

ANOTHER WAY TO IMPROVEMENT THE DIDACTIC OF DOCENT LABS: PROJECT PRACTICALS AS SCIENTIFIC RESEARCH TASKS

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The current tendencies in the experimental teaching of Physics point more and more to the realization of more complex practical tasks, where the student not only develops experimental abilities but also those that up to now have been framed as characteristic of the investigation.

In this work the results of the didactic investigation carried out in the Laboratory of Optics of the career of Physics are presented, in order to activate the effective learning and development of motivations in the students to encourage the investigative activity, as early as it is possible.

INTRODUCTION

The research on the science teaching in the last two decades has been evidence the importance of the practical work for the students (Boyer et al, 1989; Bryce et al, 1985); however the results obtained earlier were not sufficient to gives the clear vision to improve the practical work. In respect to above idea in the recent years practical activities have been criticized for the deficiencies in the present employed method. So it is important to analyze the critics and find out the drawback of the existing system:

- The contents of developing the practical activities are limited (Hodson, 1990); and there were no motivation to the students using the above contents (Bastida et al, 1990; Hodson 1990, 1991, 1994; Gil and Payá 1988); practical activities are not favorable for the detail knowledge of concepts (Byrne, 1990); it develop the abilities and procedures generally oriented just for the manipulation of instruments, observation and verification of phenomenon's without effective orientation towards the solution of practical problems, data analysis, conclusions and so on (Gil and Payá 1988; Hodson, 1990, 1991, 1994; Miguéns and Garret, 1991); it not promote the adequate knowledge of the experimental science and investigation activities (Hodson 1990; Gil and Payá 1988).
- So it is necessary to proceed without delay to offer changes in the teaching laboratories that let us to eliminate the deficiencies and at the same time transform the activities of the students in research activities (Gil and Valdés, 1997; Gil et al, 1994; Garcia Barrios et al, 1998).

Keeping the above facts in mind we proposed to renovate the didactic of the laboratories and the emphasis given on the following:

- ◆ Promote the presentation of the interesting practical problem to the students, to be sure that the degree of difficulties in the solution corresponds with the level of intellectual possibilities of the students, the students will offer the ideas to solve these problems and develop the capacity of analysis matching with the question and confrontation of the said experiment, here the role of the teacher is important in the sense to control the docent activities, promote to the student for searching the solutions, discuss the practical limitation of solution selected, analyze the errors in the experimental data and verify the theory with the practical.

The present research work is based on the result of investigations developed on the didactic of the docent laboratories by the Faculty of Physics, Havana University, Cuba, in particular by the Optics Laboratory, taken into account the new tendencies which are working now around the world and adequate its to our reality and practical limitations.

In continuation we expose the investigation realized for the last four courses since 1999-2000 and discuss the results obtained on basis of discussion with feedback's from the students after completing their course.

DEVELOPMENT OF RESEARCH

Before proceed to our research, it is suitable to present in brief the methodology applicable currently in the teaching order of the docent laboratories of Physics, specially in the General Physics courses. Also these facilitate us the comprehension to some aspects that we utilize in our work.

Traditional conception of the teaching in the laboratories:

In the carrier of licentiate in physics, each laboratory of General Physics discipline constitutes one independent matter with 50 hours in the curriculum, distributed in 12 laboratory practicals with one lesson every week.

For the preparation of the students, they have a laboratory text where they can find out the brief description of the practicals. Each practical the text offers a brief theoretical explanation with the concepts, principles and laws that the student should be verify and analyze in the his practical, the characteristics of the instruments and equipments to employ, the methodology of experimentation, magnitudes to measurements, magnitude to calculations and analyze the errors to apply for experimental data. At the end of the text bibliography is proposed which the student must refer in order to get wide theoretical and/or practical aspects.

The evaluation of each practical have three moments: The students must demonstrate their preparation for the experimental work, the accurate realization of practical exercise completing in all respect and with the explanation to the teacher regarding the measured values (accepted between the tolerance limits) and finally realization of the practical report that the students present and discuss with the teacher.

During this practical work, the teacher must attend the correct manipulation of the equipments and instruments, should help to clear the doubts raised by the students exemplification with demonstration of measurement if it is necessary or by giving some theoretical example, etc, to help the students to exact understanding of the problem.

Inquiry of the traditional conception

We know that even we applied correctly the traditional conception, it is not allowed us to get all the objects of the curriculum, particularly those related with the motivation to the investigative work in the students.

Before beginning to our method we analyzed the problem through the feedback/opinions collected from all the related sources (teachers and students) with the object to find out the insufficiencies and virtues in the traditional method which is currently applied.

The insufficiencies are pointed out by the majority mentioning that:

- ❑ **The practical laboratories do not motivate the students** to do its
- ❑ **Do not develop habits of experimental type**
- ❑ The method is **not promote the creative attitude in the students**
- ❑ The most important is that the method **not providing the opportunity to inquiry the existing experimental setup, neither to propose the alternative experimental setup**
- ❑ **The organization of the docent process in the lab do not lead increase the role of teaching like maximum responsibility of this activity**, in order to promote the development of attitude which contribute to conform adequate image of experimental techniques and research interest in the students

Even the above things are true, the traditional conception have some virtues: Particularly in the Optical Laboratory matter, exits a good vinculum with Optical matter, this helps the students to acquire the general vision of all types of phenomenon of the Optics, because at least the student realize one practical based on each phenomenon and in this manner the student get opportunity to familiarize with majority of equipments in the laboratory.

These advantageous that the traditional method offer, suggested us not refuse completely, therefore, we continued to apply the same for the first-half course in order to get the necessary preparation to apply the second half practical projects.

Practical projects: A innovative proposal

Our research proposed the alternative to the existing practical laboratory. This led us to dominate the insufficiency detected in the traditional method. The proposed consist in present to the students a number of practical projects (see Annex 1) elaborated in the manner that -the student- should:

- Propose the experimental studies and experimental verifications to be realize in order to achieve the objects of the project on the basis of theoretical knowledge
- Realize in independent manner for the selection of equipments, instruments and other related things to develop the project
- After collecting all the preliminary information related to his “experimental project work”, then the student will approach to the teachers and submit the outline of the practical. The group of teachers will examine the outline submitted by the student and will discuss the short-falls if any and suggest some modifications if required. It is important here that the student must explicit the possible argumentation and defense of his project, analyze every step proposed, must know the limitations of the instruments/equipments and other limitations. The teachers should analyze the outline thoroughly point out the students about the limitations, errors, etc; a wide and open discussion will be held with the student if it necessary to incorporate modify/change in his project. This presentation ends after the student fulfills all the queries generated by the teachers and allows him to proceed to work in the experimental part of the practical.
- Realize the experimental activities in the laboratory (start to set up the experimentation, measurements, use of computation technique) in independent manner.
- After experimentation, a final report consisting of brief theoretical introduction, experimental procedure, all data in graphical and/or tabular form, errors, comparison and discussion of results and conclusions should be prepared. After submission of final report, a presentation on the same will be held by the same group of teachers.
- Here it is expected that the student get the general vision of different parts of the particular topic of science in co-relation with the other sciences, able to propose some new model and analyze the provisional character of models and theories.

During the development of each step, the role of teacher is like only a supervisor. The necessary interference should be made without affecting the independence of the student.

Application of the proposed method

The new method was applied for the experimental teaching at the Optics Laboratory (only for the third year students) having groups around 20 students, after the students finishes the first part of the course by traditional method modified, because the students can be select and realize one practical from the group of practicals for each optics phenomenon and have liberty to realize each practical during the days that the student need. At the same time the student can be realize six practicals any day or days during the first six week of the course without another condition that submit and discuss the last practical (final report) before to begin another one.

The actual features of the proposed method are:

- ❖ Meeting of the students with the group of teachers to explain in details the characteristics of the new proposed method, the objects to be achieved and clarified the role of teachers and students, after the presentation of projects practicals explain the general objects for each one.
- ❖ Each student must be select the task for development during the next six week of the second part of the Optics Laboratory course, and have a freedom to develop the things simultaneously of the different steps or in consecutive way.
- ❖ All the tasks should consult with at least two teachers. This will proceed to approve/asses the project and pay more attention to the students preparation for realize it, then controlling the steps during the experimental activities and finally discuss the final report, evaluating the task integrally: it is, take account the quality of the presentation of project, demonstration of

knowledge of the task, independence and ability during the experimental activities, quality of the final report and the defense.

At the end of the courses, the feedback was obtained from the students by providing a questionnaire of the proposed method.

For example, the affirmative questions: is more close the practicals projects to scientific activity, increase the motivation for the experimental work, develop the independent work of the student, the tendency is to promote creative attitudes and its experience result more fruitful for the students, all of them to get a high percent of affirmative answer.

However, this work represent just a first step in a long march to transform the traditional conception of the teaching in the laboratories of our Faculty, particularly in order to close the docent labs to the scientific activities.

CONCLUSIONS

The analysis (in view to the students) shows that the insufficiencies recognized in the traditional method were eliminated by the presented method. By applying the present method the improvement in the results were observed in the recent batch due to the experience gained by the professors and at the same time realization of the activities, detailed information about the method in the students.

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ANNEX 1. Practical Projects

1. Optical characterization of lens
2. Light diffraction by long and narrow slit: obtain the new theoretical approximation for the intensity pattern
3. Optical characterization of thin dielectrics
4. Optical characterization of dissolution's active optically
5. Experimental verification of Fresnel equations
6. Construction of retardation slides
7. Construction of Ellipsometer
8. Optical characterization of Wave Guide
9. Construction of Holographic Table
10. Study of lens magnitudes in functions of matter around its
11. Transmittance determination of refraction index on a glass slide
12. Optical characterization of laser diode

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