# Remedial Courses Effectiveness on Timely Graduation Rates and Degree Progression within Construction Engineering Students

**Prof. Carmen Paz Muñoz, Universidad Andres Bello, Santiago, Chile**

Carmen Paz has a degree in Civil Construction from the Universidad Técnica Federico Santa María and a master's degree in Real Estate Development from the Universidad de Chile. She has over 22 years of experience in the areas of concrete construction, the cement industry, ready-mixed concrete, construction process consultancy, and concrete deterioration and durability. In addition, she has more than 16 years of experience in university and field-based teaching. She is the Director of the Construction Engineering program at the Universidad Andrés Bello in Santiago, Chile, and a permanent contributing columnist for the Negocio & Construcción magazine. Her areas of interest include improving academic management in the Construction Engineering degree program and seeking new ways to enhance the experience of students and teaching professionals at the university. She also focuses her efforts on recruiting and retaining students to the program and ensuring they can learn key concepts in the most meaningful manner possible.

**Dr. Monica Quezada-Espinoza, Universidad Andres Bello, Santiago, Chile**

Monica Quezada-Espinoza is a professor and researcher at the School of Engineering at the Universidad Andres Bello in Santiago, Chile, where currently collaborates with the Educational and Academic Innovation Unit, UNIDA (for its acronym in Spanish), as an instructor in active learning methodologies. Her research interest topics involve university education in STEM areas, faculty and continuing professional development, research-based methodologies, community engagement projects, evaluation tools and technology, and gender issues in STEM education. https://orcid.org/0000- 0002-0383-0179

# Remedial courses effectiveness on timely graduation rates and degree progression within construction engineering students


## Abstract

This research paper concerns the field of academic management that aims to determine the impact of intensive remedial courses undertaken during summer periods in subjects with low pass rates related to the discipline of structures and structural analysis. The literature reviewed for this research concurs that intensive remedial courses can help improve students' academic performance. Moreover, the impact of such remedial courses on indicators, such as degree progression or completion times, can facilitate informed decision-making through which effective alternatives can be established to enhance the progress of students with low-performance levels. The methodology used is based on analyzing the degree progression and graduation times of sample groups of students from a Construction Engineering program at a private Chilean university. Degree progression and graduation time results of the following groups are compared: 1) students who pass the intensive summer remedial courses, 2) students who do not take or who fail the intensive summer remedial courses, and 3) students who pass the related courses during regular semesters. The results show that graduation times are positively impacted when students have passed intensive remedial courses. However, no statistically significant differences are observed between groups in the degree progression indicator, even though the average progression of students who passed intensive courses is 9% higher than those who did not enroll in or did not pass the remedial courses. Moreover, the former group demonstrates a similar rate of progression to that of students who pass their structure of structures during regular teaching periods. Consequently, this study establishes that the impact of intensive remedial courses is positive, albeit modest. In turn, its findings lay the groundwork for evaluating the performance of students from intensive remedial courses regarding additional indicators, including dropout rates and perceptions via the use of cases of success and failure.



***Keywords:*** academic progression; construction engineering; intensive remedial courses; timely degree


## Introduction

The construction industry in Chile accounts for approximately 9% of the national GDP. Although its dynamism has waned in recent years, construction remains a highly significant sector for national development [1]. Nevertheless, there are critical challenges to overcome in this sector, such as a housing deficit of approximately 600,000 homes and several ongoing public infrastructure projects. Indeed, the State has emphasized the importance of 52 public infrastructure projects with an estimated investment of USD13.258 billion [2]. The construction of these projects requires professionals capable of leading teams, managing, understanding, and complying with technical specifications. In particular, expert knowledge is needed regarding structural standards since these represent a critical component of the design and building stages of projects in a country so prone to seismic activity.

According to the Chilean General Law on Urbanism and Construction, competent professionals are legally authorized to exercise their respective professions. Nevertheless, they are held accountable for their actions or the omission of their responsibilities within the scope of their respective competencies. For these professionals to be able to participate in a construction project, they must prove that they possess a valid license and, therefore, a recognized professional degree and operate to that effect under the particular construction permit for every project. Hence, the term 'competent professional' is defined by the legislation mentioned above as "the architect, civil engineer, construction engineer or civil constructor,

who, within their respective areas of competence, is responsible for executing the tasks or works referred to in the General Law on Urbanism and Construction and the present ordinance" [3].

In general, science, technology, engineering and mathematics (STEM) degrees experience significant early-stage dropout due to several factors: course failure, for example, in subjects including physics and mathematics [4]; a low perceived importance of these courses for engineering [5-6]; a general perception of an excessive workload in engineering courses [7]; and the modality of the course in question, including asynchronous online courses [8], among others.

Related literature reports that remedial courses are used to address bottlenecks and students' delayed progress in their studies. There is a level of concurrence in the studies reviewed that remedial courses can contribute to improving students' academic performance. For example, a study in Taiwan into second-language learning found that remedial courses led to improved performance on final standardized tests and a perceived motivation to learn [9]. Likewise, De Benedetto et al. [10] report a positive long-term impact of remedial courses on students' academic outcomes in addition to their ability to complete a degree within reasonable time frames. The study mentioned above demonstrates that the probability of completing the degree within one additional year for students who have undertaken remedial courses increases by 12%; however, it has no impact on the final degree classification. In related subject areas, a study in Germany found that taking a remedial mathematics course improves student skills, increasing the probability of passing the final course exam by 35% [11]. It can be argued that remedial courses promote learning and allow students to study a subject in a shorter time frame. Considering that some university courses are taught solely annually, a student who fails one may suffer a delay in their degree progress and graduation due to that failure.

The professional education and training of construction engineers are fundamental, and within this education, the subjects with the highest failure rates are those related to the discipline of structures. The Construction Engineering (CE) degree about which this research is conducted consists of a syllabus in which the subject of Structures is compiled of five courses: Applied Statics, Structural Analysis, Timber and Steel Construction, Reinforced Concrete Construction, and Earthquake-resistant Construction. All five courses occur between the training program's fourth and eighth semesters. Researchers have identified this subject area as representing a historic bottleneck where students experience the highest failure rates in the entire degree program.

Courses in structures contain principles and concepts that are difficult to associate with real-life applications, including energy and stiffness methods, making them hard for students to pass [12]. A study by the University of Michigan contends that student success in STEM degrees depends on four critical elements: knowledge and skill development and other social and economic factors [13]. Specific courses have high failure rates beyond the first year, which can explain why the variability of student degree progression typically increases after that first year. Mabel & Britton [14] indicate that post-first-year dropout accounts for more than 40% of all university dropouts. Therefore, it is critical for educational institutions to support students and encourage their academic success in courses with high failure rates, thus promoting degree retention [14].
One of the measures the CE degree program has systematically implemented is intensive summer or inter-semester remedial courses. These aim to ensure that students complete the

course on time and graduate on time. It is also to address the theoretical shortcomings that caused the student to fail the course in the first place during the regular semester, which, it should be noted, represents a context in which the student is only dedicated to a particular subject. Generally, when students extend their studies longer than desired, they are more likely to drop out of the course and even fail to graduate because they have failed that course. Assuring adequate academic management, it is essential to consider specific indicators fundamental in this research: 1) timely graduation; and 2) degree progression, also known as the expected curricular advancement rate (ECAR). Both indicators can account for the effectiveness of efforts in this field.

First, timely graduation (TG) is an indicator that measures the over-duration of degree programs. The TG is the quotient of the number of actual semesters a student takes to complete a degree divided by the expected number of semesters of the degree program, where one is subtracted from the result (see Formula 1). The TG is expressed as a percentage, e.g., over-duration of 30% for a degree program that formally lasts ten semesters. This means that students with that degree take on average three semesters longer than the formal duration to complete their degree. In the present study, the average over-duration is taken as an average per student who belongs to a specific category or group, consulting the process of combining the standards of actual duration with the expected time.

(1) TG = (Number of actual semesters it takes a student to complete their degree / Expected number of semesters of the degree program) - 1

As a management target for 2021, the university in question set the on-time graduation rate at 23.1%, which was surpassed by a rate of 32.9% for the CE course.

Second, the ECAR defines the relationship between the pass level achieved and the pass level expected of each student, according to the year of program entry. This measures the ratio between the total metric units passed that have been accumulated by the student during the degree (in courses, credits, or others), divided by the expected number of units to have been accumulated according to their year of entry (see formula 2) [15].

(2) ECAR = (Accumulated approved units/ Expected units by year of program entry)

In Chile, this indicator was 84.4% in university degree programs administered in 2021, compared to 77.8% for degrees in the field of Technology. The CE degree analyzed in this study was 83.1% [15].

Following those mentioned above, this study aims to investigate whether there are significant differences between the rate of degree progress and timely graduation among students who: a) take and pass intensive remedial courses; b) do not take or fail intensive remedial courses; and c) do not take intensive remedial courses because they do not need to. The fulfillment of this objective illustrates the importance and impact of running annual summer remedial courses for the CE degree program.

The present paper is organized as follows: Section II introduces the methodology utilized and describes the research context and sample; Section III outlines the results of the study; Section IV provides a discussion of the findings; and Section V presents certain conclusions, research limitations and possible lines of future research.

## Methodology

*Methodological approach*

The present study is a quantitative experimental investigation. To analyze the rate of degree progression and timely graduation of CE students, non-parametric tests (Kruskal-Wallis at 5% significance level) were performed to find statistically significant differences between groups. In addition, the normality of the data was checked using probability plots (P-P plots), where it was found not to fit the normality model.

*Sample*

The sample is made up of CE students from a private Chilean university who were divided into two types: Type 1 (T1) concerned graduates and Type 2 (T2) active students. The information to consider in the case of T1 is how long it took them to complete their degree, counted in semesters. Regarding T2, the information relates to the degree progression, i.e., the progress in terms of what they should have achieved according to their year of program entry, which was 2022. Each type of student analyzed is described below.

*(T1) Graduate students: Timely graduation*

The universe of CE graduates consists of 847 alumni dating from the time of program inception, with data from 2009 up to and including the first semester of 2022, regarding students who had completed at least ten semesters at the university. Students who, due to transfers from other institutions, had passed many courses at the time of entry were discarded from this study. Students who had graduated but who, according to the study plan prior to 2017, did not have graduate status due to a failure to submit the required dissertation and/or undertake the necessary internship were also discarded. In addition, students were eliminated who, despite having graduated, had experienced some form of health condition (pregnancy, mental disorder, among others) that prevented them from enrolling in courses for more than six consecutive semesters during the period of analysis. Thus, the sample was reduced to 217 graduates. From within this sample, the backgrounds of students who had taken intensive remedial courses were reviewed, and the extent to which this may have impacted the overall graduation rate was assessed. Consequently, the sample was broken down further into three groups, (G1) 33 students who passed remedial summer courses in the area of structures; (G2) 35 students who failed their regular courses in the subject area of structures and did not take or pass remedial summer courses, and (G3) 146 students who successfully passed their structures courses during the regular semester.

*(T2) Active students: Degree progression*

The initial sample of 198 students is compiled from cohorts of CE students dating from 2015 up to and including those with an active status in the second semester of 2022. Students who temporarily withdrew from the degree program, those who transferred from another institution or degree program, those who have shown to be knowledgeable in English due to having achieved an ECAR factor of more than 1.0, and students who failed to enroll in subjects for more than six consecutive semesters were all eliminated from the present study. Consequently, the final sample was compiled of 125 students, which was broken down as follows. (G1) 25 students who passed remedial summer courses in the area of structures, (G2) 56 students who failed their regular courses in the area of structures and did not take/pass remedial summer courses, and (G3) 44 students who passed their structures courses during the regular semester.

*Context*

As of 2022, the CE degree program consisted of 198 active students, of whom 90.1% were men and 9.9% were women. The program has a formal duration of 10 semesters, and approximately 50 new first-year students are entering the program each year. The annual dropout rate for 2021 was 14%. The syllabus is arranged in 5 blocks, as shown in Figure 1.

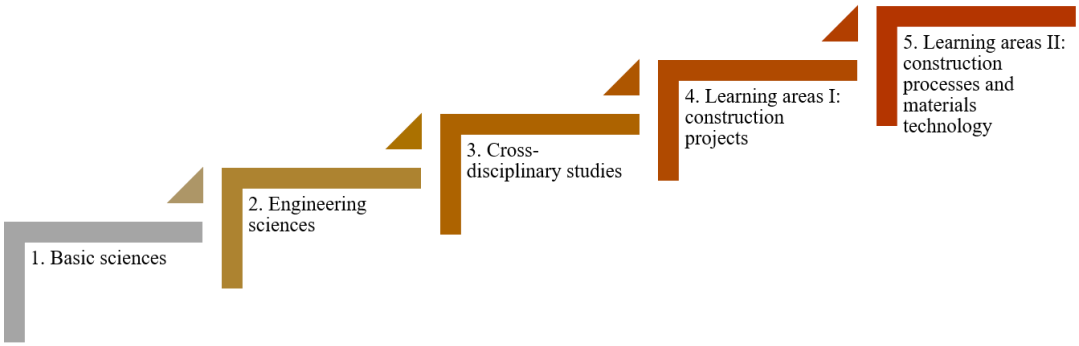


Figure 1. Construction engineering degree program blocks.

Within block 5 in Fig. 1 is the area of structures, which corresponds to the courses of Applied Statics, Structural Analysis, Timber and Steel Construction, Reinforced Concrete Construction, and Earthquake-resistant Construction. These courses form part of learning area II, which includes topics related to construction processes and materials technology. The prerequisite for taking the classes in structures is first to pass Applied Statics, which is taught in the fourth semester, once the student has already passed Introduction to Mechanics and Integral Calculus.

Program courses are taught semester-by-semester, divided into odd and even semesters. Consequently, if a student fails a course, he/she generally has to wait one year to re-enroll in that same course. This may delay enrolment in and the passing of subsequent courses, as well as final graduation. Occasionally, due to specific contingency-based reasons that may arise, some courses have been administered in an extra-semester manner. However, the degree program generally offers courses with historically high failure rates in the summer period. For example, Table 1 shows the pass rate of regular non-remedial courses in structures; while the pass rate for the CE program in 2021 was 89%, it was 67% in structures courses.

*Pass rate for structures courses*

To reiterate, the degree program in question has an overall pass rate of 89%. Table 1 shows the pass rates of the courses in structures during regular semesters.

Table 1. Pass rate of structures courses during regular semesters.

| *Course name* | *Pass rates (2017-2022)* |
|---|---|
| Applied Statics | 54.0% |

| | | |
|---|---|---|
| *Area of structures* | Structural Analysis | 61.4% |
| | Earthquake-resistant Construction | 88.2% |
| | Timber and Steel Construction | 78.7% |
| | Reinforced Concrete Construction | 64.3% |

As Table 1 shows, the Applied Statics course has a low pass rate (54%). This is the initial course in the area of structures, and it leads in to the Structural Analysis course, which in turn experiences the second lowest pass rate in this area.

*Intensive remedial courses in the CE degree program*

References to intensive remedial courses refer to courses administered outside the regular academic semester, i.e., between semesters during the summer. To participate, students must first register and then undertake the course exclusively and intensively. The study covers the same number of teaching hours as in the regular semester, albeit distributed over 3.5 weeks.

**Results**

Results are provided as follows: first, the descriptive and inferential analysis for graduate students (T1) is undertaken, in which timely graduation is analyzed; second, the descriptive and inferential analysis for active students (T2) is conducted, in which the rate of degree progression is analyzed. In both cases, the three subgroups mentioned in the methodology are compared, (G1) students who passed remedial summer courses in the area of structures, (G2) students who failed their regular courses in the area of structures and did not take/pass remedial summer courses, and (G3) students who passed their structures courses during the regular semester.

*Timely graduation*

Students are expected to graduate in 10 semesters. It should be noted that the Chilean Ministry of Education has emphasized the importance of this indicator since it provides valuable insight into the costs associated with professional training, and because it represents a higher cost-effectiveness ratio. For the student, the indicator reflects the hope that all their efforts, study and dedication will enable them to become a competent professional in order to embrace to world of work following graduation [16].

Table 2. Descriptive data for each group, by timely graduation indicator.

| | *G1* | *G2* | *G3* |
|---|---|---|---|
| | *Passed remedial course* | *Failed regular course and did not take/pass remedial course* | *Passed regular course* |
| Mean | 12.03 | 12.29 | 11.02 |
| Std. error | 0.31 | 0.33 | 0.22 |
| Median | 12 | 12 | 11 |
| Mode | 12 | 12 | 10 |
| Std. dev. | 1.79 | 1.93 | 2.63 |
| Sample var. | 3.20 | 3.71 | 6.89 |
| Kurtosis | 0.91 | -0.82 | 0.57 |
| Skewness | 1.12 | 0.50 | -0.10 |
| Range | 7.2 | 6 | 8 |

| | | | |
|---|---|---|---|
| Minimum | 10 | 10 | 10 |
| Maximum | 17.2 | 16 | 18 |
| Sum | 397 | 430 | 1609.2 |
| Count | 33 | 35 | 146 |
| Conf. level (95.0%) | 0.64 | 0.66 | 0.43 |

Due to the nature of the data, non-parametric tests were performed to analyze the sample distribution. Using the Kruskal-Wallis test performed in SPSS, statistically significant differences (at $p < .05$) were found between the groups ($p = .002$). For post-hoc multiple comparisons, t-tests with Bonferroni correction were used, and it was observed that the significant differences are between groups G1 and G3 with sig.= .007, and G2 and G3 with sig.= .007. It was also found that students in G3 (students who have passed structures courses during the regular semester) and those in G1 (students who, having failed structures courses during the regular semester, passed remedial summer courses) took less time to graduate than students in G2 (who did not take/pass an intensive remedial summer course even though they failed the courses during the regular semester).

As can be observed in Table 2, students in G1 (those who pass intensive remedial courses) take one semester longer to graduate than students in G3 (those who do not need intensive remedial courses). Students from G2 (those who do not take/pass an intensive remedial course) take a fraction of a semester longer to graduate than those from G1.

*Expected curricular advancement rate*

Degree progression, measured according to the ECAR, provides information about student progress in relation to a year of program entry. A student with a factor equal to 1.0 has enrolled and passed all the subjects in his/her study plan regarding the period from his/her entry to the degree program until the deadline date. Table 3 shows the descriptive data for the groups analyzed in terms of degree progression.

Table 3. Descriptive data for each group, by degree progression (ECAR) indicator.

| | *G1* | *G2* | *G3* |
|---|---|---|---|
| | *Passed remedial course* | *Failed regular course and did not take/pass remedial course* | *Passed regular course* |
| *Mean* | 0.87 | 0.79 | 0.81 |
| *Std. error* | 0.03 | 0.03 | 0.03 |
| *Median* | 0.93 | 0.85 | 0.87 |
| *Mode* | 1 | 1 | 0.96 |
| *Std. dev.* | 0.14 | 0.23 | 0.17 |
| *Sample var.* | 0.02 | 0.05 | 0.03 |
| *Kurtosis* | 2.19 | 0.76 | -0.31 |
| *Skewness* | -1.67 | -1.26 | -0.88 |
| *Range* | 0.52 | 0.85 | 0.58 |
| *Minimum* | 0.49 | 0.15i | 0.42 |
| *Maximum* | 1 | 1 | 1 |
| *Sum* | 21.81 | 44.38 | 35.59 |
| *Count* | 25 | 56 | 44 |
| *Conf. level (95.0%)* | 0.06 | 0.06 | 0.05 |

By means of the Kruskal-Wallis test performed in SPSS, statistically significant differences (with a $p < .05$) were found between the groups. As can be seen in Table 3, the students who took the remedial courses have a high ECAR, very close to the desired value (1.0). In terms of overall score, this group is followed by students who pass the courses in regular semesters. In this sense, it should be noted that intensive remedial courses in the summer can be taken not only by students who fail a course during the regular semester, but also by those who wish to accelerate their degree progress. By doing so, they gain an advantage over those who do not accelerate in the same manner during the summer.

**Discussion**

This research aimed to discover whether there are significant differences in the rate of degree progress and timely graduation between students who: a) take remedial courses and pass; b) do not take remedial courses and are left with a failing grade; and c) pass courses during regular semesters (and who do not take summer remedial courses). According to those mentioned above, there are statistically significant differences between the groups (G1 and G3; G2 and G3) concerning the timely graduation indicator. As seen by observing Table 2, such differences seem logical to infer. Although students who take remedial courses take one semester longer to graduate than those who do not fail these courses, they still take less time than those who fail and then do not take remedial courses. To reiterate, this is consistent with the findings of the study by De Benedetto et al. [10], who report that remedial courses are effective in improving student graduation times. However, the associated cost is that they need to acquire the necessary graduate skills to enter the labor market. Nevertheless, intensive remedial courses significantly impact the achievement of timely graduation. They could even be investigated further regarding their contribution to reducing dropout rates, as proposed in research undertaken by Mabel & Britton [14].

Significant differences were also found between the study groups regarding the degree progression indicator. Newell [17] contends that one of the main reasons why the degree progression of students who enter into engineering degree programs is negatively affected is the result of conceptual weaknesses and deficient mathematical skills. Therefore, it is important to analyze the reasons why students in the CE degree program experience difficulties in the area of structures. For example, interventions could be made in preceding courses before the failure rate grows (as shown in Table 1). By identifying significant differences in degree progression rates between courses, Table 3 demonstrates that students who take remedial courses achieve an ECAR of 0.87, a desirable number (very close to 1). In turn, that ECAR is higher than that achieved by their counterparts in the groups of students who do not take/pass remedial courses (0.79) or who pass the courses during the regular semester (0.81).

**Conclusions**

The present study explored the impact of remedial courses in structures in a Construction Engineering degree at a private Chilean university using the indicators of timely graduation and degree progression. The findings are partially in line with those reported in the literature. Intensive remedial courses in the summer favored timely graduation, improving graduation times by 25% compared to students who do not take such courses. The ECAR also differed between groups, suggesting that remedial courses offered to students who wish to accelerate their degree or make up for a failed course have a positive impact on their degree progression.

The limitations of this study are as follows: 1) the period of analysis, which included two periods in which both regular and remedial courses were taught in a remote format; 2) students who had passed more than one remedial course were included, whereby the passing of a remedial course or not is considered in binary terms; and, 3) students who had passed courses in other degree programs/universities and entered the degree program in question with equivalencies were excluded from the study.

The results of this study highlight two possible future lines of research: first, to investigate preceding courses related to concepts such as geometry, analysis of free body diagrams, and concepts of forces in order to uncover the root of the conceptual difficulties experienced by students in terms of passing the structures courses. A second pending line is to conduct a perceptions-based analysis of successful cases of students who, having enrolled and taken remedial courses, are not able to pass them, either due to the effect of the teaching methodology involved, the design of the course itself, or other social, personal or contextual factors.

Finally, it is of the utmost importance to strengthen the degree program. This will help ensure that students have improved learning outcomes and are, therefore, better placed to adequately address this area of knowledge, which is critical to their subsequent success and performance as professionals.

**Acknowledgements**
The authors would like to acknowledge the leadership and financial support provided by the School of Engineering of the Universidad Andres Bello, Chile. They also express their gratitude to the Educational and Academic Innovation Unit (UNIDA) for its mentoring and guidance in the production of scientific articles in higher education research.

**References**
[1] R. Valladares y P. Barahona, «Chile: construction and real estate sector report», Security Group, Chile, Aug, 2021 [Online]. Available in: https://www.inversionessecurity.cl/sites/inversiones/files/documentos_descargables/Informe%20Sector%20Construcci%C3%B3n%20e%20Inmobiliario%2008.2021_1.pdf
[2] MOP (2022). Plan de infraestructura público-privada 2022-2026, *Ministerio de* obras *públicas*. [Online]. Available in: https://www.mop.gob.cl/plan-infraestructura/
[3] Biblioteca del Congreso Nacional, "Biblioteca del Congreso Nacional", *www.bcn.cl/leychile*. [Online]. Available in: https://www.bcn.cl/leychile/navegar?idNorma=13560&idVersion=2020-01-23.
[4] M. Singh, L. Sudak, y P. Egberts, «Mapping Conventional Teaching Methods and Learning Styles in Engineering Dynamics», in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana, jun. 2016, p. 25677, doi: 10.18260/p.25677 [Online]. Available in: http://peer.asee.org/25677.
[5] K. Soria-Barreto y S. Zúñiga-Jara, «Aspectos determinantes del éxito académico de estudiantes universitarios», *Form. Univ.*, vol. 7, n.o 5, pp. 41-50, 2014, doi: 10.4067/S0718-50062014000500006. [Online]. Available in: http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-50062014000500006&lng=en&nrm=iso&tlng=en.
[6] G. Zavala, A. Dominguez, A. Millan, y M. Gonzalez, «Students' Perception of Relevance of Physics and Mathematics in Engineering Majors», in *2015 ASEE Annual Conference and Exposition Proceedings*, Seattle, Washington, jun. 2015, p. 26.1435.1-26.1435.22, doi: 10.18260/p.24772 [Online]. Available in: http://peer.asee.org/24772.

[7] C. Saavedra-Acuna and M. Quezada-Espinoza, “Academic performance and factors that influence the desertion of engineering students: a study with a gender approach,” in 2022 *ASEE Annual Conference and Exposition Proceedings*, jun. 2022, p. 37128, [Online]. Available in: https://peer.asee.org/40998
[8] V. Jara-troncoso, C. Saavedra-Acuna, and M. Quezada-Espinoza, “Analysis of academic performance in continuing education programs: An evaluation of synchronous and asynchronous online platform usage,” in 2022 *ASEE Annual Conference and Exposition Proceedings*, jun. 2022, p. 37550. [Online]. Available in: https://peer.asee.org/41363
[9] C.-T. Chao y C.-J. Tseng, «The Effectiveness of Remedial Intensive Course: A Case Study of a Private University in Northern Taiwan», *Procedia - Social and Behavioral Sciences*, vol. 89, pp. 16-21, oct. 2013, doi: 10.1016/j.sbspro.2013.08.802. [Online]. Available in: https://linkinghub.elsevier.com/retrieve/pii/S1877042813029339.
[10] M. A. De Benedetto, M. De Paola, V. Scoppa, y J. Smirnova, «The Long-Run Effects of College Remedial Education», *SSRN Journal*, 2022, doi: 10.2139/ssrn.4114628. [Online]. Disponible en: https://www.ssrn.com/abstract=4114628.
[11] S. Büchele, «Bridging the gap – How effective are remedial math courses in Germany?», *Studies in Educational Evaluation, vol. 64, p. 100832, mar. 2020, doi: 10.1016/j.stueduc.2019.100832*. [Online]. Available in: https://linkinghub.elsevier.com/retrieve/pii/S0191491X19301099.
[12] S. E. Crespo Sánchez, M. X. Rodriguez-Paz, and L. Hernandez Carrasco. "A Challenge-based Teaching model for Structural Analysis Courses with Strategic Industry Partners", in 2022 *ASEE Annual Conference and Exposition Proceedings*, Minneapolis, USA, jun. 2022. [Online]. Available in: https://peer.asee.org/41348.
[13] C.-S. Davis, "Making Academic Progress: The University of Michigan STEM Academy", *WEPAN 2010 National Conference: Gateway to Diversity: Getting Results Through Strategic Communications*, 2011. [Online]. Available in: https://journals.psu.edu/wepan/article/view/58555
[14] Z. Mabel y T. A. Britton, «Leaving late: Understanding the extent and predictors of college late departure», *Social Science Research*, vol. 69, pp. 34-51, ene. 2018, doi: 10.1016/j.ssresearch.2017.10.001. [Online]. Available in: https://linkinghub.elsevier.com/retrieve/pii/S0049089X17300054.
[15] SIES, «Informe de avance curricular en la educación superior matrícula 2020», Ministerio de Educación, Education, dic. 2021 [Online]. Available in: https://www.mifuturo.cl/wp-content/uploads/2020/07/Informe-matricula_2020_SIES.pdf
[16] Palm, W. (2022). First-Year Engineering Living-Learning Communities Improve Four-Year Graduation Rates at a Small Private University. in 2022 *ASEE Annual Conference and Exposition Proceedings*, p. 37860. [Online]. Available in: https://peer.asee.org/41630.
[17] Newell, S. (2015). An exploration of attainment in leaving cert mathematics, and correlation, if any, with progression from first year civil engineering in GMIT. *Articles - School of Engineering*, *37*. [Online]. Available in: http://99.80.113.84/handle/20.500.12065/302.