The Convenience of Remedial and/or Reinforcement Courses in Engineering Curricula

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Abstract: - Dropping and failure ratio count in a very high quantity among new income students in the University first course, especially referring to engineering careers. This fact can be attributed to the poor level achieved by them during their secondary education, as well as the difference between university and secondary school methodologies. In order to solve this issue, a Remedial Reinforcement course, called "Introduction to Mathematical Methodology" was offered to Informatics Engineering incoming students. Last year experience has been evaluated in two ways: by collecting the subjective opinion of the students and by comparing the rates in first course math subjects obtained by those joining the course, versus those ones who did not participate. The surprisingly satisfactory achieved results are presented in this paper.

Key-Words: - Remedial courses, educational research, mathematics learning, informatics curricula

1 Introduction

Since several years ago, new income students on Informatics Engineering at Universidad Politécnica of Madrid are facing great difficulties to overcome first course mathematics. There are three math subjects during this year: Discrete Mathematics, Linear Algebra and Calculus, and the dropping and failure ratio for those subjects are getting higher every year.

To tackle that situation, an optional curricular complement was proposed in order to increase the students' success: a Remedial+Reinforcement course in mathematics called "Introduction to Mathematical Methodology" taught to 25 freshmen from September 2005 to January 2006.

The course impact has been evaluated in two ways: first, by collecting the students' opinion, and second, by comparing the rates in math subjects obtained by the students participating in the course matched up to those who did not participate.

As a preliminary study analysing first semester data provided pretty encouraging records [6], we continued investigating the course impact on the second semester results, once the reinforcement part had concluded. Hereby in this paper, the complete analysis is displayed. Data obtained are quite relevant: the students provided a good opinion of both course's methodology and contents and the results' comparison showed a remarkable raise of passed versus a decrease of drop out for every math subject.

2 Remedial/Reinforcement courses in Engineering Education

Every year, many new income students forsake their Informatics Engineering studies. Among the causes of this desertion, we should consider the difference in didactical methodologies among University and Secondary School: the groups are bigger and the students have to become responsible of managing their own duties, while they are not conscious enough of the tremendous change they would have to achieve concerning their studying schemes.

The difficulties on adaptation are actually increased by the poor level in math knowledge acquired during their secondary education. In Sept. 2005, an initial competence test, consisting of 20 questions of secondary school math contents, four options each, was taken by a 94 students group joining Informatics Engineering at our University. In this test [7], as shown in Figure 1, 65.96% failed more than 10 questions while only 12.77% failed six or less. Furthermore, most of them had never used symbolic language as sets, quantifiers or propositional logics. With this lack of background, mathematics subjects become an insurmountable obstacle for new incoming students.

Unfortunately, the expounded problem might be extended to other engineering studies. Most technical careers show also rising drop and failure rates, which makes mandatory to find an effective way to deal with the situation.
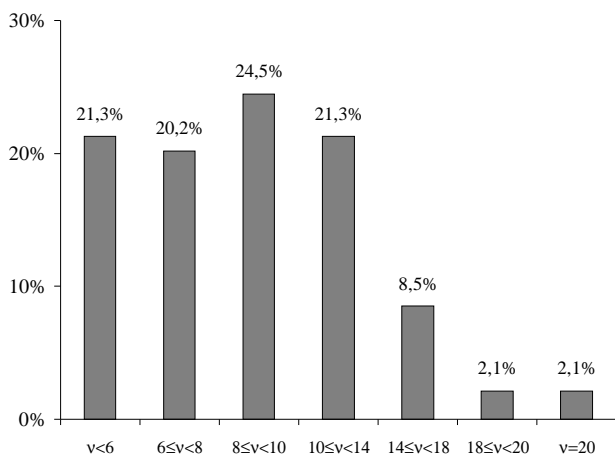
Fig. 1: Number of correct answers in the 2005 initial competence test

Many universities have already introduced remedial or reinforcement courses, just before or during the first semester ([3], [5], [8]). The solution proposed here is to complement Engineering Curricula with a combined course including both concepts, what have demonstrated to be strongly encouraging and valuable.

The proposed course combines remedial with reinforcement training in two differentiated blocks: First part consists on 45 hours during September (before the regular course starts). Within that period, an overall review of the main concepts extracted from secondary curricula is presented (with special emphasis on precalculus and basic algebra), highlighting intuition, logical reasoning and self developed methods. It is also included a basic overview about set theory, relations and quantifiers' notation, as those concepts will set up the basis for math language development.

The second part, which runs along with the regular first semester, is a reinforcement course. During it, some exercises have to be solved using Maple software in order to strengthen the concepts studied in math subjects.

The applied methodology consists in working with small groups (20 to 30 people who joined the course voluntarily) and developing together an intuitional and practical vision of mathematics. The teacher promotes direct communication within the group, trying to guide the students in such a way that they would be able to reach the proposed problems' solutions by themselves, encouraging them to use self developed methods, better than learned ones. In this way, the students are provided with new approaches to catch the concepts as well as intuitional approximations to the learned methods.

3 Evaluating an Educational Experience

In this section the two evaluation methods already mentioned will be exposed.

3.1 Students' subjective opinion

To get a measure of the students' perception, they fulfilled a questionnaire at the end of the first part, rating up to 4 over 5 both contents and methodology of the course. Figures 2 and 3 show contents' and methodology's questionnaires media values.
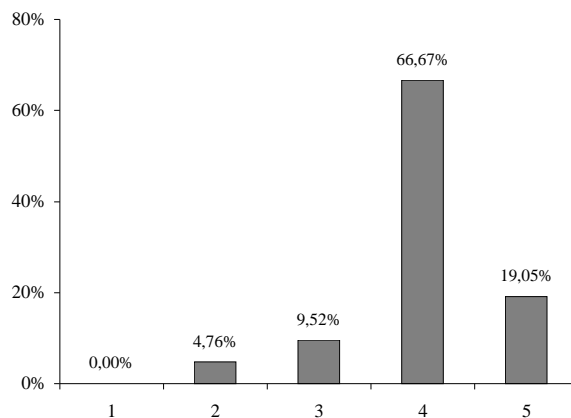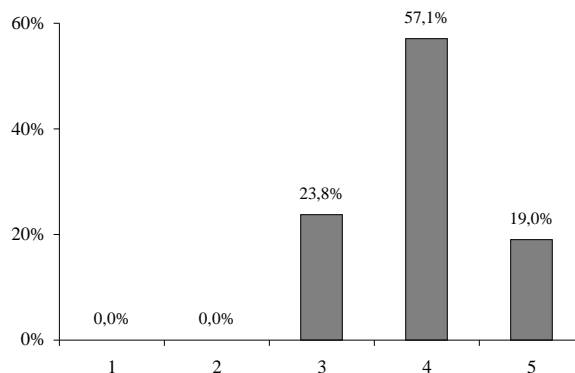

Fig. 2: Contents

Fig. 3: Methodology

During one-to-one interviews, after the first semester's examinations, the students valued the experience very positively. They considered especially beneficial the following facts: it was a small group, the work was customized to their needs, it meant a more rational and less memory based approach to the mathematics and finally, they appreciated very much the feasibility of using Maple software. They ended remarking an increase of self-confidence and the revision of topics facing the beginning of the course, as positive achievements.

3.2 Impact on math subjects' rates

Figures 4, 5 and 6 represent the comparison between the rates of new income students who did not join the course (left) matched up with those who joined the course (right) in the three compulsory math subjects taught in the first year: Discrete Mathematics, Linear Algebra and Calculus. Data are expressed in percentage on the group totals.

3.2.1 Discrete Mathematics

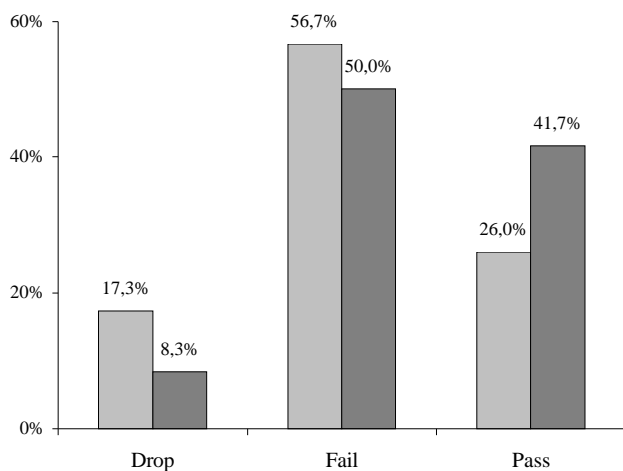|	Dropped	Failed	Passed
Without course	17.34	56.65	26.01
With course	8.33	50.00	41.66

Fig. 4: Discrete Mathematics

Discrete Mathematics is a first semester subject. It is studied simultaneously with the remedial part of the course. Data obtained mean:

- Percentage of success rises from 26.01% to 41.66% (1.6 times higher).
- Dropping rate is twice among students who didn't join the course, diminishing from 17.34% to 8.33%.
- Failure also decreases from 56.65% to 50% even with many more students taking the exam.

Discrete Math uses little knowledge from secondary school; therefore, the results can be attributed to better mathematical reasoning as well as an increase on self confidence. Course's impact on this subject is clearly positive.

3.2.2 Calculus

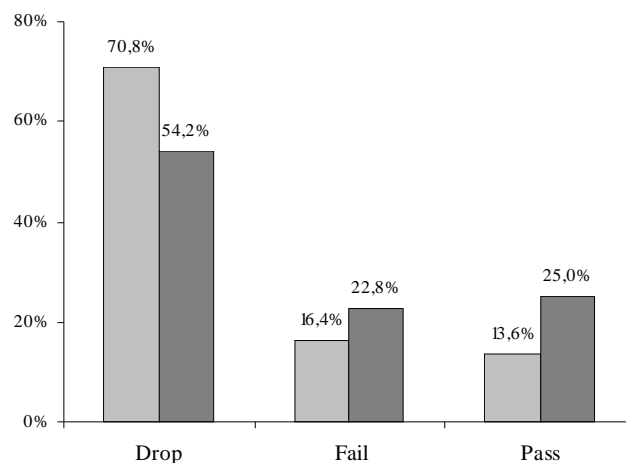|	Dropped	Failed	Passed
Without course	70.06	16.38	13.56
With course	54.17	20.83	25.00

Fig. 5: Calculus

Calculus is a two semester subject. First semester goes simultaneously with the remedial part and second one is subsequent to it.

- Percentage of success rises from 13.56% to 25% (nearly twice).
- Drop out diminishes from 70.06% to 54.17%.
- Failure is slightly higher among students who took the course, but less than the decrease of drop out.

Calculus seems to be a very difficult subject for new income students with the highest dropping and failure rates. The partial success observed in [6] is maintained, in spite of the reinforcement course's end.

3.2.3 Linear Algebra

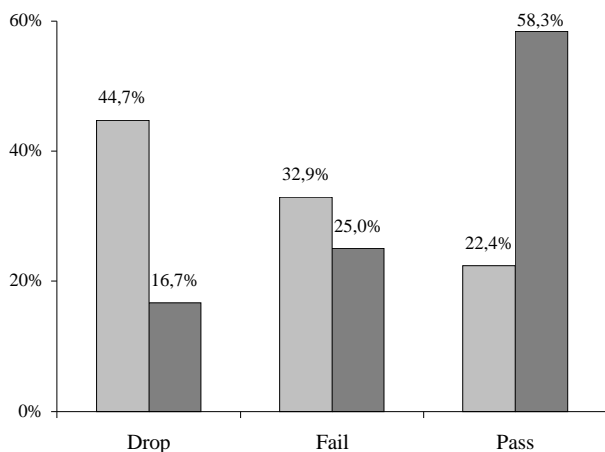|	Dropped	Failed	Passed
Without course	44.71	32.94	22.35
With course	16.67	25.00	58.33

Fig. 6: Linear Algebra

Linear Algebra is a second semester subject. It is studied after the course's end, but the impact continues being really impressive:

- Percentage of success is 2.6 times higher among students following the course, rising from 22.35% to 58.33%.
- Failure decreases from 32.94% to 25% even with higher percentage of students taking the exam.
- Drop out is nearly three times lower among students who took the course, decreasing from 44.71% to 16.67%.

The knowledge acquired during both remedial and reinforcement parts is firmly integrated in the students' background and continues acting long time after the course is concluded.

4 Conclusions and future work

From the above exposed, the next conclusions may be obtained:

- Ratio of success is clearly higher in every math subject.
- Failure and drop out percentages diminish considerably, especially in Linear Algebra, where it decreases from a total of 77.65% to 41.67%.
- The increase in success continues after the course's end and affects every math subject taught during second semester.
- A very positive influence on the students' perception of maths is observed.
- An increase of students' self-confidence is perceived.

The results indicate a very significant impact of the proposed course on the rates obtained by the students in the first course maths subjects, which proves the effectiveness of the experience. Consequently, the convenience of complementing Engineering Curricula by means of the presented Remedial/Reinforcement course is inferred. Thus new income students' negative results in math subjects will be amended.

Additionally, the improvement in mathematical reasoning entails an enhancement in logical and abstract reasoning, needed in other first course subjects such as Programming, Logic and Physics related subjects. Therefore, we suspect a positive impact in other themes and we aim to extend the research to those non math subjects.

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