The training of experimental skills in the high school physics teacher in São Luís do Maranhão

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ABSTRACT
This work is the result of the results of a master's thesis in education, referring to the reality of the teaching of Experimental Physics in the middle cycle in São Luís – MA, where the problem found was the lack of experimental skills of teachers who use the laboratories of their schools and also, how to promote experimental classes in schools that do not have laboratories. A Theoretical Practical Model that develops experimental skills in the high school teacher in the area of Physics is proposed. The model makes use of the theory of human activity in the improvement of the teaching-learning process. In the applied methodology, different research methods were used: theoretical methods (analysis-synthesis, induction and deduction; modeling and systemic-structural) and empirical methods (unstructured interview, participatory observation and questionnaires). 04 four high schools in São Luís were diagnosed, being 02 public and 02 private. The results of the diagnosis showed that even in schools that have laboratories, 85% of teachers do not have any ability to develop experimental classes of a practical nature. After the application of the proposed methodology in the schools, a partial validation of the results was promoted, applying the PNI technique (Positive, Negative and Interesting Points), where 90% of the teachers began to apply the model in their work practice.

Keywords: Teaching, Experimental, Physics, Skills.

1 INTRODUCTION

The Brazilian educational reality, formed by different social levels, is the faithful portrait of the educational system now proposed by our schools. In Maranhão, especially in São Luís, this system does not differ from the rest of the country, since the basic guidelines of education governed by the Ministry of Education and Culture (MEC) is a reflection of a teaching where it is almost always mediated according to a traditionalist approach, where the teacher develops a role of transmitter and instructor of knowledge.

The disciplines that fall among the natural sciences, among them Physics, require an adequate orientation on the part of the teacher, and the latter has to transform this reality seeking the need for the interrelationship of theory with practice (praxis). All efforts must be added to achieve transformations that raise the quality of the efficient teaching-learning process, which ensures the training of a teacher capable of incorporating into his system of knowledge the new scientific discoveries that are being produced, and always use them as a fundamental way to contribute to the accelerated development of the sciences and, therefore, of society.

The scope of the above is only possible if a creative, skilled and independent teacher is formed who can work with his students in high school, helping to form them into deeply studious, competent and prepared individuals to apply each new knowledge acquired to the concrete conditions that one lives.

The first words of Paulo Freire (1999) in the opening of his book Education as a practice of freedom were: "**There is no education outside human societies and man does not exist in a vacuum**." It is inherent to the human being to be critical of the philosophical or scientific construction of the other, or even of himself, precisely because man perceives himself inserted in a culture and, this, makes him possess inherent links to his life history and intellectual, bibliographical and formative, philosophical and scientific sources to which they had access.

These words of Paulo Freire portray his axiological, methodological, epistemological and social reflections that allow our physics teachers to appropriate them to incorporate it into their work practice.

Most of the professors in Physics in our capital are bachelors and not graduates, thus there is an imbalance in the level of knowledge of the pedagogical disciplines. Deficiencies were diagnosed from results obtained through empirical methods, such as direct observation of experimental physics classes in middle schools in the capital and other methods such as unstructured interviews that most physics teachers (85%) have not developed skills to teach experimental classes. For the development of these skills we have to think of education as a system of knowledge, habits, skills and abilities that provides the creativity of our students, influencing the development of all cognitive activity and the communication of these students in close connection with the world that surrounds them.

2 METHODOLOGY

In the development of the work, different research methods were used: theoretical methods (analysis-synthesis, induction and deduction; modeling and the systemic-structural) and empirical methods (unstructured interview, participatory observation and questionnaires). And it was structured in two chapters:

In chapter 1, it was evidenced a study of bases for the formation of experimental skills of the Physics teacher, characterizing them in the sphere of personality and valuing them through dialectical materialism, supported by the theory of knowledge and the theory of activity.

Chapter 2 presents a model for the development of experimental skills, also taking into account the theory of knowledge and the theory of activity, which was conceived through a diagnosis previously made.

3 STUDY OF BASES FOR THE FORMATION OF SKILLS IN THE PHYSICS TEACHER

3.1 HISTORICAL ANALYSIS OF THE STUDIES DEVELOPED ON SKILLS

The first intentions to explain capacity as a process of development of the human personality were carried out by Democritus, who linked it with the imitation of nature and supposed that the first creator is inherent in rational activity. Plato also set out his point of view on this question and explained capacity as a result of spiritual forces.

The followers of Democritus maintained that the creative capacity of personality is due to nature, with the explanation of Helvetius who insisted on the surrounding environment in general and the role of education.

Practical work, especially laboratory work, is given vital importance in science teaching. The English philosopher John Locke proposed the need for practical activities, helped by reflection as the fundamental way of access to knowledge.

In Latin America, particularly in Cuba, one of the main drivers of the use of practical activities in science classes was the Cuban philosopher and educator Félix Varela Morales who founded the first laboratory of Physics and Chemistry at the Seminary of San Carlos de La Habana.

At the end of the last century in England and the United States practical work was closely linked to the school curricula of science.

The physical-teacher experiment constitutes in the context of the school a reflection of what is a physical experiment for the sciences. Scientists give the experiment a role of extraordinary relevance. Thus, for example, (FEYNMAN; LEIGHTON; SANDS, 2008) assured that "*The proof of all knowledge is an experiment. Experiment is the only judge of scientific truth*." Also in this sense RAZUMOVSKY (1980) pronounced stating that "*If the theoretical consequence of an initial model is verified experimentally, then the abstract model that reflects the properties of the studied phenomenon is adapted. If the experiment does not reflect the desired results, it means that the limits of application of the theory have been discovered*."

3.2 GNOSIOLOGICAL AND PSYCHOPEDAGOGICAL CHARACTERIZATION OF SKILLS

As a historical-logical process, scientific thought develops by incorporating new theses, ideas and arguments in the solutions of the problems that are addressed, which should not be limited to the simple sum of our concepts accumulated by science, but rather, it is that the successions of ideas act as a synthesizing criterion of the needs of social development.

The emergence of the Psyche as a relatively new form of reflex in the course of phylogeny is produced in the close relationship with objective external reality. Therefore, the psychic reflex arises linked to the need to know the objective world, its properties and relations, to be able to act in it, and originates in those practical processes of interaction of the individual with the environment. On the other hand, it is indisputable that the process of creating the instruments of work is a highly stimulating result for human development.

These elements are contained in the structure of the work functions, and the characteristics of the profession that consequently requires for their successful realization. In their performance of the work each one acquires a series of knowledge, motivations and specific particularities that become the basis of his preparation to carry out the activity in the concrete conditions according to the type of profession he performs in a given sphere of society. In turn, the development and continuous progress of science and material production requires an increasing increase in the level of capacity and quality of the execution of the works.

For this intent it is necessary to consider the capacity of the personality based on the personological approach.

The personality of a psychic structure is constructed by the unity of the functions of inducing and executing character; of the internal and external planes and of the conscious and unconscious levels (voluntary and involuntary) that arise as a result of the interaction between the biological, the social and the individual.

The units that make up the personality are distinguished by their qualitative differences, such as:

a) Psychic processes that reflect directly on the reality in which man is immersed providing information about his interaction with his objective and subjective reality, since they depend on the internal conditions of the individual. They are distinguished from cognitive processes, which allow to know the objects and phenomena of reality (sensation, perception, memory, imagination ...), and the affective processes that they establish with the objects and phenomena of reality, on the basis of the satisfaction of their needs (joy, sadness, empathy, irritation, etc.).

b) Psychic properties that are qualities that acquire the psychic processes in the course of their development and individual evolution constituting characteristic traits of the person, such

as the rapidity of thought, the feeling of the fulfillment of duty, responsibility, humanity with another person, etc.

The psychic processes and properties both cognitive and affective are linked to each other and one cannot deny the existing links of the unity of the cognitive and the affective, but this unity does not reach a degree of integration and stability because it cannot be considered as integral and complete units of the personality.

c) Psychological Formations: are personality structures in which the unity of the cognitive and the affective is presented in a high degree of integration, which allows a higher level of psychic regulation of the activity of the individual having different degrees of complexity (particular and general) and are characterized by the predominance of induction and execution of the personality.

The **inducing regulatory system** comprises the mobilizing, sustaining, directional functioning of the subject, which largely determines the motivations for which man acts. It is integrated by psychological formations with a predominant inducing character, such as emotional orientation and expectation and the state of satisfaction. On the other hand**, the executing regulatory system** comprises the cognitive and instrumental functioning of the subject in the execution of his performance inherent to a context and is integrated by psychological formations with a predominant executor character, which is synthesized in **the Cognitive State that** generalizes any type of manifestation of the knowledge that the person possesses with respect to one or several concepts; the **Metacognitive** Statewhich encompasses any form of manifestation of that person about himself (self-knowledge) about his cognition about one or several contexts and about his own execution in those contexts; **the Instrumentation Executor of the Performance**, which is considered as a functional unit of executor character and that comprises the manifestations of the executions in a context. These can be conscious and unconscious, voluntary and involuntary, and we call them activities, actions and operations; skills, **abilities** and habits. It is through the executory regulation that human action is manifested.

It is important to emphasize that the presence, both in the inducing regulatory system and in the executor, of psychic processes and properties (cognitive and/or affective) and the necessary unity of the cognitive and affective have close integration in all psychic units (or psychological formation).

For the purposes of our investigation we will focus attention on the relationship with the **executing system** and especially on the relationship with the instrumental function that this subsystem has.

The operation of these executions implies a set of integrated elements that determine the performance, called ORIENTATION, which are cited below.

The **activity** is the most complete of man's forms of action. It is a form of interaction between man and his environment, whose process tries to achieve a conscious end by having an internal

condition that stimulates and drives the individual provoking a state of desire, generating a driving motive of a directed activity.

Motive, on **the other hand**, is the most important aspect that psychologically distinguishes human activities from each other. In its evolution, motives become convictions, ideal aspirations, interests, etc. And it constitutes the basis that regulates man's conduct.

Throughout all activity, man is guided by an early representation of what he hopes to achieve with this process. These anticipated representations constitute a conscious **goal** or end that man sets out to achieve.

Given the complexity of the activity, it requires man to perform many actions. And the action is that execution of the action that is faced with a conscious character, determined by the anticipated representation of the result to be achieved (objectives) and put into play the set of operations required to activate.

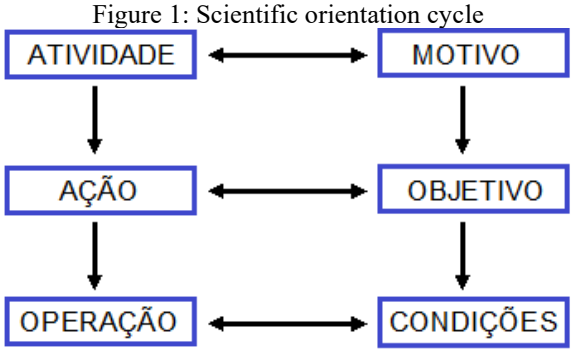
The **operation** is that execution of the action that reaches as a component of an action, without by itself, having a conscious end. It is a product of the transformation of a previous action into operation, due to the mastery achieved in it, which allows a smaller participation of consciousness, by requiring the concentration of man's attention and the attainment of a partial goal.

An action may be formed by operations, which previously constituted (by their psychological structure) actions. The dominion achieved by man in these executions is what converts them into operations. In this way, a current action could have been an activity, and this can become an action at a later time in the development of the individual. It is also necessary to highlight that the same action can be formed by different operations and the same operation can be part of different actions. The same can occur in relation to the activity, the execution of the same activity can be carried out through different actions and the same action can be part of different activities. This is due to the fact that man to obtain his goals can use an arsenal of forms of execution that he uses according to his free will and the conditions in which he develops.

We can conclude, then, that if the activity exists through the actions, these are sustained in the operations, that is, the actions arise by the subordination of the activity process, however the operations arise by the conditions in which the activity develops, those that dictate the ways in its execution.

The above can be summarized in the figure represented in the text Psychology for Educators (González Maura, 1995).

Figure 1: Scientific orientation cycle



Source: Viviana González Maura (1995)

The formation of habits and skills is one of the fundamental objectives of the teaching-educational process, and there is a great divergence in the criteria about the nature of these phenomena, the place they occupy in human activity and in relation to those conditions and fundamental requirements for their formation and development.

And this problem stands out in the theoretical contribution made by Dr. Carlos Alvarez de Zayas (1989), in which he considers that the ability is an element of the content, and expresses a didactic language a system of actions and operations to achieve a goal.

On the other hand, (Gonzalez; Repilando, 1996) consider that the ability is the mode of interaction of the subject with the object, it is the content of the actions that the subject performs, integrated by a set of operations that has an objective and that is assimilated in the process itself.

However, the term skill, regardless of the different definitions it has in the literature, given by different authors, is generally used as a synonym for **knowing how to do**.

Currently the skills are formed and developed in students through the teaching-learning process. On this point, we agree with the psychologist Sergei Rubinstein (1974) when situating the abilities in the executor regulation of the personality as a result in which the activity is carried out in correspondence with the existing conditions and with the objectives pursued by the subject.

3.3 THE FORMATION OF EXPERIMENTAL SKILLS OF PHYSICS TEACHERS.

Would it be possible to do a meaningful teaching of Physics without the use of experimental activities? Our experience in high school has shown that it doesn't. A teaching based only on the transmission of concepts provides a distance between the true objectives of science and the objectives achieved in school. In addition, it contributes to the studies having a great aversion to physics, since it becomes bookish and memoristic.

Three factors summarize the problems that permeate experimental activity:

- **Separation between laboratories and other activities developed in the classroom.**

  In most schools, the laboratory is seen as a special place where students must work in groups and only use the equipment that the teacher indicates. In this place the student

believes he is learning Physics, but when he leaves the laboratory for the classroom he no longer associates his learning.

■ **Misclassification of experimental activity as practical activity and classroom activity as theoretical activity.**

This distinction between "theoretical" and "practical" contributes to the student detaching learning in the laboratory from learning in the classroom. In this context, the typical activities of the classroom are speaking, reading, writing and those of the laboratory are measuring, smelling and, from time to time, planning, investigating, discovering.

■ **Experimental activities reduced to the laboratory class, with a variety of objectives not always compatible.**

Many teachers believe that experimental activities are only possible in well-equipped laboratories. Thus, the experimental activity is reduced to the laboratory class.

In the course evaluations made with our students it has been highlighted that the experimental activities, in their different denominations, contribute to a better understanding of the contents and make a connection between the theory and its application.

3.3.1 Systematic structure of physical abilities

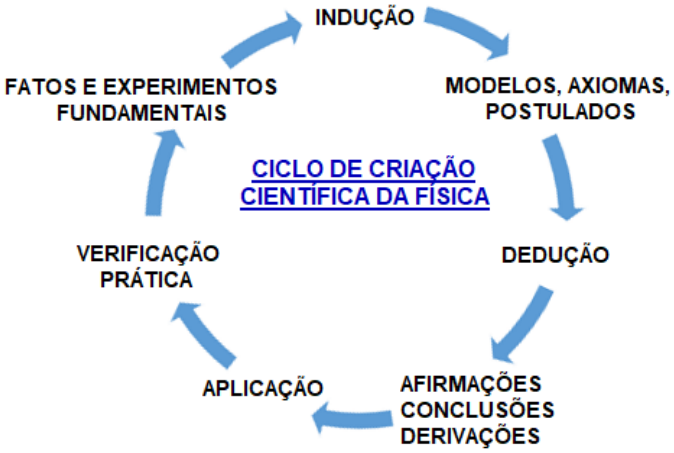
The system approach of the process of formation of physical skills guides its study in an integral way to reveal the various relations, properties, components and qualities that manifest themselves in the process of development, the states or levels through which this process passes and that materialize in the student's performance.

The systemic approach is based on the principle of systematization, but differs from it, it means that the object of study is structured with a set of invariants, constitutes the expression of the essential content and guides the process of search for the remaining knowledge that gives it precision, depth and solids.

3.3.2 The formation of individual inductive and deductive forms of students' thinking in Experimental Physics classes

Let us see how through the study of Physics this can be accomplished through **the cycle of scientific creation of Physics** (Razumovsky, 1980), which shows the continuation with the purpose of developing the logical thinking of the students:

Figure 2: Cycle of scientific creation



Source: V. G. Razumovsky (1980)

As shown from natural facts and/or fundamental experiments, through induction, the student is led to the elaboration of a model (hypothesis) in which, through deduction, it is possible to reach a conclusion that is validated through its practical application.

Inductive reasoning is that general judgment obtained from the knowledge of particular objects of a given class or type.

Deduction is that form of thought, in which new judgment is obtained directly by a law of logic, from judgments given to the premises. The same term deduction means "conclusion."

The difference between induction and deduction lies in its gnosiologic role. Induction always operates as a result of observation, of experimentation of practice. Obtained as a result of analysis and generalization, this way of thinking acts as a method of obtaining probable judgments.

Deduction is the conclusion of one judgment from others, in correspondence with the rules and laws of logic. This method of organizing the knowledge obtained, expresses the step of thought to the concept. It is used, fundamentally at the theoretical level of knowledge.

In teaching at school, as well as in scientific knowledge, induction and deduction act in unity with other methods of knowledge and teaching.

3.3.3 The potential of practical-experimental activities

As emphasized earlier, the experimental activity is not limited to the laboratory class. But, after all, what are the potentialities of practical-experimental activities?

Knowing that all these approaches fulfill different objectives and make experimental activities more motivating and less routine. Let's make some comments about each of these explorations.

3.4 DEMONSTRATION OF PHENOMENA / ILLUSTRATION OF THEORETICAL PRINCIPLES

This is the most defined practice among teachers. It is desired with this type of activity to illustrate the theory through concrete facts and/or to confirm or test certain theoretical principles. This type of activity often does not require the use of a laboratory, nor of sophisticated devices. It does require great creativity from the teacher to create real situations that illustrate the theory.

3.5 DATA COLLECTION

This type of work is very common in activities that aim to "confirm" the theory. Although it is a more mechanical activity, it has its importance as the student develops a sense of organization, a rational and clear way of recording the data.

3.6 DEVELOPMENT OF BASIC OBSERVATION AND MEASUREMENT SKILLS

With this type of activity the student develops the ability to perform measurements, from the choice of the appropriate instrument to the correct way to do the readings. Here it is important to highlight that, without a good planning of the activity, the objective may not be achieved, because often, the object of observation perceived by the student is different from that imagined by the teacher.

3.7 HYPOTHESIS TEST

This activity is sometimes confused with the confirmation of a theoretical result. But it doesn't always mean testing a hypothesis predicted by the theory.

3.8 FAMILIARIZATION WITH THE APPARATUS

Here, it is necessary to use a well-equipped laboratory, because it is intended with this activity to disinhibit the student and teach him the way to work with some basic laboratory equipment such as multimeter, caliper, distillers, etc.

3.9 ILLUSTRATION OF CLASSIC EXPERIENCES

It aims to give the student a historical view of physics by illustrating classical experiments that arouse the attention of physicists to certain phenomena. A typical example of this approach is Oersted's experiment in electromagnetism.

3.10 INITIAL MOTIVATION

In general, it is a demonstration performed by the teacher who intends to contrast a phenomenon or situation with common sense and thus motivate students to study. Therefore, it should be performed

before the development of the content and has an important role in identifying the spontaneous conceptions of students about the subject.

3.11 EXPERIMENTAL CHALLENGES

This approach is very motivating and involves a lot of students' attention. A problem situation is proposed, and the student must solve it within the conditions presented by the teacher.

3.12 INTRODUCTION OF NEW TECHNOLOGIES

At this point, it is intended to introduce new technologies in the classroom or laboratory. Typical examples: the use of computer interfaces and sensors for real-time data collection, the use of micro micro-coupled cameras for small-scale observation. This work is very motivating, because it brings to the classroom the modern technological advance.

3.13 PRACTICAL APPLICATION OF PHYSICS

The student sees in these activities a practical application of physics. Typical example are the prototypes of electric motors, bimetallic blades in fire prevention circuits, manufacture of homemade batteries, etc.

4 RESULTS AND DISCUSSIONS

4.1 MODEL FOR THE DEVELOPMENT OF EXPERIMENTAL SKILLS IN THE HIGH SCHOOL PHYSICS TEACHER

Throughout this chapter, it was demonstrated the importance of the link between theoretical and practical knowledge in the Teaching of Physics, especially in the formation of experimental skills of the high school teacher in São Luís - MA, because, observing the teacher-student relationship we find that almost no experimental activities are applied by the teacher and on the part of the student there is more and more divorce between theoretical and practical classes.

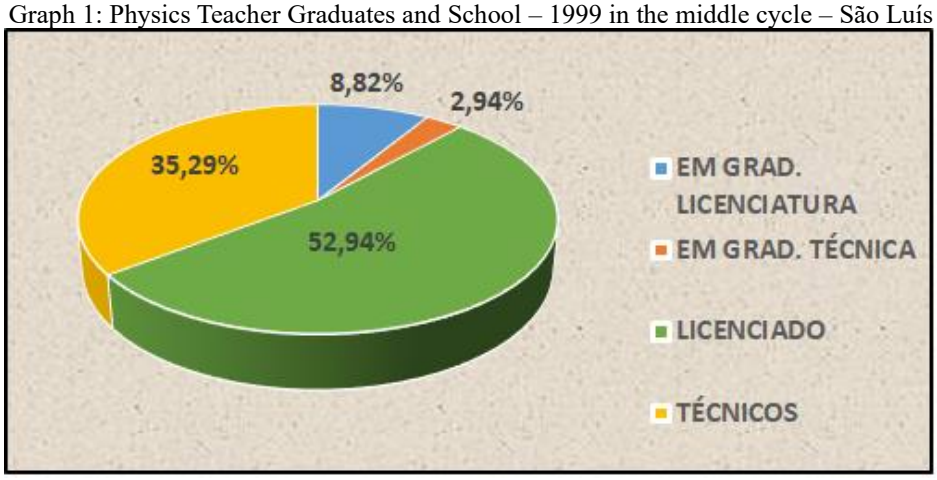
4.2 RESULT OF DIAGNOSIS PERFORMED

For the verification of the problematic reality of the teaching of Experimental Physics, through a critical reflective process, it was necessary to carry out a diagnosis through which one can verify the pedagogical practice of the teaching of this discipline, randomly taking a set of 110 existing high schools in São Luís. From this universe, we found that only 20 schools worked with Experimental Physics and we elected 04 students among them, two private schools and two public schools, in which field research was conducted with students and teachers.

In 1992 a survey was conducted by SEEDUC, where it was proven that a good part of the teachers who made up the teaching staff of the state of Maranhão, 37.4% of high school, were not qualified. And according to the Law of Guidelines and Bases of education LDB / 96 this reality would have to be changed and on an urgent basis, that is, teaching should be taught only by trained professionals.

Although today there is already a teacher training program offered by UEMA (State University of Maranhão), the number of graduates (graph 1), obtained through our investigation, indicates that only 52.94% of the teachers who work with Physics in high school in São Luís-MA are qualified.

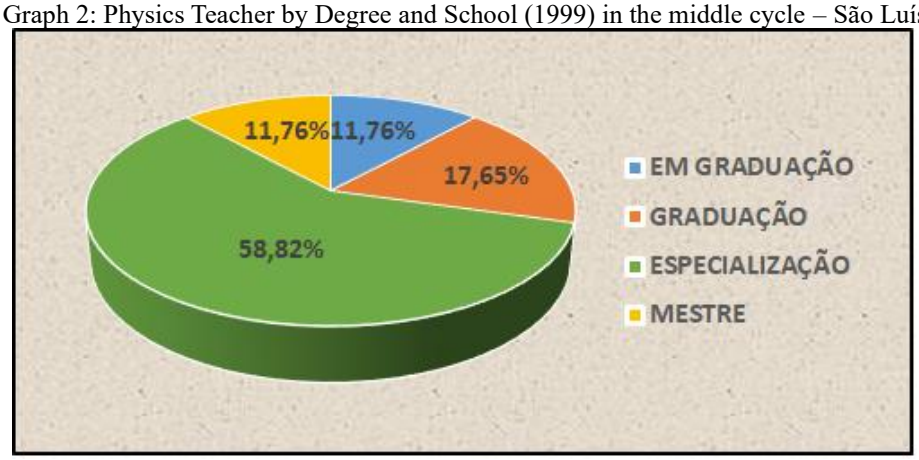
Graph 1: Physics Teacher Graduates and School – 1999 in the middle cycle – São Luís



Source: Coord. School Staff (1999)

With the realization of public examinations for the teaching career of high school, which began in the second semester of 1994, the character of hiring teachers for state education was null, while in the private network, it increased. In this research, it was found, in the teaching staff, that there was no increase in the due degree (graph 2), and, consequently, qualification for a better qualification.

Graph 2: Physics Teacher by Degree and School (1999) in the middle cycle – São Luís



Source: Coord. School Staff (1999)

In the analysis made in our study in an **unstructured interview conducted with teachers,** whose objective was to identify the teacher's conception of the act of teaching Experimental Physics, a sample of 12 teachers was conceived, 03 of them from each school.

Of the interviewees, 66.66% said that the experimental classes of Physics could be surpassed by theoretical classes, since in some schools they were not charged practical classes.

The above argument does not proceed, because the fact that the school management does not charge them, does not prevent that each subject explored theoretically does not exemplify the phenomenon through simple demonstrations.

Regarding the existence of an appropriate place for practical classes, 75% of the interviewees stated that, in order to carry out such activities, schools should have special laboratories with adequate minimum conditions for experimentation. To which we fully agree.

We understand that since Physics is a science, whose fundamental pillar is the physical experiment, it is, therefore, an inexhaustible source for students to develop not only experimental skills but also intellectual activities, providing them with a better performance in the exams in which they will participate.

In the analysis of **the unstructured interview conducted with students,** whose objective was to identify the relationship of students with Experimental Physics (their understanding and motivation for the study of physical phenomena), a sample of 700 students was conceived, 75 per school of the three years of the middle cycle in the three shifts.

In order to identify the relationship of students with experimental physics, their understanding and motivation for the study of physical phenomena, we asked students :

In relation to how the experimental physics classes were taught, 70% of the students were categorical in stating that the behavior assumed by the teacher in the classroom was basically reduced to a mechanical way of transmitting knowledge to a passive clientele and the resources used did not exceed the limit of the chalk and brush board, resolution of exercise and reproduction of the experiment, providing a monotonous climate, which could be provided by more dynamic and participatory techniques such as seminars and debates.

Regarding the duration of the classes, 60% of the students said that the time of teaching the practical classes was short, because there were questions that could not be answered.

When asked what kind of skills the teacher could provide them in an experimental class, 560 students, or 80%, were categorical in stating that the main skill developed was to simply reproduce the experiment he demonstrated, without the proper contextualization of the experiment as the physical phenomena that happen in the student's day-to-day.

The analysis of **participatory direct observation** at various moments of the diagnosis allowed us to perform comparative evaluations of the behavior of teachers in experimental physics classrooms, in such a way as to whether, if they promoted the link between theoretical and practical knowledge.

When analyzing the data of the questions, it is demonstrated, sensibly, the low level of experimental skills used by teachers in high school in São Luís.

4.3 METHODOLOGY FOR DEVELOPING THE EXPERIMENTAL SKILLS MODEL

It is a requirement for universities to train professionals with solid knowledge and a high development of professional skills, from the application of a university extension program for current and future teachers in Physics.

The planning, organization, execution and evaluation of the learning activity by the teacher, proposes to determine the operations that will be carried out for both the student and the teacher in each of these stages with the objective of achieving the effective development of the skills, habits, knowledge, capacities and values of the students.

Taking into account these characteristics, we dedicate ourselves to particularize the theoretical aspects of each of the stages in the teaching activity with the objective of developing experimental skills.

4.3.1 Orientation step

At this stage it is necessary to highlight the importance of students' motivation for the activities to be performed; the values that the student possesses before the conditions of the tasks and the objectives in function of the knowledge acquired by him.

4.3.2 Execution step

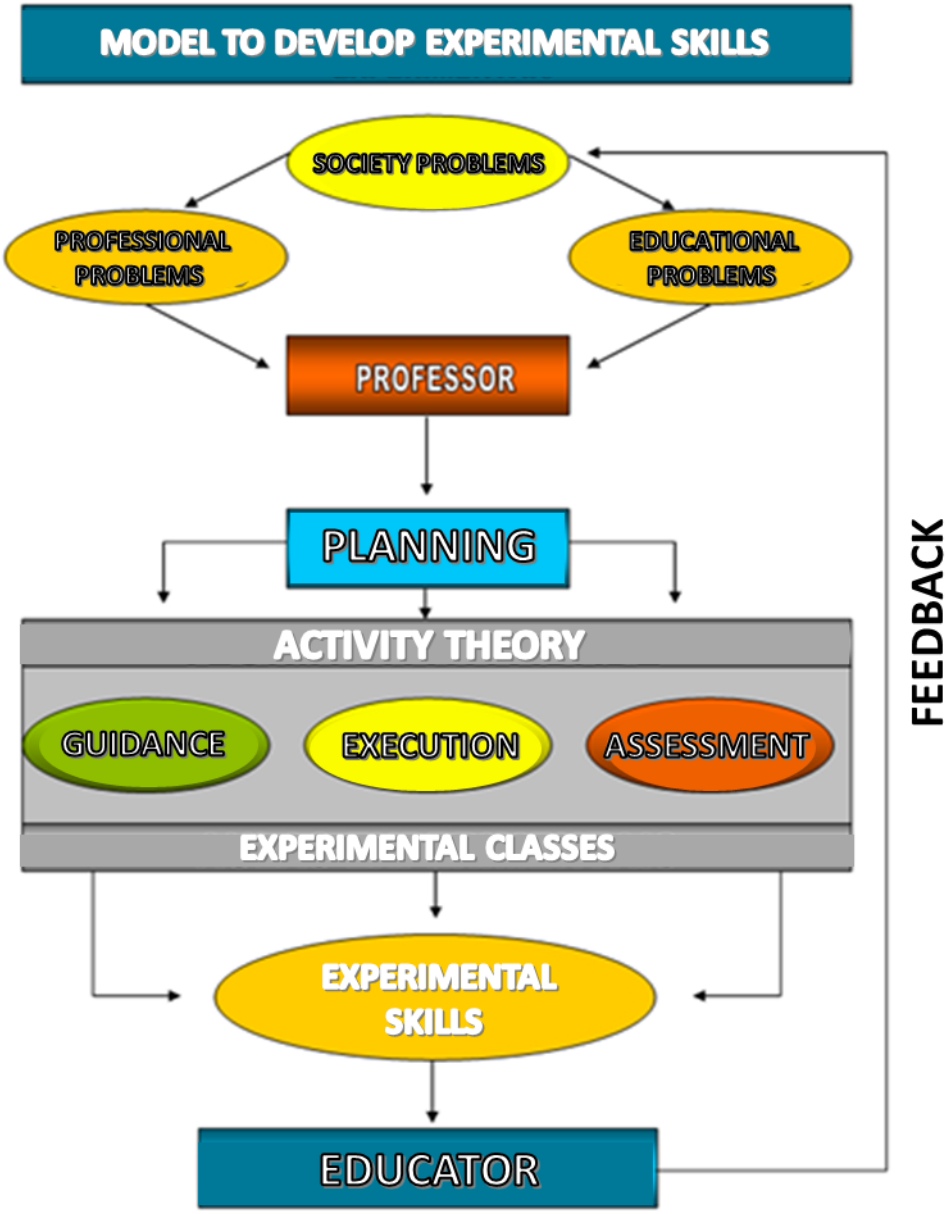
At this stage the student develops the learning strategies elaborated by him in order to solve the task or problem that is assigned to him.

4.3.3 Evaluation stage

This step is included in both orientation and execution. The teacher must take into account the effectiveness of the learning strategies to know if they have been well applied and, if not, interact with the deficiencies and improve them.

The sequence of the proposed methodology for the development of experimental skills is summarized in the following flowchart.

Flowchart 1 - Experimental Skills Model



Source: Author (2023)

4.4 EXPERIMENTAL SKILLS SYSTEM

- **The methodological requirements that contribute to the formation of mental operations by students in Experimental Physics classes.**

The sensory information of man's activity serves as the basis for rational and intellectual activity and to achieve the concentration of sensory perfection of students it is necessary to use different means and ways of teaching.

The school physical experiment, in analysis of practical examples and other means, contribute to the greater assimilation of knowledge. In this way thought interacts with language.

To stimulate the mental activity of the students, one must rationally plan tasks.

Comparison is the fundamental generalization, in which the establishment of the common and essential traits of objects and phenomena is assumed. However, it can be applied effectively by the teacher during the formation of physical concepts.

For the formation in students of the skills of substantiation of concepts it is necessary to propose questions such as: Highlight the fundamental characteristics of the given concept; Which traits of the concept are not essential; Determine the concept of a particular theme.

A fundamental factor in the development of students' thinking is the verbal stimulus that allows them to acquire and develop an exact conception of the given aspect and also the increase of interest and motivation.

A superior aspect of the methodological conditions is the orientation in the improvement of the work of the teacher for the formation of the physical thought of the students.

- **The formation of students' thinking in the process of solving physical tasks.**

The function of students' thinking directed towards a goal in physics classes requires the teacher to establish a group of special conditions. If only the expository method is used and does not make use of the technical means of teaching, then the mental activities of the students are not stimulated, converted into passive receivers of intended knowledge

For each theme of the Physics teaching program, it is necessary to select and/or elaborate a system of tasks with the fundamental objective of fixing (assimilating) a system of knowledge, the formation of skills and practical habits and the formation of activity procedures.

The task systems of different themes must relate to each other, in a way that enables systematization, achieving the assimilation of the fundamental contents of the program.

One of the complete criteria of the development of students' physical thinking is the ability to create new tasks from a work situation.

The proposed approach is directed, in the first place, so that the students become aware of the activity for the solution of tasks. The reflection of the physical task and the process of its solution, allows to form in the students the procedures of thoughts, the invariants for any concrete task of Physics, including the experimental ones.

During the teaching of Physics it is necessary that the students learn to solve the tasks, because in school the logical discipline is not taught, but the conscious application of the laws by the students will be very difficult to develop mental operations and, therefore, their cognitive capacities.

- **Demonstrative experimental skills**

Through the physical experiment the initial facts are accumulated, a representation of the physical phenomena and the physical magnitudes is obtained. Subsequently, abstract models of the phenomena are established, and, finally, the theoretical conclusions are proved.

The demonstrative experiment consists of the demonstration of physical phenomena, their regularities and their practical application intended for simultaneous preparation by students.

The objective of the demonstrations is to give students knowledge in a quick way of the qualitative aspects of the phenomena studied, such as the functioning and arrangement of different equipment and instruments using the visual and auditory perception of the students, with a view to formulating or structuring the abstract models, using demonstrative experiments, such as:

- Fundamental experiment: it is the initial source of the presentation of phenomena and concepts.
- Investigative experiment: it is used for the study of the essence of physical phenomena and the establishment of their regularities.
- Polytechnic experiment: shows the possibility of practical application of physical phenomena and their regularities.
- Auxiliary demonstrative experiment: serves to show the instruments or procedures that will be used to observe the phenomena studied or their regularities.

Importance of the demonstrative design**:**

- Contribute to the initial training on the phenomena, processes, and their practical application;
- Trigger the cognitive activity of students;
- Collaborate for polytechnic education;
- Foster awakening interest in Physics.

Experiment is the richest of forms of human experience; in addition to observation, the control of certain factors based on theoretical assumptions. The scientific experiment when it is carried out with the help of the teacher guides and affronts the result properly of the experimental method.

4.4.1 Partial Validation of the proposal

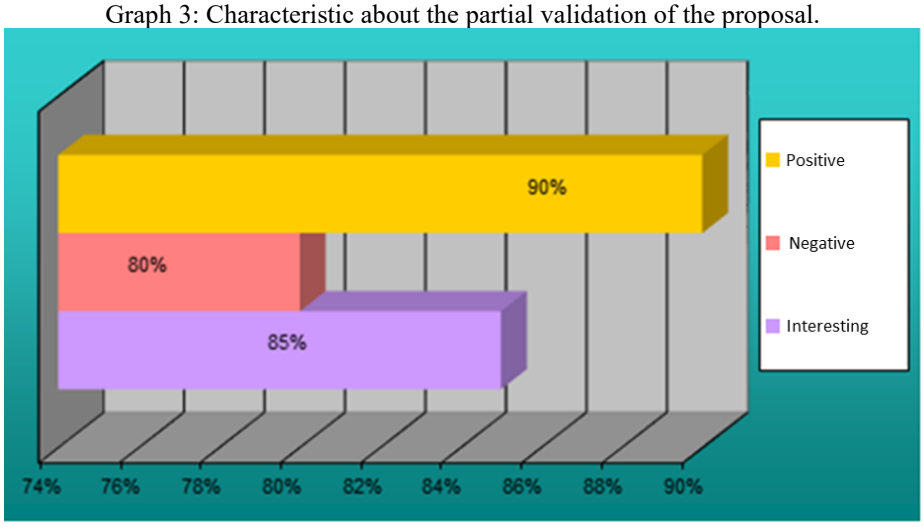
The work developed had as universe the 4th and 7th period of the Science course, qualification in Physics of UEMA, where the disciplines Physics - III and Electromagnetism were worked.

This partial validation does not constitute the conclusion of the studies that propitiate the formation of experimental skills in the Physics teacher, but a brief sample of the evaluation of the results of the proposed model.

A technique called PNI (positive, negative and interesting) was performed with 20 students from two classes, where they could reveal what was positive, negative and interesting in relation to the practical classes of Physics, worked in the way already exposed in the proposal previously. It was an anonymous testimonial so that the students felt comfortable expressing themselves. Because we considered the sample not to be significant, we did not list their answers as being representative of all.

The analyses obtained in this validation can be seen in the following graphs.

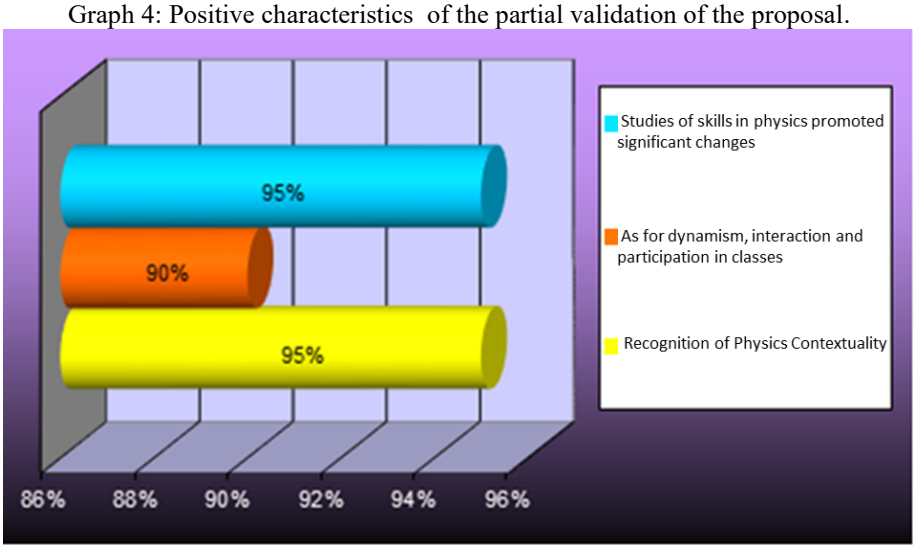
Graph 3: Characteristic about the partial validation of the proposal.



Source: Author (2023)

4.4.2 Positive Features

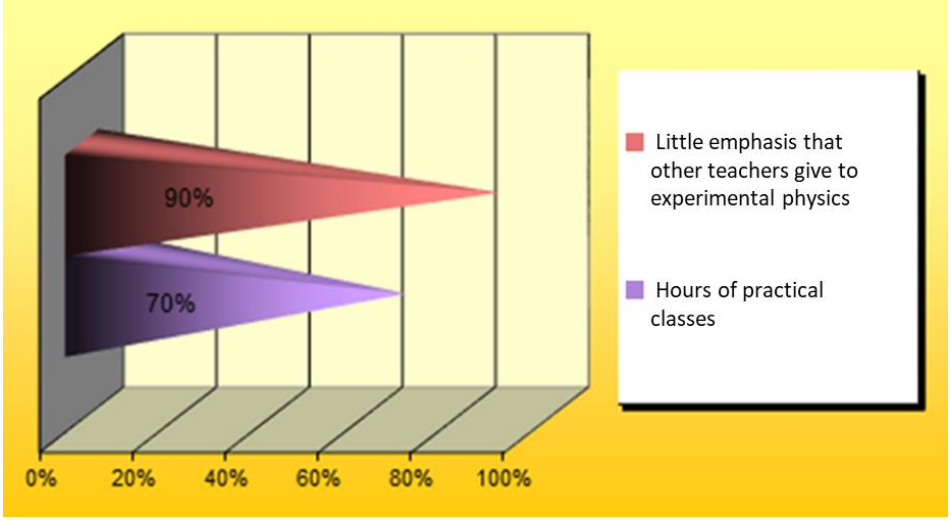
Graph 4: Positive characteristics of the partial validation of the proposal.



Source: Author (2023)

4.4.3 Negative Characteristics

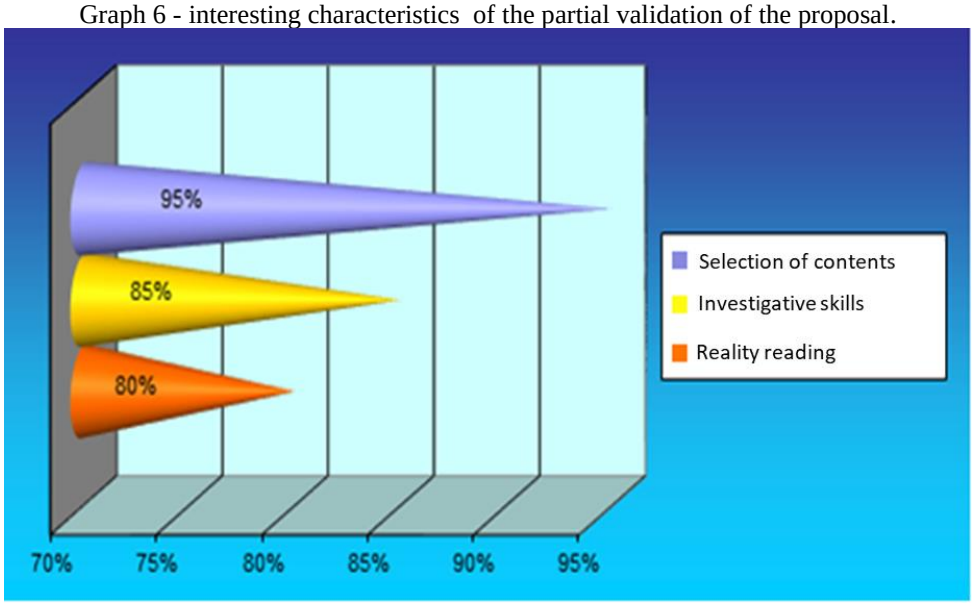
Graph 5 - negative characteristics of the partial validation of the proposal.



Source: Author (2023)

4.4.4 Interesting Features

Graph 6 - interesting characteristics of the partial validation of the proposal.



Source: Author (2023)

Thus, the formation of practical and intellectual skills, incorporated by high school teachers, should encourage students to compare scientific news, orienting themselves to the identification of the subject being treated and promoting means for the interpretation of its physical meanings.

5 CONCLUSION

In an educational process, as in almost all human activities and actions, there are types of knowledge that are acquired through theoretical and practical teachings. These teachings should be

associated, mainly, in the teaching-learning process developed in the classes of experimental Physics. In view of all that has been explained, the following is concluded:

- The knowledge through and an analysis of the bases, gnosiologic and psychopedagogical for the formation and development of experimental skills in high school physics teachers in São Luís, allows a professional performance of the teacher more solidified, conscious and effective in the teaching-learning process.
- The formation of physical thinking skills of students, analyzed through methodology and procedures allows us to achieve, through these skills a better performance of the activity.
- The experimental skills, seen through the theory of knowledge and the theory of activity, allows to prepare the students (future teachers) so that they can scientifically solve the problems that present themselves in their work.
- The decision to conceive a systemic model of experimental skills is mainly due to understanding a system as a set of elements belonging to a reality, but apprehensible in their reciprocal articulation. Where the meaning of the parts is only defined in the whole. In a vision of totality. An interdependent and related reality. Everything is related to everything and everyone depends on everyone. Therefore, the proposed system of activities that propitiates discovery, approximation to integration, with nature by physics, can not only the future students, but man recognize himself in the world, with the world and acting on it. Coming out of indifference, motivated by a teaching that privileges him as a capable being, the student sees himself as the subject of his own knowledge, appropriates it through the link he makes between the theoretical and practical knowledge offered by human culture and relates it to the action of his own existence.

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