

Success of tutoring programs for engineering education

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Abstract– *This study analyzes the effectiveness of academic tutoring programs in undergraduate engineering and technology programs at Universidad Ana G. Méndez (UAGM), Puerto Rico. Using a quantitative methodology, a structured survey was administered to active students from various engineering disciplines to assess their perceptions of tutoring's impact on academic performance, retention, and personal development. Results indicate that most students who participated in tutoring programs reported significant improvements in content comprehension, grades, and academic motivation. However, areas for improvement were also identified, particularly in terms of accessibility and sustained academic support. The study concludes that tutoring is an effective tool for supporting student success in demanding academic fields, provided it is well-structured, delivered by trained tutors, and supported by consistent institutional monitoring. Strengthening these programs is recommended as part of institutional strategies for student retention and holistic development.*

Keywords– *Engineering education, effectiveness of tutoring, associate degree, bachelor's degree.*

I. INTRODUCTION

Nowadays, higher education landscape, student retention, academic performance, and on-time graduation are major challenges, particularly in demanding fields such as engineering and technology. Several factors, including the complexity of course content, intensive academic workloads, limited prior preparation, and socioeconomic conditions, directly affect student performance and increase the risk of academic failure or dropout [1,2]. In response to this reality, academic tutoring has emerged as an effective support strategy that addresses students' individual needs. Tutoring not only reinforces specific academic content, but also contributes to the development of study skills, motivation, adaptation to university life, and career decision-making [3, 4]. In engineering and technology programs—where dropout rates are often higher than in other disciplines—its impact can be especially significant (Mendoza Rojas, 2019; González, Pérez, & Sánchez, 2020).

At Ana G. Méndez University (UAGM), several institutional initiatives have been implemented to support students academically. It is very crucial to assess the effectiveness of these tutoring programs in terms of academic outcomes, student perceptions, and retention [5]. Therefore, the purpose of this study is to analyze the effectiveness of tutoring in UAGM's undergraduate engineering and technology programs from the students' perspective. This study seeks to address this gap by providing relevant data on

student perceptions, academic performance, and the identification of areas for improvement in current tutoring initiatives.

The study is based on the hypothesis that academic tutoring, when well-structured and delivered by trained personnel, positively impacts academic performance and student persistence [6]. A quantitative methodology is used, based on surveys administered to students from various levels, to identify strengths, weaknesses, and areas for improvement in current tutoring programs. Moreover, this research aims to contribute relevant data for institutional decision-making and offer recommendations to strengthen academic support systems at Latin America colleges and universities facing same issues, with the goal of improving educational quality and promoting student success in engineering and technology programs.

The rest of the article presents a background on tutoring programs in section II, followed by challenges and opportunities in section III. Then, section IV introduces the academic programs at the School of Engineering followed by an introduction of academic support programs available at UAGM. It is important to mention that a survey on student satisfaction with tutoring programs was conducted, and it is presented in sections VI and VII. Finally, section VIII presents the conclusion for this study.

II. BACKGROUND

Academic support through tutoring has become one of the most effective strategies for improving educational quality in higher education, particularly in highly demanding programs such as engineering and technology. Tutoring provides individualized assistance to students, not only in understanding complex content but also in developing learning skills, time management, and adjustment to the university environment.

According to Tinto [1], the importance of academic and social integration are key factors in student retention. In this context, tutoring serves as a bridge between students and the institution, strengthening their sense of belonging and academic commitment. In addition, several authors [3, 4 and 6] argued that tutoring impacts not only academic performance but also academic self-confidence, motivation, and retention, particularly among underrepresented or at-risk student populations.

In Latin America, Mendoza Rojas [7] shows that institutional tutoring programs in Mexican technological universities significantly contributed to improved academic performance and reduced dropout rates in engineering programs. González, Pérez, and Sánchez [8] conducted a study in public universities in Mexico, showing that students who regularly attended tutoring sessions achieved higher grades and developed greater confidence in their academic abilities. In similar fashion, Bustos-Gonzalez [9] presents the relevance of tutoring for engineering students particularly in calculus and physics, as well as other scientific subjects.

In contrast, higher education in Puerto Rico faces additional challenges, such as academic underperformance in STEM fields, inadequate preparation in mathematics and science, and socioeconomic conditions that hinder educational continuity [5]. In response, institutions such as Ana G. Méndez University (UAGM) have implemented academic support initiatives, including both in-person and virtual tutoring, aimed at strengthening student retention and success. It is essential to understand whether these efforts are meeting their intended goals and what factors enhance or hinder their impact.

III. CHALLENGES AND OPPORTUNITIES

Although tutoring programs offer a great opportunity to students, their implementation requires institutional support and faces several challenges as follows:

A. Factors Affecting tutoring effectiveness

The effectiveness of academic tutoring programs at UAGM depends on several interrelated variables within the institutional context. While tutoring has proven to be a valuable tool for improving academic performance and student retention, its impact is shaped by specific key factors that must be addressed to maximize its potential. A key factor is the accessibility and availability of tutoring services. For tutoring to be effective, it must be free of logistical and technological barriers. This involves offering flexible schedules that accommodate students with diverse academic loads and personal responsibilities, as well as ensuring that digital platforms are reliable, user-friendly, and accessible [4]. Another critical element is the tutor's academic background. The quality of tutoring is directly influenced by the tutor's pedagogical and technical training, content expertise, and ability to foster an empathetic and motivating relationship with the student. Continuous training and performance evaluation are essential components to ensure consistent quality of service [6].

The student's commitment is another key factor. Their active participation, willingness to identify areas of opportunity, and adoption of feedback play a crucial role in their academic outcomes. Promoting a campus culture that frames tutoring as a strategic academic resource—rather than as a remedial measure—can significantly improve participation rates and program effectiveness [3].

Nevertheless, institutional monitoring and follow-up are essential to ensure ongoing improvement of tutoring services. The implementation of clear metrics, successful indicators, and assessment processes allows for continuous tracking of tutored students' progress and facilitates timely interventions. This feedback loop is key to align tutoring programs with broader institutional goals in student retention and academic achievement [1, 2].

B. Challenges and opportunities in tutoring implementation

Despite the proven potential of tutoring programs in higher education, their implementation at UAGM faces several challenges that require strategic attention to ensure sustainable impact. One major challenge is low student participation, often linked to a lack of awareness about the program or lingering stigmas related to seeking academic help. These perceptions may prevent students from accessing tutoring services while pursuing their degrees, due to fear of being labeled as underperforming [4]. Another significant challenge is the limitation of qualified human resources, especially in particular subjects such as advanced courses. This affects the availability and equity of the service, reducing its reach and effectiveness [7].

In addition, the university faces the ongoing challenge of advancing the digitalization of tutoring services. Although virtual platforms exist, there remains considerable room for improvement in the integration of technological tools, such as synchronous online tutoring, interactive academic resources, and automated feedback systems [8]. Nevertheless, these challenges also represent opportunities for institutional innovation and growth. For example, expanding virtual tutoring services can better serve non-traditional students, those enrolled in distance learning or with full-time jobs. Moreover, investing in specialized training of tutors, particularly those supporting engineering and technology programs, can improve the relevance and quality of the academic support offered. Another key opportunity is to integrate tutoring programs into the university's academic retention system, allowing for a more comprehensive view of student progress and enabling data-informed, timely interventions. These actions can position tutoring as a strategic component of UAGM's academic ecosystem and institutional success model [5].

IV. SCHOOL OF ENGINEERING (SOE) UAGM AT GURABO

It is important to highlight the academic structure of the school of engineering at Universidad Ana G. Méndez (UAGM) at Gurabo, Puerto Rico. The SOE offers five associate degrees (AD) and five Bachelors of Science (BS) degrees. The AD degrees are designed for two-year completion and the BS for four years which is common practice in United States and Puerto Rico. It is important to

note that each AD is aligned to a BS and around 80% of their credits are transferable to the appropriate BS.

The associate degree offer at SOE is as follows:

1. Quality Control Engineering Technology (AQETE). Aligned with the BS in Industrial and Management.
2. Computer and Network Engineering Technology (ACTN). Aligned with the BS in Computer Engineering.
3. Electronic Engineering Technology (AEETE). Aligned with the BS in Electrical Engineering.
4. Mechanical Engineering Technology (AMETE). Aligned with the BSs in Mechanical Engineering and Civil Engineering.
5. Electrical Technology and Renewable Energy (AEETE). Aligned with the BS in Electrical Engineering.

Alternatively, the bachelors' programs offered by UAGM- Gurabo are ABET accredited and are as follows:

1. Bachelor of Science in Civil Engineering.
2. Bachelor of Science in Electrical Engineering.
3. Bachelor of Science in Mechanical Engineering.
4. Bachelor of Science with a concentration in Industrial and Management Engineering.
5. Bachelor of Science in Computer Engineering.

The SOE's admissions policy aims to ultimately admit every student who is motivated to study engineering. However, a student is not officially admitted to any of the BS engineering programs until he/she demonstrates proficiency in basic mathematics and English. This provision stems from UAGM's stated goals, which mandate the SOE to provide opportunities for professional engineering education to all interested students in Puerto Rico. Therefore, the admission process depends on whether the applicant is a first-time freshman, a transfer student from another institution, or a current UAGM student seeking reclassification from another program as explained by Soler-Martinez et. Al, [10].

In addition, authors in [9] present the academic rigor of engineering as a major challenge for students moving from AD to BS programs. It is well-known the demanding coursework in engineering programs requires strong foundations in mathematics, physics, and other core subjects. Many students find the pace and depth of study significantly more intense than their high school experience. To navigate these challenges effectively and ensure a successful transition, students could adopt the following strategies:

1. Preparation: Start preparing early by taking advanced math and science courses in the associate technology degree. Familiarize with engineering concepts and basic programming languages to build a solid foundation.
2. Seek Academic Support: UAGM provides tutoring services, academic advisors, and study aids. In addition, UAGM is an open-door institution where students are encouraged to engage with professors during office hours to clarify doubts and deepen understanding of course material.

3. Get Involved: UAGM encourages students to participate in engineering clubs, societies, and competitions to apply theoretical knowledge to practical projects. Networking with peers and industry professionals can provide valuable insights and opportunities.

Therefore, academic tutoring seems to be an effective way to support students in their transition from AD and BS as well as students pursuing their BS in engineering.

V. ACADEMIC SUPPORT SERVICES AND TUTORING AT UAGM

UAGM provides supporting services to students such as academic advisors, academic tutoring, and study aids. In this section, authors present several academic support programs available at UAGM.

A. Center for Academic Advising and Counseling (CAAC)

The CAAC provides support to students from their first year of study, offering guidance on life goals, career planning, and the development of academic plans. Through communication and the exchange of information with their academic advisor, students are empowered to make assertive decisions and reach their full educational potential. Professional counseling services are offered based on the individual needs of those who request them and are provided in a confidential manner.

B. Center for Resources for Educational Excellence (CREE)

This center provides academic support to help students adapt to university life and achieve their academic goals. CREE offers diagnostic and placement services, the Educational Leadership and Orientation Seminar (SIGS 100), and workshops on technological tools for academic success.

C. Center for Learning and Academic Services (CASA)

Our peer tutoring program is a key support component designed to help students achieve academic success. CASA offers academic support services both in-person and remote modalities, through tutoring and peer mentoring for actively enrolled students. These services are available individually and/or in group settings.

VI. STATISTICS

This section presents the evaluation of the tutoring program implemented at UAGM serving all engineering programs. The analysis is based on survey responses from 66 students enrolled in associate (GA) and bachelor's (BS) degree programs across multiple engineering disciplines, including mechanical, electrical, industrial, and quality control engineering as shown in figure 1.

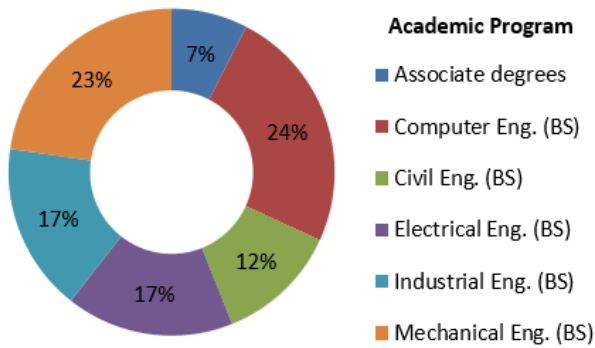


Fig. 1. Student distribution in the survey

A. Participant Overview

A total of 66 engineering students, out of 1,200 registered in the SOE, participated in the study. Most respondents were between 20 and 30 years of age, representing the typical undergraduate engineering population as shown in figure 2. The sample included students from both foundational and advanced coursework levels, ensuring representation across different stages of the academic trajectory.

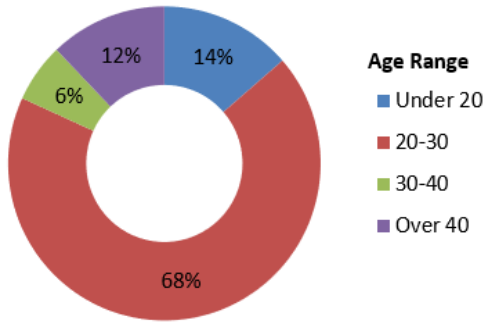


Fig. 2. Age range

B. Perceived Importance of Tutoring

Survey results indicate a positive perception of the tutoring program. As shown in figure 3, 98.5% reported that tutoring is important for improving academic performance. Only, 1 student (1.5%) indicated that tutoring was not important for academic development. This positive result demonstrates strong institutional acceptance of tutoring as a critical academic support mechanism within engineering education.

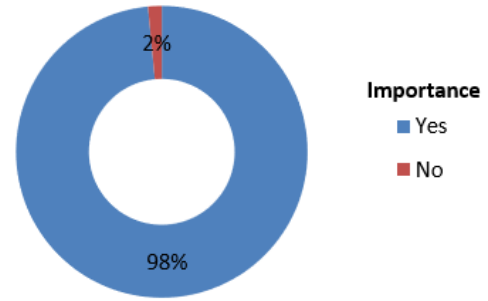


Fig. 3. Students' perception about importance of tutoring for their academic development

C. Program Utilization

Regarding participation in tutoring services, 68.2% reported having used the tutoring program. Only 30.3% reported they did not use the program as shown in figure 4. The relatively high utilization rate suggests that the tutoring program is accessible and well-integrated into the academic environment.

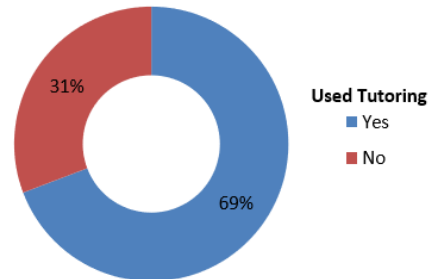


Fig. 4. Utilization of the tutoring program

However, the presence of non-participating students indicates potential opportunities for improving outreach, scheduling flexibility, or awareness program availability. Figure 5 presents the principal reason why some students have not used the tutoring program available to them. It is important to mention that no students indicated that they were unaware of the tutoring program.

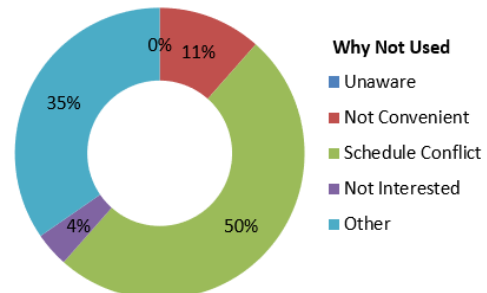


Fig. 5. Reason why some students have not used the tutoring program

D. Satisfaction and Expectation Fulfillment

Among the 53 students who reported using tutoring services, satisfaction levels were notably high. The survey indicates that 63% specified that the program completely met their expectations. Meanwhile, 30% reported that available tutoring programs partially met their expectations. Fewer than 7% expressed dissatisfaction as shown in figure 6. Overall, more than 93% of tutoring users reported at least partial fulfillment of expectations, reflecting strong perceived effectiveness and alignment with student academic needs.

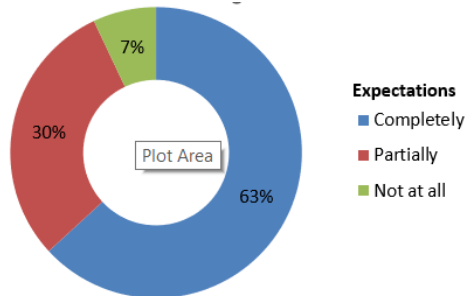


Fig. 6. Students' satisfaction

Figure 7 presents the main reasons why students participate in the tutoring program. Most students are motivated because they can clarify questions, followed by successfully approving the courses.

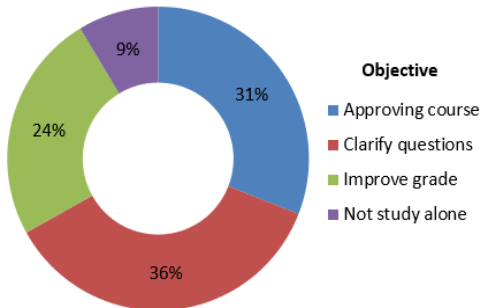


Fig. 7. Major students' motivations to participate in the tutoring program

E. Academic Areas of Impact

Tutoring services were most frequently utilized in foundational and mathematically intensive courses, including Precalculus, Calculus I–III, Physics I and II, Probability and Statistics, discipline-specific engineering courses as shown in figure 8. These subjects are traditionally identified as high-demand and high-risk courses within engineering curricula. The focus of tutoring support in these areas suggests that the program plays a strategic role in strengthening conceptual understanding and supporting academic progression.

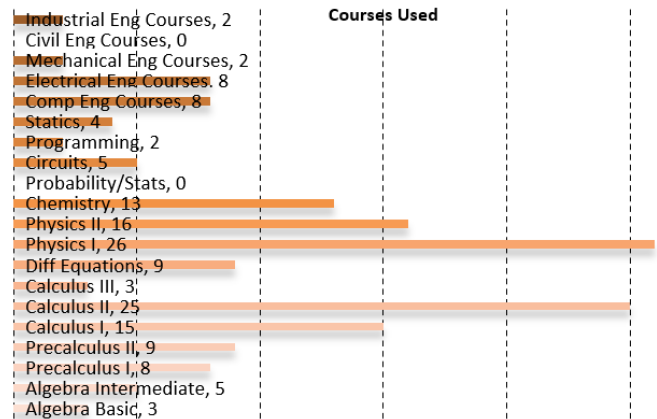


Fig. 8. Academic subjects

F. Factors Contributing to Program Effectiveness

Students identified several key factors influencing the quality and effectiveness of tutoring: Tutor subject-matter expertise, clarity of explanation, and availability of tutoring schedules.

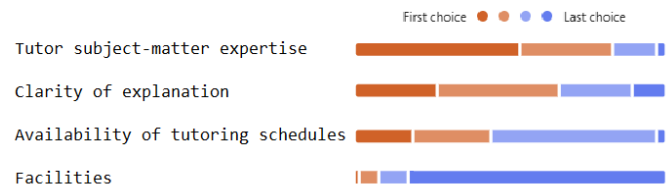


Fig. 9. Factors contributing to program effectiveness

Tutor knowledge and clarity were consistently ranked as the most important elements, highlighting the importance of tutor preparation and pedagogical competence as shown in figure 9. Figure 10 shows that students prefer person-to-person sessions over remote sessions.

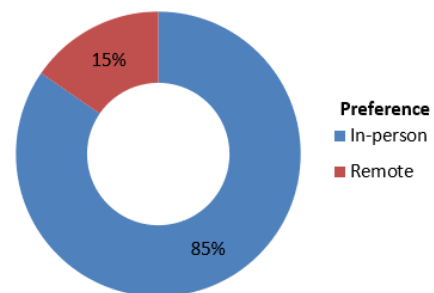


Fig. 10. Students' preferences

G. Areas of opportunity

Figure 11 shows the areas of improvement including schedule availability and extended hours of service (40%), providing opportunities for tutors to develop tutoring competencies (23%), and subject matter expertise (22%). The lack of pedagogic competencies may be seen as lack of subject mastery. These suggestions may enhance program reach, impact, and success.

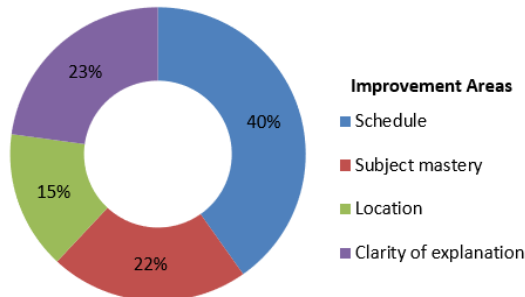


Fig. 11. Areas of opportunity

VII. DISCUSSION

The tutoring program demonstrates success across multiple dimensions, high perceived importance (98.5%), strong participation rate (69%), and high satisfaction among users (93% at least partially satisfied). Collectively, these indicators suggest that the tutoring program contributes positively to student learning experiences and academic persistence within engineering education.

These findings reinforce the value of structured tutoring initiatives as an evidence-based academic support strategy in engineering programs. By providing opportunities for qualified tutors to develop pedagogic competencies, conceptual clarity, and flexible scheduling, institutions can enhance student performance in critical gateway courses and potentially improve retention outcomes.

VIII. CONCLUSIONS

This study has highlighted the strategic importance of academic tutoring as a tool to enhance student performance, retention, and overall success in the engineering and technology programs at Ana G. Méndez University (UAGM). Through the analysis of institutional factors, student perceptions, and key elements of program implementation, it has become evident that tutoring goes beyond academic reinforcement—it serves as a comprehensive support mechanism that contributes to student motivation and persistence.

However, several challenges were identified that currently limit the effectiveness of tutoring services. These include low student participation, a shortage of specialized tutors, and the

need for greater technological integration within the tutoring system. In response, the university has a valuable opportunity to strengthen its academic support structures through strategies such as continuous tutor training, the strategic use of digital platforms, and the alignment of tutoring programs with broader institutional retention systems.

The findings of this study provide an empirical foundation to support institutional decision-making and contribute to the continuous improvement of academic support services at UAGM. Additionally, they open the door to future research focused on quantitatively assessing the impact of tutoring on academic success indicators or examining its effectiveness across different academic disciplines.

In an increasingly complex and diverse educational landscape, tutoring represents a concrete opportunity to personalize the learning experience, bridge academic gaps, and promote a university culture grounded in support, equity, and academic excellence

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