Article **Journal of Technical Invention**
December 2022 Vol.6 No.18 1-10

Design of an app for a module of practices of basic electrical installations

Diseño de una app para un módulo de prácticas de instalaciones eléctricas básicas

HERNANDEZ-SANCHEZ, Juan Fernando†*, CASTILLO-QUIROZ, Gregorio, LUNA-CARRASCO, Claudia Yadira and TORRES-JIMENEZ, Jacinto

Tecnológico Nacional de México/Instituto Tecnológico Superior de Huauchinango, Maestría en Tecnologías de la Información

ID 1st Author: *Juan Fernando Hernández-Sánchez* / **ORC ID**: 0000-0002-4409-5174, **Researcher ID Thomson**: AAS2942-2021, **CVU CONACYT ID**: 937701

ID 1st Co-author: *Gregorio, Castillo-Quiroz* / **ORC ID**: 0000-0002-1904-4172, Researcher ID Thomson: H-9402-2018**, CVU CONACYT ID**: 162009

ID 2nd Co-author: *Claudia Yadira, Luna-Carrasco* / **ORC ID**: 0000-0002-4092-9987, Researcher ID Thomson: G-2892-2019, **CVU CONACYT ID**: 368419

ID 3rd Co-author: *Jacinto, Torres-Jiménez* / **ORC ID**: 0000-0002-8006-6397, **CVU CONACYT ID:** 103469

DOI: 10.35429/JOTI.2022.18.6.1.10 Received July 12, 2022; Accepted December 24, 2022

Abstract

Currently, electrical installations of any kind must comply with minimum safety standards taken into account at the time of their construction and use. This article aims to present the design and construction of a series of practices as well as the design of a mobile application for the improvement of learning in the training of residential electrical installations of the "Mahatma Gandhi" High School of Xilocuautla, Huauchinango, Puebla, through a practice module "ElectriBasic App". The App will serve as a didactic support, since it is a graphic and technical instruction for students who wish to carry out practices related to residential electrical installations. With this module, students will be able to identify, through various previously organized practices, the types of connections and different types of accessory arrangements of a residential electrical installation, as well as identify concepts from basic to intermediate that they do not know within the topics of electricity.

Application, Tool, Teaching

Resumen

En la actualidad las instalaciones eléctricas de cualquier tipo deben cumplir con unos estándares mínimos de seguridad tenidos en cuenta al momento de su construcción y su uso. El presente artículo tiene como objetivo presentar el diseño y construcción de una serie de prácticas, así como el diseño de una aplicación móvil para el mejoramiento del aprendizaje en la capacitación de instalaciones eléctricas residenciales del Bachillerato "Mahatma Gandhi" de Xilocuautla, Huauchinango, Puebla, mediante un módulo de prácticas "ElectriBasic App". La App servirá como apoyo didáctico, dado que es un instructivo gráfico y técnico para los alumnos que deseen realizar prácticas relacionadas con las instalaciones eléctricas residenciales. Con este módulo los alumnos podrán identificar mediante diversas prácticas previamente organizadas los tipos de conexiones y diferentes tipos de arreglos de accesorios de una instalación eléctrica residencial, así como también identificar conceptos desde básicos hasta intermedios que no conocen dentro de los temas de la electricidad.

Aplicación, Herramienta, Enseñanza

Citation: HERNANDEZ-SANCHEZ, Juan Fernando, CASTILLO-QUIROZ, Gregorio, LUNA-CARRASCO, Claudia Yadira and TORRES-JIMENEZ, Jacinto. Design of an app for a module of practices of basic electrical installations. Journal of Technical Invention. 2022. 6-18: 1-10

*Correspondence to Author (e-mail: gregorio.cq@huauchinango.tecnm.mx)
† Researcher contributing as first author.

Introduction

Currently in Mexico there are hundreds of thousands of schools, some with easy access, others with difficult access due to the geographical area where they are located, including other factors. According to the National Institute for the Evaluation of Education (INEE), in rural localities, that is, with fewer than 2,500 inhabitants, 57% of the schools are for basic education and 30.4% are for upper secondary education. Indigenous and community preschools are the ones with the greatest presence in this type of locality (87.3 and 97.4%, respectively).

Within the different educational levels we find many deficiencies due to the lack of updating of teaching methods. In the rural environment in Mexico is where the highest levels of educational inequality exist, and for this reason the educational level of people who develop academically in the rural environment are low compared to the urban environment, where there are greater possibilities.

Over time things change, currently the management of ICTs in the educational field would be allowing the modernization of the teaching methods previously adopted in the educational system in Mexico. The global pandemic that began in the first months of 2020 and that spread worldwide left us with many good and bad things, due to this health problem in Mexico, the teaching method radically changed due to the risk that was presented, according to data provided by the National Institute for the Evaluation of Education (INEE) approximately 30 million students had to stop going to educational centers in person due to the health contingency.

With the passage of time and now that the country is gradually returning to normality with a hybrid educational system, which is a form of teaching that includes face-to-face and remote teaching methods. There are two modalities to impart the hybrid model, one of them is in the blended modality, which is based on the traditional teaching methods that we have applied for decades and on the other hand there is the disruptive modality in which most of the educational activities are carried out through digital platforms.

In a certain way, this model has been accepted by the majority of students and parents, since it has many advantages, among which are promoting interaction between students and teachers, learning becomes active again by contextualizing real activities, as well as that students have greater control over their own learning, which could translate into having autonomy and being self-taught. And it is that this is the importance that should be entrusted to students today, because J. Dewey and his teaching principles gave way so that in educational systems trust is placed in the student, this so that he is able to challenge his fears and help him solve his problems in such a way that the learning process would be almost autonomous.

And another of the pioneers in the area of education and teaching on residential electrical installations was Ing. Gilberto Enríquez Harper who obtained the title of electrical engineer in 1976 and throughout his career he wrote more than 215 publications of which are 75 books about engineering in various branches and one of the most important was the electrical installations detailing in each of his books the clear procedures with everyday examples as well as illustrations and diagrams that are of great help today in the teaching of electrical installations for both students and people who are interested in the area of electrical installations.

It should be noted that at the upper secondary level, learning efficiency is not the same since there are various study plans such as those offered by the (National College of Technical Professional Education) Conalep, General Directorate of Technological and Industrial Education (DGETI) are very different from the general high school, it is clear that in the basic subjects it is the same but there are special subjects which are very useful for the student's future since this type of technological learning opens the way to a clearer vision that the student has to have at the end of their studies and continue with their professional vocation.

On the other hand, it is clear that there is a lot of difference that could be shortened if the schools focused on an area that is closest to reality and that they reinforce concepts and techniques that will serve them even if the student does not follow the path to which their studies are being focused.

ISSN 2523-6792

Have basic knowledge that you could apply in your daily life or better yet, get the most out of it and earn a living for your family. We have realized that currently many students do not have defined what are basic concepts that were already seen in previously studied subjects such as physics, chemistry, mathematics, etc. These concepts are essential, but for each of the students to grasp the meaning of preparation, it is necessary to use a more practical teaching method from which they take more advantage using technology as an aid tool, as well as others using interactive additives that make them think about how to solve a real problem and with this the students would have more self-confidence when going out to work or when something similar happens to them.

The present project consists of the development of a mobile application that helps the technical review of residential electrical installations, within the same application it contains different sections with useful information as well as diagrams which facilitate the student the correct understanding of what an installation is. Residential electricity and in this way get the student interested in carrying out the practices in a didactic way using technology.

The development of this project is divided into the following sections:

1. Methodology: The steps followed for the development of the project are described.

2. Results: In this section, the results are analyzed to determine if the mentioned objective has been achieved.

3. Acknowledgments: Thanks to the people and institutions that allowed the development of this research.

4. Conclusions: It speaks of the objectives achieved satisfactorily.

Methodology

The project presented below was carried out in the "Mahatma Gandhi" high school, in the town of Xilocuautla, Huauchinango, Puebla (see Figure 1). This community has approximately 1,302 inhabitants.

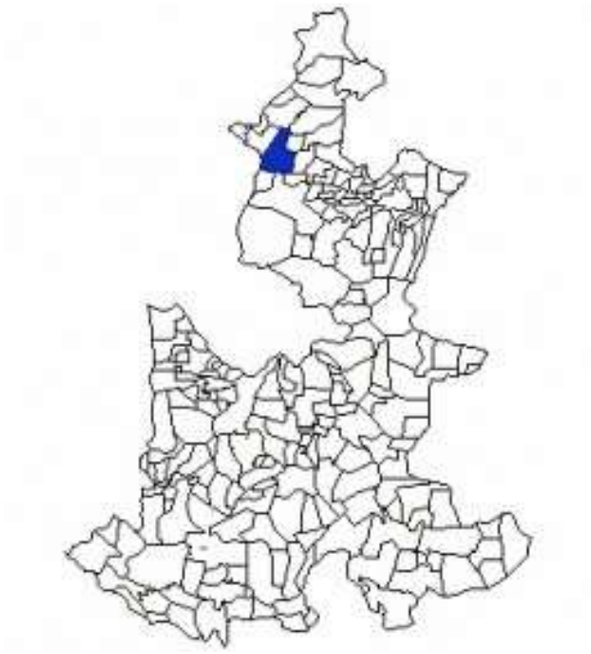


Figure 1 Geographical location of Huauchinango, Puebla.(Auditoria Superior del Estado, 2020)
Source: https://www.auditoriapuebla.gob.mx/sujetos-de-revision/informes/informes-individuales/itemlist/category/354-huauchinango

Before making the design and projection of the prototype, a survey was carried out on the students of the aforementioned high school to see the aptitudes of each one of them and to be able to detect the deficiencies in terms of knowledge about residential electrical installations, such as basic concepts of electrical installations and electrical circuits.

A. Requirements

Next, the questions of the survey carried out to the students of the "Mahatma Gandhi" high school are presented, as well as the results of the survey (see Graph 1):

1. Do you know what electrical circuits are?

2. Do you know the classification of electrical circuits?

3. Do you know the serial connection?

4. Do you know the parallel connection?

5. Do you know how to connect an electrical switch?

6. Do you know how to connect an electrical switch?

ISSN 2523-6792

7. Do you know what an energy source is?

8. Do you know what an electricity generation system is?

9. Do you know what a lighting system is?

10. Do you know what electrical installations are?

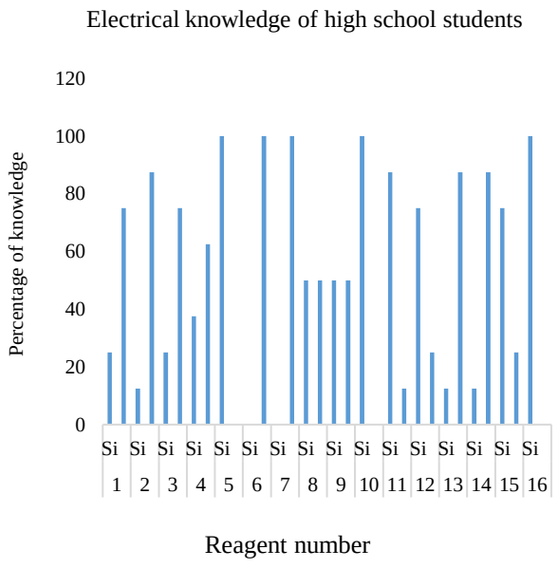
11. Do you know the importance of residential electrical installations?

12. Do you know any symbols used for the graphic representation of a residential electrical installation project?

13. Do you know NOM-001-SEDE-2012?

14. Do you know any tool as a simulator for residential electrical installations?

15. Would you like to learn more about residential electrical installations?



Graph 1 Graph of the results of the survey carried out on the students
Source: Own Elaboration

B. Design

The ElectriBasic App module is aimed at reinforcing in a technical and practical way the knowledge previously acquired in electrical installations and concepts from the basics to the most complex, since said prototype is accompanied by a mobile application which, first of all, has useful information that the The student can consult instantly without the need to have an internet connection.

This information was previously selected and analyzed so that the student can learn in a simple way, within the information it contains, topics such as the definitions of electrical installations and issues related to the installation and connection of an outlet, a switch, on the other hand a fundamental part is ohm's law, which is a case study that is applied on many occasions when making calculations, concepts of electricity that are important to the when addressing issues such as energy efficiency and other issues, electrical safety, which is the work base of every electrician since it is of great importance to know the procedures in the handling of tools as well as the safety equipment necessary to carry out work with a live line, definitions of electrical circuits to analyze the connections in series and parallel, circuits and also do some mixed calculations and analyzes of them.

To make these calculations within the application there will be a calculator section in which you can calculate the electrical power, the current, the voltage, the calculation of conductors, energy consumption, etc. And it is then the use of technology so that students become familiar with the theory of electrical installations in order to apply their acquired knowledge in a practical way.

This prototype will serve to connect the necessary arrangements according to the previously described practice, this will be based on the current official standards of electrical installations so that the student becomes familiar with the colors used in the conductors within an electrical installation, type of used switches, but this will also be possible thanks to the help of the mobile application, because when doing the practice this module will be linked and will send information in real time about the status of the connections, which will be helpful for the student who will verify if the connection made is correct or not, in this way and with the verification of the type of connection recorded by the system, the student will be able to learn in a simple way what electrical installations are and the importance of adhering to the standards in force, likewise you can also identify various daily problems in electrical installations such as short circ uites, system failures, among other cases and will be able to make the appropriate decisions to provide a solution to the problem..

ISSN 2523-6792

1. App inventor

This platform is an application development environment for all kinds of android devices. To develop a mobile application with App Inventor, you only need a web browser and an Android phone, this platform is very easy to use even if you do not have extensive programming knowledge.

When developing an application, you work with two tools; App Inventor Designer in which the user interface will be built in this way each of the elements with which the user will interact is chosen and placed, on the other hand, in the App Inventor Blocks Editor tool the behavior of each of the elements is defined the components, or in other words, it is the part that is in charge of giving the instructions.

Creating applications from this platform has many advantages, among which are:

– 100% free tool.

– Allows you to create applications from the web browser and the changes are saved automatically.

– Visual learning by blocks of code.

– Applications can be created for Android or iOS operating systems.

– Easy verification of the operation of the application.

C. Application development using App Inventor

App Inventor is a Google Labs platform which is accessed through the following link http://appinventor.mit.edu/ to then create a user account to access. Once the page is open, in the upper right part there is the "create apps" button (see Figure 2), for this it will ask us for a google account.

Figure 2 Home screen to create an account in App Inventor. (Screenshot)
Source: http://appinventor.mit.edu/

Once the google account has been accessed and verified, a new project must be created (see Figure 3) in addition to giving it a name and pressing "accept" so that the project as it changes and progresses, these changes are automatically saved.

Figure 3 Process to create a new project in App Inventor. (Screenshot)
Source: http://appinventor.mit.edu/

Once this procedure is done, we move on to the next point, which is the design of the application's home interface in the "designer" section (see Figure 4), in which the name of the application's home screen will be given. Once this is done, 4 main buttons will also be added to access the theory sections, the calculator where you can insert values to the different formulas presented to calculate the total resistance in series and parallel, energy consumption in KWH, on the other hand, also find the section of the tests proposed for the practices that are going to be carried out, as well as the section where electrical connection diagrams.

ISSN 2523-6792

Figure 4 Application home screen. (Screenshot)
Source: Own Elaboration

Pressing the theory button will open a window where you can view important information about electricity (see Figure 5), within these important topics include electrical safety, what are the basic concepts, laws and regulations in electrical matters, power plants, types of electrical connections in series and parallel, protection devices, among many other topics that the student can consult in this application without the need to be connected to an internet network.

Figure 5 Window corresponding to the theory regarding the "basic concepts" section. (Screenshot)
Source: Own Elaboration

The above actions are achieved through control, that is, in the "block editor" section, it is where the actions that the application must perform when interacting with it are declared. It is here that each of the windows is brought to life, indicating its function through simple blocks that are built using logic. These blocks for the theory section were the most basic (see Figure 6), since they are functions of the buttons that were added and when declaring that the button is pressed, another window is displayed with the selected information, either about security electricity, basic concepts, measuring instruments, etc.

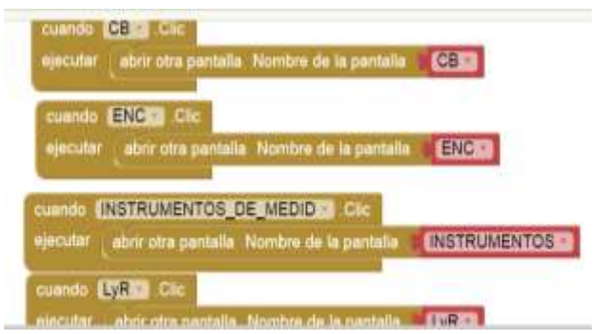


Figure 6 Block editor corresponding to the theory section. (Screenshot)
Source: http://appinventor.mit.edu/

For the calculator section we add the design (see Figure 7) in which we can calculate various factors one of them and the best known within electricity is Ohm's law, within which we can calculate the resistance, the current and voltage substituting the values depending on what is required to be calculated.

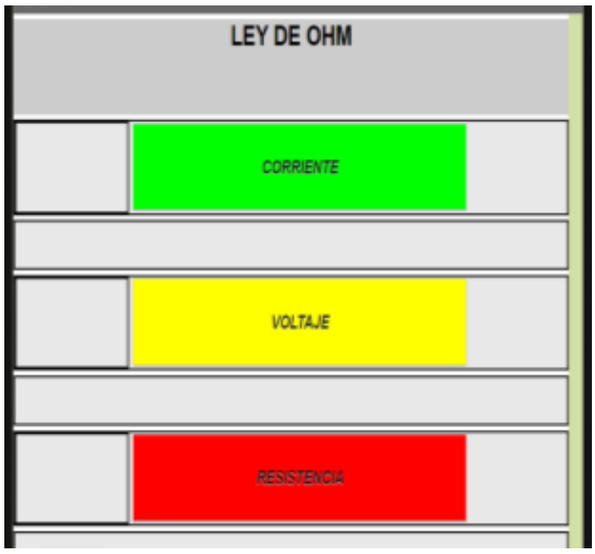


Figure 7 Calculator interface design with respect to Ohm's law. (Screenshot)
Source: http://appinventor.mit.edu/

Once the main window is done, each one of the functions is programmed in the block editor as it has been worked with the other windows of the application, in this almost the blocks determine that when substituting the value in each window, the value of the block is calculated window that is free, that is, if I want to calculate the resistance I have to fill in the voltage and current fields so that it executes the corresponding operation (see Figure 8).

In this way, the student will understand and analyze the mathematical formula, as well as be able to check his calculations until he is able to perform them manually and quickly with the calculator and thus speed up his mentality when analyzing mathematical formulas and make the student become more and more interested in the world of electricity.

Figure 8 Programming of functions related to the calculator using the block editor. (Screenshot)
Source: http://appinventor.mit.edu/

Results

As for the practice module (see Figure 10) which was previously discussed and in which the corresponding practices will be developed, it is mainly made up of the control module which will be linked via bluetooth through a "Bluetooth Communications Module HC-05" which will be in charge of processing the signal generated by the devices to the module controlled in the same way by an arduino nano. In this way we will have the control system that is going to process the signals converted to 1 or 0 which, through indicators, is going to determine if the constructed circuit is correct according to the practice that is being carried out. Next, we present the circuit design with solid-state relays (see Figure 9) which will be interconnected to the practice module, because the system works with 127 V AC and 5 to 9 V DC.

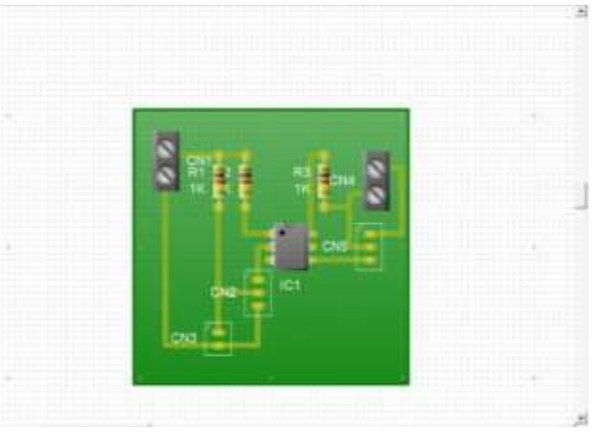


Figure 9 Design of the solid state relay circuit. (Screenshot)
Source: Own elaboration

The components of the practices module are described below, which are the most used in residential electrical installations in accordance with current regulations on residential electrical installations.

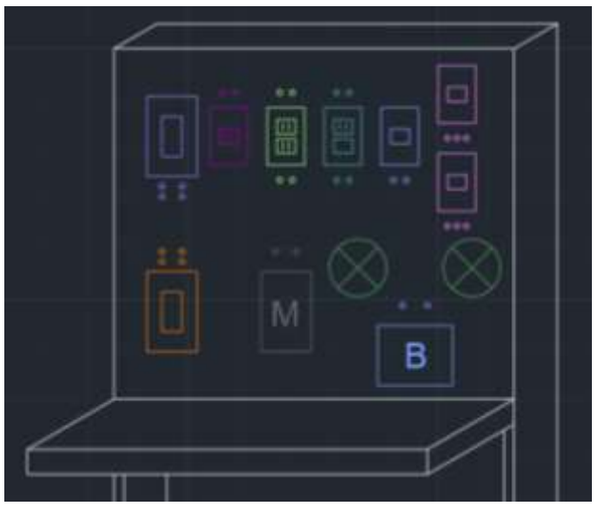


Figure 10 Modeling in AutoCad of the practice module
Source: Own Elaboration

Likewise, by showing the components we are determining some practices that are applied repeatedly in a home, since some design structures are different according to use or requirements.

Figure 11 Illustration of assembly of accessories of the first practice. (Truper, 2022)
Source: Truper Catalog 2022

One of the most common cases in electrical installations is the connection of a contact and a switch together, for this the module will have an ABS and polypropylene plate armed with a two-pole contact and a ground (see Figure 11).

As well as a simple Volteck Basic switch, in the same way the switch will be connected to a luminaire, of these components the students must be able to analyze and correctly connect these two components physically and check their operation through the application making the connections correctly with banana cables inside the connection terminal blocks that each accessory has.

Figure 12 Illustration of assembly of accessories of the second practice. (Truper, 2022)
Source: Truper Catalog 2022

Regarding the second practice, we see that the arrangements are different since this time it includes an ABS and polypropylene plate armed with two contacts with two poles and a ground, as well as a switch (see Figure 12), this arrangement is very common in electrical installations, which is why the students will be able to analyze well when making the connections.

Figure 13 Illustration of assembly of accessories of the third practice.(Truper, 2022)
Source: Truper Catalog 2022

ISSN 2523-6792

It is very common that in residential electrical installations there are always two independent switches together with a contact (see Figure 13) since it is common to control two lights independently in this way, that is why in this practice the different types of switches will be analyzed arrangements for connecting such accessories.

Figure 14 Illustration of ½ HP peripheral water pump.(Truper, 2022)
Source: Truper Catalog 2022

We know that inside a house it will always be essential to have a water pump (see Figure 14), but for these cases we cannot connect the pump directly to a contact due to the current it consumes, for this reason the students must analyze and understand the type of arrangement for the power supply of the pump as well as a thermomagnetic switch and calculate it through formulas which contains the theory part in addition to being able to calculate it also through Ohm's law in the application calculator.

Acknowledgements

This scientific article was possible thanks to the support given by the Instituto Tecnológico Superior de Huauchinango, as well as to CONACYT for giving me the support of Becas Nacional (Tradicional) 2022, and to the collaborators who participated in this project, my total thanks.

Conclusions

The "ElectriBasic" mobile application has been a way to revolutionize learning and the approach to what residential electrical installations are according to dynamic learning methods so that high school students acquire solid knowledge and help them choose their true vocation, promoting and getting the best out of each one of them in a rational way with the practices that will be developed physically until a concrete analysis and improvement in decision-making is achieved. The use of technology today is already very advanced and using said technology for common learning purposes, many goals can be achieved together with teachers, since both teachers and students will have growth in terms of theoretical knowledge and practical. Over time and as students and teachers become familiar with the application and what residential electrical installations are, students will be able to carry out electrical work at home and even better, they can fully enter the labor field of the installations and with the passage of time they will become great experts in electrical matters.

References

[1] C. Mateu, "Desarrollo de aplicaciones web", Roa.ult.edu.cu, 2019. [En línea]. Disponible: https://libros.metabiblioteca.org/bitstream/001/591/1/004%20Desarrollo%20de%20aplicaciones%20web.pdf

[2] Giovannelli, NM-C. (s/f). *Xilocuautla*. Nuestro México. Recuperado el 22 de agosto de 2022, de http://www.nuestro-mexico.com/Puebla/Huauchinango/Xilocuautla/

[3] Instituto Nacional para el Federalismo y el Desarrollo Municipal. (s/f). *Escuelas rurales: El concepto educativo de José Vasconcelos para unificar culturalmente al país*. Recuperado el 22 de agosto de 2022, de https://www.gob.mx/inafed/articulos/escuelas-rurales-el-concepto-educativo-de-jose-vasconcelos-para-unificar-culturalmente-al-pais-114595

[4] J. Betancur Valencia, "Diseño e implementación de un prototipo didáctico para la enseñanza de instalaciones eléctricas residenciales", 2019. [En línea]. Disponible: https://repositorio.itm.edu.co/bitstream/handle/20.500.12622/103/BetancurValenciaJoseRaul2017.pdf?sequence=2&isAllowed=y

[5] M. Chacana, "Guía para el mejoramiento de instalaciones eléctricas en viviendas antiguas", Repositorio.unab.cl, 2019. [En línea]. Disponible: http://repositorio.unab.cl/xmlui/bitstream/handle/ria/7439/a123580_Chacana_M_Guia_para_el_mejoramiento_de_2018_Tesis.pdf?sequence=1&isAllowed=y.

[6] *Material Eléctrico*. (Dakota del Norte). Truper.com. Recuperado el 22 de agosto de 2022, de https://www.truper.com/material-electrico

[7] (Nd-b). Mit.edu. Recuperado el 22 de Agosto de 2022, de http://ai2.appinventor.mit.edu/?locale=es_ES#5415879823982592

[8] Westbrook, RB (1993). Juan Dewey: 1859-1952. *Perspectivas, 23* (1–2), 277–291. https://doi.org/10.1007/bf02195040

ISSN 2523-6792