Using experimental modules to favour meaningful learning in high school physics

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Abstract. The following work states the schematics of the research that will be done at the UNAM's CCH high school in two groups of Physics IV from March 5 to April 4. The research consists of the implementation of experimental modules in order to favour meaningful learning by the students. We will measure the knowledge of the students prior the intervention and two times afterwards. This learning will be analysed in order to see if there is a correlation between the quality of the work done in the modules and the learning of the students.

1 Introduction

The PISA by the OECD measures the performance of students around the age of 15. One of the areas of PISA is scientific competence which includes: scientific knowledge and the use of said knowledge to identify questions, acquire new knowledge, explain scientific phenomena and to draw conclusions based on related scientific evidence [1]. The results of PISA 2015 place Mexico far below the OECD's mean and slightly above Latin America's in scientific competence. Mexico's score was 416 ± 2.1, with OECD's mean of 493 ± 0.4 and Latin America's of 408 ± 0.8 [2]. In a previous research done at the Faculty of Sciences of the Universidad Nacional Autónoma de México with a group of Biology freshmen we found that the students still have naïve ideas regarding electromagnetism [3]. This means that the scientific knowledge in high school was not meaningful for the student or that, as seen in the PISA results, there is a deeper issue at hand regarding high school physics teaching.

With this in mind we asked ourselves if this situation could be changed and how. Knowing that teachers are reluctant to change their teaching styles, we proposed the use of experimental modules as an aid for the teaching-learning experience. The modules are small, 15-20 minute long, experimental activities where the students make a hypothesis, an observation, and contrast both to draw a conclusion. They are based on Kolb's experiential learning cycle, which has 4 different phases [4]. According to Miller et al. when a hypothesis is involved in a demonstration or experimental activity the student is more prone to understand the concepts underlying said activity [5].

The proposal is to be applied during the physics class in the Science and Humanities School (CCH) of the UNAM in Mexico City in a Physics IV course. Physics IV is set during the last year of high school, the students' age range from 16 to 18. The physics class is normally divided in 3 sections: theory, problem solving and laboratory, sometimes with a very defined boundary between each one. The teachers prefer the expository style during their theoretical lectures. The experimental modules are such that the teacher does not have to substantially modify their teaching style in order to use them, nor to use specialized materials as in a laboratory session.

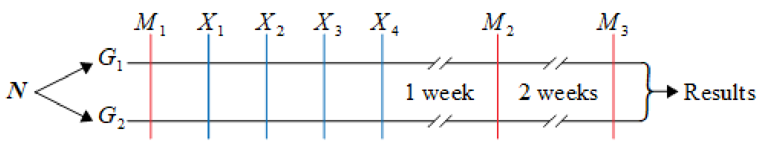

Fig 1. Research design schematic.

The primary objective is to find if the use of such modules favours meaningful learning, and as a secondary objective is to see if there is a correlation between the quality of the hypothesis, observations, and conclusions made by the students and their learning.

2 Methodology

The research design schematic is shown in figure 1. The labels are: G_i, groups used in the study; M_1, pretest; M_2 and M_3, post-tests; and X_i are the classes where the modules are implemented. The whole research will be done from March 5 to April 4 in the electromagnetism unit. Each class session is 2 hours in length and will be an expository style class. The pretest is used to know the level of knowledge the students posses prior to the intervention. The modules consist of the experimental activity, and a sheet of paper where the student will write down their hypothesis, observations and conclusions. The first post-test will be applied 1 week after the last class session and is to assess whether the students' knowledge in the subject changed. The second post-test will be applied 2 weeks afterwards and will assess if the learning was meaningful. These results will be cross checked with the work done by the student during the modules to identify if there is a correlation between the quality of the written work of the module (hypothesis, observations and conclusions) with the assessments' results.

3 Expected Results

We expect that the use of the modules will impact the students' learning in that said learning will be meaningful. If the learning was meaningful for the student, it should be understood time after the concept was seen in class. This will be obtained from the different assessments that will be applied. Also by analysing the students' module quality and cross checking with their second post-test results, it can be seen if there is a correlation between the written part of the module and the students' learning.

4 Conclusions and Implications

If the scores of the second post-test in the topics where the students had issues in the pretest improve, we can infer that the learning was meaningful. This conclusion can be done due to the test design and application. Also if there is a correlation between the quality of the written work done in the modules and the scores, we can assure the modules had a significant impact in the students' learning. This will mean that without changing the class style we can have an impact in the quality of the learning that will benefit students and teachers. Students will improve their learning and teachers can enrich their classes with only small changes to their lesson plan.

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