Remote Sensing Modules To Increase Interest In Traditionally Difficult Courses

José G. Colom and Sandra L. Cruz Pol
Electrical and Computer Engineering Department
University of Puerto Rico, Mayagüez, PR 00681-9042
(787) 832-4040 x2448 and x2444 /fax (787) 831-7564
Emails: colom@ece.uprm.edu / SandraCruzPol@ieee.org

***Abstract* – Most students traditionally consider difficult certain specific courses within any EE curriculum. This is especially true if the course contains complex abstract equations and concepts, which is typically the case for most applied Electromagnetics courses. To increase the understanding and interest in these courses it is essential that the professor maintains the students' attention and delivers the awareness that these concepts are indeed used in real life. One way to approach this goal is to introduce short modules in which the concepts taught in the course are applied to contemporary issues. Two such modules in the area of Remote Sensing were developed as part of the NASA Partnership for Spatial and Computational Research (PASCOR) to be included into two undergraduate level courses. The modules present applications in Microwave Systems and Microwave Remote Sensing of the Ocean. The assessment, in the form of a questionnaire before and after the module, is presented and analyzed.**

I. Introduction

LAST SPRING, two modules in the area of Remote Sensing of the Earth where developed and implemented for two courses in the ECE department of the University of Puerto Rico at Mayagüez (UPRM), namely, Electromagnetics and Microwave Engineering. The assessment of the modules was performed in the form of students' questionnaires before and after the modules were offered. The questionnaire examined students' interest in the class and in related areas of research. The first module, henceforth referred to as *Module A*, covers the application of active microwave systems to measure the characteristics of simulated sea ice at 35 GHz. The second module, henceforth referred to as *Module B*, consists of an overview of the applications of electromagnetic theory in the area of microwave remote sensing of the ocean. In this work, both modules will be presented, as well as the results from the assessment, which demonstrates that the modules successfully increased interest in the courses, and generated interest in both graduate school and undergraduate research.

This work was sponsored by NASA/PASCOR; a program dedicated to the integration of undergraduate research experiences in Remote Sensing and Geographic Information Systems (GIS) areas across a multidisciplinary BS curriculum at the University of Puerto Rico, Mayagüez.

II. Remote Sensing Modules

A. Module A: Microwave Systems

The module described here was integrated to the Microwave Engineering course (EE 5306). This course covers the topics of microstrip passive and active components. The passive components discussed during the course include the analysis and design of attenuators, power dividers, directional couplers, and filters. The active components material describes the design of narrowband microwave amplifiers and a brief introduction to mixers and switches. Most of the components discussed in class can be used in the design of microwave systems for remote sensing applications. With the integration of the module into the course the student was exposed to different types of active sensors that are used for the remote sensing of natural targets. The module presents the development and calibration of a 35 GHz step frequency polarimetric scatterometer. Measurement procedures for sea ice and snow under different conditions using the scatterometer are explained. The data is processed to calculate the Normalized Radar Cross Section (NRCS) and final results are discussed [1]. The students were presented with results from different types of sea ice and snow using the 35 GHz scatterometer. The NRCS was plotted versus incidence angle and versus temperature. The module illustrated the students the concepts learned in the course applied to microwave remote sensing.

B. Module B: Microwave Remote Sensing of the Ocean

The ocean permittivity module intends to promote interest and understanding in the course of Electromagnetics II (EE

4152), a traditionally difficult course. In EE 4152, the students learn about the electromagnetic properties of various media including the dielectric coefficient of materials such as ice, seawater, snow, dry soil, etc. In addition, they learn about reflection, and transmission of electromagnetic waves at boundaries between media having different properties. The module presented the application of these concepts to remote sensing of the Earth in various ways.

As part of the module it was explained that matter at typical temperatures found in Earth normally emits electromagnetic radiation in the microwave region. The microwave radiation is used to identify the composition, properties and phenomena occurring in the observed targets. Radiometers and radars are used for these purposes, having the advantages of obtaining information during high cloud cover and at night, and using antennas small enough for space implementation. This science takes advantage of specific resonances that various molecules have with specific frequencies according to quantum theory.

Examples of microwave remote sensing given in the modules included the use of

- 1.4 GHz frequency sensitivity to monitor soil moisture and ocean salinity,
- 22 GHz used to detect water vapor content in the atmosphere [2] and
- 95 GHz radars used for cloud profiling.

These have applications to meteorology, weather climate and oceanography, among others.

The operation of the NASA TOPEX/Poseidon satellite was explained in this context, specifically the use of the microwave radiometer to correct for water vapor radio delay in the microwave altimeter used in the mission to measure the oceans topography [3]. The use of this satellite to study, monitor and predict the event of El Niño was presented together with all the implications of the advantages of knowing more about this climate phenomenon.

III. RESULTS

The questionnaire used in the assessment of these activities included thirteen questions as listed in Table 1. Due to space limitations, we only present the graphs showing the results for some of the questions and for Module B. Module A was tested on 24 students in EE 5306 and Module B was presented to 31 students from EE 4152. Both groups responded in a very similar manner to the questionnaire so the graphs depicted here are representative of both groups.

All questions obtained a significantly better response (ESSENTIAL vs. NOT IMPORTANT) after the module presentation. Responses from the questionnaires were analyzed and are

TABLE 1 Questionnaire designed for the Assessment --- [All the questions were answered before and after the module. The first nine (9) questions were ranked with 1= NOT IMPORTANT, NOT INTERESTED to 5 = ESSENTIAL, VERY INTERESTED. The last three were answered YES or NO.]

1.	The impact of the application of Electromagnetics Theory in communications
2.	How important is Electromagnetics to society?
3.	Potential of its applications to help save human lives
4.	How important to help improve global economy?
5.	How important to help save animal/plants from extinction?
6.	How important it is to for me to engage in undergraduate research?
7.	My own interest to engage in undergraduate research.
8.	My interest in the class as effect from the remote sensing module
9.	Help understand the class concepts better.
10.	Do you know about current ways to perform undergraduate research at this institution, (UPRM)?
11.	Would you like to learn more about undergraduate research opportunities?
12.	Should this module be repeated in next years courses?

plotted in figures 1 to 5. The results indicate that the module presentation generated a positive attitude toward remote sensing among the students. Moreover, most students indicated that the modules should be repeated in other courses and that their interest in undergraduate research opportunities (Fig. 1 and 4) increased after the modules. The interest in the class and understanding of its concepts increased considerably after the modules was offered according to the students in both groups (see Fig. 2 and 3).

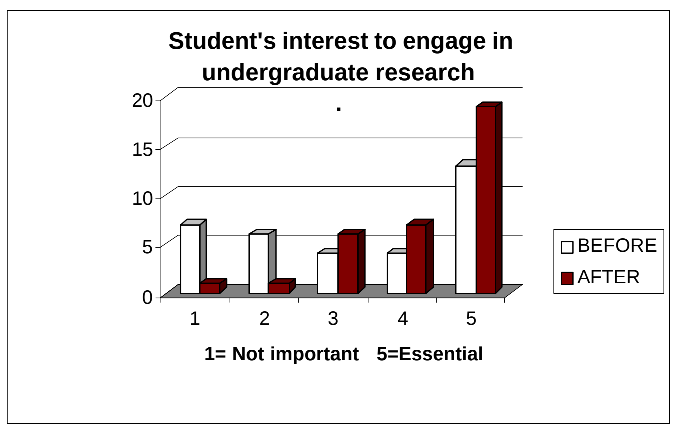

Fig 1. Students' interest to engage in undergraduate research before and after the module was presented in the Electromagnetics course.

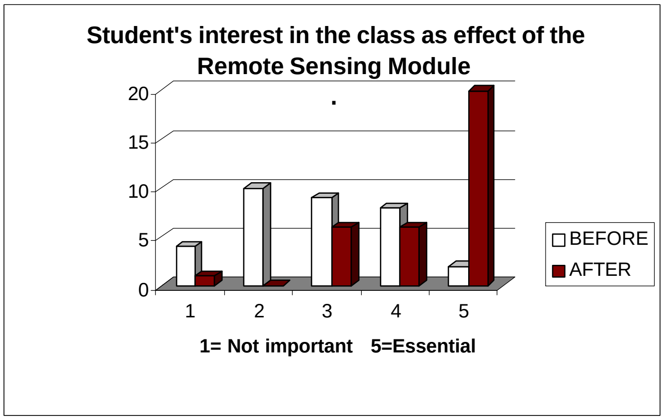

Fig 2. Students' interest in the class before and after the module was presented in the Electromagnetics course.

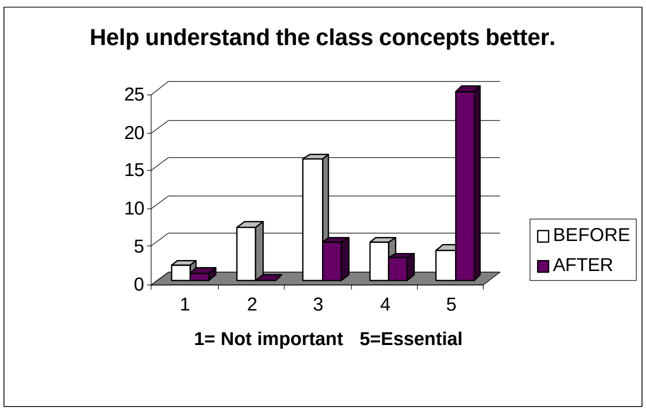

Fig 3. Students understanding of the class concepts related to permittivity and wave reflection before and after the Ocean Permittivity Module was presented in the Electromagnetics course.

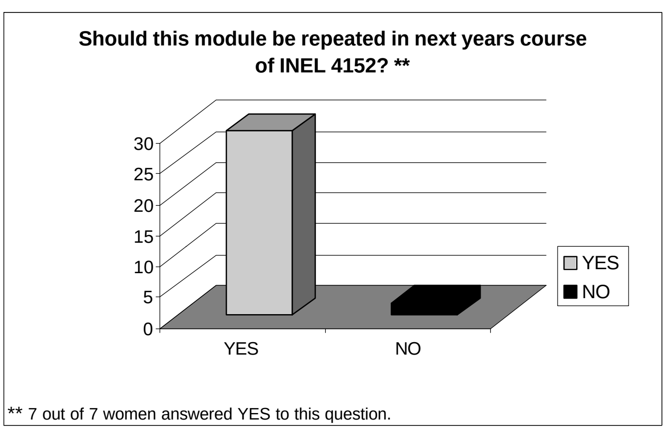

Fig 4. Students' answer to whether the module should be repeated during the following years.

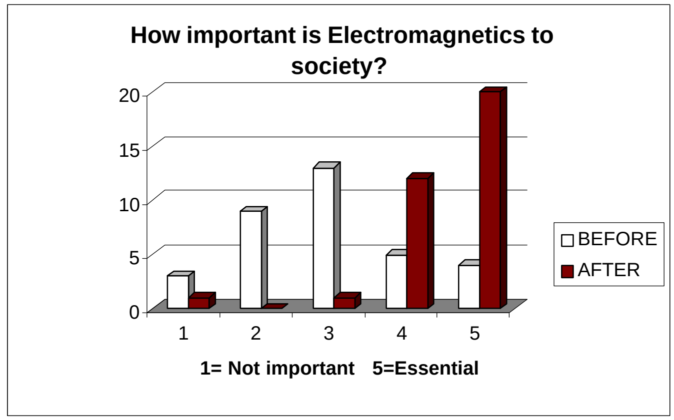

Fig 5. Students' perception of importance of the class before and after the *Module B* was presented in the Electromagnetics course.

In the question of whether the modules should be repeated in the following years, the vast majority answered YES. It is interesting to note that in one group (*Module B*), 7 out of 7 women answered affirmatively. This is particularly important if we are to foment the increase in the number of women obtaining graduate degrees in Engineering. Fig. 5 depicts students' perception of the importance of the class to society. There is a considerable change in the perception of the significance of the course to society.

IV. CONCLUSIONS

These modules have appreciably increased the interest of the student not only in the course, but also in undergraduate research and graduate school. We can therefore conclude that the integration of a short module in a one-semester course can significantly improve the attitude and understanding of the students towards a traditionally course.

ACKNOWLEDGMENT

This work was supported in part by PASCOR, the Partnership for Spatial and Computational Research, under a grant from the National Aeronautic and Space Administration (NASA Grant # NCC5-340).

REFERENCE

1. Colom J. G.. "Development of a 35 GHz Network Analyzer Based Polarimetric Scatterometer", MSEE Dissertation, University of Massachusetts, 1991.
2. Cruz Pol, S. L., C. S. Ruf and S. J. Keihm, "Improved 20-32 GHz Atmospheric Absorption Model," *Radio Science*, Vol. 33, No. 5, pp1319-1333, September-October 1998.
3. Cruz Pol, S. L., and C. S. Ruf, "A Modified Model for the Sea Surface Emissivity at Microwave Frequencies", *IEEE Trans. on Geosciense and Remote Sensing*, Vol. 38 No. 2, pp. 858-869, 2000.