Analysis of Subjects with Greater Difficulty for University Students in the Area of Computer Science

Cinhtia González-Segura, Teresita Montañez-May, Victor Chi-Pech, Carlos Miranda-Palma, and Sergio González-Segura

Autonomous University of Yucatan, Multidisciplinary Unit Tizimín, Tizimín, Yucatán, México

Summary
This paper describes a study of the subjects and topics of greatest difficulty among university students of the Bachelor's degree in Computer Science performed in the Autonomous University of Yucatan. In order to obtain the students' opinion, a survey was administered and the results were compared against their grades, considering the subjects offered during a school cycle. The subjects exhibiting higher degree of difficulty were: Vector Calculus, Theory of Computation, Compilers and Distributed Systems. There was a large overlap between the most difficult subjects, according to the students' opinion, and the subjects with the lowest grades, reported by the professors. Among the main reasons given protrudes confusion in students while performing certain activities, and the deficiency of previous foundations necessary to understand some topics. There are important mentions of a difficulty to understand the professor's explanation, and to perform activities by themselves. Therefore, a proposal to develop digital materials designed to support difficult topics and subjects is made, as well as to perform extracurricular activities to reinforce the teaching-learning process of the university students.

Key words:
Difficult subjects, academic performance, high education.

1. Introduction

There are several factors that influence the academic performance of university students, some are internal to the institution and others are external to them [1] [2]. These factors can be social, cognitive or motional, and are classified into three categories: personal determinants, social determinants and institutional determinants ([3] cited by [1]). As can be seen, the cognitive aspects and institutional determinants are the only factors internal to the institution; although in recent years it has also been tried to work on the emotional aspect, in order to attend the personal determinants, mainly due the direct effects they produce in the academic performance of students. The mentoring program is one of the actions performed by the Autonomous University of Yucatan on this topic.

On the other hand, the socio-economic factor has been observed as one of the frequent causes of student dropouts in several universities [4], and scholarship programs are trying to meet this need.

Among the academic factors influencing dropping out of students are found: pre-university, of academic integration and of academic performance (Beam 1980 cited by [5]). The last two factors include lack of supervision, lack of motivation, problems with technology, lack of support to students, learning preferences, inappropriate design of courses and inexperienced instructors (Frankola 2001 cited by [5]).

Vincent Tinto and H. Montes cited by [5] claim that there are several critical periods in student trajectory in which interactions between the institution and students can directly influence desertion. The first period occurs during the admissions process, when the students form first impressions on the social and intellectual characteristics of the institution; the second period occurs during the first weeks of college life because of the transition between two spaces of different nature. The next period occurs at the end of the first year and beginning of the second, because of the inability to meet academic requirements, in which case it is common that students change of career or institution and the reasons for that behavior are many [5] [6].

As stated in [7], "We can not ignore that school failure and dropout are complex psychosocial phenomena, where the structural, social, family and individual factors are involved and which have implications in equal number of levels of reality, from the educational system to the self-esteem of individuals." So it becomes evident that, in addition to personal causes such as lack of dedication, academic quality or commitment of students to the school, there are other factors, which have been tried to attend using various programs such as the tutoring and the granting of scholarships, among others. However, it is very useful to focus on the causes that are internal to the institution and controllable, on which it is possible to have a direct impact in order to improve the academic performance of students and teachers.

One of the factors mentioned by several authors as academic cause of student dropout is academic

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performance [5] [8]. Academic performance is the sum of different and complex factors acting on the person who learns and has been defined as a value attributed to the achievement of the student in academic tasks [3] and because of operational purposes is commonly associated with the academic grades that each student gets in a school period [9] [10]. Motivation is also an influence factor, as mentioned by Rinaudo et. al.[11].

Among the strategies implemented for students retention, are the implementation of collaborative and cooperative learning, learning communities (University of Syracuse), greater students integration through orientation programs, improving the teaching and learning process, and greater involvement of teachers (University of Ohio), curricular aspects and training focused on the student, improvement of the student/teacher relationship (University of Chile), curricular flexibility, support programmes for students in study methods, flexibility that promotes mobility between careers, and tutoring (Pontifical Catholic University of Chile). [6].

In the Faculty of Mathematics of the Autonomous University of Yucatan, some modifications has been done to the syllabi of the curricula [12], in order to positively contribute to the students permanence and school performance, as well as to the quality of educational services. It has also been implemented a tutoring program in which each student is guided by a teacher during his student trajectory. However, there are still factors that adversely affect and produce school failure and dropout, resulting in a sub-optimal use of the resources that society allocates to education.

2. Methodology

The described study corresponds to the Bachelor's degree in Computer Science at the Faculty of Mathematics of the Multidisciplinary Unit Tizimin (Autonomous University of Yucatan).

In order to propose and perform actions that could improve the students' academic performance, it was decided to find out what subjects require special attention and dedication, from the viewpoint of students; so it was designed a closed answers questionnaire, which was administered to 56 students (approximately 62% of the population) randomly selected.

The questionnaire was divided into two parts, one corresponding to the subjects of the semester August-December 2011, named as semester 1, and the other to the semester January-May 2012, named as semester 2. In turn, each part requested to first select which of the offered courses were attended during the semester and then which of them were considered to be more difficult. Finally, students were asked to specify what are the issues that, in their opinion, are of more difficulty in each of the previously selected subjects, as well as the reasons for this consideration. The reasons were expressed by selecting them from a list of suggestions, or by describing them if were not in the list.

On the other hand, the average grades obtained by students during the same semesters in all subjects were concentrated, in order to analyze what are the subjects in which students obtain lower grades and determine if there is a relationship between the students' opinion and their obtained grades.

Once collected and processed the information, it was determined what are the most difficult subjects as well as the reasons why students considered them difficult, which allows actions to address this problem and provide better conditions for the teaching-learning process, mainly on aspects related with causes internal to the institution.

3. Results

The instrument applied to gather the students' opinion indicates that the subjects with greater difficulty are: Vector Calculus, Theory of Computation, Compilers and Distributed Systems, as shown in tables 1 and 2, which list all the subjects offered during semesters 1 and 2, respectively, ordered from highest to lowest difficulty. The column "Mentions" corresponds to the number of students that considers difficult the subject and the column "Population" indicates the total number of students who attended the subject and responded to the survey. The column "Percentage" corresponds to a fraction of 100 calculated as the number of students that considers difficult the subject divided by the total number of students who attended it and responded to the survey, and then multiplied by 100.

Table 1: Survey results for semester 1

Subject	Mentions	Population	Percentage
Vector Calculus	11	12	92%
Theory of Computation	8	9	89%
Superior Algebra I	10	13	77%
Programming	3	4	75%
Differential Calculus	11	17	65%
Superior Algebra II	9	14	64%
Linear Algebra	7	11	64%
Statistical Inference	3	5	60%

Data Structures	5	9	56%
Databases	8	16	50%
Software Engineering II	2	4	50%
Numeric Algorithms	8	17	47%
Programming Fundamentals	5	11	45%
Computers Architecture	9	21	43%
Social Environment	5	14	36%
Systems Programming	1	5	20%
Computer Networks	1	6	17%
Research Methodology	2	19	11%
Operative Systems	2	24	8%

Table 2: Survey results for semester 2

Subject	Mentions	Population	Percentage
Compilers	9	9	100%
Distributed Systems	5	5	100%
Probability	22	23	96%
Analysis of Algorithms	15	16	94%
Integral Calculus	16	18	89%
Differential Equations	13	16	81%
Superior Algebra II	11	13	74%
Superior Algebra I	0	1	71%
Physics for Computing	10	14	71%
Differential Calculus	11	17	65%
Scientific Computing	3	5	60%
Programming	6	11	60%
Theory of Programming Languages	7	18	39%
Discrete Mathematics	4	14	29%
Artificial Intelligence	5	21	24%
Software Engineering I	4	21	19%
Management and Audit on Informatics	1	7	14%
Operations Research	0	13	0%

In the survey, among the most frequent reasons for the difficulty of the subjects were the confusion caused by performing certain activities and the lack of previous bases necessary to understand the issues. It is worth mentioning that students entering Bachelor's degree in Computer Science in the Multidisciplinary Unit Tizimin come from technical high schools, which explains this reason (they are focused on the technic skills), coupled with the natural correlation that exists between certain subjects that, even without being serialized, are closely related to achieve the professional profile of graduation at the end of the curriculum. It is worth mentioning that the reasons related to the performance of the teacher were also mentioned frequently, either by to not understand the explanations or by not knowing what to do when he is no longer present.

Figure 1 shows the percentages of students who indicated the reasons why they consider that their subjects are difficult. Among the reasons classified as "other", were mentioned: there is too much information in the slides, too much practice, several theorems per day, I find no material thereon, to learn the database commands, it is confusing to ask questions, to implement is complicated, lack to dig a little deeper, there is no enough time to cover the topics, several abstract concepts are handled, the programs that the teacher assigns.

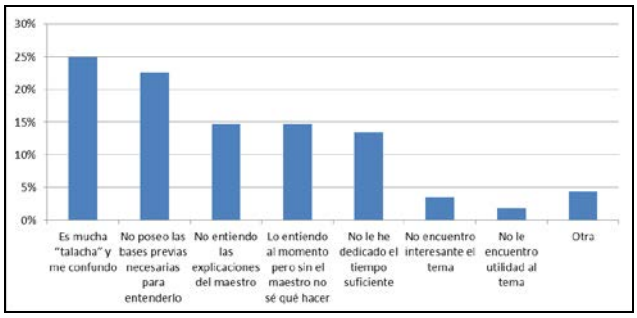

Fig. 1 Reasons of difficulty expressed by students.

3.1 Results for semester 1

Based on the answers to the questionnaire, the most difficult subjects in semester 1 were those listed in table 3.

Table 3: More difficult subjects for semester 1 in students' opinion

Subject	Mentions	Population	Percentage
Vector Calculus	11	12	92%
Theory of Computation	8	9	89%
Superior Algebra I	10	13	77%
Programming	3	4	75%
Differential Calculus	11	17	65%

Likewise, considering the grades obtained by students in this same semester, the most difficult subjects were those listed in table 4, which includes the average grades of the group ordered from minor to major, thus being first those subjects that reflect greater difficulty, according to this criterion.

Table 4: Subjects with lower average grades in semester 1

Subject	Average Grade
Theory of Computation	56
Vector Calculus	62
Superior Algebra 1	64
Programming	66
Social Environment	70

In table IV, was omitted the subject Integral Calculus, whose average grade was 51, because students attending it have different characteristics from those attending the other subjects of the list, since all of them have previously took the subject and failed it; unlike the other subjects, which are taken by the students for the first time

The subject Differential Calculus, despite being listed as difficult by students, threw a group average grade of 75, which places it in the 10 place, as is shown in table 2.

3.2 Results for semester 2

Based on the answers to the questionnaire, the most difficult subjects in semester 2 were those listed in table 5.

Table 5: More difficult subjects for semester 2 in students' opinion

Subject	Mentions	Population	Percentage
Compilers	9	9	100%
Distributed Systems	5	5	100%
Probability	22	23	96%
Analysis of Algorithms	15	16	94%
Integral Calculus	16	18	89%

Likewise, considering the grades obtained by students in this same semester, the most difficult subjects were those listed in table 6.

Table 6: Subjects with lower average grades in semester 2

Subject	Average Grade
Probability	56.25
Superior Algebra II	56.27
Compilers	56.43
Programming	58.65
Superior Algebra I	59.33

It is worth mentioning that the course Algebra Superior I that appears in table 6, was taken by repeater students, since students first enroll in it during the semester August – December (semester 1) of each school year.

3.3 Comparative Analysis

What can be seen in tables 3 and 4 is that in the semester August - December there is a correspondence between the average grade obtained by the student group and the opinions they expressed in the surveys, i.e. the most difficulty subjects during this semester are Theory of computation, Vector calculus, Superior Algebra I and Programming.

On the other hand, in the semester January - May (semester 2) was found that there was a correspondence between the students' opinion and the average grades obtained by the group, on the subjects Compilers and Probability. It is striking that in the course Distributed Systems, all students who participated in the survey and attended the course, expressed that it is difficult, despite the average grade obtained by the group was 70 (a relative high grade), so it is not ranked among the lowest average listed in table 6. A similar situation is observed on the subjects Integral Calculus (average 73) and Analysis of Algorithms (average 79). A different striking situation is the one that occurs with Superior Algebra II (table 6), since the students obtained a low group average grade despite not classifying it as one of the most difficult ones (table 2).

4. Conclusions

With the performed work, the list of subjects of greater difficulty to students was obtained, according to the average grades obtained by the group, which was observed that coincide, in the majority of cases, with the opinions expressed by the students in the surveys. However, there were cases in which students obtained a low average grade despite considering not difficult the subject. It was also noted otherwise, cases in which the subject is considered very difficult even though the group's average scores are not among the lowest ones.

The results obtained invite to again conduct this study in order to gather more historic information with more groups of students.

Therefore, the person in charge of the tutoring process has been contacted to inform him the reasons expressed by the students (figure 1), so the tutors ensure that their tutees dedicate enough time to each subject, especially to those which were classified as difficult.

On the other hand, one of the proposals resulting from this work is to develop didactic tools that serve as support

materials in the teaching-learning process of subjects. Among the advantages of using such tools, could be the decrease in failure caused by performing tasks with multiple possibilities of error or confusion, focusing the student's attention on the topic of interest. Also, those tools are attractive to the majority of students due to its interactive nature and the familiarity of young people with various currently existing technological tools, situation that could help to generate a greater interest in the topics of the courses. They would also contribute to a greater understanding for students, both when used by the teacher as a support tool in its session of class and when used by the student to advance at their own pace.

Another proposal is to encourage the participation of the students in the support workshops currently offered from some basic subjects of the degree, in the areas of Programming, Calculus and Algebra. This action would focus on students that require it on the grounds that they do not have the necessary foundation for understanding a specific topic of a subject.

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Cinhtia Maribel González Segura obtained her degree in Computer Science from the Autonomous University of Yucatan, Mexico, in 2000 and M.S. Degree in Computer Science from Monterrey Technological Institute (ITESM) in 2005. She is a professor of Computer Science at the Faculty of Mathematics at the Autonomous University of Yucatan since 2002. Currently she is responsible of the Intelligent Systems Lab from this University. Her research lines are: Optimization, Artificial Intelligence, and Mobile Robots.

Teresita del Jesús Montañez May obtained her degree in mathematics from the Autonomous University of Yucatan (UADY) in 1993 and she did graduate studies in Mathematics at the National Autonomous University of Mexico (UNAM). She has worked since 2000 at the Autonomous University of Yucatan, as a full time professor. Currently she is responsible for academic tutoring from this University. She has participated in Mathematics Teaching projects and her research lines are: algebra, calculus and differential equations.

Victor Manuel Chi Pech obtained his degree in Computer Science from the Autonomous University of Yucatan (UADY) in 1996 and his M. Sc. degree in Wireless Network from Monterrey Technological Institute (ITESM), Campus Cuernavaca, in 2007. Victor Chi has worked since 2000 at the Autonomous University of Yucatan, as a full time professor. He has participated in software engineering development projects.

Carlos Andrés Miranda Palma. Master in Computer Science for the Institute Technology of Monterrey in México, is professor of the Autonomous University of Yucatán, he was coordinator of the Degree in Computer Science, Faculty of Mathematics at the Multidisciplinary Unit Tizimín. His researcher lines: Voice recognition, Artificial Intelligence, Human Computer Interaction.

Sergio Alejandro González Segura. Received a degree in Computer Systems from the Institute Technologic of Merida in 1996 and is Master in Computer Science for the National Center for Research and Technological Development in México, in 2008. Is professor of the Autonomous University of Yucatán and responsible of the Electronic Lab since 2002. His research areas are in computer vision and Mobile Robots.