Teaching Electromagnetism in electrical engineering curriculum: New methods and new trends.

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Abstract: *In this paper, the authors will attempt to describe their experience in teaching the fundamental concepts in Electromagnetics (EM) at the undergraduate level and will describe new methods which they consider have pedagogical advantages and are better suited to the new European high education envir onment convened in Bologna in 1999 (The Bologna Declaration (BD), a pledge by 29 countries to reform the structures of their higher education systems). Some of the authors have more than 15 years experience in high education, and all of them have had duties dealing with the teaching of EM theory.*

The authors have got a broad experience in university activities, not only in lecturing but in organisation, direction and planning teaching activities and, in recent years, they have also taken part in the develo pment of strategic plans and accreditation of new engineering syllabus aiming to create convergence at European higher education under BD. Nevertheless, this paper will focus in the close experience with the students, including lecturing, laboratory course s and tutorial activities. Our concern about the transformation of the established academic training in the Spanish universities turned out in a large collection of information which spreads from Physics and Electromagnetics world -wide texts and reports ab out engineering education innovations.

Since the first teaching duties in EM for electrical engineers, a strong demand was detected within the students for a change in the theoretical approach of the subject. Through their direct comments and the results of surveys, the contents were reorientated towards a more practical approach. One of the main complaints of the students was the gap between what they were told to learn, which demanded a huge effort and waste of time and energies due to the mathematical skills demanded, and their future engineering task. Trying not to get rid of the basic theory, which can not be overlooked although it is not appealing at all for many students, changes have been made in lecturing methods and tutorials. For instance, lectur e demonstrations, scarcely used in the Spanish universities, have been reintroduced (they are very well documented at the PYRA, Physics Instructional Resources Association), and real engineering study cases have been adapted in order to be solved by the st udents with more straight forward analytical and mathematical tools. Also new electrical engineering calculations techniques, as the finite element method , have been lightly introduced aiming at reducing the gap between basic mathematics and high sophistica ted research tools. Even if new er EM software is becoming more friendly, it still demands too much time to master it.

Students have participated as a key element in some of the new learning techniques introduced. The construction of simple electromagnetic devices (Van de Graaff generator, electrical induction motor, electromagnets, electric transformer) as part of their curriculum, and the tutorials specifically dedicated to improve their problem -solving techniques are examples of these activities. C ompute r based learning techniques have been introduced with caution due to the low efficiency of the s oftware and hardware resource s available for u s. However, the continuos improvement of these kind of tools have allowed to start a collection of images, animati ons and web pages links which are introduced as a lecturing support during the class. The construction of a Web page within the ADD (Digital Teaching Ring) of the University of Zaragoza has also been started.

Some evidences of these efforts are our contri butions to national a nd international high educatio n conferences [1, 2], and the participation in the scheme for educational innovation promoted by the University of Zaragoza. The results are not yet good in terms of "cost effective" although students seem to be more satisfied with the new approach. The authors have not any personal experience in academic training outside Spain, but have gathered plenty of written records. Therefore, the main goal in this conference is to meet lecturers and teachers in the

field of EM and electrical engineering, taking the chance to know different approaches and its results and to share our experience with them.

References:
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