The science contests as a didactic strategy.

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Abstract: - Since the past eight years, the Chemistry School of the Universidad Nacional Autónoma de México, has organized an end of term contest about Physics experiments where students are asked to propose new developments or prove physic laws and principles through the design of devices and measuring processes that will improve technology. The success that has been obtained throughout these competitions can still be improved, most important, can be taken as a top didactic strategy for improving the process of teaching-learning Physics at the Chemistry School. The authors of the present article make several suggestions that could lead to a better organization of these events, to obtain results that will adjust to the students learning needs in a better way, and at the same time such activities would become the kind of experiences that will enrich the academic formation of our students.

Key-words: - Didactic, Experiments, Physics learning

1 Introduction

The Coordination of the Physics laboratories at the Chemistry school of the UNAM, introduced since the semester 1998-2 the Exposition about Physics Laboratories Projects, where students of those laboratories present their piecework related with themes about: Kinematics, Dynamics, Electromagnetism, Statics, Waves and Optic.

The central objective of the exposition is that students apply what they have learned about the mentioned topics in the development of a project.

Since its first edition, the exposition has been presented without interruption, but the projects' quality is generally inadequate considering the students' academic level.

The projects are done in teams of two, three or four students with de coordination of their respective professors.

The laboratory professor decides in a discretionary way, the number of projects to be presented, the number of students that will participate in each project, the projects themes as well as the internal evaluation.

The deadlines and dates for the project presentations are assigned by the Physics Laboratories Coordination and those projects are shown to a jury, formed generally by Physics professors of the Chemistry, Science, or Engineering Faculties, and by scientists from the Physics, Chemistry or Science of Materials Institutes that are selected by the Coordination.

The authors of the present article, have participated as jury and coordinators in the exposition, and in base of the acquired experiences, we considered that it is necessary to establish a series of rules that would allow projects to have a better quality, in a way that the results of the competition will correspond to the learning necessities of the students, transforming this activity in an enriching experience for the academic formation of our students.

2 Detect problematic

Even though projects with good quality have been presented, a high percentage of them lack the minimum characteristics that are necessary for them to be considered high level Physics Projects. Because of this, in some editions of the contest, the winning places have been declared vacant.

This is due to the following aspects:

2.1 Student's Attitudes

Generally speaking, students think of a device that is novel or visually attractive to their judgment, and not in one that finds an answer to their restlessness; they have not clear which themes to apply in their project and more important they have no idea how to develop a science project; they generally search on the Internet information about experiments that will guaranteed successful results; they have no sufficient time for planning the project, because they spend, in the better cases, the two last weeks of the course to develop it; they only consider the project as a way to obtain a grade, and because of that, they are incapable to explain what happens in it.

2.2 Professor's attitude

The professor doesn't give the sufficient advising to their students during the project realization. Some of the experiments they approve don't correspond either with the assignment or with the level in which the students are inscribed. They direct projects with purely demonstrative traits that lack the experimental development that would permit its evaluation.

2.3 Jury Attitude

There are no guidelines that describe how the evaluation process should be. Therefore, in some competitions originality is graded, other focus on the student's domain of the concepts involved, and other evaluate the interpretation and manipulation of mathematics in the experimental results.

The questions that the jury formulates are sometimes very strict, while others are really relaxed. Even though the questions are always directed to inquiring about the knowledge that the student has acquired, there is no written proof of this part of the competition. Because of this, valuable information for improving the teaching-learning process is lost.

3 Critical Stages

To get better results during the project expositions, it is necessary to analyze the critical stages of its making. These stages are:

3.1 Topic Selection

The science project has to be, in a first instance, interesting for the student and requires to be simple an easy to make.

Students must know what they want to achieve and which their objectives are before starting the project.

3.2 Documentation

Students must be well informed about the scientific aspects that are related with the topic they have chosen. The information sources have to be adequate to the academic level of the students, otherwise, there is a risk to make a childish project or with understandable content for the student, giving as a result in both cases, a frustrating feeling. The student has to have in mind that he research made in books and specialized magazines are fundamental for a successful project.

3.3 Planning

Once the students consider themselves to be well informed, they should plan the activities they will undertake. They should:

- Create a simple and clear statement that identifies the experiment's purpose.
- Identify the variables, and the experiment's result.
- Establish the conditions for the experiment elaboration (Temperature, Pressure, Humidity, etc.)
- Make a detailed list of the materials, instruments, equipment and substances to be used.
- Formulate a hypothesis that can be worked on with the experiment.
- Develop a detailed algorithm that explains how to build the device and how many tests should be made.
- Identify possible sources of mistakes.
- Register the obtained information
- Analyze the information and determine if it is related with the stated objectives.
- Identify the mathematical treatment the information should receive.
- Determine if the results allow one to prove the truthfulness or falsehood of the stated hypothesis.
- Register all the activities in a detailed way.

All these actions should be made before the established deadlines.

3.4 Project Development
Taking pictures and making drawings or diagrams of the project is very important. These will be shown to the jury and to the exposition's audience.

3.5 Results and Analysis
Once the experimental stage of the project has been finished, the information should be processed and presented in a way that allows the relationship with the objectives to be shown.

3.6 Written Report
In the written report that the students must present, they must explain what they did, how they did it, and what they found out in a clear way. They must also include the methodology they followed, the description of the experimental stage, the obtained data, the mathematical manipulation of the information, and the conclusions.

3.7 Preparing for the Project Exposition
The students must prepare a speech to give out before the audience and the jury at the exposition. It should be clear and organized. It must include an introduction to the theme, the formulated problem, the objective, the experimental procedure that was followed, the hypothesis, the results, and conclusions. Drawings, diagrams and graphs must be shown when necessary.

3.8 During the Exposition
The speech to be presented must be approved beforehand by the professor, and it must include important information. It is recommended to present the speech to other people before the project exposition.

4 Guideline Proposition for the Presentation of Physics Projects
As a part of the proposition, we present a series of guidelines that must be followed by the students and professor for the project presentations.

4.1 Exposition Objective
The objective of the exposition is that students coursing Physics Laboratories apply the knowledge they have acquired on the subject by creating an experimental project.

4.2 Project Themes
The project should be within one of the following categories:
- Demonstration and /or confirmation of one of the physical laws included in the course syllabus.
- Design of devices of practical use.
- Design of alternative experiences for the laboratories.
- Design of measuring devices.
- Design of auxiliary devices for investigation.
- Recreational applications of physical principles.

The particular topics of the projects must be related with the course syllabus.

4.3 Working Teams
Each project should be elaborated by a team formed by no more than four and a minimum of two students.
Hopefully, all the laboratory professors will participate in the exposition, with, at least, two projects per group.

4.4 Professor's Roll
The professor should coordinate the making of the projects, giving suggestions that lead to a better development of the task. It is important to point out that the central idea of the project should be proposed by the students, not by the professor.
The professor will chose, from the varied proposals that each team makes the one that adjusts better to the following requirements:
- Correspondence with the course syllabus.
- Equipment and material availability.
- Project originality.
- Scope of project.

4.5 Students' Roll
The team members should make a proposal about the project and experimental route.

Each team should create the experimental device before the assigned deadlines and guarantee that it will work correctly.

4.6 Laboratory Coordination's Roll

The Laboratory Coordination will provide, beforehand, the deadlines for the summaries, and the dates for the project presentations.
It will guarantee the availability of a space in which to display the projects.
It will gather the jury for the competition.
It will file all the summaries and give them to each member of the jury to analyze them.
It will organize a ceremony to give out the awards.
It will create and make sure the judges have the evaluation guidelines.

4.7 Summary Format

Summaries must include:

4.7.1 Project title
4.7.2 Members' name
4.7.3 Professor's name
4.7.4 Assignment name and code
4.7.5 Group
4.7.6 Description of the project's objective
4.7.7 General description of the device created and of the methodology followed to reach the objectives
4.7.8 Drawings and/or diagrams that explain the way the device is used and how it works.
4.7.9 The summary should be a page long. It should be written in font Times New Roman size 12.

4.8 Material and Equipment

Students, with their professor's approbation, can use the instruments and equipment available at the Physics Laboratories in the Chemistry Faculty. However, if they consider it pertinent, they can buy and use their own material, equipment or instruments.
The material, equipment and instruments available at the Physics laboratories will be at students' disposition during class hours.
If students need anything during extracurricular hours, they should have the authorization of the Laboratories Coordination.
Students cannot withdraw the equipment, material and instruments from the Physics laboratories, except on the day of the exposition

4.9 Deadlines and Dates for Project Presentations

The deadlines for the projects' summaries and the date for the presentations will be timely published in the Physics Laboratories of the Faculty.

4.10 Submission of project's summaries and presentation

The teams must submit the project summary to their professor, whom at the same time, should deliver it, signed in agreement with its contents, to the Laboratory Coordination in the assigned dates.
The projects must be presented in the previously defined dates, in the site designated by the Physics Laboratories Coordination, in presence of the corresponding jury.
Regarding the project presentation, the team members should demonstrate their project to the jury, and answer all the questions posed by the jury.

4.11 Project Evaluation

It is suggested that the project be considered as part of the normative evaluation of the corresponding academic subject.
Each team must present a report about activities that are related to the project, according to the guidelines provided by the professor.

4.12 Jury

The jury should be integrated by guest professors or researchers, who could be members of the Chemistry Faculty or other premises of the UNAM or members of any other academic institution.
Members of the jury could not participate as project coordinators.
The jury will name the winning projects according to the following criteria:

4.12.1 Connection of the project content to the course syllabus.
4.12.2 Project presentation and demonstration.
4.12.3 Student's performance during jury questioning on the day of the presentation.
4.12.4 Project originality.

4.12.5 Scope of the project
4.12.6 Handling of experimental information.
The jury will name the winning teams, by academic subject. Tied and deserted places can be declared regarding the winning places.
The jury's decision is final.

4.13 Project Awards

All students must be present for the project awards at the time and place indicated by the Laboratories Coordination.
The winning teams will be awarded a diploma and each team member of the winning teams will receive the corresponding participation constancy.

5. Conclusions

The issues covered in the present article, were applied during the semester 2006-2 with a team that presented a Physics Laboratory project named "Electromagnetic Scale". The project's objective was to develop a device that could determine body mass, based on the magnetic force experienced by a solenoid inside a constant magnetic field. This team was awarded the First Prize.
Finally, we, the authors of this article, consider that the monitoring of the observations shown in this document, could lead to the better development of a science project, and an enriching experience for students of scientific careers. Because of the project development and the jury questioning, it is possible to incorporate changes to the didactic strategies, and identify students' misconceptions. Professors could organize debates among students (during the classroom mock presentations), so that this encourages and directs the competitive and comradeship spirit among the students.

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References:

1. Aebli H., *Doce formas básicas de enseñar: Una didáctica basada en la psicología*, Narcea, Madrid, 1988
2. Flores F., L. Gallegos, *Consideraciones sobre la estructura de las teorías científicas y la enseñanza de las ciencias*, Perfiles Educativos, No. 61, UNAM, México, 1993
3. Ausubel D., *Educational Psychology*, Holt Rinehart & Winston, New York, 1978
4. Carretero M., *Construir y enseñar las ciencias experimentales*, Aique Grupo Editor, Buenos Aires, 2002.
5. Díaz F. y Hernández J., *Estrategias docentes para un aprendizaje significativo*, McGraw Hill, México, 1999.