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Innovative Praxis in the Teaching of Physics through Experimental Activities to Improve Academic Performance

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Abstract

The Teaching of Physics needs school intervention projects to maximize the quality of teaching and provide meaningful learning in this research project, suggestions of inexpensive, experimental activities are presented to supply the absence of physics laboratories in the schools of the public network, specifically from the state school Mineko Hayashida. For the investigation, 325 students of that universe were selected, being: 71 students of the 1st series of the secondary education, for formation of the experimental group and 254 students of the same level, to compose the control group. For the application of the technique, 10 classes were elaborated with experimental activities and applied for the 71 students that made up the experimental group. And for the control group 100% traditional lessons were carried out, in the same period of time as the experimental group, with the support of didactic book and explanations in the classroom. It is understood that the applied technique provided significant learning. Thus, it is expected to contribute to new conceptions and educational innovations are part of the school daily of the research institution and show that it is possible to innovate, through creativity and expand the quality of teaching offered to students of secondary education. effectiveness of the practice, with the approval of 59% of the students participating in the experimental group, and on the other hand, the control group, resulted in 34% approval. The analyzes show us that the students of the experimental group presented a better performance than the control group, that makes us understand that the applied technique provided significant learning. Thus, it is expected to contribute to new conceptions and educational innovations are part of the school day of the investigated institution and show that it is possible to innovate, through creativity and expand the quality of teaching offered to students in high school.

Keywords: Physics Teaching, Innovative Praxis. Experimental Activities

Introduction

Physics is a science that is present in the development and scientific and technological advance, with its varied contributions to the daily life of society. For example, in contemporary times, practically one does not live without electric power, electricity-operated machines and apparatus. Some human activities can even be considered dependent on it to survive. Electric energy is one of the elements of everyday and practical use of society that is due to the discovery of physics, sparks produced by Tales of Miletus from the process of electrification by means of friction. Consequences such as these have economic, social and political implications. From the birth of physics as a science to contemporaneity, there is a need to understand the physical phenomena of nature, its origins, its effects, and its consequences. Being, because it is part of human daily life, it is a very important discipline in high schools. Thus, in what way the teaching of physics is conceived by the students is one of the problems to be answered in this research.

In general, the teaching of physics at the intermediate level in Brazil is carried out in a way that is alien to the production of science and technology, that is, it favors the memorization of contents, formulas and problem solving techniques, to the detriment of, for example, understanding of the conceptual bases involved in the studied contents and of the relation of the concepts to the operation and use of the technological equipments derived from the scientific advance, of daily use of the students.

In this approach, traditional classes present abstract concepts, with only verbal or textual methodologies, and these, in turn, usually fail to achieve their objectives. It is understood that physics classes without the use of experiments may jeopardize the entire teaching-learning process, since most of the time it does not present sufficient and favorable results in the students' performance. Thus, it is intended through this article to dissect about the importance of the use of equipment, and to offer suggestions for the construction of experiments of low cost, that will give a more effective support to the Physics classes and to discuss about their implications in the academic performance of the student .

Innovative Practices

Learning requires innovative didactic strategies centered on the learner, which leads him to appropriate the proposed knowledge and develop skills that bring him to a high level of knowledge. Innovative teaching has been widely promoted in recent years. Educational innovation, in general, is associated with technological advances and with the need for schools to adapt to such advances by implementing technology in education.

Innovation is closely related to change. According to Tidd (2015), is to implement practical and technical tools, with

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the goal of generating changes, large or small, to products, processes and services.

However, innovation must be distinguished from simple change and its correlation with technology, since every innovation implies a change, but not every change presupposes innovation. For a change to be considered an innovation, it must generate added value to a process or service (Tigre, 2014).

Educational Innovation

Educational innovation can be understood as a set of ideas, processes and strategies, more or less systematized, through which introduces and causes changes in current educational practices. Innovation is not a punctual attitude, but a process, a long journey or a journey that stops to contemplate life in classrooms, the organization of schools, the dynamics of the school community and the professional culture of teachers (Dias, Bianconcini; Silva, 2013).

According to Carbonell (2016), the purpose of educational innovation is to change the current reality, modifying conceptions and attitudes, changing methods and interventions and improving or transforming, as appropriate, teaching and learning processes.

Innovation, therefore, is associated with change and has a component - explicit or hidden - ideological, cognitive, ethical and affective, because it appeals to the subjectivity of the subject and to the development of his individuality, as well as to the theoretical and practical relations inherent to the educational act .

In turn, França *et al*. (2011) affirm that educational innovation is the attitude and the process of inquiry of new ideas, proposals and contributions, made in a collective way, for the solution of problematic situations of the practice, which will bring about a change in the contexts and the institutional practice of education.

Already Leal (2013) considers that educational innovation supposes a bet by collectively constructed as desirable, by the creative imagination, by the transformation of the existing. It claims, in short, the opening of an open utopia within a system which, like the educational system, enjoys an excess of tradition, perpetuation and conservation of the past. Thus, innovation is equivalent to a certain climate throughout the education system that, from the direction to the teachers and students, provides the willingness to inquire, discover, reflect, criticize and change.

Carbonell (2016) concludes by saying that talking about educational innovation means referring to socio-educational projects that transform the usual educational ideas and practices in a socially and ideologically legitimized direction, and that this transformation deserves to be analyzed in the light of criteria of effectiveness, functionality, quality, justice and social freedom.

For Leal (2013), innovation within the field of education implies introducing new changes in this area to improve the teaching-learning process. Educational innovation can affect a number of elements, such as the material resources used (eg the introduction of interactive devices such as digital slates in the classroom), activities, timing, or evaluation methods.

For França *et al*. (2011), innovation implies change to improve, not change simply by the eagerness to do something different. In this sense, educational innovation is always aimed at improving the teaching-learning process.

The goal of innovation in teaching should be to ensure significant changes in learning, which is why an innovative teaching practice requires, according to Carbonell (2016): a needs analysis to decide what changes need to be implemented; a description, through didactic planning, of how change will be achieved; a strategy to promote change within the classroom; and an evaluation plan to see if change in teaching has been innovative and whether it has fostered meaningful learning.

Related to this, an innovative teacher is not one who only uses technology or who uses change only by doing something new, but one that drives change continually, with the aim of improving the teaching-learning process (Dias; Bianconcini; Silva, 2013). That's why an innovative teacher has the following characteristics, according to Carbonell (2016):

1. Self-assessment ability: is able to recognize your skills as well as your areas of opportunity.

2. Evaluation ability: counts on the strategies to verify that its students have learned in a significant way, moving towards this objective.

3. Collaborative learning: forms teams with other teachers to foster multidisciplinary learning.

4. Metacognition in your teaching: recognize what your teaching style is and how you can innovate correctly from it.

5. Researcher: is constantly searching for new ways to teach and learn.

6. Flexible and adaptable: Flexible in the face of new ways of teaching and learning, adapting the strategies to your class according to your own teaching style.

7. Uses resources and technology to meet diverse learning styles: it uses a variety of multimedia resources and materials to develop students' perceptions of learning.

8. Learning environments generator: builds an ideal environment to foster learning for your students.

França *et al.* (2011) caution that innovation should not be confused with something that is new, because innovation is not good because it is new, but basically because it contributes in a different, reliable and valid way, to solve educational problems or to improve the doing educational.

In conclusion, an innovative teaching practice is one that constantly reflects on new ways to improve the teaching-learning process by implementing changes that lead to more meaningful learning. It is a permanent job, which implies living the profession in constant movement and change.

Objectives of educational innovation Although the main objective of innovation processes is to improve the quality of education, there are also other objectives, such as those cited by Carbonell (2016):

1. Promote positive attitudes throughout the school community as a function of permanent behavior, open to the need for change and its implications for the adequacy of the curriculum and the needs and interests of the students.

2. Create spaces and mechanisms in the educational institution to identify, value, systematize, standardize, apply and disseminate innovative experiences that contribute to the solution of educational problems that are affecting the quality of student learning.

3. Encourage the development of valid educational proposals that respond to the reality of the country and that rescue the creativity, the human wealth and the natural and cultural resources that the medium offers.

4. Promote flexible, creative and participative curricular transformations, according to the needs of the subjects and their community, looking for a quality education and meaningful learning.

5. Implement the application of accepted theories, processes, methods and administrative techniques and teachers, consistent with the needs of the institution and the community, with the purpose of seeking a better quality of education.

6. To stimulate research as a daily element that determines the continuous professional formation of teachers from their own educational practice.

7. Recover and systematize the experiences of teaching staff, direction and pedagogical coordination.

8. Sharing and transferring innovative educational experiences to other schools and teachers.

9. Create permanent conditions for innovative experiences to become an institutionalized practice, that is, in an organizational culture.

An innovation is not necessarily an invention, but something new that provides a breakthrough in the system for its fullness, a new order or system.

The transformations that take place in a particular educational system do not necessarily have to be inventions or something entirely new, to be considered innovations, but something new or qualitatively different from the previous one and therefore new and different for the people who use it (Dias) .

In this sense, Carbonell (2016) understands that innovations imply new models, order or focus, a different way of organizing and relating the components of innovation, because innovating means finding or changing things, introducing novelties, while inventing means finding or discover something new or unknown.

Innovation implies intentionality or deliberate intervention and as a consequence must be planned Innovation is a deliberate change. For Santos (2016), changes that occur spontaneously, without clear intentionality and planning, can not be considered innovations. The planning element is assumed as an element to differentiate an innovation from a general change.

However, as Carbonell (2016) thinks, the key element is the meaning of change and perceived change, not so much the planning itself. Obviously, planning is a strategy that helps to make conscious the change that is intended and contributes to optimize the process, as long as it does not become a limiting element that prevents to propose new questions or to create new spaces during the course of innovation.

Santos (2016) concludes that innovating is a process that can take very different courses, which can hardly be predicted in advance. In this sense, planning must also be considered as a constant process that is changing according to the dynamics that happens in practice.

Experimental Activities as an Example of School Innovation

The realization of experimental activities will always be a school innovation, a remarkable tool in the teaching process, where the teacher makes possible the relation of the contents taught with their application in the daily life, besides facilitating the students' understanding of the contents, turns the physics classes into significant moments of learning. According to Araújo and Abib (2003: 176), experimental activities are considered by teachers and students as one of the most effective strategies for learning and teaching physics in a meaningful and consistent way.

There has long been a discussion about the use of activities to improve the teaching of physics. And in order to contribute to provide quality in the teaching of physics, we speak here of experimentation in the classroom, as a form of school innovation. Experimental activities can be developed with the approaches: demonstration, verification and investigation.

In this perspective, the research carried out during the school year developed through the use of experimental activities these different approaches, such that: In the first two months, the experiment was performed, explanations were provided for the phenomena - Demonstration; In the second two-month period, students' activity was monitored; diagnosed and corrected errors - Verification; And in the third bimester, the activities were oriented; the students' decisions - Research were encouraged and questioned.

Experimental activities besides being an innovative pedagogical tool in the hands of teachers, promote the teacher / students relationship through the exchange of information between teachers and students and results in the formation of the necessary structures for the formation of knowledge, stimulation to observation, in creativity , in the interaction, in the curiosity, in the motivation to study and to learn, in the responsibility, in the clarification of doubts, in the dynamization of the classes, in the facilitation and understanding of the contents

Search

The aim of the research is to analyze the use of activities and their implications on students' academic performance. The research was carried out from a sample of 325 students from the 01 high school series at Mineko Hayashidase School, divided into two groups: 71 students from the experimental group; and 254 students, to compose the control group, during the Physics classes, given in the year 2015, in a total of 10 hours / classes of practical activities. The methodological process was applied during two semesters, being: in the first semester - among the months from February to June; and in the second half - between August and November. It is important to note that the evaluated school presented some characteristics that should be scored, they are:

a) It has 15 classrooms - 13 of them are not air-conditioned and are maintained with the use of ventilators, while only two are air-conditioned;

b) It has a small library whose collection is very limited, but it makes books available for loan;

c) It has a video room without working computers, so that the teacher who wishes to make use of the room must take his personal computer to teach the classes that make use of this resource;

d) The school has no laboratories;

e) Of the 20 computers that were received by the school through a program of the Ministry of Education, only five are in operation and connected to the Internet. The connection to the network is poor.

We used the observation of the groups: control and experimental and analysis of the classes directed by means of activities and experimental. A questionnaire was also applied - containing eight open and closed questions for the students of the physics discipline and the 1st grade of the experimental group.

Applications of Proposed Activities Using Experiments in Physics Teaching

The control group had classes taught with textbook support and explanations in the classroom. Therefore, the experimental group and the control group, correspond to nine classes, both had classes taught by the same teacher, but conducted with different teaching methods. In the experimental group the students were separated into groups of six students and each group was evaluated at three different times during the four bimonths, these moments were divided as follows:

1. In the first two months, each group received an elaborate experiment made by reusing materials by the researcher. Each experiment should be analyzed by the group, which should make an oral presentation about the applicability of the equipment relating it to the contents taught in the classroom. For this analysis, the group made use of the didactic book as support to make the relation between theory and practice. The duration of the activity was 200 minutes, equivalent to four (04) classes;

2. In the second two-month period, after students realized that creativity could be used to develop simple, low-cost experiments, each group was asked to develop their own experimental equipment and then introduce them to other classes. On the day of the presentation, the classroom was organized as a science fair, allowing the exhibition of the works. The teacher invited other classes and other teachers for the visitation, being one class at a time was brought, because it is a small environment. The visiting professor accompanied his class, the students in the other classes were encouraged to ask questions, while the exhibiting students explained the purpose of their experiments. The duration of the activity was 200 minutes for presentation and interaction with other classes, equivalent to two classes;

3. In the third bimester the previous activity of experimentation was repeated, however, this time the presentation occurred in the schoolyard, since the classroom was considered too small to offer space for visitation of other classes and teachers. The duration of the activity was 100 minutes;

4. In the four-month period, lectures and expository lectures were given without the use of experimental activities, were also applied to formal tests.

The experimental activities that corresponded to the three moments, presented inside the school, had the total workload of 500 minutes, equivalent to 10 classes of the discipline of physics, or equivalent to 12.5% of the annual workload of 80 classes.

The research evaluated the reflection of these ten experimental classes in the life of the control group, of students who never attended the physics laboratory, but had the opportunity to learn physical concepts through the discovery of problem issues raised during the group meeting.

In this process, it is possible to emphasize that the control group counted on a visually impaired student, but this one had equal opportunity to the others to touch the experiments, to perceive their operation through the touch and the description made by their colleagues. The control group received 80 classes over the four quarters, traditional classes with formal tests and without use of experimental activities.

Results

1. Refers to the Moment before the Application of the Experimental Activities

In the present study, it was observed that 30% of the students answered that yes, they had a physics class in the ninth year of elementary education and 70% answered that they did not, 'to question 1. Noting that most of the students studied did not have the introductory of the Physical discipline in the ninth year of elementary education, where

the curricular grade of the same has an introduction to Physics.

In question 2, one observes in the research as it had already suspected the 71 students consulted, 5% responded that they like the Physical discipline and 95% answered that they do not like it (Table 1, Figure 1). And the justifications of the 71, were the following:

40% of the students answered: "No, because we do not understand much of what the teacher teaches";

30% of the students answered: "No, because the calculations are gigantic and I can not understand;

14% of the students answered: "No, because I do not like math";

15% of the students answered: "No, because it's boring";

1% of the students answered: "Yes, because I think the calculations are good"

It is observed in question 3, 100% of the students answered that the excellent teacher should master the contents, use experimental activities to allow the relation with the practice and that the physical discipline should be interdisciplinary.

For question 4, it is observed in the research that of the students consulted, 10% answered that Physics has a connection with their day to day and 90% answered that there is no relation whatsoever of what is seen in the classroom during the classes of Physics with its daily life.

And in question 5 it is observed that all the answers pointed out that the students would like classes different from the traditional classes. Emphasis is given to some answers:

18% of the students answered: "Dynamics";

10% of the students answered: "Fun";

10% of the students answered: "No calculations";

2% of the students answered: "Relaxed".

60% of the students answered: "Experimental".

2. Refers to the Moment after the Application of the Experimental Activities

After carrying out experimental activities with the students, it is observed in question 1 that 100% answered that yes, considering the activities experiences in the physics classes as something innovative and dynamic.

And in question 2, it is observed that after the experimental activities carried out by the researcher, the students consulted gave their opinions as the classes practice. And the result is pointed out, that 90% Excellent; 6% Great; 4% Good: 0% Fair. This confirms the hypothesis that students are attracted to experimental, differentiated classes.

It is also observed that in question 3 all the students consulted answered that yes, considering the experimental classes improve their understanding of the scientific concepts treated and pointed out some arguments:

40% of the students consulted answered: "with practice, the contents become clearer to be understood";

30% said: "Understanding happens easily";

5% of the students answered: "We realize that there is a connection with what is written in the books";

10% of the students said: "We visualize the experiments made by the scientists";

15% of the students answered: "We have learned in practice what is in theory."

Concerning question 4, it is observed that 100% students emphasized something positive about experimental classes, the answers stand out:

50% of the students answered: "More dynamic and fun classes";

10% of the students answered: "More relaxed";

30% of the students answered: "Improves learning";

5% of the students answered: "Improves the teacher / student relationship";

5% of the students answered: "Interaction with colleagues".

And in question 5, it is observed that all students answered affirmatively to this question, that there are no negative points. The justifications are:

45% of the students answered: "We begin to see the content more clearly from the interaction with the practice", that is, we learned in practice what is written in theory ";

27% of the students answered: "Experiments improves the understanding of the contents";

20% of the students answered: "There is an easier understanding of the discipline".

3% of the students answered: "Stop being the 7-headed animal";

5% of the students said: "You can see what is written in the books and how cool we can also see in the experiments how scientists discovered the laws and principles of physics."

It is observed in question 6 All the students affirmed that yes, that the experimental activities should happen more frequently, pointing out the mentioned aspects previously. The following are the answers:

70% of the students answered: "dynamic and fun";

10% of the students answered: "Relaxed";

15% of students answered: "Improve learning";

3% of the students answered: "Teacher and student relationship";

2% of the students answered: "Interaction with colleagues".

In question 7, it is observed that all the students justified why they did not perform experimental activities in their school. The answers are pointed out:

3% of the students answered: "The direction does not help";

5% of the students answered: "Teachers are not prepared";

2% of the students answered: "Teachers are too lazy to do different classes";

30% of the students answered: "Teachers do not have the creativity to innovate through the recycling of materials and the elaboration of experiments";

60% of the students answered: "There is no laboratory in our school".

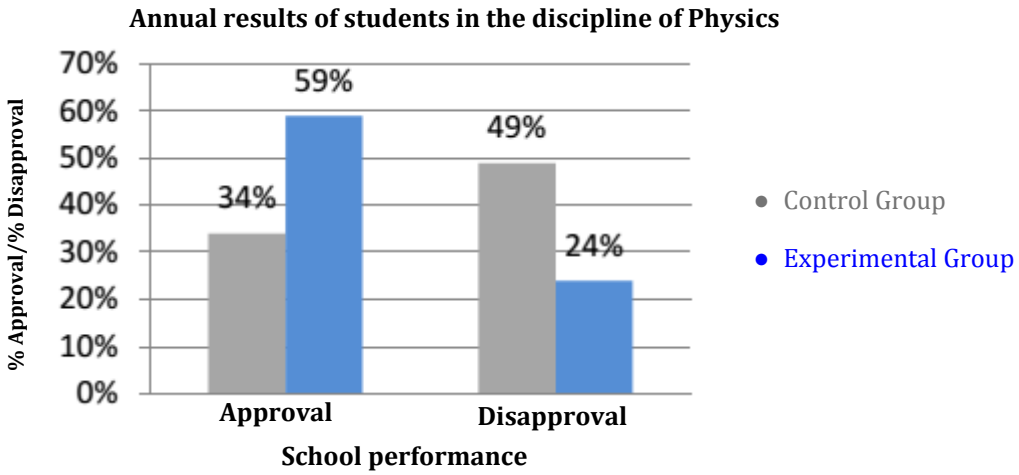
2º Analysis of the percentage of school performance of the experimental group with the control group

The analysis of the comparative table of income was carried out with 9 classes of the 1st high school, totaling 325 students, two (02) of the experimental group, with 71 students and seven (07) groups of the control group, with 254 students. The seven classes cited in the research did not have effective application of experimental activities, unlike the experimental group that in turn participated directly in the research with ten (10) experimental classes. (Table 1, Figure 1)

Table 1: Comparative table of school performance between two groups: experimental and control

Experimental Group		Control Group	
Approval	Disapproval	Approval	Disapproval
59%	24%	34%	49%

Source: survey data



Source: survey data

Figure 1. Income of the experimental group and the control group. Histogram of the annual result between the two groups

Comparing graphically the results of the two groups: experimental and control, during the four bimonths, it is observed that the experimental group represented in the blue color bar chart, in general, performed better than the control group represented in the graph of bars, gray color.

The graph (figure 1) indicates that the practical activities contributed in a way that in the experimental group there was an approval of 59% and 29% of approval, and for the control group, 34% of approval and 49% of disapproval.

Table 1 as well as in the graph (figure 1): final result show that the students of the experimental group, presented in terms of grades better and higher than students in the control group. This allows us to infer that possibly this result is due to the use of experimental activities, a differentiated methodological proposal that was adopted in this experimental group, with a minimum working load of 10 lessons of the 80 annual classes that compose the curricular physics curriculum in high school, that is, with 12.5% of this total load, the methodological proposal was valid.

Discussion of the Data Collected

"Through touch, sight and hearing, contributing to the deductions and abstract considerations about the phenomena observed" (Villatore; Higa, Tychanowicz, 2008, p.107). A small significant change of behavior was observed in relation to the majority of the students, the low frequency was reduced and the participation of the students increased during the period in which the classes were taught with experimental activities, handling experimental equipment, such as: free, dynamometers, spring force, vertical launch, uniform motion, energy transformation, hydraulics and hydrodynamics. There were curious and stares in the equipment and questions about them. The students began discussing each other about the functionality of the equipment and relationships with the contents previously

taught in the classroom. Curricular parameters, affirms that the Teaching of Physics must provide the relation of the theory with the practice, that is, this junction, allows the development of competences and abilities and one of them is "to establish relations between the physical knowledge and other forms of expression of the culture (PCNS 2000).

In the second two months, the experimental activities were directed with topics suggested by the researcher. They were six subjects on contents of the first series of High School, being: Average speed, average acceleration, uniform movement, free fall of bodies, vertical launch and hydrodynamics, subjects theoretically taught by the researcher during normal classroom hours. It was observed that the groups themselves entered into discussions about the experiments and were already able to relate them to various activities that were customary in their day to day, thus becoming more and more familiar with physics. Many groups had no difficulty in putting together the experiments and even enriched their research with experiences lived in everyday life. They set up their equipment, tested, reformulated their ideas and presented their results.

PCNs (2000, p.7) "say" that learning should not be focused on the student's individual interaction with instructional materials, nor should the student's exposure to the teacher's speech be summarized, the student should have active participation, both individual and collective, so the educational process tends to be social, since such practices are elaborated in a social context.

In the third bimester, they continued in the constructions of several other equipment, but now free subject, chosen by the group. The experimental activities explained in the third one were to put the student in the condition of "actor", allowing him to construct his experimental material - construction of rockets of PET bottles and PVC pipes, robots with syringes, boats with electric motors, models illuminated with energy coming from the transformation of kinetic energy into electric and etc. They tested and tested their hypotheses. The activities were planned so that the student had autonomy in the search for answers and solutions. The PCNs (2002) affirm the purpose of teaching physics in research and understanding: "To construct and investigate problem situations, to identify the physical situation, to use physical models, to generalize from one situation to another, to predict, evaluate and analyze predictions." During this period the groups presented their research, demonstrated and set up their experiments, opening up to great debates and discussions with the group during the explanations of the researches. At the end of each presentation the group applied the classmates, asking questions about the experiment. And so the groups, the class, interacted with each other.

It is noticed that the students developed personal capacities, such as: motivation, decision-making power, group interaction with their colleagues and teacher, creativity, self-confidence, self-esteem, ability to communicate, ability to do critical analysis, determination, discipline, etc. .

All these capacities depend on strategies that the mediating teacher in the teaching-learning process applies throughout classroom activities, that is, in their pedagogical doing, because it is believed that the students have obtained good academic results, these are reflections of good teaching , and in turn, the teacher feels fulfilled his mission as a teacher in education. Besides all this, experimentation, awakens in the student and the teacher, research ability and scientific training within the society in which he lives.

During the activities, low cost equipment was used to develop the experiments, which was interesting, since we proved that there is possibility of elaboration of the practice in physics classes, even without the existence of a laboratory in the school. The teacher uses creativity to create his or her equipment by reusing recyclable materials. Also, the experimental group had the opportunity to elaborate their experiments, they were responsible for assembling them and organizing the exhibition for other classes, for school in general.

Conclusion

Innovating the practice is the way to improve teaching, making it assume a meaning in the life of the student, which is not difficult, on the contrary, Physics is present in the student's life, inside and outside the home, and is connected, when perceived by the student, arouses his interest. Transpose your didactics in the teaching of physics with an alternative of transforming scientific knowledge into school knowledge.

The attitude of changing the methodology of physics teaching depends on the reflection of the teachers, since they are the mediators in the learning process. The use of practical activities at school accelerates and facilitates the process of understanding, taking into account that there is a lack of interest on the part of students in learning the discipline of physics and the experiments that are elaborated according to the creativity and the use of materials from below financial cost are closer to the reality of the students. It is necessary to break this paradigm, to overcome this inheritance of learning by repetition and to risk the implantation of new curricular proposal with innovative methodologies.

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