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Assessing academic workload in computing engineering programs: A preliminary study

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Abstract— Assessing academic workload is a critical component of the educational process, given its importance in the health and performance of students. Several universities worldwide have evaluated their programs using academic credit systems as a reference by contrasting the expected and real academic workload through strategies based on surveys, focus groups, questionnaires, and logbooks. In this work, we perform a preliminary study by extracting information for curricular updating of our computing engineering programs based on academic workload. The related method is divided into four stages: (1) the designing of an informatic tool to manage the class-to-class activities; (2) the recording of the academic workload expected by academics; (3) the application of surveys to record the workload declared by students; (4) and the formulation of recommendations based on a mixed analysis that combines qualitative and quantitative elements. This preliminary study can be extended by analysing other educational contexts.

Keywords— Higher education, curriculum evaluation, Chile, credits, perception.

Recibido: 25 de noviembre de 2023. Revisado: 27 de febrero de 2024. Aceptado: 18 de julio de 2024.

Evaluación de la carga académica en programas de ingeniería informática: un estudio preliminar

Resumen— La evaluación de la carga académica es un componente crítico del proceso educativo, que influye directamente en la salud y rendimiento de los y las estudiantes. Diversas universidades alrededor del mundo han evaluado sus programas educativos utilizando sistemas de créditos académicos como referencia, comparando la carga académica esperada con la real mediante estrategias basadas en encuestas, grupos focales, cuestionarios y registros diarios. En este trabajo se realiza un estudio preliminar para obtener información relevante asociada a la actualización curricular de programas de ingeniería informática, centrada en la carga académica. La metodología empleada se divide en cuatro etapas: (1) el diseño de una herramienta informática para gestionar las actividades de clase a clase; (2) el registro de la carga académica esperada por los académicos y académica; (3) la aplicación de encuestas para captar la carga declarada por los y las estudiantes; (4) y la formulación de recomendaciones basadas en un análisis mixto que integra elementos cualitativos y cuantitativos. Este estudio preliminar tiene el potencial de expandirse a otros contextos educativos.

Keywords— Enseñanza superior, evaluación del currículo, Chile, créditos, percepción.

1 Introduction

Given its impact on student performance and health, students' academic workload distribution has become crucial in curriculum design, particularly with the recent COVID-19 pandemic. Academic overload, poorly scheduled activities, and lack of recreational time can increase students' stress levels [1], the likelihood of burnout [2], anxiety [3], depression [4], and a sense of helplessness [5]. These factors could affect the student's academic efficiency and motivation, promoting drug consumption, sleeping disorders, and avoidance of responsibility, among other negative phenomena [6].

To manage academic workload, universities have implemented student-centred curricular programs based on frameworks such as the European Credit Transfer and Accumulation System (ECTS) [7], the Credit Accumulation and Transfer Scheme (CATS) in the United Kingdom [8], or the Chilean Academic Credit Transfer System (SCT-Chile) [9]. Through their use, universities aimed to decrease academic pressure and promote students' mobility [10].

The academic credit systems typically determine the maximum number of credits a course can be assigned in a curriculum, considering the number of hours students must invest to achieve the learning goals. These hours include both classroom instruction and self-study at home. However, accurately quantifying the workload of self-study is often challenging, especially measuring the perceived workload [7]. Studies worldwide have attempted to estimate self-study workload through interviews, focus groups, surveys, logbooks, and questionnaires [7], [11]–[17], evidencing substantial differences between the planned, declared, and perceived workload reported by students [7], [14].

In 2019, Chile experienced a wave of social movements, where university students protested nationwide against the negative impact of academic overload on mental health. In this context, we conducted a review of the management of academic workload in undergraduate programs associated with the "Departamento de Ingeniería Informática (DIINF)" at the Universidad Santiago de Chile (USACH). Findings suggested that students were experiencing academic overload in some courses, also detecting issues with the consistency, quality, granularity, and completeness of records related to activity programming and academic workload estimation. Therefore, we propose an improved strategy to understand these findings comprehensively through a preliminary study. This study included four stages: (1) developing an informatics tool for managing class-to-class activities; (2) reviewing with academics the planned or expected academic workload of their courses; (3) applying surveys to capture the workload declared by students; (4) and formulating recommendations based on a mixed analysis that combines both qualitative and quantitative strategies.

The first stage's development has been thoroughly documented in [18]. The current work focuses on the remaining stages of the method, describing each of them and introducing the results achieved during the study of the fourth-level courses offered in the undergraduate programs of "Ingeniería Civil e Informática" (Bachelor's Degree in Computer Science and Information Technology Engineering) and "Ingeniería Civil Informática" (Bachelor's Degree in Computer Science Engineering) at the Universidad de Santiago de Chile.

This manuscript is structured as follows: Section II introduces the critical concepts related to academic workload, followed by Section III, which outlines this proposed method. The preliminary study results are presented in Section IV, while Section V provides an in-depth analysis of the findings. The final section summarises the main conclusions drawn from this study.

2 Background

2.1 Chilean Academic Credit Transfer System

In 2006, the "Consejo de Rectores de las Universidades Chilenas" (CRUCH) (Council of Rectors of Chilean Universities) proposed a unique academic credit system compatible with the European Credit Transfer System (ECTS) to be used at a country level [19]. Its primary purpose was to enhance the quality of academic programs by (1) considering the time required by a student to achieve learning outcomes and develop competencies in a specific curricular activity, (2) promoting the legibility of training programs and the transfer of academic credits between Higher Education Institutions, and (3) support the student mobility.

According to the SCT-Chile system, a full-time program typically considers 60 credits per academic year, each equivalent to approximately 45-50 hours of student work per week (1,440 to 1,900 hours for a full-time undergraduate program per year). Thus, a five-year undergraduate program requires 300 SCT-Chile credits to be completed [9].

Despite the positive impact, the SCT-CHILE implementation has faced challenges, including resistance from some academic institutions and the need for monitoring and evaluation to ensure its effective implementation [20].

2.2 Academic workload assessment

The related literature has formally defined different academic workloads [14], [21]. The expected or planned academic workload represents the theoretical hours students should dedicate to successfully achieve the learning goals for a specific course, activity, or academic period. This measurement is often established based on an academic credit transfer system. On the other hand, the declared academic workload refers to how much time a student declares to have dedicated to academic activities. It is a more objective measure than the perceived one, but it still depends on the student's self-assessment and honesty. The perceived academic workload involves the individual's subjective perception of the work associated with a particular course or academic period. Time management skills, prior knowledge, personal interest, and motivation influence it. Unlike the expected and declared workload, the perceived academic workload is usually measured not in hours but on perception scales. Understanding and addressing these different aspects of academic workload is essential in supporting students' well-being and improving their learning experiences.

The assessment of academic workload has been addressed using different approaches. The first of them is primarily aimed at balancing the planned academic workload at a curricular level [10], [22]–[26]. These approaches include different optimisation algorithms proposed to solve the Balanced Academic Curriculum Problem (BACP), which involves assigning courses to academic periods while satisfying prerequisite constraints and the workload defined by an academic credit system. For instance, the authors in [23] designed a curriculum based on course correlations, achieving workload balance by optimising prerequisite conditions in a Turkish university. Similarly, [10] proposed a quadratic integer programming model and genetic algorithms to analyse different undergraduate programs in Chile. In [26], the authors introduced functional solutions based on different classical metaheuristics. Recently, [27] addressed workload balance using the discrete firefly algorithm studying classical state-of-the-art data sets. These approaches typically operate through command-line interfaces, requiring code input without incorporating any visual interfaces.

A second group of approaches is focused on optimising different resources associated with the academic workload timetabling and scheduling, such as time, academics, rooms, and equipment, among other resources [28]–[32]. These approaches include popular software tools like Moodle and UPlanner and other notable solutions such as Celcat, UniTime, TimeEdit and aSc Timetables [33].

A third group of approaches has focused on analysing the real and perceived academic workload. In the context of healthcare programs in Chile, researchers in [34] and [35] developed a self-administered questionnaire based on a comprehensive literature review and two focus groups. This questionnaire helped measure students' actual and perceived academic workload. Similarly, researchers in [36] conducted a study using self-questionnaires among students at Universidad del Desarrollo by finding that the organisation of modules and professors' actions influence students' perception of workload. In another study by [34], students were surveyed to examine the impact of stressors, including academic workload, separation from school, and fears of contagion, on college students' stress and health during the COVID-19 outbreak at Universidad de Los Andes, Chile. Additionally, e-diaries and register books have been utilised as recording tools. Authors in [37] employed a weekly system register during the pandemic, revealing that reading, information preparation, and organisation are the most demanding activities. In [38], authors developed a self-registration system in which students reported investing more time than they initially believed was necessary.

The authors have also used surveys, interviews, and focus groups with professors and students in other countries to determine the academic workload. For example, at Universidad de Piura, Peru [39], researchers conducted surveys, interviews, and focus groups to gather data on academic workload. In [40], the authors examined the relationship between physical activity and academic workload in Colombian students using a self-questionnaire to identify unhealthy and healthy practices. Authors in [41] interviewed students at Universidad Veracruzana, México, looking for strategies for managing workload and curriculum progression. In [42], surveys were conducted with professors and students at Universidad Nacional de Buenos Aires, Argentina, to identify differences in perceptions and planned workloads between the two groups. The study also explored the connection between academic workload and mental health during the pandemic. Similarly, [43] conducted surveys and collected qualitative data on the perceived academic workload among undergraduate students, uncovering dissatisfaction with the university environment, particularly regarding academic workload, basic facilities, and services. This study was conducted at the College of Science and Technology, University of Bhutan. Using online questionnaires, authors in [44] measured student workload needs during online learning in Western India. In [45], authors introduced an e-diary, requiring participants to carry a study smartphone or a computer to record their processes or respond to questions, including COVID-19 testing.

3 Materials and methods

3.1 Materials

The “Departamento de Ingeniería Informática” at the USACH offers two daily undergraduate programs: “Ingeniería en Ejecución en Computación e Informática” and “Ingeniería Civil Informática”. The first lasts four years and eight semesters, whereas the second lasts five and a half, 11 semesters.

During the Social Movements 2019, students expressed concerns about the academic overload in these undergraduate programs in their fourth level or semester. Hence, our analysis focused on this curricular level. In the case of the first program, the courses involved were (1) “Análisis de Algoritmos y Estructuras de Datos” (Algorithm Analysis and Data Structures), (2) “Estructura de Computadores” (Computer Structure), (3) “Fundamentos de Economía” (Economics Fundamentals), (4) “Ingeniería de Sistemas” (Systems Engineering), (5) “Inglés II” (English II), and (6) “Paradigmas de Programación” (Programming Paradigms). The second one included (1) “Análisis de Algoritmos y Estructuras de Datos” (Algorithm Analysis and Data Structures), (2) “Análisis Estadístico para Ingeniería” (Statistical Analysis), (3) “Cálculo III” (Calculus III), (4) “Estructura de Computadores” (Computer Structure), (5) “Inglés II” (English II), and (6) “Paradigmas de Programación” (Programming Paradigms).

Table 1 includes the specific information for each 2020 and 2021 curriculum course. The STC-Chile column indicates the number of credits allocated to each course. The TEL column quantifies the number of 45-minute slots dedicated to Theory (T), Exercises (E), and Laboratories (L), representing the guided learning hours. The Hours per Week column displays the total hours assigned to each course based on the SCT-Chile credits, including guided and self-study hours. Lastly, the Self-study Hours per Week column indicates the time allocated for activities that do not involve direct guidance or supervision from a teacher or instructor.

At USACH, 1 SCT-Chile represents 30 hours per semester. Therefore, a 5 SCT-Chile course requires 150 hours in a 17-week semester, with an average of 8,8 hours per week, distributed between synchronous classes and autonomous work. A course with a TEL of 4-0-2 equals six blocks of weekly 45-minute synchronous classes, totalling 4,5 chronological hours. This results in 76,5 hours of synchronous classes for the semester. Consequently, students have 73,5 hours of autonomous work per semester or 4,3 hours per week. Each course planning was documented by the leading correspondent professor by recording the activities and the academic workload. The study focused on students who had studied fourth-level courses during the second semester of 2020 and the first semester of 2021, resulting in a total of 195 students.

All data processing and analysis were performed using R version 3.6.3 and RStudio version 1.2.5033 in an Intel (R) Core (TM) i7-3930K CPU 3.20GHz, six cores, 16 GB RAM and 2TB. Further methodological details are outlined in the following subsection.

3.2 Methods

To perform this work, we followed a methodological approach which considered four stages:

3.2.1 Developing an informatics tool for managing course activities considering the planned academic workload

During this stage, an informatics tool was developed to enhance the course organisation at the DIINF. The tool, created using the Scrum methodology [46], focuses on managing class-to-class activities efficiently by scheduling activities, assigning academic workloads, and monitoring students' progress while providing valuable statistics on their distribution. To ensure the tool’s effectiveness, a series of meetings were conducted with informatics engineering experts, educational specialists, lecturers, and academic managers.

These collaborative sessions were instrumental in defining the tool’s requirements and testing its advancements. Through iterative feedback and continuous refinement, the final version of the tool was meticulously evaluated for its functional capabilities. Details of this development can be found in [10] and [47].

Table 1: Fourth-level courses - Ingeniería en Ejecución en Computación e Informática and Ingeniería Civil Informática. The TEL quantifies the number of blocks of 45 minutes assigned for each course in terms of Theory (T), Exercises (E), and Laboratories (L) (Guided learning hours).

Undergraduate program	Courses	SCT-Chile	TEL	Hours per Week	Self-study hours per Week
Ingeniería en Ejecución en Computación e Informática	Análisis de Algoritmos y Estructura de Datos	5	4-0-2	8,8	4,3
	Estructura de Computadores	6	4-2-1	10,6	5,3
	Fundamentos de Economía	5	4-2-0	8,8	4,3
	Ingeniería de Sistemas	5	4-2-0	8,8	4,3
	Ingles II	3	0-0-2	5,3	3,8
	Paradigmas de Programación	6	4-0-2	10,6	6,1
	Total	30	20-6-7	52,9	28,2
Ingeniería Civil Informática	Análisis de Algoritmos y Estructura de Datos	5	4-0-2	8,8	4,3
	Análisis Estadístico para Ingeniería	5	4-2-0	8,8	4,3
	Cálculo III	6	4-2-0	10,6	6,1
	Estructura de Computadores	6	4-2-1	10,6	5,3
	Ingles II	3	0-0-2	5,3	3,8
	Paradigmas de Programación	6	4-0-2	10,6	6,1
	Total	31	20-6-7	54,7	30,0

Source: Own elaboration.

3.2.2 Planned or expected academic workload recording

A comprehensive approach was implemented to record and quantify the planned academic workload. Our team reviewed the plans defined by each lecturer for fourth-level courses to assess the proposed activities and the associated workload. Any additional observations or questions about the planning process were addressed and resolved collaboratively through email or meetings.

The informatics tool was used to record and organise the course plans in a structured and standardised format. By entering relevant information, such as activities, their associated planned workload, and any additional details, the tool provided a unified framework to manage and analyse the planned academic workload.

3.2.3 Declared and perceived academic workload recording

A survey was designed to accurately record the students' declared and perceived academic workload. Before the application, the survey was reviewed by three educational experts external to the teamwork and approved by the institutional ethics committee of USACH. The designed instrument is available in the USACH Research Data Repository.

The survey was available to fourth-level students from August 3rd to 10th, 2021. Out of a total of 195 students, 47 voluntarily completed the survey after providing informed consent to participate. Before their participation, the students were informed about the purpose of the survey, and measures were taken to ensure the data anonymisation and keep the confidentiality through an informed consent.

The survey included 33 questions centred on three areas. The initial set of questions aimed to obtain data regarding the academic workload declared by the students.

The second set focused on mapping the real workload distribution across different courses to identify differing workload intensity levels and ensure a fair allocation of academic responsibilities.

The final set involved self-study work and its description. This aspect aimed to understand the amount of independent time studying and preparation students were engaged in outside formal class hours. We completed this stage by recording each student's evaluation score by course to complement our analysis.

3.2.4. Data analysis

The analysis employed a mixed methodology, combining the strengths of qualitative and quantitative approaches. This allowed for a comprehensive analysis of the academic workload data, utilising descriptive and inferential statistics. The goal was to estimate the planned academic load for different semesters, compare the balance of workload distribution, and identify any discrepancies between the estimated, declared effective load and performance. Additionally, the study aimed to identify either overestimated or underestimated courses in workload.

4 Experimental results

This section presents the experimental results, following the same stages outlined in the previous section.

4.1 Developing an informatics tool for managing course activities considering the planned academic workload

The evaluation of the informatics tool involved different stages. Initially, educational managers from DIINF provided a successful validation for the modelling processes associated with the informatic tool's design. This validation focused on views, mock-ups, and diverse user roles. Subsequently, after the informatic tool's development phase, the tool was functionally tested by different kinds of users. In the third stage, the tool was assessed by ten managers and academics who participated in a survey based on Nielsen heuristics, utilising a rating scale ranging from 0 to 5 [48], where a higher score indicated better performance. The evaluation included diverse dimensions, yielding average quality scores for visibility (4,4), design (3,6), navigation (3,8), consistency (4,0), recognition (3,8), error prevention (3,0), aesthetics (4,2), data treatment (4,0), educational resources (3,6), and satisfaction (4,0). In the final stage, diverse performance and acceptance tests were effectively realised and yielded successful outcomes. Details of this evaluation can be found in [18], [47].

4.2 Planned or expected academic workload recording

Assessing the plans defined by each lecturer for fourth-level courses reveals different degrees of comprehensiveness (see Table 2). Most courses exhibited detailed plans, including scheduled lessons by date (column 2), unit breakdowns (column 3), content descriptions (column 4), evaluations and activity details (columns 5 and 6). However, only "Estructura de Computadores" included additional information associated with the self-study hours regarding each activity (column 7). We collaborated with the lecturers through meetings or email correspondences to address this gap, using the SCT-Chile credits as a reference (column 8).

For courses like "Fundamentos de Economía", "Análisis Estadístico para Ingeniería", and "Cálculo III", which are coordinated centrally by the "Facultad de Ingeniería" (Engineering Faculty) instead of DIINF, we completed the related plan using the information provided through email by the coordinator manager. Given the unavailability of a detailed plan for "Inglés II", we considered only the planned academic workload in this study without specifying individual activities.

Fig. 1 provides a detailed overview of the weekly scheduled activities for the second semester of 2020 and the first semester of 2021, considering both the "Ingeniería en Ejecución en Computación e Informática" and "Ingeniería Civil Informática" programs. Different icons have been employed to represent various activities, including laboratory sessions, university-scheduled exams, minor quizzes, homework assignments, and holidays. The dashed line means the weekly planned workload based on SCT-Chile credits. Furthermore, Sections Appendix S-A and S-B show the weekly course schedules for both periods and programs.

4.3 Declared and perceived academic workload recording

From 47 students' answers, we considered 38 responses for further analysis after applying a statistical filter. Among them, 13 belonged to the "Ingeniería en Ejecución en Computación e Informática" program (32%), while 26 were part of the "Ingeniería Civil Informática" program (68%). Figs. 2 and 3 show the students' survey answers regarding the perceived academic workload for the most and least demanding courses. Across both undergraduate programs, 80% of the students indicated that "Paradigmas de la Programación" required the most time to complete their activities. This course was followed by "Análisis de Algoritmos y Estructura de Datos", which received 20% of the votes from "Ingeniería en Ejecución en Computación e Informática" students and 10% from those in "Ingeniería Civil Informática". Additionally, "Cálculo III" shared this position with 10% of the votes in this program.

Undoubtedly, the course with the least demanding time was "Inglés II", reaching over 60% votes for both undergraduate programs. The rest of the votes are divided into the remaining courses associated with each program.

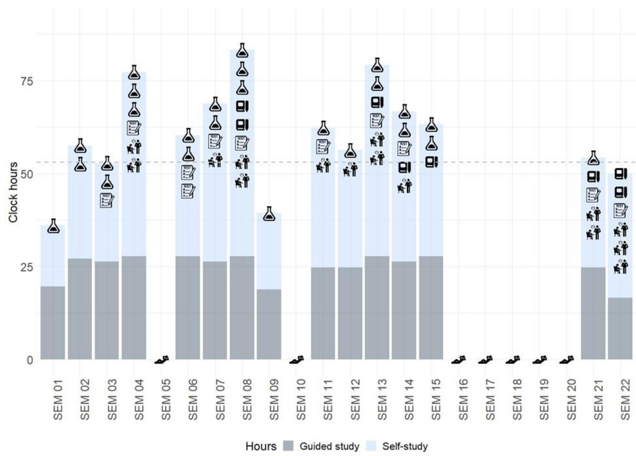
Figs. 4a and b show the self-study hours reported by students for each course in "Ingeniería en Ejecución en Computación e Informática" and "Ingeniería Civil Informática", respectively. The coloured horizontal line represents the threshold of self-study hours defined by SCT-Chile credits to attain the corresponding learning objectives. Additionally, Figs. 5a and b present the self-study hours declared by students for each type of activity: reports, presentations, information retrieval, written exams and quizzes, exercises, and Moodle usage.

4.3 Data analysis

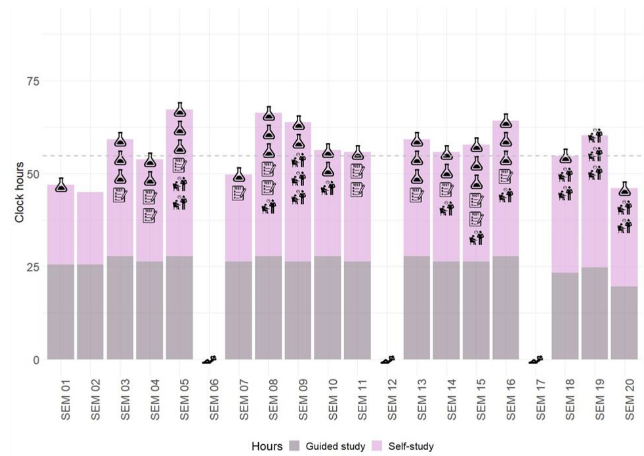
In addition to Fig. 4, the implementation of multiple one-sample Wilcoxon signed rank tests ($\alpha = 0{,}05$) uncovered interesting insights about the academic workload of courses within the "Ingeniería en Ejecución en Computación e Informática" program. The tests indicated an overload situation for "Paradigmas de Programación" and "Análisis de Algoritmos y Estructura de Datos", wherein the academic self-study workload declared by students exceeded the recommended SCT-Chile self-study hours (Table 3). On the other hand, in "Ingeniería de Sistemas" and "Inglés II", students answered they dedicated fewer hours than the SCT-Chile recommendation, potentially reflecting variations in perceived complexity and workload distribution. "Estructura de Computadores" and "Fundamentos de Economía" aligned closely with the reference workload. By considering a broader perspective, statistical analysis revealed no significant difference between the declared academic self-study workload and the SCT-Chile recommendation when considering the overall balance during the semester.

In the context of "Ingeniería Civil Informática", the course exceeded students' declared self-study workload was "Paradigmas de Programación". Notably, this diverged from the pattern observed in the other undergraduate program. Specifically, students reported dedicating fewer hours to "Análisis de Algoritmos y Estructura de Datos", which now resulted in closely aligned with SCT-Chile recommendations. Furthermore, across various other courses, including "Estructura de Computadores", students consistently reported dedicating fewer hours than the reference standard. Considering the global view, students are allocating less time than the SCT-Chile guidelines, considering their self-declared workload.

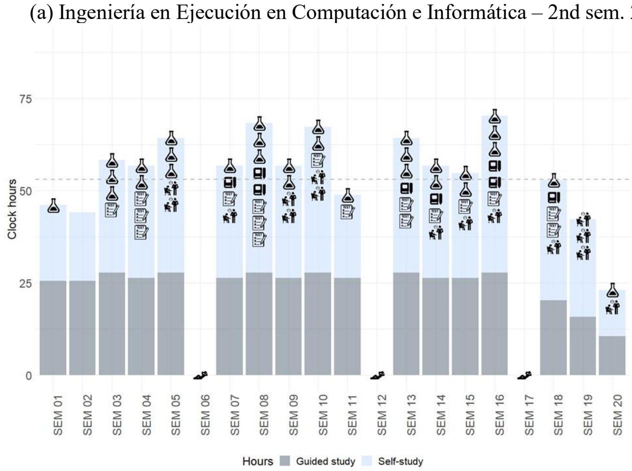
The statistical analysis found no significant differences between the declared academic self-study workload and the scores across both undergraduate programs. However, using



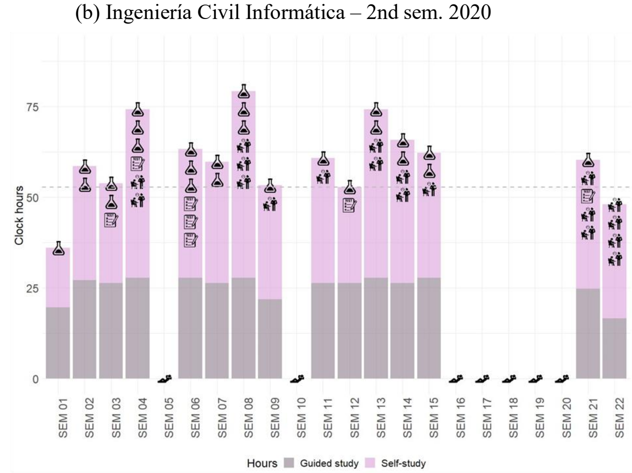
(a) Ingeniería en Ejecución en Computación e Informática – 2nd sem. 2020



(b) Ingeniería Civil Informática – 2nd sem. 2020



(c) Ingeniería en Ejecución en Computación e Informática – 1st sem. 2021



(d) Ingeniería Civil Informática – 1st sem. 2021

Fig. 1: Weekly planned activities and academic load associated with the fourth-level courses. The icon represents the period of holidays, corresponds to laboratory experiences, includes university-scheduled exams, represents minor quizzes, and includes homework activities. The dashed line represents the weekly workload based on SCT-Chile credits. Source: Own elaboration.

Source: Own elaboration.

Table 2: Course planning overview - Planned academic workload.

Courses	Dates	Units	Content	Evaluations	Formative activities	Planned workload	Communication
Análisis de Algoritmos y Estructura de Datos	✓	✓	✓	✓	✓	✓	✓
Análisis Estadístico para Ingeniería	✓	✓	✓	✓	✓	✓	✓
Cálculo III	✓	✗	✓	✓	✓	✓	✓
Estructura de Computadores	✓	✓	✓	✓	✓	✓	✓
Fundamentos de Economía	✓	✓	✓	✓	✓	✓	✓
Ingeniería de Sistemas	✓	✓	✓	✓	✓	✓	✓
Ingles II	✗	✓	✗	✗	✗	✗	✗
Paradigmas de Programación	✓	✓	✓	✓	✓	✓	✓

Source: Own elaboration.

pairwise comparisons, Dunn's all-pairs test adjusted by Holm over the declared self-study workload indicated that students in both undergraduate programs allocate significantly more hours to preparing for written exams and reports than other activities (α = 0,05). Furthermore, the activity that received significantly less commitment in terms of the self-studied workload declared by students was Moodle usage. These results are complementary to Fig. 5.

Figs. 6a and b show the correlation and the related linear regression analysis between students' self-study-declared hours in undergraduate programs and their scores across all courses. However, the observed relationship lacks statistical significance due to the limited sample size and a low R2 coefficient measuring below 0,06 (Square of the Pearson correlation coefficient). Section

Despite the R2 coefficient's value, these linear regressions can still be utilised to determine the score associated with each course students could achieve by dedicating the planned self-study hours defined by SCT-Chile (Scores SCT). Additionally, the regressions provide insights into the number of hours required to attain the maximum score in a course (Hours 7,0).

At a purely quantitative level, results in Table 4 indicate that although students in the "Ingeniería en Ejecución en Computación e Informática" program dedicated the recommended hours to self-study, they still failed "Análisis de Algoritmos y Estructura de Datos" and "Paradigmas de Programación". These courses demand 10,4 and 11,7 hours to attain the highest scores and achieve the learning goals. This implies that students must invest twice the amount of time compared to the recommended reference hours. A similar pattern emerges among students in the "Ingeniería Civil Informática" program for "Cálculo III" and "Paradigmas de Programación". However, students require less time than recommended to reach good results in the rest of the courses.

Fig. 7 illustrates the correlation between scores and selfstudy declared hours for each course, revealing distinct and significant correlations. Notably, students from the "Ingeniería en Ejecución en Computación Informática" program exhibit a significant positive correlation between self-study hours e dedicated to (1) "Estructura de Computadores" and "Paradigmas de Programación", (2) "Análisis de Algoritmos y Estructura de Datos" and "Ingeniería de Sistemas", (3) "Análisis de Algoritmos y Estructura de Datos" and "Estructura de Computadores", as well as (4) "Inglés II" and "Fundamentos de Economía". Similarly, an equivalent pattern emerges in their scores, highlighting associations between (1) "Estructura de Computadores" and "Ingeniería de Sistemas", (2) "Análisis de Algoritmos y Estructura de Datos" and "Paradigmas de Programación", and (3) "Análisis de Algoritmos y Estructura de Datos" and "Estructura de Computadores".

For students from "Ingeniería Civil Informática", several correlations emerge between the self-study hours allocated to different courses. There are correlations between (1) Ingeniería de Sistemas" and "Fundamentos de Economía", (2) "Estructura de Computadores" and "Fundamentos de Economía", as well as (3) "Inglés II" and "Ingeniería de Sistemas", (4) "Ingeniería de Sistemas" and "Estructura de Computadores", (5) "Ingeniería de Sistemas" and "Paradigmas de Programación", and (6) "Paradigmas de Programación". Given the prevalence of positive correlations and the absence of negative correlations, the findings could suggest that students tend to distribute their study hours across all courses without adversely affecting their commitment to studying other subjects. Moreover, students who do not allocate study hours tend to apply this approach consistently across all courses.

5 Discussion

Evaluating the academic workload for students in both undergraduate programs unveiled a substantial discrepancy inthe workload of specific courses relative to the SCT-Chile reference. Courses such as "Paradigmas de Programación" and "Análisis de Algoritmos y Estructura de Datos" showed students dedicating almost twice the recommended hours. This empirical data resonates with the opinions associated with the students during the 2019 meetings However, a broader perspective on the academic workload throughout semesters reveals a contrasting picture. Students, on average, dedicated the same or even fewer hours than the SCTChile benchmark to several courses. Courses such as "Fundamentos de Economía", "Inglés II", "Ingeniería de Sistemas", Análisis Estadístico" and "Estructura de Computadores", particularly "Ingeniería Civil Informática" showed less dedication yet yielded relatively high scores.

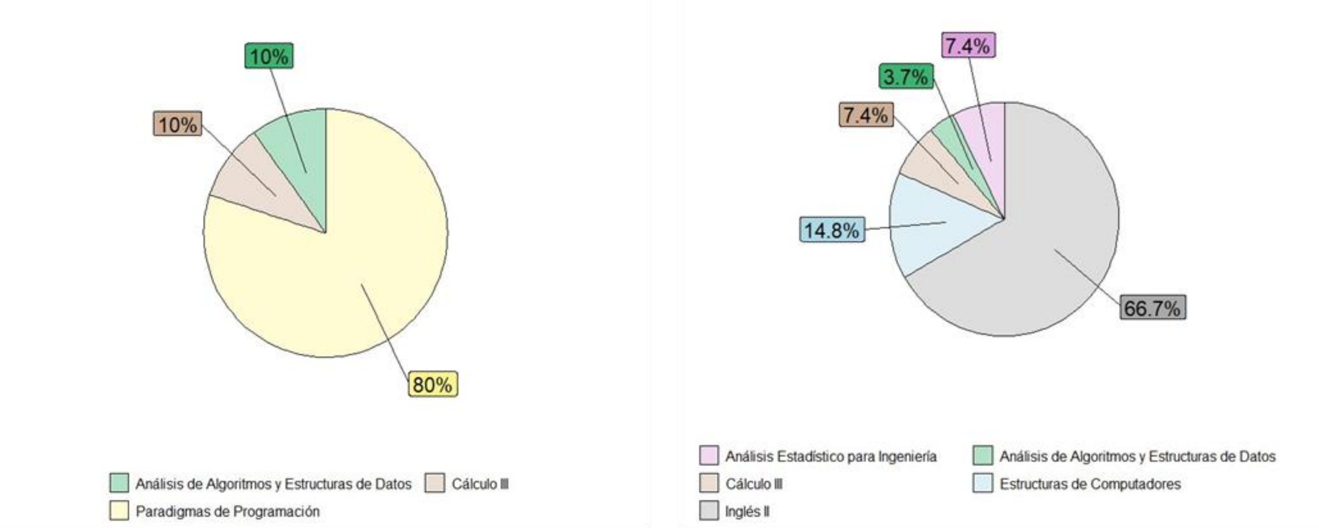
Intriguingly, even a traditionally challenging course like "Cálculo III" fell below the reference in dedication. Qualitatively, this balanced approach to workload suggests that students did not prioritise one course over another but instead sought to manage their academic commitments in males under 25 balancing academia with employment and, in many cases, familial or parental responsibilities. Furthermore, significant proportion of these students retake these courses, which could account for the reduced study hours compared to first-time takers.

In our analysis, we observed that despite the lack of a significant correlation between academic performance and study hours across both undergraduate programs—a result anticipated given the sample size—several courses exhibited a negative correlation between these variables. One plausible explanation might be the discrepancy between students' perceived study hours and the actual time dedicated to their studies, indicating a potential overestimation of study effort.

Alternatively, this negative correlation could be explained from the detrimental effects of workload overload on academic achievement. Furthermore, the quality of study time deserves attention; it is conceivable that reported study hours include periods filled with distractions, such as the use of mobile phones or television, or are impacted by stress, personal circumstances, or an unsuitable study environment. These factors could significantly diminish the effectiveness of study time, suggesting that not all study hours are equally productive [49]. Addressing these complexities requires an additional approach to understanding the dynamics between study habits and academic outcomes, pointing toward the importance of qualitative aspects of study time including quantitative measures.

Our study had its limitations. While we meticulously examined the declared academic load, the perceived load, a crucial metric for understanding student stress, burnout, and other relevant emotional factors, was not comprehensively explored. Nevertheless, the findings have already proven valuable. Academic managers have integrated the early results into the curricular redesign for the 2020 "Ingeniería Civil en Informatica" program. The newly designed curriculum now staggers the identified overload courses across different semesters and emphasises scheduling academic activities to mitigate simultaneous assignments, which can amplify perceived workload.

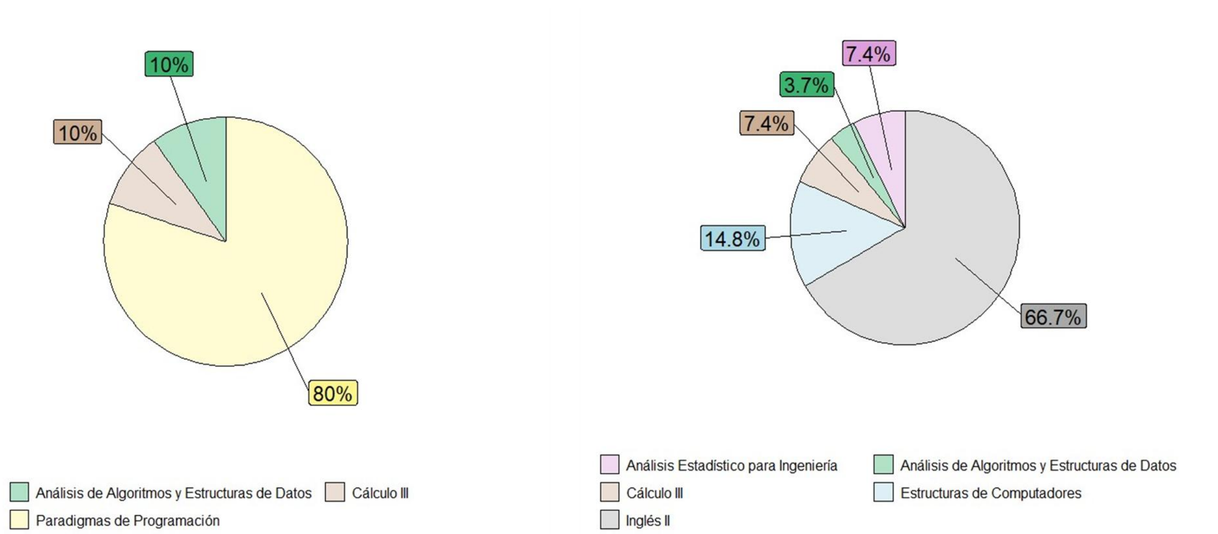
Our future efforts are aimed at refining our analytical tools. We will tend to concentrate on perceived academic loads by integrating retrospective self-reports [50]–[52].



(a) Preference for the course with the highest academic load among students in Ingeniería en Ejecución en Computación e Informática.

(b) Preference for the course with the lowest academic load among students in Ingeniería en Ejecución en Computación e Informática.

Fig. 2: Courses with the highest and lowest perceived academic load among students in Ingeniería en Ejecución en Computación e Informática. Source: Own elaboration.



(c) Preference for the course with the highest academic load among students in Ingeniería Civil Informática.

(d) Preference for the course with the lowest academic load among students in Ingeniería Civil Informática.

Fig. 3: Courses with the highest and lowest perceived academic load among students in Ingeniería Civil Informática. Source: Own elaboration.

This would allow us to study the new curriculum's implications and compare student experiences during regular academic settings and unprecedented times, such as the past COVID-19 pandemic, which coincides with the application of the current study. However, since we have no baseline without this disruptive event, further conclusions cannot be inferred.

6. Conclusion

The study at Universidad de Santiago de Chile aimed to comprehend the academic workload of two Departamento de Ingeniería Informática undergraduate programs. This work was divided into four stages: (1) the creation of an informatics tool to streamline class-to-class activities; (2) collaborative reviews with

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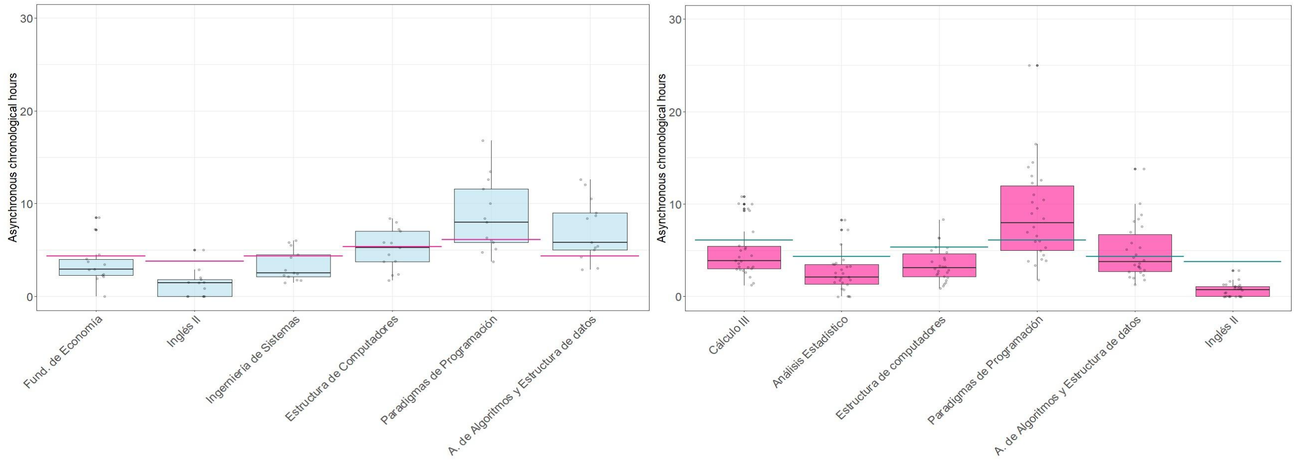

(a) Ingeniería en Ejecución en Computación e Informática

(b) Ingeniería Civil Informática

Fig. 4: Self-study hours declared by students for each course in Ingeniería en Ejecución en Computación e Informática and Ingeniería Civil Informática, respectively. Source: Own elaboration.

Table 3: Comparison between students' self-study declared academic workload and SCT-Chile reference by course and undergraduate program using the One-Sample Wilcoxon Signed Rank Test. Declared Load: Average and standard deviation of students' self-study declared academic workload in hours. SCT-Chile Load: Planned self-study hours according to the SCT-Chile reference. P-value: Result from the Wilcoxon signed rank test (significant results are marked with *). Evaluation: Conclusion drawn from the statistical test. Scores: Average and standard deviation of scores (on a scale from 1 to 7, where 7 represents the highest and 4 is the minimum passing threshold). %Repeating: Percentage of students retaking the course.

Undergraduate program	Courses	Declared load	SCT-Chile load	p-value	Evaluation	Scores	%Repeating
Ingeniería en Ejecución en Computación e Informática	A. de Algoritmos y Est. de Datos	7,1±3,3	4,3	*0,01	greater	4,8±1,8	38%
	Estructura de Computadores	5,1±2,2	5,3	0,36	equal	5,4±0,8	15%
	Fundamentos de Economía	3,5±2,2	4,3	0,07	equal	4,5±0,6	8%
	Ingeniería de Sistemas	3,3±1,7	5,3	*0,00	lower	5,1±0,9	8%
	Inglés 2	1,3±1,5	3,8	*0,00	lower	6,6±0,4	0%
	Paradigmas de Programación	8,7±3,4	6,1	*0,05	greater	5,2±0,7	8%
	Total	29,0±10,5	28,2	0,44	equal	5,5±0,5	-
Ingeniería Civil Informática	A. de Algoritmos y Est. de Datos	4,7±1,1	4,3	0,41	equal	4,7±1,1	15%
	Análisis Estadístico para Ingeniería	2,5±2,1	4,3	*0,00	lower	4,9±0,9	15%
	Calculo III	4,8±2,8	6,1	*0,04	lower	4,0±1,0	42%
	Estructura de Computadores	3,4±1,8	5,3	*0,00	lower	5,6±1,2	0%
	Ingles II	0,7±0,7	3,8	*0,00	lower	6,5±0,6	0%
	Paradigmas de Programación	8,9±5,1	6,1	*0,01	greater	4,7±1,4	19%
	Total	25,2±11,8	30.0	*0,02	lower	5,1±0,6	-

Source: Own elaboration.

faculty regarding the anticipated academic workload of their courses; (3) the deployment of surveys to gauge the self-reported workload of students; and (4) the derivation of recommendations based on a hybrid analysis integrating both qualitative and quantitative methodologies.

Our findings suggested that specific courses exhibited an academic overload, with students dedicating nearly double the recommended time to "Paradigmas de Programación" and "Análisis de Algoritmos y Estructura de Datos". However, when evaluating the workload across semesters, students, on average, either aligned with or even fell below the reference hours. The results also showed that students equitably distributed their academic commitments, refraining from one course over another. Nevertheless, other factors may reduce the efficacy of study sessions, indicating that not every hour dedicated to studying yields the same level of productivity. While the root cause of this overload might be attributed at first glance to the curricular implementation of the planned academic load, other pivotal factors could elucidate this phenomenon: foundational knowledge, initial experience, and personal determinants. However, these elements were not incorporated into our preliminary analysis, underscoring the necessity for subsequent research and potential refinements to our tools, with a concentrated focus on the academic workloads perceived by students.

Acknowledgments

We would like to thank the team associated with the "Proyecto InES Ciencia Abierta", USACH, for their contributions and support during this work.

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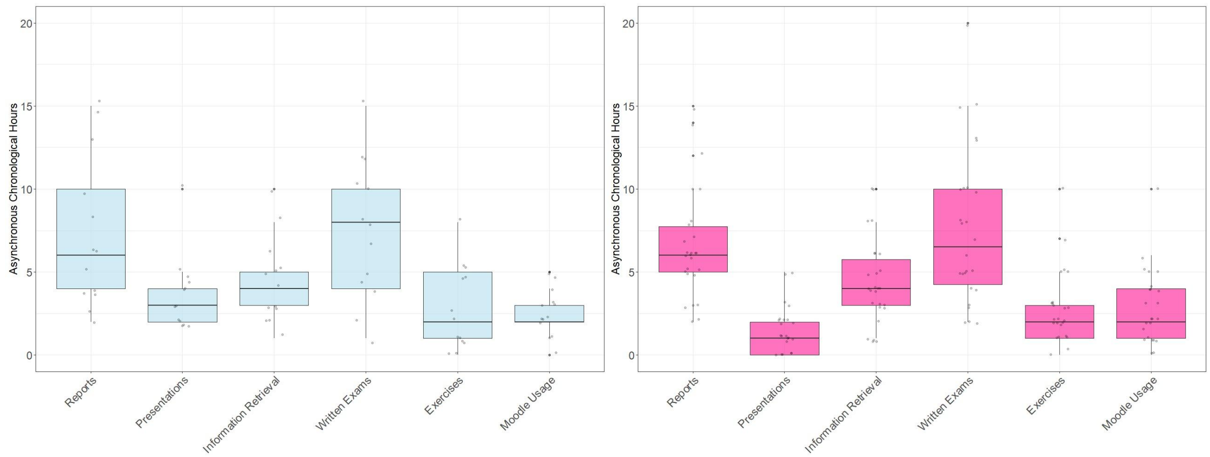


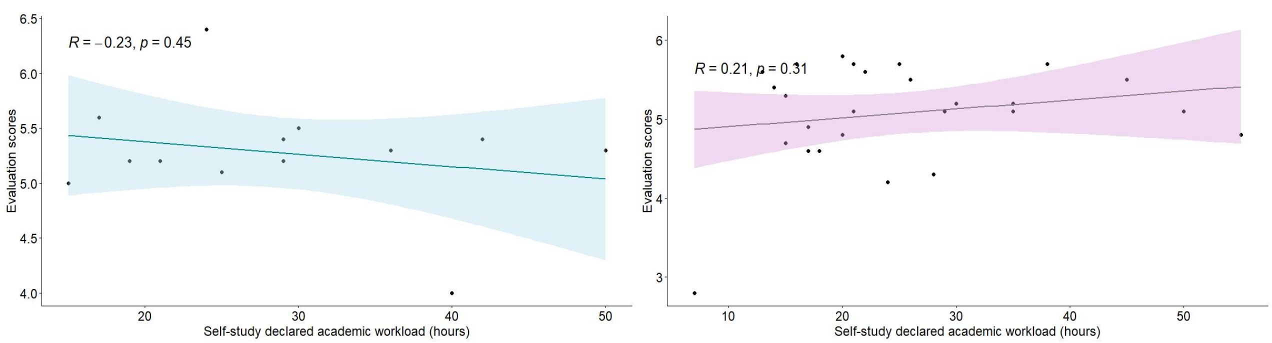
(a) Ingeniería en Ejecución en Computación e Informática

(b) Ingeniería Civil Informática

Fig. 5: Self-study hours declared by students for each type of activity. Source: Own elaboration.

(a) Ingeniería en Ejecución en Computación e Informática

(b) Ingeniería Civil Informática



(a) Ingeniería en Ejecución en Computación e Informática

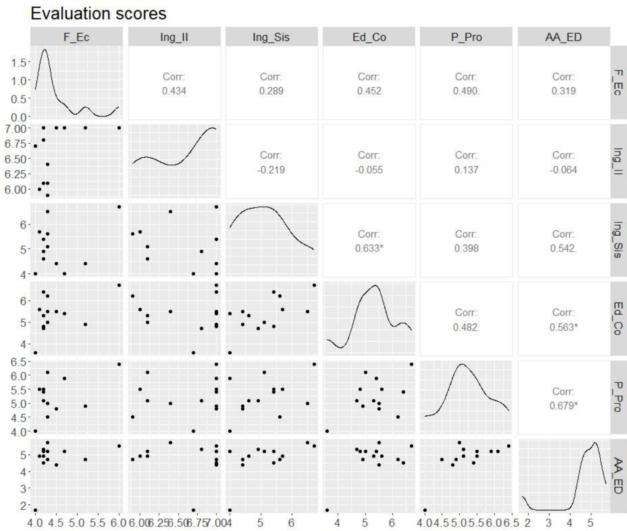
(b) Ingeniería Civil Informática

Fig. 6: Correlation chart between students' self-reported academic workload and their corresponding scores. Source: Own elaboration.

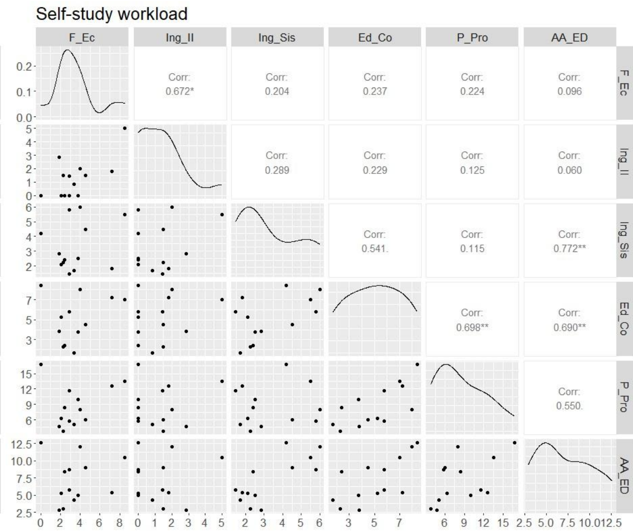
Table 4: Regression parameters derived from linear regression models for each course. Declared Load: Average and standard deviation of students' self-study declared academic workload in hours. Scores: Average and standard deviation of scores (on a scale from 1 to 7, where 7 represents the highest and 4 is the minimum passing threshold). SCT-Chile Load: Planned self-study hours according to the SCT-Chile reference. Scores SCT: Score obtained by dedicating self-study hours defined by the SCT-Chile load for a given course. Hours 7,0: Self-study hours a student would need to dedicate to achieve the maximum score of a course.

Undergraduate program	Courses	Declared load	Scores	SCT-Chile load	Scores SCT	Hours 7,0
Ingeniería en Ejecución en Computación e Informática	A. de Algoritmos y Est. de Datos	7,1±3,3	4,8±1,8	4,3	3,0	10,4
	Estructura de Computadores	5,1±2,2	5,4±0,8	5,3	6,7	6,6
	Fundamentos de Economía	3,5±2,2	4,5±0,6	4,3	5,4	3,1
	Ingeniería de Sistemas	3,3±1,7	5,1±0,9	5,3	6,7	4,5
	Ingles II	1,3±1,5	6,6±0,4	3,8	7,0	1,4
	Paradigmas de Programación	8,7±3,4	5,2±0,7	6,1	3,6	11,7
Ingeniería Civil Informática	A. de Algoritmos y Est. de Datos	4,7±1,1	4,7±1,1	4,3	4,1	7,3
	Análisis Estadístico para Ingeniería	2,5±2,1	4,9±0,9	4,3	7,0	3,6
	Calculo III	4,8±2,8	4,0±1,0	6,1	5,0	8,4
	Estructura de Computadores	3,4±1,8	5,6±1,2	5,3	7,0	4,5
	Ingles II	0,7±0,7	6,5±0,6	3,8	7,0	0,8
	Paradigmas de Programación	8,9±5,1	4,7±1,4	6,1	3,2	13,3

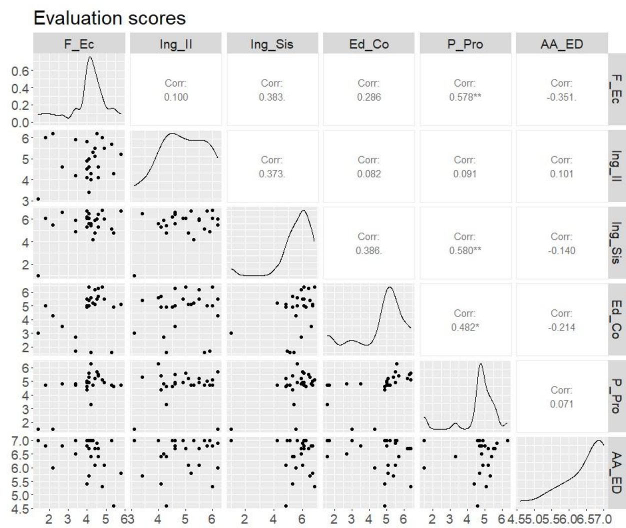
Source: Own elaboration.



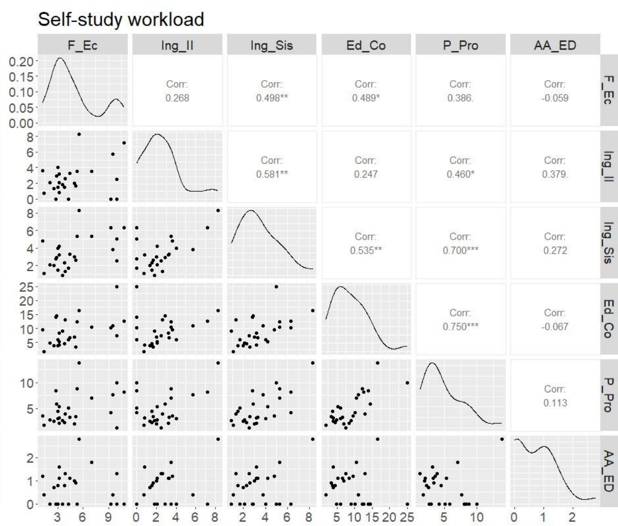
(a) Ingeniería en Ejecución en Computación e Informática



(b) Ingeniería Civil Informática



(a) Ingeniería en Ejecución en Computación e Informática



(b) Ingeniería Civil Informática

Fig. 7: Correlation between score and self-study declared hours regarding each course. Source: Own elaboration.