro SG92R motor, which is a type of low-cost servo motor with plastic gears that is ideally used for electronic projects. It has carbon fiber pinions and its digital electronics allows a more controlled, precise and smooth movement.

For the connection of this motor, the direct wires to the connector are distributed as follows:

Red = power (+)

Brown = ground (-)

Orange = PWM signal

Torque	2.5kg - cm
Rotation speed	0.1 sec/60o and 0.08/60o
Rotation range	180o
Weight	9 gr.
Dimensions	21.5 x 11.8 x 22.7 mm
Gear type	Plastic
Connector type	Female
Modulation	Analog
Period	20 ms
Voltage	4.8 ~ 6V
Pulse width	1.0 ~ 2.5 ms
Temperature	0o ~ 55o
Accessories	Arms and screws

Table 2 Characteristics of the servo motor
Source: Own elaboration

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E. NFC technology

NFC technology allows to make a wireless connection between devices that are close to each other, so that these devices can maintain a communication. When two devices communicate using this technology, bringing one close to the other, there is an exchange of data that allows to make the transaction that is needed.

As an example of the use that can be made of NFC technology in everyday life are the devices that have Bluetooth, which allow file sharing between devices such as computers, tablets and phones. Another example that can be mentioned is the use that is made in supermarkets when paying without contact with the datafono, thus reading the information of the chip of the cards at a short distance.

Consequently, how the exchange of information happens, this occurs when a device approaches another, and one of the two receives the signal, modifies or uses the data and responds to the signal. For this signal transmission there are two types of transmission mode: passive and active.

For the passive mode, the communication method works when one device (the active one) acts as the reader (the NFC device), for which it generates an electromagnetic signal, and when the passive device is close to this signal, it starts to transfer the information it has stored (applies to the example of contactless payment with a card and a data phone).

In the case of the active device, the communication method works differently, since in this case both devices have the NFC module, so that each one generates its own electromagnetic signal, so that both can transfer information (applies to the example of two mobile devices communicating via Bluetooth to transfer information or files between them).

F. PN532 module

The PN532 module used in the project, works with the NFC technology explained in the previous section, however, the modules that use this type of technology are quite expensive and complex for the development of small projects, however, due to the market demand that this technology has today, the PN532 module has a fairly affordable price and is easy to use because there are libraries for use directly with Arduino.

The technical specifications of this module are shown below:

Torque	2.5kg - cm
Rotation speed	0.1 sec/60o and 0.08/60o
Rotation range	180o
Weight	9 gr.
Dimensions	21.5 x 11.8 x 22.7 mm
Gear type	Plastic
Connector type	Female
Modulation	Analog
Period	20 ms
Voltage	4.8 ~ 6V
Pulse width	1.0 ~ 2.5 ms
Temperature	0o ~ 55o
Accessories	Arms and screws

Table 3 PN532 Module Specifications
Source: Own elaboration

Figure 1 Visual model of the module
Source: http://robot.com.ve/

In addition, Figure 1 shows the representation of the module's pins, which makes it very flexible and one hundred percent efficient in communications with microcontrollers, allowing it to do practically everything, read and write devices, communicate with phones that support NFC (to process payments, for example) and even act directly as an RFID/NFC device.

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Operation of the project

Together with the NFC technology explained in the previous sections, the PN532 module uses RFID (radio-frequency identification) technology, whose definition is radio-frequency identification, which uses electromagnetic fields to track the tags attached to an object. In general terms the operation of this technology is quite simple, a receiver sends a continuous signal within a specific range and when a tag (chip that is attached to the objects to be identified) comes into contact with it, it sends data that the reader interprets as programmed.

Depending on the characteristics of the tag, the information can be recorded or edited, which is very useful in applications such as logistics, where it is possible to have a specific control of stock or in the location of shipments.

In this project, RFID tags will be used, which function as a radio receiver, these, once activated by the wave emitted by the transmitter, will retransmit the identification data that has factory recorded and this in turn read by the Arduino through its corresponding programming.

For this it is necessary to initialize the module and to define the pins for communication through the I2C protocol (serial communication protocol).

```
#include <Wire.h>
#include <SPI.h>
#include <Adafruit_PN532.h>
#include <Servo.h>

int val =0;
//datos referentes a la cantidad de medicamento a dis
Servo servo1;
Servo servo2;
Servo servo3;
Servo servo4;
// se inicializa cada servo, cabe destacar que es un
#define PN532_SCK  (2)
#define PN532_MOSI (3)
#define PN532_SS   (4)
#define PN532_MISO (5)
#define PN532_IRQ  (2)
#define PN532_RESET (3)
Adafruit_PN532 nfc(PN532_IRQ, PN532_RESET);
```

Figure 2 Code for the start of the communication
Source: Own elaboration

Once the PN532 module is instantiated, the pins in charge of the movement are defined, i.e., the servo motor pins, after making the call of the Liberia Servo.

```
void setup() {
  nfc.begin();
  nfc.SAMConfig();
  servo1.attach(8);
  servo2.attach(9);
  servo3.attach(10);
  servo4.attach(11);
```

Figure 3 Servo motor initialization
Source: Own elaboration

Once the physical components have been defined, the data to be obtained through these components must be processed in order to be understood by the system, so a routine is generated where this information is transcribed and the UID (User ID) number of each card, the same data contained in RFID, is assigned to each user.

```
void loop(void) {
  boolean success;
  uint8_t uid[] = { 0, 0, 0, 0, 0, 0, 0 };
  uint8_t uidLength;
  String tarjeta, user1, user2,user3, user4;
  user1="5781216129";
  user2="201238210129";
  user3="18323412938";
  user4="89116209129";
```

Figure 4 UID data formatting and UID assignment to each user
Source: Own elaboration

Once this information has been established, a prescription is generated for each user. In order for it to be unique, a direct relationship is made with the user ID, so that, once the data obtained has been processed, only the related UID has interaction and triggers the functions corresponding to the dispensing of the medication, which are detailed below.

It is important to note that the number of loops used will depend directly on the number of motors to be used; however, the structure of the program varies according to the person who designs it.

```
void dispensar(int cnt1, int cnt2, int cnt3, int cnt4)


    for (int ser1 = 0; ser1 < cnt1; ser1 ++)
    {
      delay(500);
      val=180;
      servo1.write(val);
      delay(500);
      servo1.write(0);

    }
```

Figure 5 Dispense function in the Arduino code
Source: Own elaboration

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Results

Once the circuit design was assembled, and having clear the functionality of each of its components, we proceeded with the assembly, but not before foreseeing a correct arrangement or arrangement of each of its parts so that one does not interrupt the operation of the others.

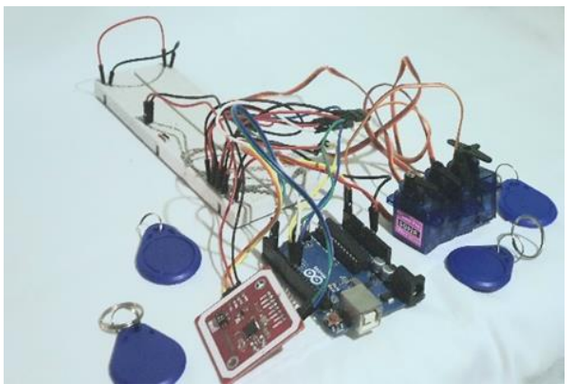

Figure 6 Prototype presentation
Source: Own elaboration

The previous figure shows the prototype that was built. In general terms, the assembly of the circuit was not very complicated since not many components are used, also, since it was only a prototype, it was not mounted on a frame that would allow hiding the cables and better order all the components, however, in general terms, the operation was optimal and fulfilled the premise that was initially had.

Although it is true that a small-scale prototype was assembled, it is already possible to implement in small places such as centers for the elderly or our own homes, where there is a person with a daily routine of medications to be ingested, facilitating the distribution process in case of any motor difficulty.

Consequently, it is important to mention that we found the express need to know the origin and manufacturer of each of the components, since, being generic components, where we can come across many of the same, of different brands, the technical specifications and processes of use may vary, so going to the documentation of the component was the solution to many of the incidents presented throughout this development.

Within the theoretical research process we found that similar projects have already been developed, however, focused on the industrial sector where only the efficiency of dispensing and packaging is sought as part of the production line and not focused on the end user.

The use of different technologies present in the market was addressed and the advantages of each one of them were identified and the technical specifications of the technologies to be used were known. With this research, the knowledge of possible future solutions and even the analysis of new improvements has been expanded in order to have a more advanced and optimized development for its operation.

It is also possible to improve the design by implementing modules for connection to Internet networks where it is possible to manage medical prescriptions directly online, or to manage a control through a log of how many times and at what time a medicine has been dispensed. In addition, it is also possible to implement visual or audible signals to warn people about any type of incident or event in the device.

Conclusions

With the information gathered throughout this project, it was possible to identify the points and tasks that this medication dispenser could solve in a simple and practical way, since it is a process that, although it is easy to do by a person, an automated process is much simpler, in addition to this, it would also represent a saving of money in hiring personnel and would eliminate the factor of human error. As a consequence of the implementation of this project, also, little by little these tasks would be identified, which can be done by a simple, easy to develop and low-cost device.

We want this project and this research to raise an unknown, not about our project but focused on any development to undertake, where it should be taken as a premise the question "What could I develop to improve this process?" or to question "What impact will our development have?" , we faithfully believe that based on these questions about each task we do during our day to day, we would open a world of possibilities that perhaps, until now have not been contemplated, and could become the solution to the great current problems.

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Analysis of the use of the cell phone in the learning process of the students of The Superior Technique in Industrial Processes of the UTNA

Análisis del uso del celular en el proceso de aprendizaje de los estudiantes de Técnico Superior en Procesos Industriales de la UTNA

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Abstract

The present study is an analysis of the uses that the cell phone has for the support of the students of the career of TSU Industrial Processes Manufacturing Area of the Technological University of the North of Aguascalientes that seeks to show an overview of the situation of the students in this area. This analysis allows us to observe what are the resources that students take as support to improve their learning in the different subjects they take. The sections that are analyzed in the following pages offer teachers and students a topic for reflection on the significant progress that the use of cell phones has had in the educational field with the students of these careers.

Education, Technology, UTNA, Quality, Cellphone

Resumen

El presente estudio es un análisis de los usos que tiene el celular para el apoyo de los alumnos de la carrera de TSU Procesos Industriales Area Manufactura de la Universidad Tecnológica del Norte de Aguascalientes que busca mostrar un panorama de la situación de los alumnos en este rubro. Este análisis permite observar cuales son los recursos que los alumnos toman como apoyo para mejorar su aprendizaje en las diferentes materias que cursan. Los apartados que se analizan en las siguientes páginas ofrecen a los profesores y alumnos un tema de reflexión, sobre el avance significativo que ha tenido el uso del celular en el ámbito educativo con los alumnos de estas carreras.

Educación, Tecnología, UTNA, Calidad, celular

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Introduction

This report presents an Analysis of the use of the cell phone in the learning process of the students of the Superior Technique in Industrial Processes of the Universidad Tecnológica del Norte de Aguascalientes.

A survey was conducted to determine the most important parameters to measure on the information of students of the Superior Technique in Industrial Processes.

The results of the survey applied to a sample of 45 students from the generation 2020-2022 are shown below.

This project benefits the Universidad Tecnologica del Norte de Aguascalientes since it allows it to know the most important information about its students in this entry.

Methodology

According to Hernández Sampieri (2010), the study that was applied was a "Quantitative Exploratory" study where a survey-type data recovery tool was used where a series of questions about Superior Technique in Industrial Processes in the use of cellphone, this question were specified and the survey was applied to a large number of our alumni in order to gather data or to detect public opinion on a given matter.

The objective is to evaluate the impact of cell phone use on the learning conditions that students had during the transition from the pandemic, hybrid classes and later face-to-face classes.

Sampling

The type of sampling that was carried out was stratified. The advantage of this type of sampling is that it tends to ensure that the sample adequately represents the population based on selected variables. It also allows more precise estimates to be obtained and its objective is to obtain a sample as similar as possible to the population in terms of the stratified variable (s).

The results of the survey applied to a sample of 45 students from the generation 2020-2022. The survey was applied from June to September 2021.

Background

The human being can be considered as a permanent learner, taking into account that even in the activities of less intellectual demand, he requires training, or training, that he had to acquire and develop. It must be taken into account that in this elementary type of learning, it is carried out almost always unconsciously by the subject who performs it. Intellectual learning in human beings previously requires adequate psychobiological and neurophysiological maturation on the part of the student or scholar. It can be stated that if the individual is not prepared to learn, that is, they do not have the necessary maturity, they will have difficulties during learning.

Once the individual meets the conditions for the development of intellectual work, their ability to learn should no longer have any type of intellectual limitation. Moreover, it is in a position to demand the right to access the goods of education and culture. UNESCO has been advocating for years for continuous learning throughout life, with no limitations other than personal interest or motivation. In a society that is constantly changing, it no longer makes sense to speak of an age of learning that ended with university graduation. Permanent learning is essential, either to acquire the training and learning of the times that you demand, or to satisfy the innate desire to learn, even if it is a compensatory way in adulthood.

Applied learning

There is a clear relationship between learning and application or realization, considering that it is as compliance and verification of what has been learned, rather than as a personal achievement of a series of attitudes and values that the subject develops.

The application or realization is considered here as an evaluation of the learning achieved before a specific proposal. Precisely the implementation of a change of attitude is, in some way, the evaluation of it, although without considering the conditions that affect learning: forgetfulness, fatigue, etc., or aspects such as attitudes, ideals or interests.

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Another consideration to be made is the relationship between learning and the context in which it takes place; it is the undeniable social condition of the individual that involves a series of conditions of all kinds with the environment in which they are immersed.

From childhood, the citizen has to accommodate their behaviors to various conventional forms that are, more or less, dictated by the family and social environment that have to do with the personal or the subjective. Society, in short, will evaluate them and the result of this evaluation will result in the qualification of accepted or rejected, the consequence of this last qualification being the marginalization of the individual, from which they will be given the opportunity to change, but always having taking into account the objectives set by the company. It is about the permanent interaction between the individual and the community, or between the person and society: we are, in part, what our circumstances are.

Purposes of human learning

The great purposes of education can be explained around three fundamental areas of every human being: personal environment, cultural environment and social environment.

1. Personal sphere: knowing oneself, one's own capacities, the way of adapting and fitting into society, the way of satisfying one's own needs within the socially established framework, the development of one's potentialities and aspirations, etc.

2. Cultural field: learning to function, not only in the physical environment, but especially in the part of the environment made by him through knowledge of language, numbers, technology, customs and traditions.

3. Social sphere: know how society works in its great manifestations of economy, politics, governments, religion, coexistence and tolerance, democracies and human rights, constitutional values of citizenship, etc.

These fundamental objectives can be explained with the acquisition of knowledge, skills and attitudes in relation to all branches of knowledge.

Levels of Bloom's Taxonomy

According to the six fundamental levels of Bloom's Taxonomy.

The first level is the knowledge that allows the student to record, memorize, recognize and recover.

The second level is understanding which allows the student to interpret, translate from one medium to another, describe with one's own words.

The third level is the application that allows you to solve problems, apply information to produce some result.

The fourth level is analysis by breaking something down to show how its parts come together, find the underlying structure of a communication or message, identify motives.
The fifth level is synthesis to create a unique and original product either in verbal form or as a physical object.

The sixth level is the evaluation to make value decisions about different issues, resolve controversies or differences of opinion.

Analysis of tasks for knowledge and thought processes. Orlich, D.

Level 1. Facts. It is an event or occurrences that happen only once and can be observed but has no predictive value.

Level 2. Concepts. It is a class of stimuli that have common characteristics. It is developed in the processes of observation and inference (categorization)

Level 3. Generalization. It is a proposition of a relationship between two or more concepts that generally meet specific conditions. This proposition is developed through the process of observation and inference.

The student must learn from the simple, then the concrete, then the complex, and finally the abstract.

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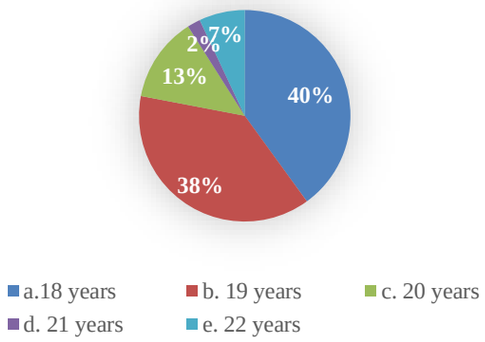
Results

The results of the survey applied to a sample of 45 students of the 2020-2022 generation on the use of cell phones in the educational process during the pandemic and the hybrid classes and later the face-to-face classes are shown below.

Results and discussion

1. Age

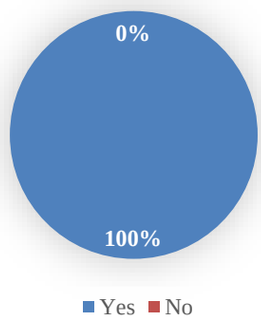
The age of the surveyed students ranges between 18 and 22 years.



Graphic 1 Age of the surveyed students

2. Do you use the cell phone as a support in your studies?

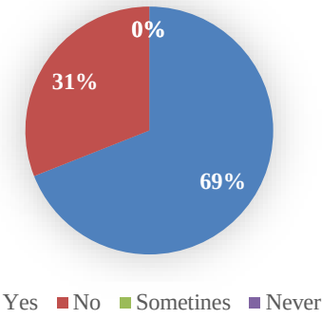
In the survey of students of business careers, 100% of those surveyed answered that they use the cell phone as support in their studies.



Graphic 2 Use the cell phone as a support in your studies

3. Do you consider that the cell phone facilitates your study?

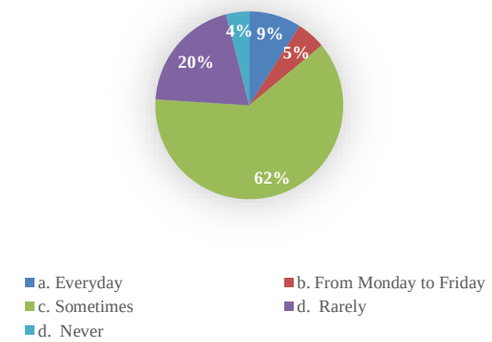
Regarding the question of whether the student considers that the cell phone facilitates their studies, 69% of the students surveyed answered that it does facilitate their studies, 31% answered not.



Graphic 3 Percentage of students consider that the cell phone makes their studies easier

4. Do you use the cell phone for "Comprehension reading of some of your classes"?

During the survey, students reported that 62% sometimes use the cell phone for reading comprehension in some of their classes. 5% say that if they use it from Monday to Friday, 20% reported rarely, 9% said daily, and 4% reported never.



Graphic 4 Use of cell phone for Comprehension reading of some of the classes

5. Do you use the cell phone to "process any of your work in class"?

58% of the students answered that they sometimes use the cell phone to process some work in class. While 13% of the students answered that they rarely used it.

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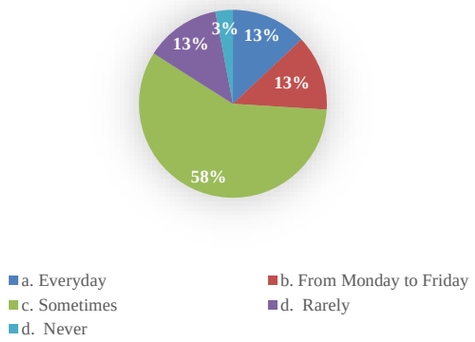
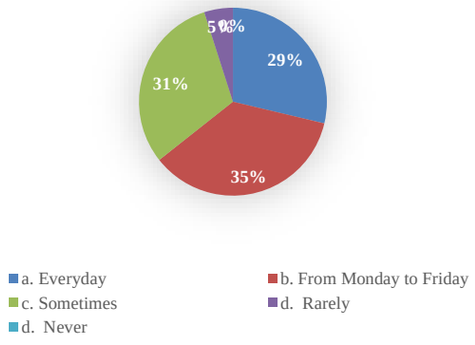


Graphic 5 Use of cell phone for process any work in class

6. Do you use the cell phone for the "investigation of a specific topic that one of your teachers left you"?

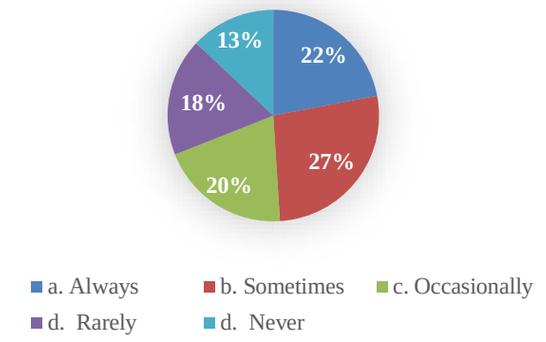
In this question, 29% of the students surveyed commented that they use the cell phone daily for research on a specific topic. In contrast to 31% who said that they sometimes use it, while 35% mention that they only rely on the cell phone to investigate from Monday to Friday.



Graphic 6 Use of cell phone for investigation of a specific topic that one of the teachers left them

7. Do you use the cell phone for "support in any of your school presentations"?

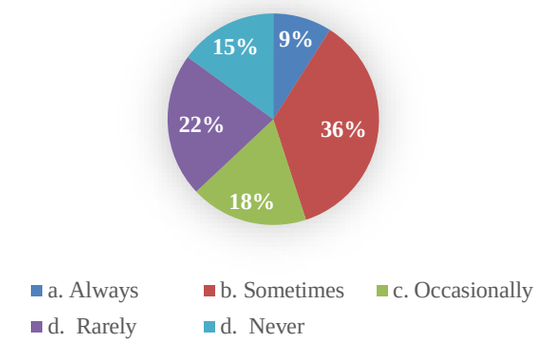
A very common case today is that students make their presentations with the support of the cell phone, reading the key information of the cell phone presentation. For this answer, the students answered that 22% always use the support cell phone during their presentations, 27% answered that sometimes, 18% answered that rarely, 22% answered that occasionally, while only 13% answered that they are never.



Graphic 7 Use of cell phone in support in some school presentations

8. Do you use the cell phone to "perform some mathematical calculations on a specific problem."?

Another use that students give to the cell phone for support during their classes is to perform mathematical calculations for the subjects that require it. To this question, the students responded that 9% always use their cell phones for this operation, while 22% said rarely, 18% said occasionally, 36% sometimes and 4% said they never use it. to do mathematical calculations.



Graphic 8 Use of cell phone for perform some mathematical calculations on a specific problem

9. Do you use the cell phone for the "see classes that have already passed"?

The students surveyed mentioned that only 22% use the cell phone to see classes that have already passed, while 23% answered that they rarely carried out this activity, 24% mentioned that sometimes, 20% said that occasionally, while 22% of the students surveyed mentioned never.

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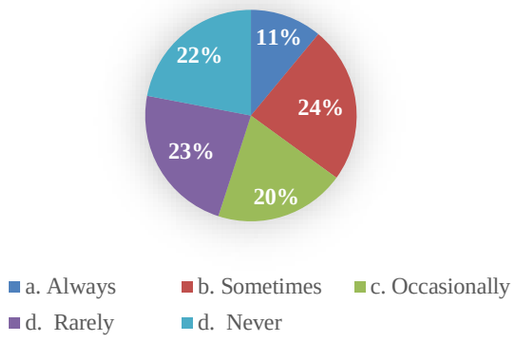
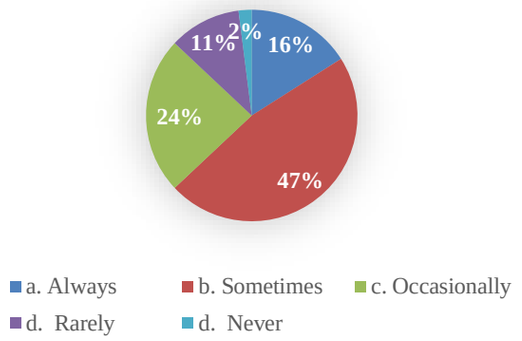


Graphic 9 Use the cell phone for the "see classes that have already passed

10. Do you use the cell phone for the "Watch videos to study for your classes"?

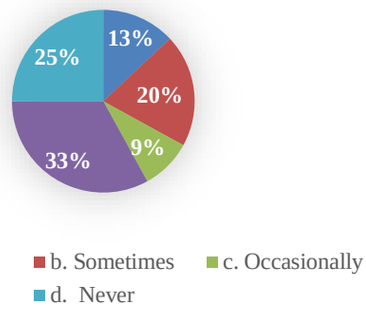
Another use of the cell phone that the students surveyed were asked is that, if they used this device to watch study videos for their classes, to which the students answered that 16% always do it, 47% answered that sometimes, 24% answered occasionally, while 11% answered rarely and 2% said never.



Graphic 10 Use the cell phone for the "Watch videos to study for the classes

11. Do you use the cell phone for the "Participate in conferences"?

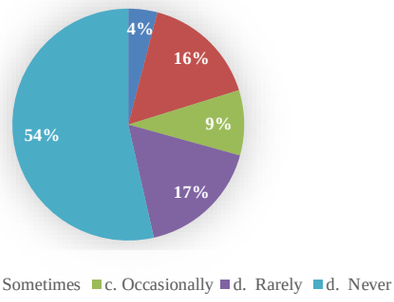
The students responded to the question of the use of the cell phone to participate in conferences that 13% always do it, while 20% sometimes do it, 9% do it occasionally, 33% rarely, and 25 % never.



Graphic 11 Use the cell phone for the Participate in conferences

12. Do you use the cell phone for "Support during exams"?

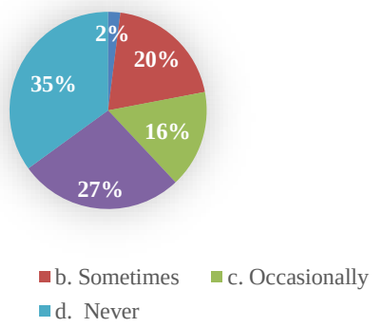
Another question that was also asked of the students surveyed is if they used the cell phone as a support during the exams, to which the students responded by 4% always, 16% sometimes, 9% occasionally, 17% rarely, and 54% never.



Graphic 12 Use the cell phone for Support during exams

13. Do you use the cell phone to study with educational games?

The students responded to the question of using the cell phone to study with educational games that 27% always do it, 20% sometimes, 16% occasionally, 27% rarely and 2% never.



Graphic 13 Use the cell phone to study with educational games

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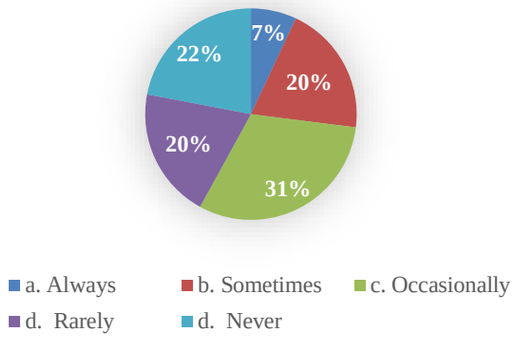
14. Do you use the cell phone to take quizzes or some other type of exam?

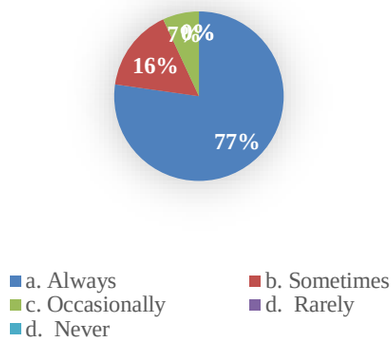
In this question, the students surveyed answered that they use the cell phone in 7% to take quizzes or some other type of exam, while 20% answered that sometimes, 31% answered that occasionally, 20% said that rarely, and 22% mention never.



Graphic 14 Use the cell phone to take quizzes or some other type of exam

15. Do you use your cell phone to communicate with your classmates?

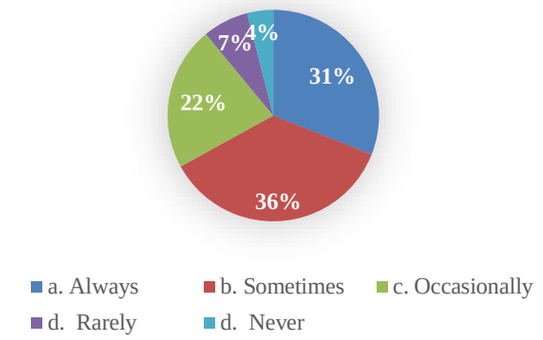
Another use that students are asked about the use of the cell phone was if they use this device to communicate with their classmates, for which they answered, 77% always do it, 16% sometimes, in a 7% occasionally.



Graphic 15 Use of cell phone to communicate with the classmates

16. Do you use your cell phone to communicate with your class teachers?

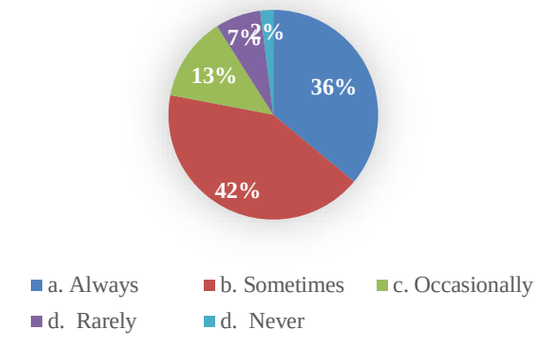
The students were also asked about the use of cell phones to communicate with their teachers, for which 31% responded that they always do so, 36% sometimes, 22% occasionally, 7% rarely, the 4%. never



Graphic 16 Use of cell phone to communicate with class teachers

17. Do you use your cell phone to share class material "?

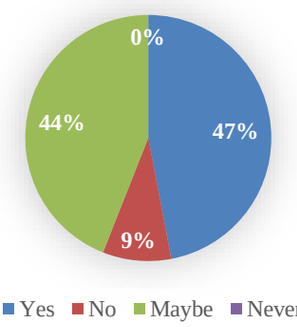
Another use that the students were asked was if they used the cell phone to share class material, for which the students answered that 36% always, 42% sometimes, 13% occasionally, 7% rarely and 2% never.



Graphic 17 Use of cell phone to share class material

18. Do you think you learn by using your cell phone?

The students responded to the question of whether they learned using the cell phone, 47% yes, 9% no, 44% maybe.



Graphic 18 Learning by using your cell phone

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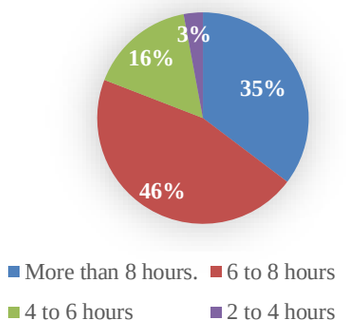
19. *How many hours a day do you estimate that you use the cell phone?*

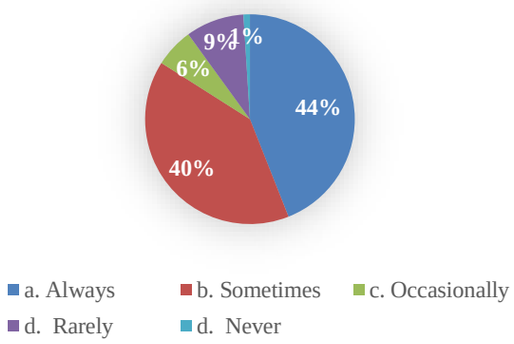
In students regarding the use that is given to the cell phone daily for hours, the respondents answered in 35% that they use it more than 8 hours a day, 46% answered that they use it from 6 to 8 hours, 16% said that they use it used 4 to 6 hours and 3% of the contest that between 2 and 4 hours.



Graphic 19 Estimated hours per day of cell phone use

20. *During your stay in the Pandemic while you were at home, do you use your cell phone to take your classes??*

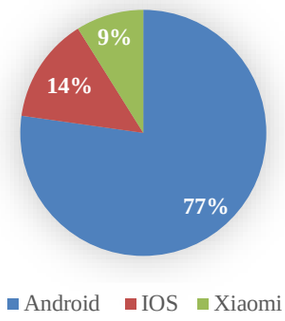
When asked if you used your cell phone to take classes during the pandemic, the students answered that 44% always, 40% sometimes, 6% occasionally, 9% rarely and 1% never.



Graphic 20 Use of cell phone to take the classes during the Pandemic

21. *What operating system does your cell phone use?*

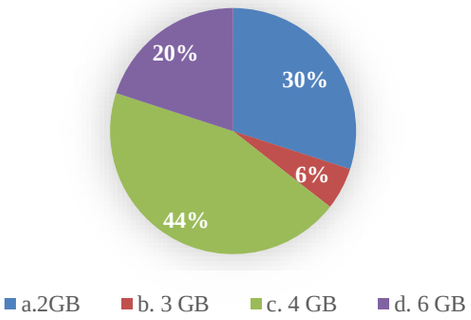
The operating systems that the students have are Android with 77%, IOS with 14% and Xiaomi with 9%.



Graphic 21 Operating system's cell phone

22. *What RAM memory does your cell phone have?*

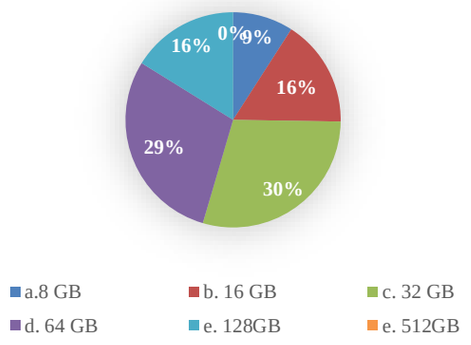
The capacity of the cell phones used by the students is diverse, the characteristics are shown in the following graph, however, the 4 GB capacity stands out over the others.



Graphic 22 RAM memory

23. *What capacity does your cell phone have?*

The capacity of the cell phones used by the students is diverse, the characteristics are shown in the following graph, however, the 32 GB capacity stands out over the others.



Graphic 23 Cell phone capacity

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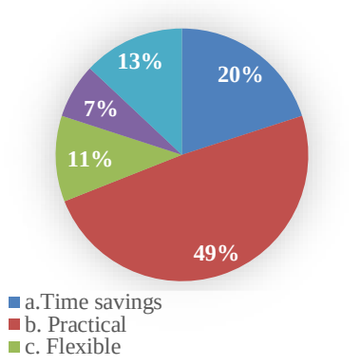
24. What is the main benefit that you consider your cell phone brings you in your studies?

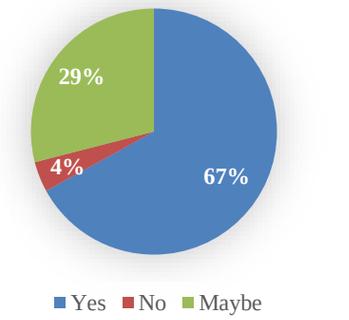
The students responded that the main benefit of the cell phone in their studies was 20%-time savings, 49% practical, 11% flexible, 7% dynamic, 13% immediate communication



Graphic 24 Benefit cell phone

25. Do you consider that it is necessary to carry out a practice after leaning on the cell phone to reinforce your knowledge?

The students responded to the question that if they consider it necessary to carry out a practice after relying on the cell phone to reinforce their knowledge, 67% said yes, 29% maybe, and 4% no.



Graphic 25 Practice after leaning on the cell phone

Conclusions

Currently, it can be said that 100% of our students use cell phones to support and develop their classes, which is very important because it allows the student to continue to be motivated during their studies.

As can be seen in this investigation, the use of cell phones is very important since it allows students to speed up learning through various applications such as Word, Excel, Power Point, Socrates, Kahoot, Zoom, YouTube, Meet.

Also, the use of cell phones in education has multiple benefits for them as it is more practical, saves time, is flexible, and allows instant communication between students, groups of students and teachers.

Currently, students can search for information, enter classes, watch videos, take exams, etc. This allows students to acquire knowledge while using the cell phone.

In general, it can be concluded that the cell phone is of vital importance for the studies of the students.

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SiO_2-PDMS as oil removal system

SiO_2-PDMS como sistema de eliminación de aceite

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Abstract

En este trabajo se presenta un diseño de sistema de remoción de aceite basado en el uso de sílice hidrofóbica (SiO_2/PDMS) obtenida por la co-condensación de sílice con polidimetilsiloxano (PDMS) empleando DBTL como catalizador de policondensación. La cantidad de PDMS en la estructura de la SiO_2/PDMS varió del 10 hasta el 40%w. La SiO_2/PDMS se impregnó en un sistema de esponja y se evaluó la cantidad de sílice hidrofóbica atrapada en la misma por gravimetría; además, la espectroscopia de infrarrojo permitirá identificar a la sílice hidrofóbica en la esponja y los principales grupos funcionales de la misma. El carácter hidrofóbico se determinó a través de la modificación en la capacidad de absorción de agua de la esponja y mediante la medición del ángulo de contacto. Por otra parte, La microscopia óptica permitió identificar cambios en la superficie de la esponja debido a la presencia de la SiO_2/PDMS. Finalmente se determinó el efecto de la cantidad de PDMS sobre la capacidad de remoción de aceite en agua.

SiO_2-PDMS, Hydrophobicity, Oil removal, Hybrid materials, Hydrophobic sponge, Hydrophobic sponge

Resumen

En este trabajo se presenta un diseño de sistema de remoción de aceite basado en el uso de sílice hidrofóbica (SiO_2/PDMS) obtenida por la co-condensación de sílice con polidimetilsiloxano (PDMS) empleando DBTL como catalizador de policondensación. La cantidad de PDMS en la estructura de la SiO_2/PDMS varió del 10 hasta el 40%w. La SiO_2/PDMS se impregnó en un sistema de esponja y se evaluó la cantidad de sílice hidrofóbica atrapada en la misma por gravimetría; además, la espectroscopia de infrarrojo permitirá identificar a la sílice hidrofóbica en la esponja y los principales grupos funcionales de la misma. El carácter hidrofóbico se determinó a través de la modificación en la capacidad de absorción de agua de la esponja y mediante la medición del ángulo de contacto. Por otra parte, La microscopia óptica permitió identificar cambios en la superficie de la esponja debido a la presencia de la SiO_2/PDMS. Finalmente se determinó el efecto de la cantidad de PDMS sobre la capacidad de remoción de aceite en agua.

SiO_2–PDMS, Hidrofobicidad, Remoción de aceite, Materiales híbridos, Esponja hidrofóbica

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Introduction

A hydrophilic substance is one that readily takes up water molecules, i.e., it is soluble in water. This is due to the polar groups that interact with the water molecule as shown in Figure 1a; where NaCl dissociates into Na^+ and Cl^-, then, the positively charged sodium interacts with the oxygen of water that has a negative partial charge density (δ^-); while Cl^- will interact with the hydrogens of water since they have a positive partial charge δ^+. On the other hand, a hydrophobic substance is one that is insoluble in water, such as fats, hydrocarbons, among others, since they do not have polar groups that allow their interaction with H_2O (Figure b) (Ahmad D, 2018).

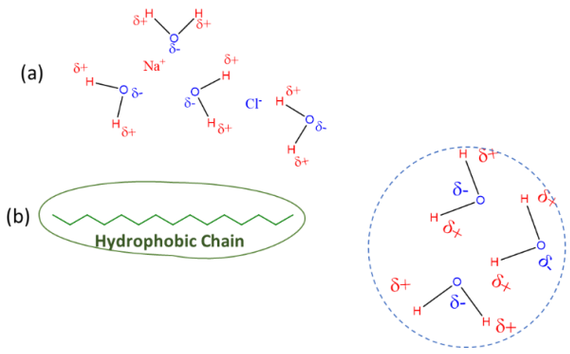

Figure 1 (a) hydrophilic behavior (b) hydrophobic behavior phase separation with water

Hydrophobic silica and surface modification by co-condensation

As shown in Figure 2a, on the surface of a silica are found the functional groups "silanols, Si–OH" which on dissociation generate an H^+ and a negative charge on oxygen forming a hydrophilic character on the silica. However, silanols are reactive groups that can be used to react with organosilanes, $R–Si(OR)_4$ (Figure 3b) and modify the silica surface to obtain hydrophobic surfaces (Yokogawa H,1995; Daoud W.A, 2006; Anderson A.M, 2011; Liu J; 2022; Ariati R.M, 2022). Among the widely used methods for the modification of a silica surface, highlights the method of co-condensation, which consists of carrying out the co-polymerization of TEOS in the presence of an organosilane ($R\text{-}Si(OR)_4$) resulting in the formation of the three-dimensional silica network trapping the hydrophobic R groups inside and outside of the silica surface (Putz A.M, 2019; Costa M.B, 2018).

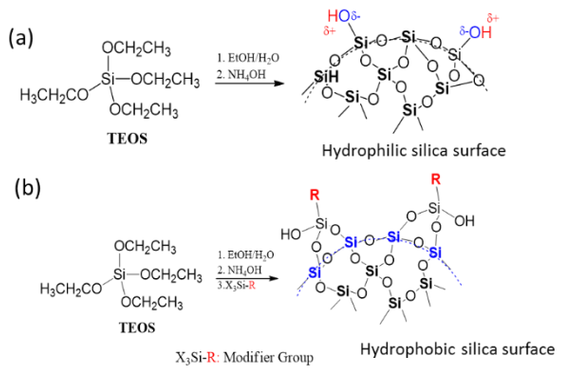

Figure 2 (a) Production of hydrophilic silica (b) Production of hydrophobic silica

Hydrophobic silica as an oil contaminant removal system

Nowadays, water quality is a relevant issue of high environmental concern, since water is exposed to many pollutants, including oily substances that cause serious environmental damage (Gupta R.K, 2017). To remove this type of substances, the use of hydrophobic surfaces has been proposed (Xue Z, 2014; Chu Z, 2014; Chen CH, 2019; Kumari P, 2022). For example, Baing N et al, 2021 propose the use of hydrophobic silver nanoparticles modified with dopamine and incorporated into a cellulose foam as an oil removal system, obtaining a removal efficiency higher than 95%. The authors attribute this result to the hydrophobic behavior of the material.

On the other hand, hydrophobic silica has been employed in oil removal through oil gelation and thereby causing water separation (Wang J, 2019; Sert Çok S, 2021; Syed S, 2011; Dai X, 2022). Cho Y.K et al., modify silica nanoparticles with PDMS (polydimethylsiloxane) using chemical vapor deposition obtaining hydrophobic silica with contact angle around 163.55º that enhance the oil gelation for its separation (Cho Y.K,2014).

This paper presents the modification of a silica using PDMS through the sol-gel method and the use of a polycondensation catalyst to obtain a sol solution containing the structure shown in Figure 3; the SiO_2-PDMS is impregnated in polyurethane foam to determine its effect as an oil-in-water removal system.

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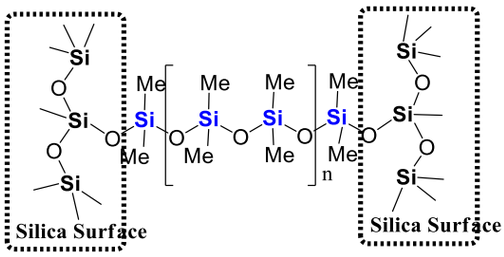

Figure 3 Structure for SiO_2/PDMS-functionalized

Methodology

SiO_2/PDMS Synthesis

The silica modification was conducted by Co-condensation; as reported by Salazar-Hernandez et al (Salazar-Hernández C, 2019; Salazar-Hernández C, 2021). The polymerization of TEOS (Aldrich; 99%) adding PDMS (Gelest) and DBTL as polycondensation catalyst is performed by magnetic stirring for 30 min at 50 ºC. Table 1 specifies the concentrations of PDMS used in the silica modification.

	TEOS	PDMS
SiO_2-10PDMS	10 g	1 g
SiO_2-20PDMS	10 g	2 g
SiO_2-40PDMS	10 g	4 g

Table 1 Amounts of TEOS/PDMS used for silica modification.

SiO2-PDMS-functionalized SiO_2-PDMS-Sponge Impregnation

Polyurethane foam samples with dimensions of $5 \times 3 \times 2$mm are obtained and these are immersed in the sol solution prepared with TEOS/PDMS/DBTL to achieve its total impregnation. Subsequently, they are dried at 50ºC for 24 h.

SiO_2-PDMS characterization

The chemical structure of the foam and SiO2-PDMS were observed by ATR-FT using a Nicolet-iS10 Thermoscientific analyzer, obtaining an average of 16 scans, with 4 cm^{-1} resolution and spectral window from 4000 to 600 cm^{-1}. On the other hand, gravimetry analysis is used to quantify the weight percentage of SiO_2-PDMS gained in the foam (1).

$$\%M_{SiO2-PDMS} = \frac{(M_{sponge/SiO2-PDMS}) - M_{sponge}}{M_{sponge}} X100 \quad (1)$$

The hydrophobic property is quantified through the change in water accessible porosity ($\%P_{H2O}$); using Equation 2. In addition, the contact angle for the modified sponge is measured by performing hydrophobicity tests using 1 μL water droplets and measuring the contact angle with IC-Measure software.

$$\%P_{H2O} = \frac{M_{wet} - M_{dry}}{M_{dry}} X100 \quad (2)$$

On the other hand, the change in the foam structure caused by the SiO_2/PDMS deposition was observed through a stereoscope.

Oil Removal Capacity Measurement

To measure the oil removal capacity of the modified silica, 2 g of vegetable oil was added to a beaker and then the modified foam was passed with SiO_2-PDMS. After removal, the foam/SiO_2-PDMS is placed at 100°C for 24 h to evaporate the absorbed water and subsequently quantify the amount of oil removed by weight gain of the modified foam.

Results

Infrared Spectroscopy Characterization of R-SiO_2

Figure 4 shows the infrared spectra of the polyurethane foam, SiO_2-PDMS and P.F/SiO_2–10PDMS. For the polyurethane foam (Figure 4a) the characteristic bands of a urethane were observed. At 3293 cm^{-1} the N-H group is observed; while in the range of 2969-2865 cm^{-1} the C–H stretching bands were observed, while at 1704 cm^{-1} the carbonyl group (–C=O) is present and at 1639 cm^{-1} the C–O–C deformation.

On the other hand, the spectrum corresponding to SiO_2-PDMS (Figure 4b) indicates the chemical bonding of PDMS with the silica structure. It is observed that at 1100 cm^{-1} the siloxane groups (Si–O–Si) that form the inorganic matrix are found and at 1200 cm^{-1} the intense signal of the C–Si group of PDMS is observed and, finally, at 773 cm^{-1} the siloxanes corresponding to the PDMS chain are observed as an intense signal. The C–H stretching band corresponding to the $–CH_3$, of PDMS was found as a single band of low intensity at 2961 cm^{-1}.

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The spectrum of the foam impregnated with SiO_2-PDMS is presented in Figure 4c. It is observed the integration of the signals corresponding to the foam (3293 cm^{-1}, N-H; 1704 cm^{-1}, –C=O and 1639 cm^{-1} C–O–C) as medium intensity signals. On the other hand, the signals corresponding to SiO_2–PDMS are maintained as intense signals.

The amount of modified silica deposited on the sponge specimens varies according to the PDMS modifier percentage, as observed in Figure 5. The higher the PDMS content in the SiO_2–modified SiO_2 increases the mass deposited inside the foam specimens; having as a minimum mass of 4.53±0.25g SiO_2–PDMS/g P.Foam and as a maximum 7.36±0.71 g SiO_2–PDMS/g P.Foam.

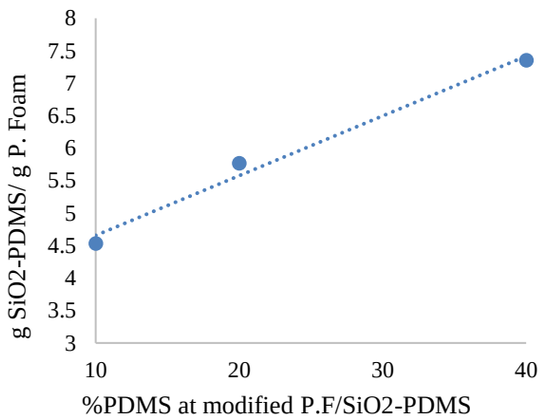

Figure 5 SiO_2-PDMS deposited into polyurethane foam

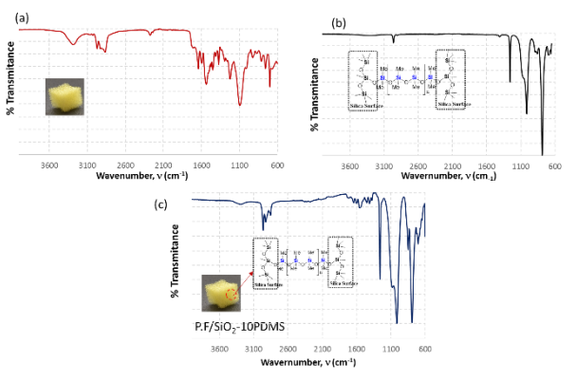

Figure 4 FT-IR (a) polyurethane foam (b) SiO_2-PDMS (c) P.F/SiO_2-PDMS

Figure 6 shows the change in the pore network present in the P.Foam due to the SiO_2-PDMS deposit; where it can be seen that, according to the PDMS content, there is an increase in the amount of pores filled with the modified silica. With 10% PDMS the pore structure is preserved reducing only the pore size, while at 20% a higher pore filling is observed with a higher number of pores filled with 40% PDMS.

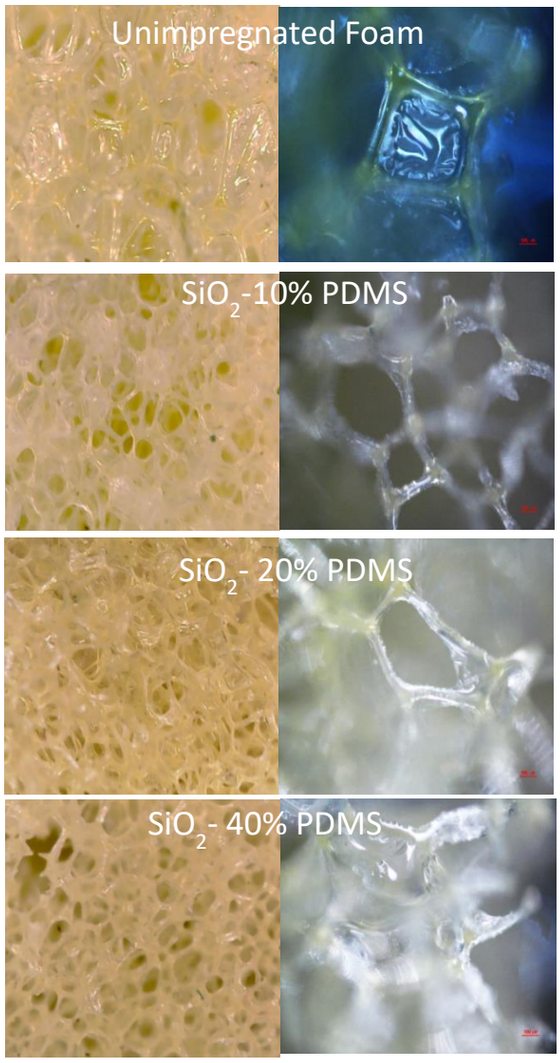

Figure 6 Porosity changes into P. Foam due to SiO_2-PDMS deposited

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Hydrophobic assessment

The hydrophobicity of P. foam and modified silica was evaluated through the change in porosity accessible to water (Figure 7). It is observed that P. Foam has a high-water absorption capacity, reaching 19 gH_2O/g P.Foam. When P. Foam is modified with SiO_2–PDMS the adsorption capacity is drastically reduced to 1.619±0.45 $gH_2O/gP.F/SiO_2$–PDMS when modified with SiO_2–40PDMS; while for P.Foam modified with SiO_2–10PDMS an adsorption capacity of 2.08±0.71 $gH_2O/gP.F/SiO_2$–PDMS is observed.

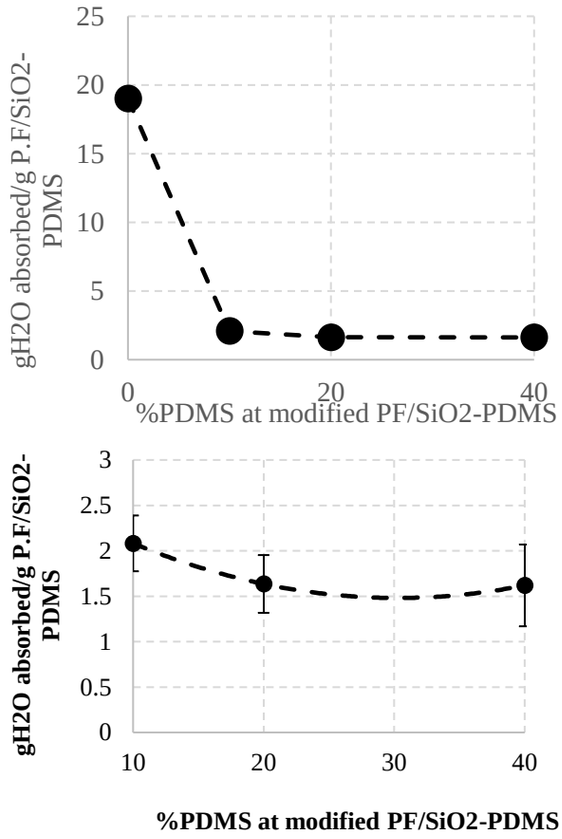

Figure 7 Water absorption capacity for P.F/SiO_2-PDMS

The decrease in water absorption capacity is due to the change from hydrophilic to hydrophobic behavior in P.foam, in addition to a decrease in porosity due to the deposition of SiO_2–PDMS within the pores of the foam in the silica modified with 20 and 40% PDMS, respectively.

On the other hand, the contact angle θ was measured for the different samples tested with the modified silica (Figure 8a) if the angle value is greater than 10º and less than 90º the material is hydrophilic; while if the angle value is between 90º and 120º it is a hydrophobic material and greater than 120º corresponds to a superhydrophobic material (Zhang X.F, 2020). According to the results obtained, the unmodified foam is a hydrophilic material with a contact angle θ=57.505±1.54º (Figure 8b and c).

According to the modification of P. Foam with SiO_2–PDMS changes the behavior from hydrophilic to hydrophobic presenting contact angles between 107.8±2.46º for P.F/SiO_2–10PDMS, 116.67±2.46º for P.F/SiO_2–20PDMS and 118.2±1.28º for PF/SiO_2–40PDMS. The increase in contact angle occurs linearly as the PDMS content in the modified silica increases. Therefore, the hydrophobic behavior in these materials is due to the PDMS content in the modified silica and the effect of foam roughness does not generate a significant contribution in the hydrophobicity of the material.

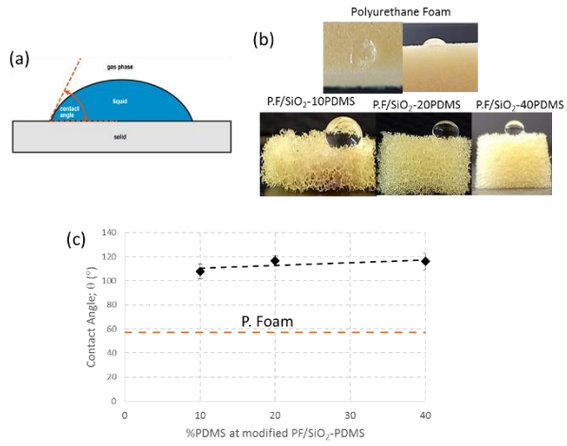

Figure 8 (a) Contact angle (b) water drop on surface foam and surface foam modified (c) contact angle according to PDMS

Oil removal capacity

The removal capacity for SiO_2–PDMS-modified P.Foam increased linearly with PDMS content. For PF/SiO_2-10PDMS a removal capacity of 14.69 g oil/m^2 PF/SiO_2–PDMS was determined, while PF/SiO_2–40PDMS presented a removal capacity of 21.22 g oil/m^2 PF/SiO_2–PDMS. The unmodified sponge has a low removal capacity, having a removal capacity of 10 g oil/m^2 PF (Figure 9).

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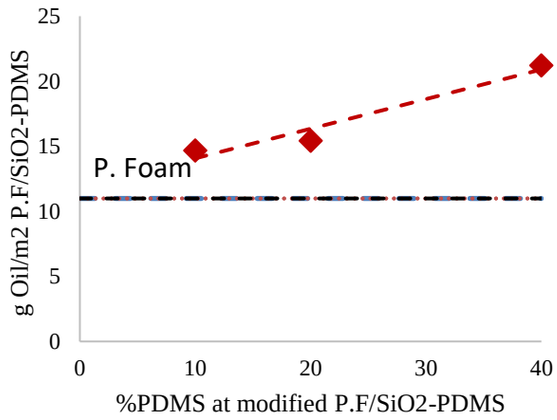

Figure 9 Oil removal capacity

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Conclusions

According to the results, the SiO_2–PDMS was impregnated in the macroporosity of the Polyurethane Foam; modifying its physical properties such as contact angle and water absorption capacity. The P. foam presents a contact angle of 57.50º, corresponding to a hydrophilic material, however, the oil removal capacity was 10 g oil/m^2 P. Foam. On the other hand, Polyurethane Foam impregnated with modified silica is a hydrophobic material with a higher oil removal capacity.

The increase in oil removal capacity in the P.F/SiO_2–PDMs is due to the integration of hydrophobic groups (PDMS) in the foam which improves the compatibility with the hydrocarbon increasing the removal capacity up to 21.22 oil/m^2 PF/SiO_2–PDMS.

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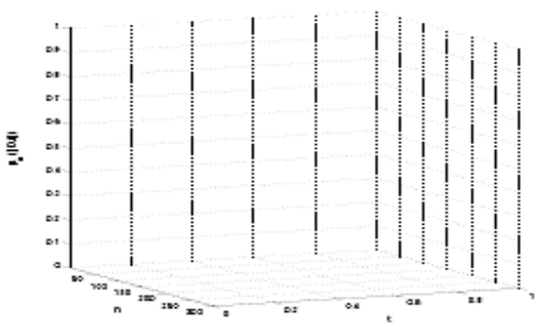

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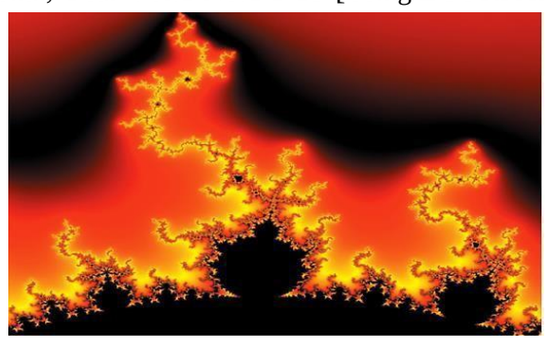

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