Levels of Success of First Year Students in First Degree Courses on Science and Engineering at the University of Aveiro

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Introduction

One of the great challenges today, of higher education and of the educative systems is the pedagogic, scientific and human quality, even the excellence in the educative processes of teaching and learning. This quality is total because it implies interaction between persons, knowledge, tasks, processes, strategies, materials and equipment, spaces, management systems and the environment.

This research project is based on assumptions concerning the development of scientific, pedagogic and psychological quality as well as the quality of social support available to third level students, and attempts (1) to identify and characterize the factors responsible for the levels of success or lack of success in the processes and results of teaching/learning and training of first year students of the common course of the Science and Engineering Degrees (Licenciatura) offered at the University of Aveiro, (ii) to identify possible forms of intervention leading to their optimization. The achievement of these objectives involves a certain sequence: diagnosis-reflection-intervention-diagnosis and so on.

The aim is to achieve a high-quality of learning such as that expressed by Cunningham: "No wonder, therefore, there is a lack of awareness of need for rapid, high-quality new learning. But the biggest learning is changing assumptions. Acquiring new knowledge, skills and competences will be irrelevant if managers do not change fundamentally their mind sets, their mental frameworks". (1994:31).

This supposes a strategic thought and a strategic learning requiring a combination, among other things of i) visual acuity (real seeing what was going on); ii) recognition of the value of this data; iii) linking this data to a strategic vision; iv) integrating that with practical action; (v) continual monitoring of the results". (Cunningham, 1994:33).

This pedagogic and scientific quality and innovation also underlies Shulman's assumptions about pedagogical content knowledge when he writes: "In my writing and speaking regarding the centrality of subject-specific pedagogy in the education of teachers (e.g., Shulman, 1987), 1 have contributed to some confusions in failing adequately to distinguish among three distinctive (albeit interrelated) conceptions to which the notion relates. These three aspects of pedagogical content knowledge are: 1) a form of understanding that teachers possess (or should possess) that distinguishes their thinking and reasoning from that characteristic of mere subject-matter experts. This is an example of the "wisdom of practitioners"; 2) part of the knowledge base of teaching, a body of understanding, skill and, to some extent, disposition that distinguishes teaching as a profession and which includes aspects of both technical rationality and those capacities of judgement, improvisation and intuition Schön has dubbed "reflection-in-action". This a component of the "wisdom of practice" ; and 3) a process of pedagogical

reasoning and action through which teachers bring their understandings to bear on the problem of teaching something in a particular context, thoughtfully enact their plans and spontaneously amend and improvise around them as the inevitably unpredictable moments of teaching arise, and by means of which these teachers develop new understandings, intuitions and dispositions. (Shulman, 1993:56-57).

We might ask whether Shulman's concept of pedagogical content knowledge has any application in the aims of this research project. Our answer is certainly yes, because one of the factors attributed to lack of success of students is the intersection between knowledge of subject matter and the general principles of pedagogy and the articulation between theory and practice. The conjugation of these factors makes possible the development of the teacher as a person and as a professional.

Method

Sample

In the last restructuration of the degree courses in Science and Engineering at the University of Aveiro we decided to organize the same set of foundation disciplines for students doing the first year of all courses in Science and Engineering. Included here are also the Teacher Training courses in Science and Engineering. The courses embraced a population of around 950 students, consisting of students who made their inscription in the academic year 1994-95, and who were distributed among 25 courses. Of these 950 students, we asked 600 to complete an exploratory questionnaire, 333 questionnaires were then randomly selected in order to try a diagnostic of the situation.

This approach represents, of course, a great challenge to the University in terms of organization, teaching, learning and personal and social support structures. The principal purpose of this research project is to discover the main factors responsible for the levels of success or lack of success. These factors according to our response hypotheses are related to lack of prerequisites, level of motivation, psychological problems (stress, anxiety, integration, etc.), study methods, teachers' pedagogical skills and institutional constraints.

Instruments

According to the objectives of the research we shall run over multiple approaches involving the use or adaptation of the research instruments of similar inquiries, for example: questionnaires, IQ or aptitude tests, interviews, etc. This project however began with an exploratory questionnaire.

This exploratory questionnaire is built around six sets of questions about i) students' previous preparation in content areas of mathematics, physics, chemistry, introduction to computing and English ii) their levels of motivation, iii) their psychological problems (stress, anxiety, integration, etc.), iv) their study methods, v) the teachers' pedagogical skills and vi) the institutional constraints.

Analysis of data

In the analysis of data of the exploratory questionnaire we use mainly analysis, correlation, regression, factor analysis, contingency tables and eventually analysis of variance and covariance using a programme based on the StatView or SuperAnova to Macintosh.

Because of lack of time, we now present only some tables of a descriptive analysis. This descriptive analysis concerns some of the items considered more relevant to our aims and directly related with our hypotheses: items 2 to 10 concern the level of studies; items 11 to 17 concern personal problems, self-confidence, self-image, self-esteem; items 18 to 21 concern study methods and class attendance; item 22 concerns student's interest in the first year courses (Calculus I, Physics I, Chemistry I, Introduction to Computing and English); and items 23 to 25 concern the adequacy of class timetables, exam timetables, library opening hours, material conditions of the University, information and the introduction to University life. Item 26 is an open question.

Results

So far we have worked on a sample of 333 randomly selected questionnaires. The results of the analysis of some items in the questionnaire are presented in the following tables:

Table 1. Final marks for 1st year (1st semester)

	Calculus I (Mathematics) n=288	Physics I n=244	Chemistry I n=304	Introduction to Computing n=316	English n=327
Average 1° Year (1st semester)	8.59	7.66	11.95	11.74	12.54

NOTE: Scale of marks 1-20

Table 2. Self-evaluation of secondary school preparation in relation to each of the following disciplines of the first year.

	Calculus I It. 4.1 n=331	Physics I It. 4.2 n=331	Chemistry I It. 4.3 n=300	Intr. To Computing It. 4.4 n=309	English It. 4.5 n=303
Very high	2.12	2.67	6.47	5.28	11.42
Quite high	30.82	17.00	29.77	6.93	29.32
Moderately high	45.32	14.33	27.51	14.52	33.03
Low	18.13	22.33	12.62	17.82	16.05
Non-existent	3.62	43.67	23.63	55.45	10.19

Table 3. Students' satisfaction and expectations

	Satisfaction with the first year It. 8	Expectations of material conditions It. 9.1	Expectation s of the teachers It. 9.2	Expectations of fellow students It. 9.3	Expectations of the work atmosphere It. 9.4	Expectations of the equipment It. 9.5	General Expectations of the course It 9.6
Mean	2.505	2.793	3.096	3.643	3.243	3.583	3.030
Std. Dev.	.904	.837	.628	.652	.710	.710	.934

NOTE: 1-5

Table 4. Students' motivation

	19.1 % n=330	19.2 % n=331	19.3 % n=330	19.4 % n=331	19.5 % n=328	19.6 % n=332	19.7 % n=332	19.8 % n=328	19.9 % n=333	19.10 % n=332	19.11 % n=331	19.12 % n=324	19.13 % n=331
Always	3.94	42.9	22.73	11.78	15.24	3.92	2.71	7.6	35.14	78.01	2.72	0.93	2.42
Quite often	21.21	38.97	36.67	46.53	42.07	16.57	14.16	29.88	51.35	19.58	16.31	12.96	10.57
Sometimes	58.79	14.50	28.49	36.56	31.40	43.98	39.46	45.43	11.11	2.41	54.99	52.47	46.83
Rarely	15.15	3.63	10.00	5.14	9.76	30.12	37.35	16.77	2.40	-	23.57	27.20	34.44
Never	0.91	-	2.12	-	1.52	5.42	6.33	0.31	-	-	2.42	6.48	5.74

Table 5. Self-evaluation in relation to the disciplines of the 1st year

	Calculus I	Physics I	Chemistry I	Intr. To Computing	English
Usefulness of training 22.1	3.8 n=327	3 n=317	3.2 n=318	3.8 n=328	3.5 n=325
Interest in the program 22.2	3.3 n=326	2.8 n=313	3.2 n=313	3.3 n=323	2.9 n=311
Relevance to other disciplines 22.3	3.2 n=305	2.7 n=292	2.6 n=293	2.7 n=302	2.7 n=295
Relevance to theoretical practical classess 22.4	3.9 n=302	3.3 n=306	3.5 n=307	3.7 n=313	3.3 n=206
Adequacy of bibliography 22.5	3.5 n=297	3.2 n=284	3.3 n=284	3.1 n=290	2.9 n=246
Adequacy evaluation system 22.6	3.4 n=314	3.1 n=301	3.3 n=304	3 n=314	3.3 n=291
Investment in this discipline 22.7	3.7 n=322	3 n=310	3.4 n=312	3.5 n=322	3.2 n=300
General impressioins 22.8	3.5 n=320	2.8 n=307	3.3 n=310	3.5 n=319	3.2 n=300

Note: Scale 1-5

The results of the questionnaire seem to confirm our hypotheses related with lack of prerequisites, level of motivation, psychological problems (stress, anxiety, integration, etc.), study methods, teachers' pedagogical skills and institutional constraints.

In fact, students have a great lack of the required prerequisites, their motivation for their courses is not very strong, they have psychological problems such as stress, anxiety, integration, fear of failure ill their studies) and their study methods and the teacher's pedagogical skills are not very adequate.

Let us comment upon the data in more detail.

The final marks for the first semester in Calculus (Mathematics) and in Physics are not very good - and tend to accord with the marks they attained in Secondary School in the same disciplines. The students themselves consider their levels of secondary school preparation in relation to those disciplines to have been weak or very weak, and most of them consider their results during their final three years of secondary school less than satisfactory. In general, they consider their performance at university as unsatisfactory and they ire not very satisfied with the common first year course.

In general they consider the material, the teachers, the fellow students, the work atmosphere, the equipments (labs. libraries, etc.) as corresponding positively enough or moderately to what they had expected. Their level of interest in Calculus I is quite high, in Physics I is low, in Chemistry I is moderately with tendency to low, in Introduction to Computing is quite high and in English is quite high also. As regards their feelings as to whether they have or do not have problems, and whether they are more or less concerned with them, about 24% say they don't have problems. 76% are very, quite or moderately concerned with some problems and identify them as related to their studies, their attention and concentration and their physical disposition (headaches, tiredness, poor sleep, etc.), and depression.

Students are normally satisfied or more or less satisfied with their lives.

Their adaptation to university is more or less good. At the university they consider themselves happy enough and they feel confident they will not have problems during their course. They are also quite confident in relation to their capacities. Most of their time is spent attending classes and studies. Participation in student activities and different leisure activities is not very absorbing. For each of the following statements in item 19: I prepare for classes using course material throughout the year - I take notes during the classes - I organize my notes after class - I read support material - I do homework - I study with the fellow students - I use library or other documentation centers - I succeed in dividing my time well between study and leisure - I am punctual for classes - I attend theory/practical classes regularly - I participate actively in class - my comments in class are relevant - I regularly try to clear up doubts, with the help of my teachers - student's answers are normally "quite often" or "sometimes".

When asked to make a general assessment of their study methods, their capacities, their attention and concentration during theoretical classes and practical classes the students consider these to be very satisfactory.

The assessment of the different courses in relation to: usefulness of teaching, level of interest in the programme, relevance to the other disciplines on the course, relevance to the theoretical/practical classes, adequacy of bibliography, adequacy of evaluation system their level of commitment in these disciplines, their general impressions, is more positive in Calculus I, Introduction to Computing, Chemistry I, and less positive in English and Physics I.

The students express a positive opinion concerning the following: class timetable, exam timetable, number of students attending theoretical and practical classes possibly affecting their academic performance, duration of theoretical/practical classes, adequacy of physical space, adequacy of the supporting structures for gathering bibliography material, equipment and quality of laboratories, adequacy of informatics supporting infrastructures for the needs of the course, adequacy of general social gathering areas, adequacy of group work space, adequacy of individual work space, adequacy of library opening hours, adequacy of the material conditions of the university, proportion of space to the number of students, acoustic environment, quality of aeration, of lighting and the adequacy of furniture for the work.

Students' knowledge about the different sectors, services and offices of the University and about the participation of the students in it, is moderately good or not very good. In general, their satisfaction with reception in the University is not very good.

Conclusion

This research has confirmed our hypotheses concerning the main factors contributing to the success or lack of success of students degrees of the first year common course in Science and Engineering of the University of Aveiro. We shall continue developing this project during the next academic years with a view to the organization and implementation of programmes to improve the quality of teaching and learning in higher education. Considering the results already attained we intend to undertake comparative research in other institutions with similar contexts. As a first step, we plan to extend this research project to the Universities of Minho, Oporto and Algarve.

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