

## **Evaluation of the learning of technological working methods in the course Basic Electronics**

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### **ABSTRACT**

In the theory of didactics of Technical and Professional Education, the use of technological work methods is referred to in a general way; however, its systematization in the particularities of each of the technical specialties is insufficient; which brings as a consequence insufficiencies in their learning by the students. The objective of this research was the evaluation of the learning of technological work methods in the subject Basic Electronics. The methods used were the theoretical systematization, observation, interview, survey, review of the products of the process and the pedagogical test.

**Keywords:** Technical education; Evaluation; Learning; Teaching; Assessment

### **Introduction**

In the Guidelines of the Economic and Social Policy of the Party and the Revolution for the Period 2021-2026, approved at the VIII Congress of the Communist Party of Cuba (2021), it is stated in guideline 94 (...) to ensure that the training of the skilled labor force

provides an integral response to the demand required by the socioeconomic development of the country and the territories (PCC, 2021, p. 70).

With a view to responding to these Guidelines, the mission of Technical and Vocational Education (ETP) is to guarantee the initial and continuous training of the qualified workforce through the integration between educational institutions, production and services labor entities and Universities (...), in addition, in the training model of the Medium Technician in Electricity it is intended to: “develop a vocational training that guarantees a middle level qualified workforce in this specialty required by the organizations with a common base, broad character, of a comprehensive nature. ), in addition, in the training model of the Medium Technician in Electricity it is intended: “to develop a professional training that guarantees the qualified workforce of medium level in this specialty required by the organizations with a common base, of a broad character to facilitate occupational mobility (...)” (Ministry of Education (MINED), 2024, p. 6).

These general aspects of Cuban educational policy are specified in each subject of the curriculum of the Electricity Technician; in the case of Basic Electronics, its purpose is to provide the acquisition of knowledge and the development of skills and habits, which contribute to ensure the basic professional training of students and serve as a basis for acquiring and developing their specific professional training.

In Basic Electronics, the teaching-learning process is conceived with a unique, systemic, systematic and flexible character, due to the contribution it makes to the development of habits, skills, abilities and values in the future graduates, such arguments justify the need to use teaching-learning methods that develop in the students the learning to learn, for the solution of professional problems.

On the other hand, the factual study of the teaching-learning process of the subject was based on the professional experience of the researcher as a teacher of the specialty Electricity, on the observations made to the process, on the consultations to reports of class controls and the exchanges in the teaching area allowed to identify the following manifestations of insufficiencies:

- Inadequate interpretation by the students of the specific characteristics, operation and behavior of electronic devices in real situations.
- Little independence of the students in the maintenance and repair of electrical equipment with electronic components.

- Inadequate selection of didactic methods, on the part of the teaching staff, that favor the linking of the content with the technological work methods of the Basic Electronics subject.

The above arguments revealed a problem in the learning of technological work methods in the subject Basic Electronics, for the Medium Technician in Electricity, which is why the evaluation of the learning of technological work methods in the subject for the solution of professional problems of the Medium Technician in Electricity was proposed as an objective.

In the teaching-learning process of the Middle Technician in ETP authors such as Abreu (2014), Mena (2022), Bermúdez (2014), Soler (2013), and Alonso *et al.* (2022), developed theoretical and methodological conceptions aimed at consolidating a Pedagogy of TVE, while revealing models, principles and regularities of pedagogical and didactic character, oriented to understand, explain and interpret the training process of the Middle Technician of the different specialties, agreeing on the need to achieve integrated pedagogical processes that allow the appropriation of technological work methods in a general way; without specifying in the content of the technical subjects.

The teaching-learning process of Basic Electronics addressed by Duque *et al.* (2014) and Peña (2020) highlights experiences of some teaching strategies, based on cooperative learning, in the delivery of laboratory practices and the incorporation of technologies in education.

These authors referred to didactic aspects, but offer few results on the learning of technological work methods as content of technical subjects, leaving the way open for this research. In general terms, the background of the subject, an empirical study, the proposal of a methodology for the learning of these methods in the Electricity specialty and the evaluation of the results obtained in students and teachers were taken into account.

## **Development**

In order to deepen in the background of the teaching-learning methods of the Basic Electronics subject in the specialty of Medium Technician in Electricity in the ETP, the

study of the historical evolution was carried out, being consistent with the periodization criterion: transformations operated in the curricula of the Medium Technician in Electricity, in addition, the following indicators were taken into account:

- Conception of the teaching-learning process of Basic Electronics
- Didactic methods used in the subject Basic Electronics.
- Conception of the technological work methods.

The historical analysis allowed identifying three stages: the first one, from 1984 to July 2006, which includes the emergence and improvement of the Medium Technician specialty in Electricity in Las Tunas. The second, from September 2006 to July 2009, when the study plans of the Bachelor Technician in Electricity were implemented. The third, from September 2009 to the present, in which the curriculum of the Medium Technician in Electricity and the III perfecting in the National Education System are implemented again.

In the first stage, it was evidenced that the theoretical-practical elements that pointed to the need of a developmental teaching-learning process, which allows the assimilation of the professional contents, were insufficient. The didactic methods used limited the motivation of the students towards the specialty and were selected without taking into account the methods of technological work as contents of the technical subjects. The teacher did not know the methods of technological work for the formation of technicians in accordance with the technological development.

The second stage was characterized by the existence of a more solid conception of the teaching-learning process with respect to the previous period; but with little student protagonism. The didactic methods used were still those of general pedagogy. The relationship between didactic methods and technological work methods was deepened, although in a general way without specifying any specialty.

In the third stage, the teaching-learning process of TVE was strengthened, but there is still insufficient training and updating of teachers in the subject and this has a negative influence on the training of Middle Technicians with a higher scientific and innovative level. The use of didactic methods of general pedagogy is maintained, with limitations to respond to the interests of professional training demanded by society. The relationship between technological work methods and didactic methods is still insufficient, due to the

fact that the technological work methods are in correspondence with the technical scientific advances, however, the didactic methods remain static.

As a result of the study carried out, it was evidenced that: the teaching-learning process of Basic Electronics went from a theoretical conception marked by the reproduction of contents, to a more integral one that includes elements of a practical nature in the educational institution, to a developmental approach that allows the theoretical-practical linkage in the solution of technical and professional problems.

The didactic methods used in the subject Basic Electronics had a generic character centered on the teacher, with a transition to instructional methods for the development of practical skills centered on the learner, up to a solution approach to technical and professional problems.

Technological work methods were not identified in the specialty; they were treated as professional skills, until reaching a conception that identifies them as content and method of the profession.

Empirical research on the learning of technological work methods

With the objective of verifying the state of the learning of the technological working methods in the teaching-learning process of Basic Electronics, an initial diagnosis was made for which a sample of 16 students of the second year group of the Electricity specialty at the Industrial Polytechnic Institute (IPI) "XI Festival" of Las Tunas Municipality was selected, for being the year that they receive the contents of the subject; 4 teachers, 1 Head of the Electricity area of the IPI "XI Festival" and 1 provincial methodologist of Electricity, who are specialists and teach the technical subjects from the 1st to the 3rd year of the specialty.

The study was carried out in two stages, one of empirical inquiry and the other of evaluation of the results. In the empirical inquiry stage, the variable selected was the learning of technological work methods of the Electrical Technician, which was operationalized in the dimensions: regulation activation, significance and motivation to learn.

The dimensions were evaluated with indicators referring to the mastery of procedures, originality and independence, mastery of logic and strategy, significant relations between what he knows and what he can get to know, acquired knowledge, formation of feelings, attitudes and values, professional interests and satisfaction in the solution of problems.

The rating scale for the measurement of the variable, dimensions and indicators was Good, Fair and Poor.

In the stage of evaluation of the results, 70% of the teachers considered that the students are dependent on help to solve professional problems because they do not fully master the procedures for the application of technological work methods. (50%) considered that it is because they do not have the habit of independent work. (20%) stated that sometimes the professional problems raised do not respond to the differentiated attention according to the characteristics of the group.

(80 %) stated that students usually work in teams because they have limitations as to how and when they should apply the contents to solve professional problems, needing to socialize with others the procedures to be developed because some of them already have knowledge of the contents they have acquired in daily interactions and allow them to easily understand the results obtained. The (20 %) referred that they need the teacher's explanation to achieve the solution of the professional problem because they are not able to follow a logic that allows them to reach conclusions to identify the cause of the problem and consequently they do not determine the possible solution.

The methodologist stated that in the normative documents for the Medium Technician in Electricity specialty, neither the technological work methods nor the procedures for their application are identified. He masters the procedures to solve professional problems because they are part of the content of the technical subjects; however, he recognizes that the updating they have in the didactic contents is insufficient to achieve the linking of the technological work methods with the teaching-learning methods.

(12.50%) of the students stated that they feel satisfaction in achieving the solution of the professional problems that arise during the class, because it allows them to master the content and to be able to apply it in the solution of any professional problem during their work performance. The (87.50 %) referred that they feel dissatisfaction when not being able to solve the professional problems because it is difficult for them to link the technical knowledge of the subject with those that allow them to solve the electrical problems during their work performance, also they do not attribute to the operation and behavior of the electronic devices the relevance it deserves to solve operation problems in the machines and electrical equipment.

The triangulation of the results of each of the instruments applied (classroom observation and methodological preparations; interviews with teachers and methodologists; student survey; review of the products of the teaching-learning process and the pedagogical test) yielded the following results:

Dimension activation regulation, it is evaluated of Mal: it affects the assimilation of knowledge that allows the development of habits and skills in the mastery of the necessary procedures to interpret the behavior of the elements that compose the electronic circuit, according to their characteristics and the strategies to be used in the calculation of the different magnitudes and parameters with originality, logicity, fluency and independence, applying the methods, laws and theorems studied in the diagnosis and repair of electrical equipment and/or systems.

Significance dimension, it is evaluated as Regular: it is affected the level of depth with which meaningful relationships are established in the learning of the measurement of magnitudes and/or parameters, as necessary, in laboratory conditions, allowing the student to apply the knowledge he/she already possesses on the use of software that allows the design and assembly of measuring means and devices. In addition, negative attitudes were evidenced in terms of collaboration and cooperation among the members of the group towards the learners who need help from the teacher and other agents when performing maintenance of equipment and/or electrical systems.

Motivation to learn dimension, evaluated as Poor: the interest and involvement of the students in learning the elements that allow them to physically interpret the results of the calculations and/or measurements performed with the necessary security to make an assessment of them and reach conclusions, according to the technical requirements for the operation of electrical equipment and/or systems, with the honesty and industriousness that correspond to their profession and the morality of our socialist society was affected.

Based on the evaluation of the dimensions, it was determined that the variable: learning of the technological work methods of the Electrical Technician is evaluated as Bad, since two dimensions are evaluated as Bad and one as Regular.

Main limitations identified in the students:

Insufficiencies in the mastery of procedures to apply technological work methods with originality and independence and mastery of logic and strategy for the solution of electrical problems with electronic components.

Insufficiencies in the establishment of relationships between acquired knowledge and daily experiences to contribute to the solution of professional problems and the formation of feelings, attitudes and values.

Insufficient professional interests and motivations before the necessity of the use of technological work methods expressed in the insufficient perseverance and security when solving professional problems.

Whose cause is centered on: insufficient theoretical and methodological preparation of the teachers to attend to the learning of technological work methods in relation to the professional content of the Medium Technician in Electricity.

Pedagogical experiment and impacts

In order to evaluate the results obtained with the implementation of the methodology, the pedagogical experiment was used in four steps:

First step: select the experimental group, the IPI “XI Festival” of the municipality Las Tunas in charge of the professional training of the Medium Technician in Electricity was taken as a reference. The sample selected in the initial diagnosis was not taken into account, because these students are in their third year of the Medium Technician in Electricity specialty and have already received the Basic Electronics subject. It is in the interest of the research to select as the second cohort the second year group with an enrollment of 28 students who are currently receiving the Basic Electronics subject and in which the methodology for the learning of technological work methods in the Medium Technician in Electricity specialty was implemented.

Four teachers were also selected, one of them head of area of the IPI “XI Festival” and a methodologist of the General Directorate of Education in the Province of Las Tunas, who are graduates of higher level in the specialty Electricity and teach the technical subjects from 1st to 3rd year of this specialty, thus being in charge of directing the teaching-learning process during the training process of the students; individually, we worked more systematically with the teacher who teaches in the second year of the specialty the subject Basic Electronics.

To emphasize the relevant participation of these specialists in the developed trainings, prevailing the commitment, responsibility and sense of belonging of the teacher who teaches the Basic electronics subject in the process of understanding the methodology.

Second step: to apply the entrance test being consistent with the operationalization of the variable established in the research.

Two classes of the subject Basic Electronics were observed (an introductory class of the new content and a practical class) in the second year of the specialty. In the indicator of mastery of the procedures of the technological work methods evaluated as regular (35.71%) and Poor (64.29%), they need the help of the teacher or another student to appropriate the system of knowledge, habits and skills that they should develop in the second year or they do not achieve it.

In the level of originality and independence in the use of technological work methods for the solution of problems, evaluated as Good (7.14%), they are capable of applying technological work methods in the repair of electrical equipment because they learned it empirically, evaluated as Fair (28.57%) and Poor (64.29%), they demonstrate mastery of the content, but they are not capable of generating new knowledge and sometimes do not apply it with independence, logic, originality and fluency.

In the mastery of the logic and strategy of the use of technological work methods, they are evaluated as Regular (7.14%) and Poor (92.86%) due to the insufficient use of learning strategies that allow the student to apply different ways to solve professional problems.

In the level of depth that they establish between the significant relationships between what they know and what they can get to know, they are evaluated as Regular (7.14%) and Poor (92.86%), because they do not manage to fully understand the content of the subject related to the repair of electrical equipment, taking into account the failures that occur in the device that affect the proper functioning of electrical machines and equipment.

In the level in which the acquired knowledge contributes to the formation of feelings, attitudes and values, good interpersonal relations can be witnessed in part of the group, which is evaluated as Good (82.14%); but it is still necessary to continue working with the students who do not manage to integrate into the group with the objective of contributing to the formation of values such as honesty and industriousness that allow the

student to have a better performance in his working life, for which they are evaluated as Bad (17.86%).

In the level of manifestation of professional interests expressed in the need to use technological work methods, they are evaluated as Regular (82.14%) and Poor (17.86%), due to the insufficient combination that exists between the technological work methods and the teaching-learning methods in the systematization of the professional content, which provides the student with the need to learn to interpret the results obtained in the measurements to operate, maintain and repair electrical machines and equipment.

And in the level reached in the self-assessment and satisfaction in the solution of problems with the use of technological work methods, it is evident that most of the students (71.43%) are evaluated as Regular because they feel satisfied when they manage to solve the professional problem posed; but they need help from the teacher constantly and the rest are evaluated as Bad (28.57%) because they do not manage to apply the knowledge acquired in the solution of the problem and this makes them demotivated from the activity.

The survey was applied to second year students of the specialty. Regarding the level of depth established between the significant relationships between what they know and what they can get to know, they are evaluated as Good (21.43%) because they easily relate the knowledge they already have from their experiences in society with their professional training; but the others are evaluated as Fair (42.86%) and Poor (35.71%) because they find the subject of little importance for their professional training because they are not able to link the content of electronics with the maintenance and repair of electrical devices and equipment.

In the level of manifestation of professional interests expressed in the need for the use of technological work methods, (100%) state that they do not find necessary the application of technological work methods to satisfy their professional interests because they do not master the necessary procedures to apply them, so the indicator is evaluated as Poor.

In the level reached in the self-assessment and satisfaction in the solution of problems with the use of technological work methods, (10.71%) are evaluated as Good because they state that they feel satisfaction in achieving the solution of the professional problems that arise during the class and have a better command of the content to be able to apply it in the solution of any professional problem during their work performance; while the

others are evaluated as Fair (35.71%) and Poor (53.58%) because they find it difficult to link the technical knowledge of the subject with those that allow them to solve electrical problems during their work performance.

Third step: to transform these limitations, a methodology for learning technological work methods was designed, for which the criterion of (Alonso *et al.*, 2019, pp. 236-239) is assumed by identifying the following actions with their procedures:

Elaboration of the theoretical-cognitive component of the methodology: it is based on the assumptions assumed about the learning of technological working methods in the teaching-learning process of the subject Basic Electronics and are identified in the research. Two new relations are determined, the first one professional problem-content of the profession-technological working methods and the second one didactic transposition-technological working methods-teaching-learning method. In addition, the method of teaching and learning technological working methods is proposed, with its definition, characteristics and procedures.

Elaboration of the instrumental component of the methodology: Four stages were established: the first: training of teachers for mastering the procedures of the method for teaching and learning technological working methods, the second: professionalized didactic transposition of technological working methods, the third: development of the teaching-learning process of technological working methods and the fourth: evaluation of the practical activity of learning technological working methods.

Fourth step: evaluation of the impacts obtained in the teaching-learning process of technological work methods in the subject Basic Electronics.

In the evaluation of the impacts, it was corroborated that the students showed mastery of the procedures and strategies to apply the technological work methods with originality and independence in the solution of electrical problems with electronic components. They were able to more easily identify faults related to electronic devices and increased the number of participants in scientific societies related to electronics.

The teachers developed satisfactorily the procedures of the method to teach and learn technological work methods, which favored the motivation of the students, reflected in the classroom annexed to operate, maintain and repair electrical equipment. In the teachers' group, methodological preparations were planned together with specialists of the labor entities for the updating of the contents in correspondence with the technological

advances; they were able to transpose real problems of the company to the classroom process.

## **Conclusions**

The historical background of the learning of technological work methods in the teaching-learning process of the Basic Electronics subject constituted the starting point for the design of the evaluation and development process.

The initial diagnosis revealed the main limitations and potentialities that the students and teachers of the Medium Technician in Electricity specialty have to appropriate the contents related to the learning of technological work methods, where the need for updating in the teachers and the mastery of the contents in the students stand out.

The methodology used strengthened the relationship between teaching-learning methods and technological work methods in the subject Basic Electronics, which facilitated the transformations and impacts achieved during the evaluation process.