Web Site: https://latinjournal.org/index.php/ipsa

IPSA Scientia

Revista Científica Multidisciplinaria
ISSN: 2711-4406 | e-ISSN:2744-8355
Octubre-Deciembre 2022, Vol. 7, No. 4, pp. 10-23

ResearchArticle

Necesidades de seguridad y protección de Maslow, rendimiento académico y aprendizaje significativo en estudiantes de ingeniería

Maslow's safety and security needs, academic performance, and significant learning in engineering students

FONG-SILVA, Waldyr
Universidad de Cartagena, Cartagena de Indias, Colombia

FONG-AMARÍS, Waldyr
Centro de Innovación y Productividad para la Investigación y Desarrollo, Cartagena de Indias, Colombia

PÉREZ-MENDOZA, Jaime
Universidad de Cartagena, Cartagena de Indias, Colombia

Corresponding author: *wfongs@unicartagena.edu.co*

Received: 29-08-2022**; *Accepted:*** 08-11-2022**; *Online:*** 14-11-2022

DOI: https://doi.org/10.25214/27114406.1542

How to cite this article:
Fong-Silva, W., Fong-Amarís, W. & Pérez-Mendoza, J. (2022). Necesidades de seguridad y protección de Maslow, rendimiento académico y aprendizaje significativo en estudiantes de ingeniería. *IPSA Scientia, revista científica multidisciplinaria, 7*(4), 10-23. https://doi.org/10.25214/27114406.1542

Abstract – The objective of the present research was to evaluate the statistical significance between the safety and security needs established by Maslow (1943) and academic performance and significant learning in undergraduate students of the faculty of engineering of the University of Cartagena, Colombia. The sample was composed of four hundred and fifty (450) engineering students between the years 2018 and 2020. The technique used to measure the fulfillment of Maslow's (1943) safety and security needs was the survey, weighted on a dichotomous scale of 0 and 1. The academic performance was evaluated from the dimensions of conceptual (conceptualization), procedural (problem-solving competence), and global (groups the partial grades of conceptual and procedural interpretation) performance defined by Santos & Vallelado (2013). Ausubel's (2002; 1983) significant learning was measured from the three types of significant learning: representational, concept and propositional, using an instrument constructed from the strategic and self-regulatory learning scale of Weinstein & Mayer (1983). With respect to the findings, when crossing the dependent variable Maslow's needs for security and protection with the independent variables: academic performance and significant learning, it was found that there is no statistical significance at a 95% confidence level in the sample analyzed between Maslow's needs for security and protection and academic performance and significant learning.

Keywords: safety and security needs, Maslow, academic performance, significant learning, student, engineering.

Resumen – Como objetivo de la presente investigación se evaluó la significancia estadística entre las necesidades deseguridad y protección establecidas por Maslow (1943) y el rendimiento académico y aprendizaje significativo en estudiantes universitarios de la facultad de ingeniería de la Universidad de Cartagena, Colombia. La muestra estuvo

compuesta por cuatrocientos cincuenta (450) estudiantes de ingeniería entre los años 2018 y 2020. La técnica utilizada para medir el cumplimiento de las necesidades de seguridad y protección de Maslow (1943) fue la encuesta, ponderada en una escala dicotómica de 0 y 1. El rendimiento académico, se evaluó desde las dimensiones del rendimiento conceptual (conceptualización), procedimental (competencia para resolver problemas) y global (agrupa las notas parciales de interpretación conceptual y procedimental) definido por Santos & Vallelado (2013). El aprendizaje significativo de Ausubel (2002; 1983) se midió desde los tres tipos de aprendizaje significativo: el representacional, de conceptos y proposicional, haciendo uso de un instrumento construido a partir de la escala del aprendizaje estratégico y autorregulatorio de Weinstein & Mayer (1983). Con respecto a los hallazgos, al cruzar la variable dependiente necesidades de seguridad y protección de Maslow, con las independientes: rendimiento académico y aprendizaje significativo, se pudo constatar que no existe significancia estadística a un 95% de nivel de confianza en la muestra analizada entre las necesidades de seguridad y protección de Maslow y el rendimiento académico y aprendizaje significativo.

Palabras clave: necesidades de seguridad y protección, Maslow, rendimiento académico, aprendizaje significativo, estudiante, ingeniería.

Introduction

Maslow's (1943) hierarchy of needs is a theory that has been widely used to understand human motivation, according to which individuals are motivated to satisfy certain basic needs before they can focus on higher-level goals, such as academic achievement or self-fulfillment. The most basic needs, which must be satisfied for an individual to survive, include food and shelter; the next level corresponds to safety and security; then there are social needs such as love and belonging.

Once these needs are satisfied, individuals can begin to focus on esteem and self-actualization; the former includes the need for respect and recognition from others, while the latter is associated with being able to reach one's full potential. According to this theory, when these lower-level needs are met, individuals can begin to focus on higher-level goals, such as academic success or self-actualization. However, it is important to keep in mind that individuals may move back and forth between different levels of need depending on their current circumstances. For example, an individual who feels insecure may temporarily focus on security before returning to other goals such as social recognition (Maslow, 1943; Taormina & Gao, 2013; Okafor & Abraham, 2021; Fong-Silva et al., 2020).

For undergraduate engineering students, meeting these higher-level needs can be essential to achieving their academic and career goals. Engineering is a highly competitive field and students who feel recognized and supported by their peers are more likely to succeed. In addition, students who have a strong sense of self-fulfillment are more likely to persist in the face of adversity and ultimately achieve their goals. Thus, Maslow's hierarchy of needs may play an important role in the success of engineering students (Branco & Silva, 2017; Hoffman, 2008).

On the other hand, the academic performance of college students has been extensively studied and there is much debate about the factors that contribute to success in college. Some experts argue that intelligence and natural ability are the most important predictors of success, while others point to the importance of factors such as motivation, hard work, and self-discipline.

Research on the topic is ongoing, but there is no clear consensus on which factors are most important. One thing is certain, however: the academic performance of college students has a significant impact on their prospects. Students who do well in college are more likely to get good jobs and earn high salaries. They are also more likely to be admitted to graduate programs andpursue successful careers. Therefore, universities should continue to invest in programs that help students achieve and succeed academically (Estrada García, 2018; Lamas- Rojas, 2008).

Despite the stereotype of the struggling engineering student, research shows that undergraduate students in engineering programs have higher GPAs (Grade Point Average) than their peers in other disciplines. In fact, a study of more than 200,000 students found that engineers had the highest GPA of all majors, with a mean of 3.38. However, this doesn't mean that engineering students don't face challenges; they simply tend to be better equipped to handle them. Engineering students learn to think analytically and solve problems systematically. As a result, they tend to be better prepared to deal with the rigors of undergraduate courses. In addition, engineering students often have access to more resources, such as tutoring and advising services. These supports can make a significant difference in academic performance. Ultimately, although engineering students may face some unique challenges, they also have unique strengths that allow them to perform well academically and succeed in their studies, as proposed by Gargallo et al. (2007).

When students are engaged in learning that is significant to them, they are more likely to be motivated and successful. One of the best ways to ensure this learning is to allow students to choose their own topics of study, give them a list of options to choose from, or allow them to design their own research project. Another way to promote significant learning is to connect what students are studying to real-world issues. For example, if they are learning about the water cycle, you could have them research ways to conserve water in their community. By making learning relevant and engaging, you can help ensure that it is also significant to your students (Sanchez & Ramis, 2004; Fong-Silva et al., 2017; Fong-Silva et al., 2021).

Many factors contribute to an engineering student's success, but one of the most important is a commitment to lifelong learning. In a field as ever-changing as engineering, it is essential to be able to adapt and learn new skills throughout your career. For students in Latin America, this can be a challenge. There are many barriers to accessing quality education, such as socioeconomic factors, political instability, and limited resources. As a result, many engineering students in Latin America face significant challenges in achieving their goals. However, there are also many opportunities for students who are willing to make a commitment to the lifelong learning. There are several programs and initiatives that provide access to quality education for engineering students in Latin America. These programs typically focus on providing resources and support to students who are willing to go the extra mile to succeed. As a result, they offer an excellent opportunity for students who are committed to lifelong learning (Moreira &Greca, 2003; Ordoñez & Mohedano, 2019).

Maslow's Hierarchy of Needs and Academic Performance

Although often taken for granted, the role Maslow's (1943) needs play in academic performance is important. According to the hierarchy of needs, individuals must satisfy their basic

physiological and safety needs before they can focus on higher-order needs such as love/belonging, esteem, and self-fulfillment. For students who struggle to meet their basic needs, it can be difficult to find the motivation to succeed in school.

This is especially true for students who juggle work and family responsibilities while attending class. However, even those who can meet their basic needs may find it difficult if they do not have a sense of belonging or esteem within their academic community. When students feel that they are part of a supportive community, they are more likely to perform well academically. Therefore, creating a sense of community among students is essential to promote academic success (Núñez et al., 1998; Doubront, 2020).

This theory has been applied to a wide range of fields, including education. Some researchers have argued that Maslow's hierarchy can be used to explain the academic performance of engineering students. This is a highly cognitive field that requires a deep understanding of complex concepts. As such, it is often considered to be relatively inaccessible to low-income students. However, Maslow's hierarchy suggests that these students can overcome this barrier if their basic needs are met. If they are provided with food, shelter, and other basic needs, they will be able to focus on their studies and reach their full potential. This theory offers a compelling explanation for the academic success of engineering students from low-income backgrounds. Ultimately, it underscores the importance of meeting basic needs to facilitate high-level learning (Oyarzún et al., 2012; García et al., 2014).

Maslow's Hierarchy of Needs and Significant Learning

Maslow himself recognized the importance of significant learning experiences in helping students reach their full potential, and he believed that college was an ideal place for students to learn about themselves and the world around them. In recent years, there has been a growing movement among educators to focus on providing students with opportunities for significant learning experiences. This approach recognizes the importance of helping students find their own identity and purpose in life and has proven to be very effective in promoting student success (Contreras et al., 2005; Matienzo, 2020).

One of the most important things college students can do is to ensure that their learning is significant. According to Maslow's pyramid of needs, human beings have certain basic needs that must be met to thrive. For learning to be significant, it must be relevant to the student's life and meet their needs at whatever level they are at. For example, a student who is having difficulty paying their bills will probably find little point in a philosophy class discussing the nature of reality. However, a student who is interested in philosophy and has their basic needs met may find the class very significant. Therefore, it is important for college students to consider their own needs and how they can best be met to ensure that their learning is significant (LoliMonzon, 2022).

Materials and Methods

This research is framed in positivism with a quantitative and non-experimental approach. The research was designed as cross-sectional, correlational, and descriptive research. The population

consisted of four hundred and fifty (450) students of the Engineering programs of the University of Cartagena, in active condition between the years 2018 and 2020. The sampling used was simple random and of probabilistic type for a finite population. The analysis criteria were a) old university student (from the third semester onwards) and b) over age: 18 to 22 years old.

The study sample was obtained from fourth, fifth, and sixth-semester students of the systems, civil, and food engineering programs of the University of Cartagena. The sample size was 208 subjects (40% female and 60% male) students, according to the formula for finite populations, considering a statistical confidence level of 95%, a margin of error of 5%, and a variability of 50%.

The variables used in the research were of the dependent and independent types as described below:

- Dependent variable: security and protection needs (housing, health, employment, family, economic and environmental).
- Independent variables: significant learning and academic performance.

The instrument used to evaluate compliance with safety and security needs was a questionnaire designed for the study, consisting of 50 questions on a dichotomous scale (0 and 1); where one (1) expresses compliance with safety and security needs while zero (0) indicates the opposite. The weighting used to consider that the safety and security needs are met corresponds to 80% or more of the points obtained by the student when answering the instrument.

On the other hand, Ausubel's (2002, 1983) instrument for measuring significant learning was used, which included the strategic and self-regulatory learning scale of Weinstein & Mayer (1983) and was analyzed from the different types of significant learning such as representational, concept and propositional.

Likewise, the conceptual, procedural, and global dimensions were used to evaluate academic performance (Santos & Vallelado, 2013), which were included in the instrument used. The conceptual dimension evaluates concepts and contents, the procedural dimension evaluates the student's skills when solving contextual problems, and the global dimension is related to the final grade obtained by the student in the subject.

The study was planned to be applied to a total of 24 students per academic semester and per program, for a total of 216 subjects. However, only 210 surveys were applied, which exceeds the 208 surveys planned. The procedure followed comprises three (3) phases: in the first phase, the fulfillment of Maslow's safety and security needs for the engineering student at the University of Cartagena was evaluated by means of the dichotomous questionnaire; in the second phase, significant learning and academic performance were evaluated; and in the last phase, the crossing of independent variables with the dependent variable was made. This analysis was performed by means of contingency tables; the round of experts was the strategy used for the validation of the instruments and Cronbach's Alpha (Cronbach, 1943; 1951) was used to evaluate the reliability of the test, 0.80 was obtained, which indicates a high degree of internal consistency. The variables

IPSA Scientia, multidisciplinary scientific journal, 7(4), 10-23.
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were categorized (see Table 1) and the Chi-Square statistical test was used to determine statistical relationships (if any) between them.

Table 1. Categorization of variables

Variable	Categorization
Safety and security needs (dependent)	Safety and security need met (NSPS)
	Unmet safety and security needs (NSPNS)
Academic performance (independent)	Low academic performance (RAB< 75 points)*
	High academic performance (RAA >= 75 points)*
Significant learning (independent)	Low significant learning (ASB < 75 points)*
	High significant learning (ASA >= 75 points)*

* out of a total of 100 points

Source:own

Results and Discussion

Table 2 shows the Chi-square test with p-values (statistical significance), it is observed that there is no relationship of high statistical significance between the safety and security needs established in Maslow's hierarchy pyramid and academic achievement (p >0.05), nor between the safety and security needs established in Maslow's hierarchy pyramid and meaningful learning (p >0.05).

Table 2. Chi-Square test for Safety and Security Needs

Variable	Chi Square	GL	p**
Academic Performance	2.44	1	0.1184
Significant Learning	0.29	1	0.5932

** Relationship with high statistical significance at a confidence level of 95%

Source: own

The lack of statistical significance between safety and security needs and academic performance allows inferring that engineering students at the University of Cartagena are students who, despite having all their safety and security needs met, that is, they are students who have safe accommodation in a family or rented housing, do not have significant health problems, their family nucleus has a job and economic security, they are protected from insecurity and they are also safe students, but these are not necessary or sufficient conditions for good academic performance, so the postulates of Maslow (1943) could not be proven , nor the approaches of Oyarzún et al. (2012), García et al. (2014), Branco & Silva (2017), Hoffman (2008), Céspedes-Gallegos et al., (2021) and Fong-Silva et al. (2020).

It is likely that safety is necessary for good academic performance (Okafor & Abraham, 2021; Fong-Silva et al., 2020). These results, force us to rethink the research based on postulates that consider the existence of other factors that affect the academic performance of students (Fong-Silva et al ., 2018; Taormina & Gao, 2013; Núñez et al ., 1998). Likewise, one can think of the possibility that students actively participate as consultants, reviewers, or assistants in research or community projects so that, through social recognition and the conjunction of previous

knowledge with new information converted into new knowledge in the classroom, they manage to potentiate their academic and engineering capabilities that allow them to increase their academic performance (Doubront, 2020; Fong-Silva et al ., 2017; Fong-Silva et al ., 2021; Gallegos & Huerta, 2014; Sánchez & Ramis, 2004; Estrada García, 2018; Lamas-Rojas, 2008; Gargallo et al., 2007).

On the other hand, the non-statistical significance between safety and security needs and meaningful learning determines that to develop meaningful learning it is not only necessary to have these needs satisfied but surely to comply with aspects such as lifelong learning, since the study of engineering is not a matter of a few hours but a full-time dedication (Moreira & Greca, 2003; Ordoñez & Mohedano, 2019). In the same way, it is necessary for students to join professional associations where they enrich their engineering knowledge from the hand of professionals active in the performance of hard engineering (Matienzo, 2020; Sánchez & Ramis, 2004; Fong-Silva et al., 2016; Moreira & Greca, 2003; Ordoñez & Mohedano, 2019).

Likewise, it is probably necessary to reinforce meaningful learning experiences in engineering students at the University of Cartagena so that they learn from works under construction, from real-life engineering mistakes, from unfinished projects and in general from that other state of the art of engineering that nobody wants to talk about but that is part of the professional experience (Contreras et al. (2005); Loli Monzón, 2022).

Table 3. Contingency table of safety and security needs and academic performance.

Academic Performance	Safety and security needs		
	High	Low	Total
High	66 (31.4%)	74 (35.2%)	140 (66.6%)
Low	41 (19.5%)	29 (13.8%)	70 (33.3%)
Total	107 (50.9%)	103 (49.0%)	210 (100%)

Source: own

Table 3 shows the contingency results obtained during the research between Maslow's safety and security needs and academic performance; according to which, 66 cases (31.4%) of engineering students show a high satisfaction of safety and security needs, which correspond to high academic performance; that is, this is not a condition that guarantees high academic performance in engineering students. It is likely that for these students it is necessary to do more field work that stimulates and potentiates them to obtain higher academic performance in the classroom (Sánchez & Ramis, 2004; Fong- Silva et al., 2016; Matienzo, 2020; Estrada García, 2018).

On the other hand, 41 cases (19.5%) with high compliance with safety and security needs correspond to low academic performance. This means that maintaining high compliance with safety and security needs does not guarantee high academic performance, i.e., there is a possibility that other factors affect students' academic performance such as family problems, resource deficiency, or low motivation (Fong-Silva et al ., 2018; Taormina & Gao, 2013; Núñez et al., 1998; Lamas-Rojas, 2008; Vázquez- González et al., 2022).

Only 74 cases (35.2%) of the students with low compliance with safety and security needs correspond to high academic achievement, being the most representative frequency, which allows inferring that having low compliance with safety and security needs does not condition

the student to have high academic achievement, however, some of the students in the studied population obtained it above all prognoses. This also suggests that there are other factors that influence the academic achievement of university students such as social recognition or love for the career that drives them to be better (Moreira & Greca, 2003; Ordoñez & Mohedano, 2019; Gargallo et al., 2007).

Likewise, 29 cases (13.8%) of the students with low compliance with safety and security needs correspond to low academic performance, which represents the percentage with the lowest frequency. This category shows that for a group of students in the sample studied, having a low fulfillment of their safety and security needs does affect their academic performance, i.e., having a house or a roof over their heads, having health insurance or being affiliated to an EPS (health insurance company), having an income and having security for themselves and their families represent determining factors for good academic performance at the University (Maslow, 1943; Okafor & Abraham, 2021; Fong-Silva et al, 2020); however, it is important to keep in mind that there is the possibility that other factors also influence students ' academic performance (Fong-Silva et al., 2018; Taormina & Gao, 2013; Núñez et al., 1998).

Hereafter, Table 4 shows the results obtained from the percentage analysis by rows and columns for the data in Table 3, where, of the 140 cases of students with high academic performance, 61.7% had high compliance with their safety and security needs, while 71.8% had low compliance. Likewise, of the 70 cases of students with low academic performance, 38.3% had high compliance with their safety and security needs, while 28.2% had low compliance. Similarly, of the 107 cases of students with high compliance with their safety and security needs, 47.1% had high academic performance, while 58.6% had low compliance.

Table 4. Percentages of rows and columns of the data inTable3.

		Safety and security needs					
		Percentages (%) for rows			Percentages (%) for columns		
		High	Low	Total	High	Low	Total
Academic Performance	High	47.1	52.9	100	61.7	71.8	66.7
	Low	58.6	41.4	100	38.3	28.2	33.3
	Total	51.0	49.0	100	100	100	100

Source: own

Finally, of the 103 cases of students with low compliance with their safety and security needs, 52.9% had high academic performance, while 41.4% had low academic performance. According to these data, there is no correspondence between the fulfillment of safety and security needs and the academic performance of engineering students because although the highest and lowest percentages of students with academic performance correspond to students with high and low fulfillment of their safety and security needs, respectively, there is no statistical significance between them. This is probably since in each category of the study the cases obtained were quite homogeneous.

The following is the contingency table obtained during the research between Maslow's safety and security needs and significant learning (see Table 5).

Table 5. Contingency Table Safety and security needs and Significant learning

Significant Learning	Safety and security needs		
	High	Low	Total
High	57 (27.1%)	81 (38.6%)	138 (65.7%)
Low	27 (12.9%)	45 (21.4%)	72 (34.3%)
Total	84 (40.0%)	126 (60.0%)	210 (100%)

Source: own

According to these data, 57 cases (27.1%) of engineering students with high satisfaction of safety and security needs correspond to high significant learning, i.e., this is not a condition that guarantees high significant learning in engineering students. It is likely that for these students it is necessary to work on more relevant processes in the classroom or even to conduct field workshops to further enhance their learning process (Sánchez & Ramis, 2004; Fong-Silva et al., 2016; Matienzo, 2020).

On the other hand, 27 cases (12.9%) that comply with high safety and security needs correspond to low significant learning and represent the lowest frequency of the data shown, which does not correspond to what would be expected since it is assumed that the lowest percentage should correspond to the category of low safety and security needs with low significant learning, so it is expected that other factors such as lifelong learning, full-time dedication to study,practical learning, among others, have an impact in students' significant learning (Moreira & Greca, 2003; Ordoñez & Mohedano, 2019; Matienzo, 2020; García-Mogollón & Mogollón-Rodríguez, 2020).

Only 81 cases (38.6%) of the students with low compliance with safety and security needs correspond to high significant learning; this percentage is equivalent to the highest representativeness, which allows inferring that having low compliance with safety and security needs does not condition the student to have high significant learning; however, some of the students of the population studied obtained it above all expectations. This also leads to think that there are other intrinsic factors specific to the student such as intrinsic motivation, social recognition,or participation in research or community projects that drive them to achieve their academic achievements (Moreira & Greca, 2003; Sánchez & Ramis, 2004; Fong-Silva et al., 2016).

Likewise, 45 cases (21.4%) of students with low compliance with safety and security needs correspond to low significant learning. In this category, there are students who have a low fulfillment of their safety and security needs and that surely have some influence, so that they obtain a low significant learning, but it is not the main cause and other factors should be analyzed, such as, for example, lack of motivation and dedication to study. These reasons lead to evaluate other possibilities to encourage meaningful learning of the student such as affiliation to professional associations where the student can enrich their engineering knowledge from the hand of professionals who apply hard engineering (Matienzo, 2020; Sanchez & Ramis, 2004; Fong-Silva et al., 2016; Moreira & Greca. 2003; Ordoñez & Mohedano, 2019).

Finally, Table 6 presents the results obtained by performing the percentage analysis by rows and columns for the data in Table 5.

Table 6. Percentages of rows and columns of the data in Table 5

		Safety and security needs					
		Percentages (%) for rows			Percentages (%) for columns		
		High	Low	Total	High	Low	Total
Significant learning	High	41.3	58.7	100	67.9	64.3	65.7
	Low	37.5	62.5	100	32.1	35.7	34.3
	Total	40.0	60.0	100	100	100	100

Source: own

Table 6 shows that of the 138 cases of students with high significant learning, 41.3% had high compliance with their safety and security needs, while 58.7% had low compliance with their safety and security needs. Likewise, of the 72 cases of students with low academic performance, 37.5% had high compliance with their safety and security needs, while 62.5% had low compliance. Similarly, of the 84 cases of students with high compliance with their safety and security needs, 67.9% had high significant learning, while 32.1% had low significant learning. Finally, of the 126 cases of students with low compliance with their safety and security needs, 64.3% had high significant learning, while 35.7% had low significant learning.

According to these data, there is no correspondence between the fulfillment of safety and security needs and meaningful learning since it would be expected that the highest percentage of students with meaningful learning would correspond to those students with high fulfillment of their safety and security needs, which is clearly not the case since students in this category correspond to 27.1% which represents a lower percentage than those students with high meaningful learning and low fulfillment of their safety and security needs which represent 38.6%.

The same happens with the category of low significant learning and low safety and security needs, which corresponds to 21.4%, which is a higher percentage than the category of low significant learning and high safety and security needs (12.9%) and lower than the other categories. It is important to note that this category of low significant learning and low safety and protection needs should have been the lowest of all due to its status as the lowest category. This is what probably contributed to the non-significant association between the variables.

Conclusions

Once the satisfaction of safety and security needs has been surpassed, the undergraduate student of the engineering faculty of the University of Cartagena focuses their attention on achieving academic goals and objectives. However, the results of this research indicate that there is no statistical significance at a 95% confidence level between the safety and security needs established in Maslow's hierarchy pyramid and academic performance, nor with significant learning in engineering students at the University of Cartagena.

This means that the academic success of engineering students is not conditioned by the satisfaction of safety and security needs, which can be attributed to the fact that the students of this faculty take advantage of the various university welfare programs offered by the institution

such as generation e, sponsor plan, tutor plan, scholarships for academic performance, internships, among other strategies and whose main objective is to supply those critical needs of students and that some of them are categorized by Maslow in his hierarchy pyramid.

To improve academic performance, one could think about the possibility of students participating in consulting activities, and working as project assistants, and it is also probably necessary to reinforce meaningful learning experiences for students to learn from works under construction, engineering mistakes, unfinished projects, and, in general, from that other state of the art of engineering that almost nobody talks about but that is part of the professional experience of any good engineer.

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