Revista Iberoamericana de la Educación, Vol - 7 No.4, October – December 2023
e-ISSN: 2737-632x
Pgs 29-38

Competency-based teacher training using didactic boards in the Electrical Technology course

How to cite:
Salguero, V., Mendoza, R., Montalvan, J., Andrade, A. (2023) Competency-based teacher training using didactic boards in the Electrical Technology course. *Revista Iberoamericana De educación,* 7(4) 29-38

Formación del profesorado basada en competencias mediante tableros didácticos en la asignatura de Tecnología Eléctrica

Formação de professores com base em competências utilizando quadros didácticos no curso de Tecnologia Eléctrica

Victor Hugo Salguero Sumba*
Raul Mendoza**
Jose Montalvan***
Arnaldo Andrade****

Received: April, 2023
Approved: July, 2023

DOI: https://doi.org/10.31876/ie.v7i4.259

http://www.revista-iberoamericana.org/index.php/es

* Ing. Tecnológico Simón Bolívar, v_salguero@istsb.edu.ec, https://orcid.org/0009-0006-2820-0524

** Ing. Tecnológico Simón Bolívar, rmendoza@istsb.edu.ec, https://orcid.org/0000-0002-9806-9465

*** Ing. Tecnológico Simón Bolívar, jmontalvan@istsb.edu.ec, https://orcid.org/0000-0002-7907-9692

**** Ing. Tecnológico Simón Bolívar, aandrade@istsb.edu.ec, https://orcid.org/0000-0002-5821-2319

Abstract
In the year 2019, after analyzing the progress of Technological Education in the ISTSB and the development framework of the career of Higher Technology in Electricity where emphasis is given to control, several projects of control and starting of single-phase and three-phase motors were developed and after consulting experts, students and teachers of the ISTSB, a board is developed where it is combined, forms of traditional starting, with solid state equipment, such as soft starter and a frequency inverter. Plus a module for PLC, i.e. a tour of all the study material of Electrical Control, units of study of Industrial Installations, Instrumentation and Industrial AutomationThe pandemic occurred in 2020 made the board of Industrial Practices, is not followed as a generator of skills, but was repowered in 2020, as a result of which it has been used by two careers Superior Electromechanical Technology and Electricity in the subjects of Instrumentation, Industrial Installations and Automation. The result is 90% favorable to the improvement of skills, supported by the surveys conducted to those who used the control panel in the period 1H 2023 from April to July 2023.
Key words: Technological education, skills, starters, curriculum.

Resumen
En el año 2019, luego de analizar el avance de Educación tecnológica en el ISTSB y el marco de desarrollo de la carrera de Tecnología Superior en Electricidad donde se le da énfasis al control, se

desarrolló varios proyectos de control y arranque de motores Monofásicos y Trifásicos y luego de consultar a expertos, estudiantes y profesores del ISTSB, se desarrolla un tablero donde se conjunta, formas de arranque tradicional, con equipos de estado sólido, como el arrancador suave y un variador de frecuencia. Más un módulo para PLC, es decir un recorrido de todo el material de estudio de Control Eléctrico, unidades de estudio de Instalaciones Industriales, Instrumentación y Automatización IndustrialLa .pandemia ocurrida el año 2020 hizo que el tablero de Practicas Industriales, no sea seguido como generador de habilidades, pero fue repotenciado en el 2020, consecuencia de lo cual ha venido siendo utilizado por dos carreras Tecnología Superior de Electromecánica y Electricidad en las materias de Instrumentación, Instalaciones Industriales y Automatización. Resultando un 90% favorables al mejoramiento de habilidades, sustentadas por las encuestas realizadas a los que usaron el tablero de control en el periodo 1S 2023 desde los meses de Abril a Julio del 2023.
Palabras clave: Educación Tecnológica, habilidades, arrancadores, plan de estudio

Resumo
No ano de 2019, após análise da evolução da Educação Tecnológica no ISTSB e do quadro de desenvolvimento da carreira de Técnico Superior de Eletricidade onde se dá ênfase ao controlo, foram desenvolvidos vários projetos de controlo e arranque de motores Monofásicos e Trifásicos e após consulta a especialistas, alunos e professores do ISTSB, é desenvolvido um quadro onde se junta, formas de arranque tradicionais, com equipamentos de estado sólido, como o soft starter e um inversor de frequência. A pandemia ocorrida em 2020 fez com que o quadro de Práticas Industriais, não fosse seguido como gerador de competências, mas foi repotencializado em 2020, em resultado do qual tem sido utilizado por duas carreiras Superiores de Tecnologia de Eletromecânica e Eletricidade nas disciplinas de Instrumentação, Instalações Industriais e Automação. O resultado é 90% favorável à melhoria das competências, apoiado pelos inquéritos realizados a quem utilizou o painel de controlo no período 1H 2023 de abril a julho de 2023.
Palavras-chave: Educação Tecnológica, competências, iniciantes, currículo.

INTRODUCTION

The article evaluates and validates the positive improvement of the technological skills of students based on complementary learning through the use of boards designed based on the syllabus of the subjects of the technologist career, of Higher Technology in Electricity of the Instituto Superior Tecnológico Simón Bolívar, which proposes to carry out didactic practices of electrical control and management of motors by means of starters, with the purpose that the students carry out practices, based on the theoretical knowledge acquired.

By improving the practical skills and competencies for professional development of students with the use of didactic devices, we will have better trained professionals for the challenge of continuous technological improvement.

This improvement exposed in the article was made in the first place recognizing the shortcomings in education, lack of practical workshops, tools, which contribute to the fact that the skills and abilities in the T.S. Electricity career are not developed at the same time the theoretical part of the syllabus with the practical part that improves the operational part of the student.

Secondly, we turned to professors of the Simón Bolívar Technological School, teachers of the UCSG and professionals of the Electrical area who, based on interviews and surveys, outlined a Didactic Board that covers the detected needs of the moment, and using as a design element the syllabus of the Electrical career, the Electrical Control Board that is evaluated in the article was manufactured.

Finally, in semester 1S2023, after using the board for 3 semesters, the application in technological education, the use of the didactic board and establishing whether or not there was an improvement in professional competencies in a group of students will be evaluated.

If we recognize the economic shortcomings of education in the third world, of which Ecuador is not exempt, we will say that the training of skills and abilities in T.S. career. Electricity, is a notorious lack, for not having workshops that give the image of company that the students will have in the professional field therefore it is manufactured according to interviews and surveys a Didactic Board that covers the detected needs, and we believe that its application to the technological education the mentioned didactic board applied on a group of students we will obtain an improvement of practical abilities and its competences in the professional development of this

group of students where the use of the didactic boards, will be a main part of this result.

An electrical panel is a closed metallic box that contains the connection, maneuvering, command, measurement, protection, alarm and signaling devices, which fulfill different functions in a single or three-phase electrical system. The elaboration or construction of an electrical panel, must meet design criteria and various regulations NEC, IEEE, NATSIM that allow its correct operation once energized, ensuring the safety of operators and facilities in which they are located.(González Lopera, 2019).

Controlling is a paradigm of the human being, likewise cover the gap of what was studied in the classroom with the industry should be a priority (modernize), therefore it is mandatory to design control boards of alternating current induction motors, where the student can prove to himself that he can do it, in this learning as a first step we describe the principle of the induction machine, the working conditions with changes in voltage, frequency and phase for operation. Then next explain the purpose of building the board for the practice of motor control, also how the design of the board was made so that it is didactic to project learning to future generations. The scope that has project is to try to maximize the number of motor control practices using measurement equipment connected applications, explaining and describing the parameters to be measured, electrical connections, as well as build the guide (González Lopera, 2019)We always associate, that electrical panels are metal structures, in which the connection-disconnection, control, protection, measurement, signaling and distribution devices are concentrated; all these devices allow an electrical installation to operate safely (González Lopera, 2019).

Every electrical system is made up of a type of energy, conductors, and a receiver that changes the electrical energy into light (lamps), movement (motors) and heat (stoves). For the transformation to occur, it is necessary that current flows through the system, this must be composed of conductive elements, connected to a source of voltage or voltage, the devices that allow to open, close or control systems are called switches or keys. The devices of an electrical system are said to be in series when they are placed one after the other so that the electrons passing through the first device of the system and then through the other devices. The intensity of the current is the same at all points of the system, characteristic of series circuits (voltage control), we can also connect the elements next to each other so that

the voltage that feeds them is the same (current control). (Aldaz-Suarez et al., 2022)

The asynchronous rotating machine consists of a device where electricity is induced from the stator to the rotor by means of a path provided by the magnetic field, allowing the motor rotor to generate mechanical power. An induction motor is of the single-phase and three-phase type, the latter being the most common. The characteristic of the asynchronous motor lies in the way in which power is supplied to the rotor by the stator first to be subsequently converted into torque product of the magnetic force of the stator. (Chacha Yugcha, 2020).

One way to start an alternating current motor is with direct connection to full voltage network, where the motor is connected to the mains voltage, in this case, the motor will generate a starting current, two to six times higher than the normal current regime. In case the motor is built for this situation this high initial current shock, it will not experience working inconveniences; however, when it comes to higher power motors, it is usually convenient to reduce the starting current, otherwise this high current could mechanically affect the motor and its load, as well as energy losses. The alternating current electric motor par excellence is the induction motor or three-phase asynchronous motor, being the most used for the drive of machines in the industry, its wide use is due to its ease of maintenance, installation, low cost and robustness. (Torres Mejía & Lema Tapia, 2009)..

The didactic board is a useful tool where different practices were carried out to help students of the Instituto Superior Tecnológico Simón Bolívar to polish their knowledge. As the students learn, the board will be improved so that it can provide greater professional skills, that is why an investigation was conducted based on interviews, review of syllabuses and came to the assembly of each of the modules of the board under that point of view, that is, solving needs attached to what was studied in the subjects of Facilities, Electrical Control and Industrial Instrumentation.

After consulting with experts such as Eng. José Montalván, Eng. Arnaldo Andrade, Eng. Juan Quispe, it was concluded to structure a board of 12 modules, each one of 25x 20 cm where the first one would occupy 2 places to mount the three-phase and single-phase thermo magnetic protections of 2 poles, as well as a reader of currents and digital voltages, the third module of mechanical control signals such as on and off push buttons and two-position switch for transfers, a fourth signaling module to be able to have visual signals on and off

here in the 2021 version was reorganized to be able to mount a screen coupled to a PLC complementing or taking the board to be used in a new subject Industrial Automation, which made the fifth module was repowered under the tutelage of Eng. Raul Mendoza and the PLC was migrated to a commercial brand, the initially installed was of the Lobato brand and the current one is SIEMENS, the PLC is a Logo 8 with expansion of analog signals and a communications module with sending information via text messages of the PLC operation plus the screen that was installed in module 4 thus complementing a simulation of HMI interface, the sixth module is something new in the 2021 version where 2 limit switches and two sensors are installed, one inductive and one capacitive, npn type at 24 vdc. These modules make up the upper part.

MATERIALS AND METHODS

Contactors (two), 240 VAC and 2 auxiliary contacts plus 4 force contacts, module eight is composed of thermal relays for recognition of differences with another module that is in position twelve which is the module of Guard motors, module ten is a module where a soft starter was installed and module eleven a starting module via frequency variation, module nine is a total of six relays that provides us with 2 contacts NA, NC, those are the twelve modules that make up the board and that is currently working in the Electrical Control Laboratory at the Gabriela Mistral School where the Electromechanical career of the same Simón Bolívar Technological School is working.

Modules Installed on the Board

Module 1 and 2 Power supply and measurement modules

Module 3 Mechanical Control Signals Module

Module 4 Signaling module to be able to have visual signs

Module 5 SIEMENS PLC module, Logo 8 with analog communication signals

Module 6. End-of-stroke module with inductive and capacitive sensors

Module 7. contactor module (two), 240 VAC

Module 8 Module with thermal relays 240 VAC

Module 9 2-contact relay module 240 VAC

Module 10. Soft Starter Module

Module 11 Frequency inverter module

Module 12 Module of two motor guards.

RESULTS

The practices that have been carried out and on which the learning capabilities are going to be evaluated in the period 2S2022 and 1S2023 in the subject of Industrial Electrical Installations, on a frame of 100 students plus guests who were presented the boards to perform various practices and could evaluate the functionality of the same in the program of Linkage with society of the period 1S2023.

PRACTICE 1. Recognition of existing electrical elements in the panel.

Table 1. *Theoretical concepts of the syllabus that are reaffirmed in practice 1 of Industrial Installations. (ISTSB, 2020)*

Unit 1 Industrial Electrical Installations Syllabus 1S2023
Basic concepts of electrical measurements
Alternating current circuits
Electrical power and energy
Electrical connection circuits

PRACTICE 2. Direct starting of three-phase motors using contactors and relays.

Table 2. *Theoretical concepts of the syllabus that are reaffirmed in practice 2 of Industrial Installations. (ISTSB, 2020)*

Unit 4. Syllabus of Industrial Electrical Installations 1S2023
Alternating current motor starting

PRACTICE 3. Direct starting of three-phase motors using contactors and relays to recognize delta star connections in the motor windings.

Table 3. *Theoretical concepts of the syllabus that are reaffirmed in practice 3 of Industrial Installations. (ISTSB, 2020)*

Unit 4. Syllabus of Industrial Electrical Installations 1S2023
Determination of the requirements for an electrical installation. Control devices

PRACTICE 4 Starting three-phase motors using limit switches, inductive and capacitive sensor applications.

PRACTICE 5. Motor starting using soft starter
PRACTICE 6. Motor starting using variable frequency drive.

Table 4. *Theoretical concepts of the syllabus that are reaffirmed in practice 3 of Industrial Installations. (ISTSB, 2020)*

Unit 4. Syllabus of Industrial Electrical Installations 1S2023
Different types of start-up

To evaluate the validity of the learning with the boards, a survey was made to one hundred students in a google-type format with ten questions using the LINKER evaluation, in the questions neither mail nor name was requested so that the student is free to express his ideas voluntarily.
In each question, the evaluation of a practice, part of the syllabus, is requested and the respondents overwhelmingly indicate that the development of didactic boards taking the syllabus as the central axis of design is approved by the majority on the basis that it should be the practical verification of the theoretical foundations.
Question 10 is the most conclusive because it indicates that 97 out of 100 students agree that learning was improved with the use of the didactic board.

CONCLUSIONS

The article confronts the protection of investments, maximizing the improvement of the career of Superior Technology in Electricity of the Simón Bolívar Superior Technological Institute, starting from an argument that is the Silabo of the professionalizing subjects of Electricity, such as Industrial Installations, Electrical Control, Instrumentation and Industrial Automation, all of them with high incidence in the industrial development.
Seventy students of the Superior Technology course in Electricity in the 4th, 5th and Graduation semesters were surveyed and 86% accepted the use of didactic boards in the teaching of the Electricity course, and indicating that the level of skills achieved would not be the same if they had not had a didactic aid of this magnitude, recognizing the lack of the Technological Center in teaching, which is the use of didactic boards that demonstrate what was taught in the classroom in a practical way, because there was no place to test what the professor had exposed in class.
The validity of the proposed practices and the design is more than 90%, i.e. 9 out of 10 students validate the use and design of the board

in its 12 modules, based on the fact that all of them are used in the practices. Demonstrating the validity of the design and even reaching the need for the creation of new modules for the teaching of units of other subjects of the professionalizing syllabus.

In the development of new modules and having the complete board in its 12 spaces, it is considered to design and manufacture a modular board that supports 3 modules and to carry out demonstrative practices of teaching and learning, in a more agile way, taking the practice to the classroom, which is the main objective of bringing technological education to the hands of the students.

The three objectives were validated in the surveys:

The shortcomings in technology education at Simón Bolívar are not practicing the theory in a practical way.

The didactic boards should solve practical teaching gaps in the syllabus and prioritize its design to the fulfillment of objectives, asking the teachers of the areas they would like to demonstrate on the board because it would be the only way for the tool to be valid and not end up as just another manufacturing object with no clear use in the course.

The student feels that he benefits from these tools, in his learning, in his professional development, being able to go out into the professional field without fear of the new technologies, in constant growth.

Therefore, it is concluded that the construction of didactic boards is based on compliance in teaching, filling learning gaps.

REFERENCES

ISTSB. (2020). Electricity Syllabus. Guayaquil.

Aldaz-Suarez, P. A., Bermúdez-Chica, J. J., & Acebo-Arcentales, A. S. (2022). Didactic board of industrial electrical connections and drives. *Revista Científica y Arbitrada del Observatorio Territorial, Artes y Arquitectura: FINIBUS-ISSN: 2737-6451.*, *5*(10), 13-17.

Chacha Yugcha, J. L. (2020). *Analysis of the operation of three-phase motors through the design and implementation of a didactic module in the electromechanics laboratory of the Technical University of Cotopaxi-La Maná.* [BachelorThesis, Ecuador : La Maná : Universidad Técnica de Cotopaxi (UTC)]. http://repositorio.utc.edu.ec/handle/27000/7928

González Lopera, H. (2019). *Design, construction and certification of electrical panels based on the technical regulation of electrical installations (RETIE).* https://bibliotecadigital.udea.edu.co/handle/10495/12162

Torres Mejía, R. M., & Lema Tapia, D. P. (2009). *Didactic board for starting and control of a three-phase220v 1/2 HP motor by means of a VDF (variable frequency drive) equipped with protection, measurement and signaling systems.* [B.S. thesis].