

AN INNOVATIVE STRATEGY FOR THE TRANSITION TO UNIVERSITY PHYSICS COURSES

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1. INTRODUCTION

When reaching the university, students often consider that their pre-university Physics background is sufficient. Nevertheless, some students do find great problems to understand lectures. Similar problems arise in Mathematics, Chemistry and Graphical Expression courses.

Physics is usually taught to Engineering students in the autumn-winter term of the first undergraduate year. One of the most important problems is that students fail. As an example, in the University of Girona as many as 70% Computer Engineering students do not pass the Physics course. Similar problems exist in other Catalan universities offering Engineering studies.

It is difficult to recover the students' illusion, and many leave the university. The solution cannot be to lower the level of Physics contents. Innovative methods and strategies are sorely needed. Such an approach is described below.

2. INNOVATIVE APPROACH

Because of the problems described in section 1, the University of Girona promotes changes in technological studies, under the program "Actuation scheme for the improvement of the students' performance".

The main purposes of this program are the following:

- a) To improve the academic performance of students.
- b) To give to the students the basic knowledge such that they become prepared to follow their studies successfully.
- c) To increase the personal attention to students

This project is currently at work in Computer and Agricultural Engineering studies. Within this scheme, personal tutorials and new basic courses have been introduced. In the next section, we explain our experience in innovative Physics teaching.

3. NEW PEDAGOGICAL TECHNIQUES

Tutors try to detect those new students who have an insufficient level of Physics. Then the tutors recommend them to follow a new course during the second term of the first academic year, called "Basic Physics". This is a course that can be chosen voluntarily by the students. It has been offered for the first time in the academic year 1999-2000.

"Basic Physics" is a course with a level that corresponds to pre-university centers. The main purpose is to provide the students with the necessary knowledge to understand the compulsory university Physics course in the subsequent academic year. Sometimes, before going ahead it is better to turn back. Innovative methods used include the reduction of the number of students per class to 20.

Moreover, complementary didactic instruments have been developed. A special book on basic Physics has been written [1], in order to facilitate individual work by the students. In this book, the authors introduce the basic concepts of each Physics subject. Simple examples are solved and auto-evaluation problems and questions are given.

The contents in brief are:

- 1) Introduction: Quantities. Units. Dimensions. Vector algebra.
- 2) Kinematics.
- 3) Causes of movement: Forces. Newton's laws.
- 4) Causes of movement: Work and energy. Conservation laws.
- 5) Electricity: Electric field. Electric potential. Conductors and dielectrics.
- 6) Electric current: Basic principles. DC Electric circuits.
- 7) Magnetism: Magnetic field. Sources of the magnetic field.

For every chapter of the new course, the following items are covered:

- a) Objectives
- b) Basic concepts
- c) Examples (solved problems)
- d) Problems

In addition, the final solution to all problems is given.

At present, chapter 7 is not taught to Agricultural Engineering students, since magnetism has a relatively minor importance in these studies. Similarly, chapter 4 is not taught to Computer Science students, because the dynamics of N -particle systems has less importance than magnetism in the context of Computer Science. The total number of lecture hours is 60, which means about 10 hours per chapter. Additionally, we recommend the students to spend a minimum of 15 hours of homework per chapter. There is midterm exam and a final one. The students who fail can take

an additional exam. In the academic year 1999-2000, 83% of the students passed the course.

Some additional techniques that we try to stress in the course are the following:

- i) the use of analogies to help students to understand difficult physical concepts (e.g., the analogies between electrical current and a fluid flowing along a pipe).
- ii) the agility in the transformation of units.
- iii) the checking of the results, not only analytically but also intuitively.
- iv) the intuitive prediction of the mathematical form of physical laws, on the basis that there is not effect without cause, and that the effect increases with increasing cause.

4. PRELIMINARY EVALUATION

In order to assess the usefulness of the new course, it is necessary to wait until the students take the compulsory Physics course. This will happen the next academic year 2000-2001. However, we can already now know the students' feeling.

At the end of the course, we asked the students to fill up a test with their opinion about the new course. The students graded (from 0 up to 10 points) the following items:

- 1) Adequacy of the pedagogical material (book)
- 2) Are the examples (solved problems) a satisfactory complement to the theoretical explanations?
- 3) Are the problems suggested adequate?
- 4) Usefulness of each chapter of the course
- 5) Has the lecturer stimulated student-student and student-lecturer interactions?
- 6) Have the explanations been adequate and clear?
- 7) Will the Basic Physics course allow you to progress more easily in the compulsory Physics course? Has it been useful?
- 8) Correctness of the evaluation procedure (exams)
- 9) Usefulness of this inquiry

The students were also asked the following questions:

- 10) Would you introduce any additional chapters or sections in the course? Would you eliminate any?
- 11) Please include any additional suggestions to improve the course
- 12) Please suggest how this inquiry could be improved

Figure 1 shows the students' answers to question 7). It is seen that only 4% of the students have a negative perception on the usefulness of the new course. Moreover, 80% of the students grade it with 7 or more points out of 10.

The mean grade (out of 10 points) given by students to question 4) was 7.0. Thus most students find that the content of the course is reasonably adequate. The mean grade given to questions 1), 2) and 3) was 6.5, 6.7 and 6.6, respectively, which in our opinion shows the importance to prepare an improved edition of the book. We plan to make this new edition accessible both in print and on-line in September 2000.

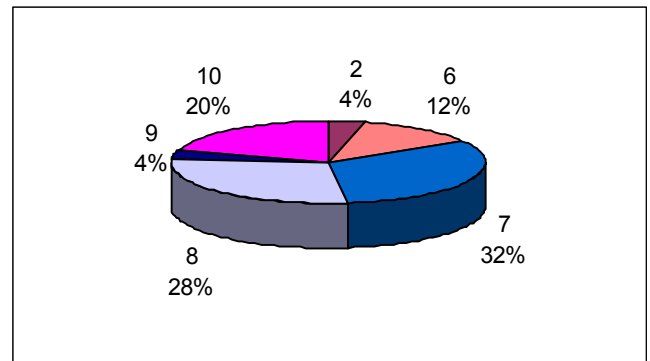


Figure 1. The students' opinion on the usefulness of the "Basic Physics" course. This graphic shows the percent of students giving a particular grade (upper number) in a scale from 0 to 10.

Finally, we mention that the answers to question 10) have lead us to consider the possibility of including an additional chapter on AC circuits -as suggested by some Computer Science students. However, this would imply a decrease in the time devoted to some of the other chapters. Our view is that such a change has to be planned very carefully.

Although the preliminary evaluation of the new course is positive as a whole, there is clearly still a lot to be done for improving the success of students in the transition to University Physics courses.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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