Physics for the area of biological sciences and health within STS context

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Abstract

Students that pursue to study careers belonging to the area of Biological Sciences and Health; as medicine, chemistry, biology, dentistry, psychology, etc. must take a propaedeutic physics curse in their last high school year at "Escuela Nacional Preparatoria" in México City. For many of them this may be the last physics course in their academic life. They believe that physics is not really relevant to their future career and least to their professional life, so there is little interest in their study, primarily because a lack of contextualization of content. Physics is generally considered a difficult subject and in some cases useless, mostly for the way in which it is usually taught, demanding the memorization of formulas and the solving of mechanical problems to the students without any significance to them and their lives. We intend to address some physical concepts from the analysis of various technological applications, in which students may be interested because they can be related with their future careers. This will be done not only to motivate students, but also to highlight the connection of the subject to the real world, by showing the role of physics in the technological development and how it impacts our life in every way.

Keywords: Physics in biological science, STS, observe-absorb-retain-apply.

Resumen

La materia de Física IV (Área 2) que se imparte en la Escuela Nacional Preparatoria tiene carácter propedéutico y está dirigida a quienes quieren estudiar carreras como medicina, química, biología, odontología, psicología, etc., pertenecientes al área de Ciencias Biológicas y de la Salud. Para algunos alumnos ésta será la última materia de física que cursen en su vida académica, aunque independientemente de esto, la mayoría consideran que la Física no es realmente relevante para su futuro desempeño profesional, por lo que existe poco interés en su estudio, principalmente debido a la falta de contextualización de los contenidos. La física es considerada en general como una materia difícil y en algunos casos hasta inútil. La enseñanza tradicional de la física a nivel bachillerato, basada en la memorización y resolución mecánica de problemas ha contribuido a esta visión de la Física fragmentada y alejada de la realidad, al no considerar los intereses de los estudiantes y de la sociedad. Nosotros proponemos abordar algunos conceptos físicos a partir del análisis de diversas tecnologías con las cuales los estudiantes puedan tener una mayor identificación, con el fin no sólo de motivarlos, sino también para evidenciar su conexión con el mundo real, al mostrar el papel de la Física en el desarrollo tecnológico y como éste impacta nuestra vida en todo sentido. Este trabajo se enmarca dentro de la corriente constructivista, bajo un enfoque CTS (Ciencia, Tecnología y Sociedad).

Palabras clave: Física para ciencias biológicas, STS, observar-absorber-retener-aplicar.

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I. INTRODUCTION

The traditional teaching of physics in high school level, based on memorization and solving mechanical problems, has not worked because it provides a fragmented view of science away from reality.

While recognizing the importance of physics as a promoter of many of the changes that humanity has suffered throughout its history, it is usually not considered part of the culture and it is identify more with its language and some of instruments that are used for learning and not with their applications or with the creation of models that help to describe and interpret the nature [1]. This is in many ways, motivated by the way teachers approach the scientific knowledge, focusing on the use of formulas and calculations that are meaningless to students.

The unfavorable attitude of students towards physics is not only due to the conceptual difficulties of it, but of the few incentives offered to them in their learning as a result of little or no connection with everyday life. Physics is perceived as an abstract and formal subject, reserved for the few brilliant students [2].

The physics of high school is, in many cases, the last chance to show students that science and technology are

social constructions accessible and relevant to all members of society, not only for future scientists. "Today more than ever, the concepts, language and methodology of physics are fundamental to understanding the world and should be part of the general culture of every citizen" [3].

Physics IV (Area 2) which is taught at the National Preparatory School (ENP) have preparatory character and is aimed for those who want to pursue careers as medicine, chemistry, biology, dentistry, psychology, etc. Many of the disapprovals are made to the teaching of physics in this area is its focus on theoretical and technical aspects, without reference to the context in which this knowledge will be used. This causes most students to consider that physics is useless to their future profession in addition of its difficult, so there is little interest in its study.

To try to change this view some physical concepts will be addressed from the analysis of various technologies in which students of this area may have a greater interest (endoscopy, solar ovens, ultrasound, x-rays, etc.). In order not only to motivate them, but also to highlight the role of physics in technological developments and it impact in our daily life.

Seeking this result, theoretical - practical sequences were developed, in some of which ICTs (Information and Communication) were used in order to facilitate access to reference materials, provide interactive learning environments, network communication and promote collaborative work.

II. THEORICAL FRAMEWORK

We live in a world where the rapid advance of technology overwhelms us, every day we are surprised with new phones, mini computers, music players, PDAs (personal digital assistant), digital cameras and more.

The scope of technology is such that impacts all areas of our lives: family, social, school, work and entertainment. Today we could not imagine our daily routine without the technology that surrounds us.

We must understand that all this technological growth has been thanks to the development of science. Most developed countries are also those who spend a greater investment in basic science. A country without scientific culture is intended for technological dependence. For the personal assessment of risks and effects of new technologies it is essential to have a minimal scientific background.

Scientific literacy is now a social demand because it requires informed and critical citizens to make responsible decisions about issues related to science and technology as health, hygiene, environment, sustainable development, etc. However, as physics teachers we must analyze whether we are contributing to this literacy from the model of science that we promote in our everyday work, since the model of science will condition largely the possibility of dialogue towards science and its methods.

Under these considerations, the teaching of physics cannot be limited to theoretical and abstract physics, it is part of culture, and as such it is influenced by the society. Hence, science and technology education have no sense outside the social context in which they are immersed. According to Gallagher [4]: "For the future citizens of a democratic society, understanding the interrelationships between science, technology and society can be as important as the concepts and processes of science".

The STS approach (Science, Technology and Society) extends the field of science education by considering the interactions of this triad in order to present science in a more humanistic and relevant to students [5]. It also promotes scientific literacy aimed to achieve public participation of citizens in decisions that involve the development of science and technology, in order to democratize and make society aware of the responsibility for their future.

In this view underlies the idea that science is an important element of contemporary culture, of which students should form a well-versed opinion, thus demystifying the idea of a "neutral" science away from the interests and concerns of the world "outside". There is also a revaluation of practical knowledge, represented by the technology, which goes from being a "simple" application of theory to be the real engine of scientific knowledge.

The STS approach is not a break with the teaching of scientific concepts, rather it is intended that these concepts become more significant when used to identify and resolve problems in real contexts, but in addition it is proposed that students acquire values and attitudes related to their social environment.

In Shamos' [6] words: "[...] STS movement's basic premise is that by making science more relevant to everyday life of students, they can be motivated, more interested in the topic and work more harder to master. Another argument in its favor is that by giving importance to the teaching of social focus of sciences, will help to form good citizens, that is, if we raise awareness among students of social problems based on science, they will be more interested in science".

III. PROPOSAL

One of the conditions necessary to achieve significant learning is that students want to learn, so they are important both the will and motivation, which are determined largely by the sense that students attributed to the learning situation [7].

According to Hernandez, Finders & Solé [7] to achieve a meaningful content the following conditions should be given:

- Students should know which is the goal pursued by certain task (what? How? And why?).
- Present the task to the student so that is perceived as something that interests.
- The task should be seen by students as something that can be learned or performed with the resources they have.

In our experience as physics teachers we have seen that lectures focused entirely on abstract concepts and algorithmic manipulations lead to student disinterest, which is reflected in a question that has become recurrent in physics courses: And this, when should I use it? It must be shown that physics is important beyond the classroom. The operation of some technology allows us to build a bridge between the abstract and the concrete, and helps to motivate students to understand concepts in order to be able to explain those applications perceived as important to their professional future; in this way the physics we teach approaches to the demands and needs of students in the contemporary world.

Our proposal consists of a series of teaching sequences with a STS focus for Unit 3 (Optics and Acoustics) of the subject physics IV (area 2) of the ENP.

This approach is used so that from the analysis of various technological applications, students make sense of theoretical concepts strengthening its usefulness and functionality outside the classroom. Likewise, it is intended that through the proposed activities, students can ask questions and to make hypotheses, in order to speak science and so to get a discourse closer to real science.

The inclusion of technology allows students to recognize the problems that have led to its development, reflect on their implications for both society and nature as well as discuss various issues related with solutions to practical and productive activities.

The following table shows the technological applications that are proposed for the specific contents of the unit.

TABLE I. Unit 3: Optics & Acoustics Times marked in the program of ENP (20 hours).

Content	Technology
3.1. Light reflexion and plane mirrors	Endoscope
3.2. Reflexion on concave and convex mirrors	Solar ovens
3.3 Light refraction	Endoscope
3.4. Convergent and divergent lenses	Microscope Telescope
3.5. Longitudinal and transversal waves	
3.6. Doppler effect	Doppler apparatus
3.7. Wave nature of light. Interference polarization and diffraction	Solar filters Polarized lenses
3.8. Sound waves	Ultrasound

In the development of the sequences next issues are taken into account:

• The sequence serves for the students to understand the mechanisms of the technology application.

• That within the sequence are studied several subjects related to:

- Environmental-impact
- Balance cost benefit
- Social impact
- Nature of Science
- Scientific Objectivity

• That through the sequence students get the opportunity to acquire some of the skills associated with scientific work such as observing, measuring, classifying, communicating, predicting, deducing, controlling variables, interpreting data, formulating hypotheses, and so on.

• That through the activities the impact of science in culture may be shown

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