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Contributing factors in academic performance and troubles associated with teaching in areas of physics in engineering students

P A Garzón-Agudelo¹, W Palacios-Alvarado¹, and B Medina-Delgado²

¹ Grupo de Investigación en Productividad y Competitividad, Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia

² Grupo de Investigación y Desarrollo en Electrónica y Telecomunicaciones, Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia

E-mail: pedroantonioga@ufps.edu.co

Abstract. Learning processes are affected by a series of factors, both individual students and the institutional environment in which they develop. The present work is developed under the context of learning processes in areas of physics in engineering students, belonging to the academic program of technology in industrial processes, considering the socio-demographic and academic variables that affect students and that in turn affect student dropout. Data collection instruments were applied to a population group of 90 students, allowing to propose strategic scenarios that would contribute to improve the quality of academic processes and students' skills in the study of mechanical and electromagnetic physics. It was determined that the role played by teachers and the methodology in which they teach their students, the physical conditions and teaching methods directly affect the effectiveness of learning and academic performance. It was also demonstrated that the lack of prior knowledge in the fundamentals of logic-mathematics and basic physics are determining aspects in the failure and repetition of the subjects.

1. Introduction

The educational level allows the human being to develop with greater ease in society and in the work environment, because it generates the possibilities to improve the quality of life and achieve goals and purposes. Since education is a gradual process through which a set of knowledge, values, behaviors, attitudes and ways of acting or thinking are transmitted, which when acquired will be used in the course of existence [1] to achieve active and participatory development in it. Therefore, it is especially important to analyze the elements that favor the satisfactory performance of students participating in the educational process in areas of knowledge such as physics, characterized by its thematic extension, which sometimes makes it difficult to appropriate learning in socially complex scenarios, such as university institutions.

The learning processes are affected by a series of factors both individual students, as the institutional environment in which it develops. Previous research suggests that academic performance is a variable that depends on the types of learning and the type of intelligence that the student possesses and, is also affected by family and motivational factors [2]. It has also been shown that academic performance is multi-causal and interacts with social, personal, institutional and academic factors that can vary from one population to another [3].



The context of study, related to students in the areas of physics, showed a high rate of repetition in those subjects, which is fundamental to the importance of carrying out an analysis that allows for the establishment of intervention measures that, in addition to strengthening the tools of physics teaching, contribute to reducing the dropout statistics in the industrial process technology program.

According to Table 1, and Figure 1, the areas of physics that are taught in the program are those that register the highest rates of repetition, if observed comparatively against the average of the other areas of knowledge that the students are studying. This situation was the starting point for advancing the research. With regard to the teaching of basic sciences such as physics, it has been previously established that one of the characteristic features is the performance of theoretical classes and laboratory practices, which provides a series of benefits in learning activities [4].

The aim of the study is knowing the sociodemographic and academic variables that affect students and that also affect the desertion of university studies, taking as a base the students who are studying physics subjects in the faculty of Engineering of the Universidad Francisco de Paula Santander, Colombia; seeking to formulate a series of strategies that allow the reduction of student desertion in the program of technology in industrial Processes.

Table 1. Repetition rate in the area of physics by academic periods.

Repeatability level	Year									
	2015-1	2015-2	2016-1	2016-2	2017-1	2017-2	2018-1	2018-2	2019-1	2019-2
Mechanical physics	89%	90%	62%	84%	59%	66%	56%	77%	62%	64%
Electromagnetic physics	86%	36%	70%	67%	43%	40%	47%	48%	15%	38%
Average repeat academic program	21%	12%	19%	9%	8%	10%	6%	9%	6%	5%

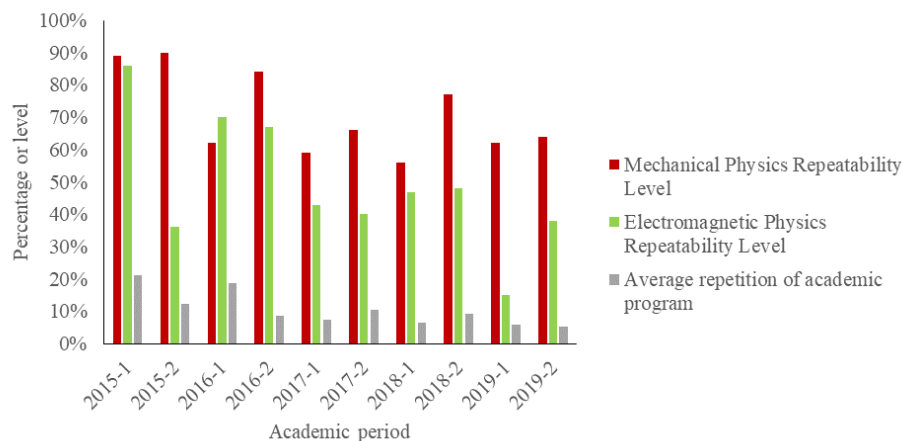


Figure 1. Comparison of repetition rates by academic period.

2. Methodology

For the collection of information, a structured survey with Likert assessment was used as the main instrument. In Table 2 it is possible to see the scale implemented in the instrument, which was directed to engineering students of the academic program technology in industrial processes of the Universidad Francisco de Paula Santander, Colombia, in six different groups of physics, during the second academic semester of the year 2019.

The research used a descriptive approach [5] as well as a combination of qualitative and quantitative data processing techniques, following structured surveys of students in the mechanical physics and electromagnetic physics courses. For the application of the instruments, a number of 90 students were considered in the period from the second semester of the year 2019. A sample size for finite population was estimated, considering Equation (1).

$$n = \frac{(90) \times (1.96)^2 \times (0.5) \times (0.5)}{(90-1) \times (0.05)^2 + (1.96)^2 \times (0.5) \times (0.5)}, \quad (1)$$

where, n is the number of students in the physics courses of the industrial process technology program, corresponding to 90 people.; Z corresponding confidence level of 95%, with a Z of 1.96 reliability in the results; p is the proportion of occurrence 0.5; q is the rejection ratio 0.5; and e is the error or maximum difference between sample rate and population rate = 0.05. Applying these parameters, we have a result of 74 students considered as candidates for the analysis.

Table 2. Scale of the research instrument.

Aspect	Value
It does not influence	1
It has very little influence	2
It sometimes influences	3
Its significant influence	4
It has a total influence	5

3. Results and discussion

The data collected were oriented in four dimensions drawn from the instrument that was applied to the students. The aspects evaluated considered the situations previously investigated in the literature [6-8] in which it has been attempted to establish causal relationships between the main factors affecting students and their academic performance.

According to Figure 2, and based on the perception of the students who were surveyed, it stands out at the global level that the group of aspects that presents a greater direct incidence in the academic performance in physics subjects is the one that refers to the thematic content with 79.9%, followed by the aspects inherent to the teacher and his or her methodology with 71.3%. With regard to personal-sociodemographic aspects and aspects of the training environment, which obtained a result of 68% and 63.2% respectively, although their overall result is not as high, several conditioning aspects of academic performance stand out in these categories.

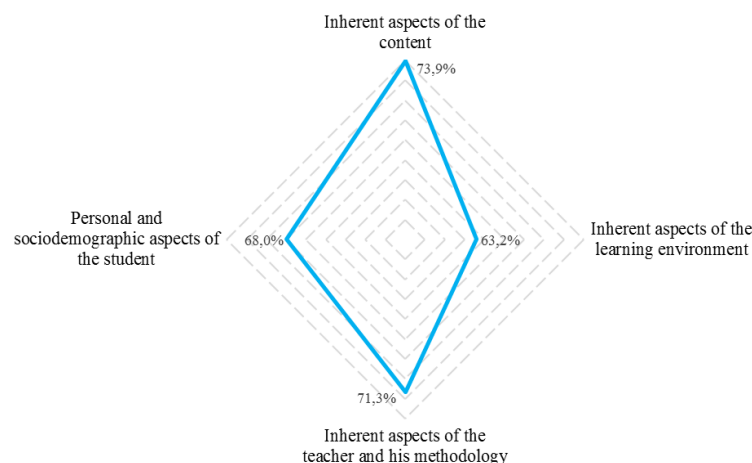


Figure 2. Overall performance issues.

Figure 3, presents that the use of laboratories is the aspect related to the training environment that most affects academic performance, considering that the approach of the subjects' mechanical physics and electromagnetic physics requires the development of pedagogical activities that are based on the use of these educational resources. Laboratory practices offer the possibility of collaborative academic work, being at the same time a more efficient mechanism to understand complex situations and develop

problem-solving skills. Students stress that accessibility to these resources is a very necessary factor. On the other hand, the use of information and communication technologies is not seen as a conditioning factor in the success of these subjects, despite the fact that these teaching tools have proved [9] to be especially useful for providing feedback and complementing the classes seen. In relation to class size or number of students per group, the results obtained support what was obtained in previous studies [4] about the satisfaction of the students in the groups being inversely proportional to the size of the same, demonstrating that an adjusted level of students per class is more propitious for a more dynamic exchange of information.

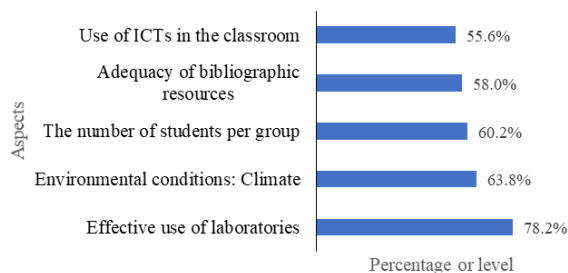


Figure 3. Aspects related to the training environment.

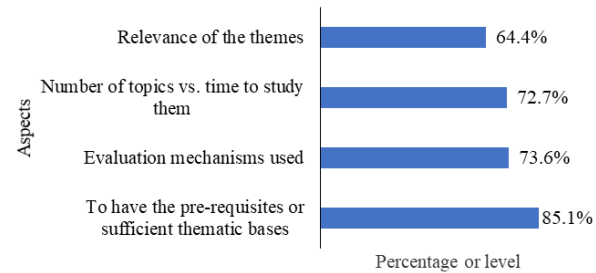


Figure 4. Aspects related to the thematic content.

Figure 4 shows that students need to have a sufficiently solid thematic foundation that contributes to a better understanding of the topics seen in the subjects; this thematic foundation is obtained in previous subjects from their university training in areas of logic-mathematics, as well as from their training in basic sciences given in their schools. Likewise, the evaluation mechanisms used are perceived as a key aspect in academic performance with 73.6%.

The teacher who guides the training processes plays a very important role in the university environment. Therefore, seven aspects were investigated in which a strong relationship was found between teachers and the provision of assessment or tutoring in additional spaces in the classroom. This is a mechanism for accompanying and leveling out students with academic difficulties in certain areas, and corresponds to what has been demonstrated in some studies [10] that state that direct interaction between teachers and students in this type of thematic area, such as physics, has an impact on the effectiveness of learning and promotes academic performance.

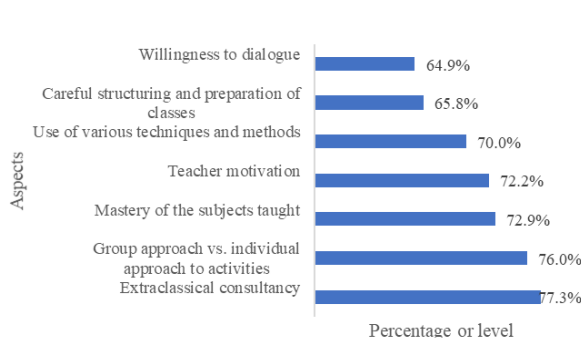


Figure 5. Aspects related to the teacher and the teacher's methodology.

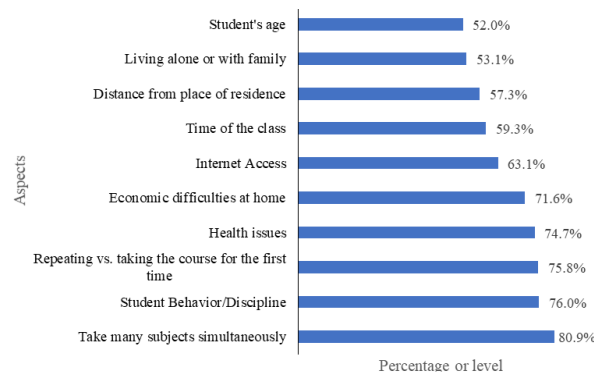


Figure 6. Personal and socio-demographic aspects.

Figure 5 shows that 76% of teachers are able to teach academic activities in groups or individually. The most widespread academic management models suggest that group work allows for the development of human skills that strengthen comprehensive training. Within the personal, social and/or demographic aspects, it was found, as indicated in Figure 6, that academic performance can be most

affected when students have to take a large number of subjects simultaneously, which can be equally demanding in their academic complexity and could add to other possible problems such as the way in which the student manages his/her time. On the other hand, factors such as the student's age, living with his family and distance from his place of residence are not representative for academic performance in the areas of physics.

Once the behavior of the information collected in the four dimensions was analyzed, a behavior congruent with previous results is highlighted [11], where the approaches and didactic strategies implemented as part of the teacher's methodological strategies in physics courses is decisive for the motivation of the students in the class and also their academic performance. On the other hand, it is important to discuss that the present research shows again [12] that there is a strong influence of teachers to foster an attitude around physics classes.

4. Conclusions

From the analysis of the results, it became evident that the academic performance obtained in physics areas for the specific case study, can be affected by a large number of factors that might not act individually or separately, but their coexistence is an indicator of better or worse academic conditions for the students. However, the data obtained reaffirm what existing studies suggest about the role of the teacher as a motivator of students, especially those who have difficulties in understanding the content. There are a large number of teaching methods that could be applied to the teaching of areas of physics; however, the personal conditions of students will require a flexible and adaptable curriculum that allows for academic achievement.

The results of the present project were based on an empirical analysis for a specific case study, which showed that factors inherent to the thematic content of the courses and factors related to the teacher and his/her methodology are the ones that mostly affect the academic performance of students in the areas of mechanical physics and electromagnetic physics. Educational systems should pay special attention to the level of prior knowledge that students possess at the time of starting physics courses, since this is one of the factors that, if not met, would cause multiple difficulties in academic processes and pedagogical reprocessing for teachers.

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