ACTIVE LEARNING DURING COVID-19 AT THE FI-UCSC: TEMPORAL ADJUSTMENTS?

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ABSTRACT

Chile's higher learning institutions have been strongly affected both by the country's social unrest which started in October 2019 and, since March 2020, by the global COVID-19 pandemic. As a result, the School of Engineering at the Universidad Católica de la Santísima Concepción, Chile, had to quickly adapt its programs from classroom-based education to the use of synchronous and asynchronous virtual learning environments. This article presents three case studies of adjustments made to the student-centered activities in different undergraduate engineering programs which have been following the CDIO 12 standards since 2011. In all cases, we adjusted the syllabi to focus on essential learning outcomes, chose teaching methodologies suitable for online learning, and revised our student assessment tools and techniques. The first case study covers a Computer Science introductory course, for which the teaching methodology was changed from the traditional lectures-and-labs approach to a methodology based on flipped classroom and virtual labs using MIT AppInventor. The second case study describes a Fundamentals of Mineralogy course in the Geological Engineering program, where in-person lectures and labs were replaced by flipped classroom and interactive video lessons using EdPuzzle. Finally, the third case study covers the Civil Engineering program's Reinforced Concrete course, where flipped classroom was also used, instead of lectures and face-to-face workshops. These case studies present novel experiences applicable to diverse engineering education contexts of high variability in terms of connectivity and equipment availability not only among students but also among instructors. Passing rates for these adjusted courses are satisfactory and very similar to those of previous years' classroom-based courses. The standard institutional instructor performance assessment survey was also adjusted to take virtual courses into account. Its results show that student favorably evaluate their online learning experiences. Instructors positively evaluate those online activities that promote autonomous learning and student collaboration and agree on the importance of creating an environment conducive to student participation in virtual classes.

KEYWORDS

Online Learning, Active Learning, Flipped Classroom, Standards: 4, 8, 10

INTRODUCTION

The School of Engineering of the Universidad Católica de la Santísima Concepción (UCSC) reformed the curricula of its five undergraduate engineering programs, based on the CDIO Initiative (Crawley et al., 2014). These curricula have been implemented since 2011 and aim to address problems such as too many technical courses, inflexible critical paths, and lack of personal and interpersonal skill development, leading to a decrease in student motivation (Loyer et al., 2011). These new programs follow a student-centered teaching and learning approach. The UCSC Teaching and Learning Center supports these programs by providing

faculty training programs that promote teaching skills development (CDIO Standard 10), and the adoption of active learning (CDIO Standard 8). An effective mechanism for these purposes has been the creation of teaching communities, where instructors can support each other in the development of their pedagogical innovations.

Due to inequalities in primary and secondary education, many of our students have deficiencies in their entry skills at the tertiary level. In October 2019, these same system-wide inequalities triggered a series of massive national public demonstrations that brought the people's discontent with the economic model, abuse of power and corruption to the fore. This, added to the pandemic's social and economic effects, forced a series of adjustments to the educational system's planning and teaching modes.

FRAMEWORK

Student entrance profile

According to the UCSC Self-Assessment Accreditation Report, the undergraduate student entrance profile is built using data provided by the Department of Evaluation, Measurement and Educational Registry (DEMRE) of the Universidad de Chile and data obtained from the UCSC Student Characterization Survey that qualitatively profiles new students. 79% of all students enrolled in the last 5 years comes from the Biobío region, where the University is located, while 10% come from the neighboring Ñuble region. Moreover, in the last 5 years, on average 31% of students do not live in the Concepción metropolitan area, so they must move from their home to follow higher studies at UCSC. In 2020, 51.9% of incoming freshmen come from public schools, 41.9% come from private subsidized schools, while only 3.6% come from private schools.

The vulnerability index is an indicator that represents a student's social, economic, psychological, cultural, environmental and/or biological risk. This indicator ranges from 0 (low vulnerability) and 1 (high vulnerability). UCSC freshmen come mostly from schools with a high vulnerability index. The average freshmen vulnerability index has increased by 0.24 points in the last 5 years.

Consistent with students' income profile, the University has increased the coverage and diversity of student support services, adding more hours of psychological, medical, and dental care, residence and transportation scholarships and mechanisms for academic support.

The 2019 UCSC Student Characterization Survey shows that students chose the University mainly for its prestige and teaching quality, and their study programs for their vocation and the field's job opportunities. They feel prepared for the university challenge and state that they have the necessary skills and academic requirements. However, at the same time, they state that they will need academic reinforcement to succeed in higher education and most of them expect to receive financial aid to pay for their studies. 13% of students report that they have parents with complete higher education. At the same time, 29% of students have siblings in higher education and a similar number of students have already had complete or incomplete higher education studies.

Few students state that they participate in community organizations, and, in a significant proportion, they expect to find at the University the opportunity to practice sports, arts, cultural and voluntary social assistance activities. 49% state that they will live with their parents while

they study, followed by 26% who state that they will live with other relatives. 11% of students have a child under 5 years old and thus need a support network for their care. Most feel supported by their network of family and friends. This also shows the diversity of new students' situations and contexts. This freshmen profile confirms that the main challenge for the University is being an effective source of opportunities for all students.

Given this situation, it is worth considering the Student Success CDIO standard proposed by González et al. (2018), which suggests a curriculum supported by the analysis and synthesis of information that allow taking effective actions to mitigate risk and vulnerability in the student population; with strategies focused on dropout prevention and student academic success. This implies an articulation of all student support units, such as finance management, academic records, among others. To meet this challenge, UCSC offers a series of articulated mechanisms, both for the students' professional education and for the expansion of their personal and cultural horizons, by generating academic and non-academic support devices and networks.

Educational Context

The sustained increase in coverage of Chilean higher education (Figure 1), which is accelerated by the Chilean Higher Education Law No. 21091, stating that *Higher education must be available to all persons, according to their abilities and merits, without arbitrary discrimination so that they can develop their talents. Also, higher education seeks the integral and ethical education of people, aimed to the development of autonomous and critical thinking, which encourages them to participate and actively contribute in the different areas of society life, according to their diverse talents, interests and abilities*. This statement not only implies a greater number of students accessing higher education, but also students differing in age, gender, economic situation, ethnicity, qualifications, cultural capital, and expectations. 70% of students who enter UCSC are the first ones in their family to enter higher education. AEQUALIS (2013) shows that young people who come from poor families and/or public schools in Chile are more likely to drop out of school and are less likely to graduate on time. Munizaga et al. (2018) compiles from a collection of related studies that the "Individual" factor appears associated to student dropout with the highest frequency. This factor includes "Motivation", "Adaptation" and "Vocational guidance". This forces institutions such as ours to take care of the students' particularities integrally and not only on academic or economic aspects.

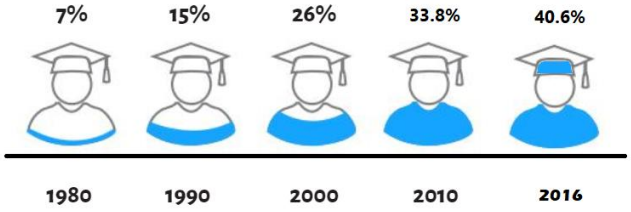

Figure 1. Evolution of higher education coverage in Chile (SIES, 2018).

The students' social and educational contexts require improving their educational readiness, to help them grasp the opportunities being offered to them; this means initial access, permanence and successful completion of higher quality and relevance studies, which are expressed in improved retention, student progress and employability. In this context, UCSC offers a student support structure, which includes the Student Support Centre - DAE, the Student Accompaniment Centre – CEADE, and the University Accompaniment and Access Unit - PACE.

The Student Support Centre contributes to the student's integral development by providing support in medical, dental, and psychological care, promoting healthy living programs, managing student benefits, supporting student inclusion programs and by promoting physical and recreational activities and their harmonic integration to the university environment.

The Student Accompaniment Centre (CEADE) is responsible for supporting students in levelling and strengthening basic skills required for their academic development, as well as in the insertion of freshmen to university life. CEADE provides support through integrated programs of language, mathematics, science, and personal development, which are carried out based on the undergraduate programs' specific requirements. It also manages the University Life Induction Program (PINVU), which seeks to strengthen freshmen skills during the first weeks and prepare freshmen for what university life is like.

Finally, the University Accompaniment and Access Unit hosts the PACE Program, which is responsible for preparing a group of vulnerable meritorious high school students through an integral accompaniment allowing them to have a successful university life.

Despite the existence of these initiatives offered by the UCSC to support students, as described previously, they generally do not articulate and do not include follow-up instances allowing for an effective intervention.

INSTITUTIONAL ADJUSTMENTS

Given the global, national, and local contexts previously described, our institution made a series of adjustments in terms of regulations, student-teacher interactions, methodologies, technological support, pedagogical competence for faculty, and academic support for students.

Regulatory adjustments

The Office of Academic Affairs established a series of transitory measures easing some of the processes and requirements related to course dropping, course attendance and grades. These measures are consistent with the Ministry of Education's flexibility guidelines for all educational institutions. This flexibility should consider difficulties and inequalities of access to good Internet connections or to adequate equipment, factors which degrade the quality of teaching at the beginning of the pandemic. The Center for Innovation and Teaching Development (CIDD) created a website for sharing information related to UCSC Teaching in virtual mode (http://cidd.ucsc.cl/docencia-ucsc-en-modalidad-virtual/).

Student-teacher interaction adjustments

Even though the University has had a Moodle-based e-learning platform called Virtual Learning Environment (EV@) for more than a decade, new audiovisual materials had to be prepared, which would allow for more efficient synchronous sessions, focused on student-centered practical activities. Classes had to transition from a classroom + asynchronous (EV@) approach to a synchronous + asynchronous (Zoom videoconference tool + EV@) one. Class time was reduced from 1 hour to 50 minutes, and a one-week break every four weeks of class was established to avoid overload and allow students to organize their study material. These adjustments were agreed upon along the way during the first semester of classes.

Methodological adjustments

Faculty who had already implemented a flipped classroom strategy were much better prepared for this adjustment, as modifications to their instructional designs were minimal. Faculty that followed more classical teaching practices had a harder time adjusting. Evaluation schemes had to be redesigned as a continuous evaluation process with several feedback sessions, focusing on essential knowledge and reducing the number of course exams.

Technological support adjustments

The Student Support Center took care of student connectivity issues through financing their internet data plans. The School of Engineering took care of faculty technology resource needs by acquiring web cameras, digitizing tablets, microphones, and computers. It also created the e-assistants program: students that aided teachers in designing virtual classes, audiovisual material, animations, videos, etc., or even supported the teachers themselves regarding the use and configuration of diverse ICT tools. The University also implemented a help desk for its different services to help with problems with institutional mail services, training on the student intranet use, University services connectivity problems, among others (https://ayuda.ucsc.cl).

Pedagogical competence adjustments

Thanks to financing from the USC 1799 project, an online Diploma in Innovation in University Teaching organized by LASPAU was taught from August to December 2020. This general-scope diploma was aimed at more than 100 faculty members from different academic units. A second STEM Diploma, financed by the USC 1899 project, will start in January 2021.

Student support adjustments

The Institutional Student Accompaniment Centre also adjusted their student support through an online academic support plan: tutorials, workshops, or interventions in courses. This online support was done by the center's staff and by the students making up the Student Tutoring Program (PTE). The official institutional platform for undergraduate teaching activities, the Virtual Learning Environment EV@, was used to carry out online academic support activities. This platform uses a set of tools to support students in their learning process. The EV@ platform was complemented by the Zoom application, to facilitate communications with students participating in the different academic accompaniment activities offered by the Centre. This virtual service was available since April 2020.

CASE STUDIES

In the following sections, we present three case studies of adjustments made to the student-centered activities in courses of the Computer Science, Geological Engineering and Civil Engineering undergraduate programs.

Introduction to Computer Science (IN1045C) in the Computer Science Program

Introduction to Computer Science (IN1045C) is a 3-section course taught during the 1st. semester of freshman year. This course was traditionally based on a programming project developed via in-person laboratories and teamwork with direct feedback. The course was adjusted to use a learning strategy based on the ADPT++ methodology (Martinez-Araneda et al., 2017) where problem analysis migrates to collaborative analysis and planning, supported

by a virtual Kanban board through Trello. Feedback was given both remotely by the teacher on a weekly basis and in synchronous direct feedback sessions. Similarly to the traditional version, MIT App Inventor was used in the design, implementation and testing phases, which now were done asynchronously. Synchronous Zoom sessions were used to give feedback throughout the process and for the final product presentations (see Figure 2). Student performance was similar to previous semesters (Figure 3), but course dropout rates, which usually are lower than 2%, increased to 5%.

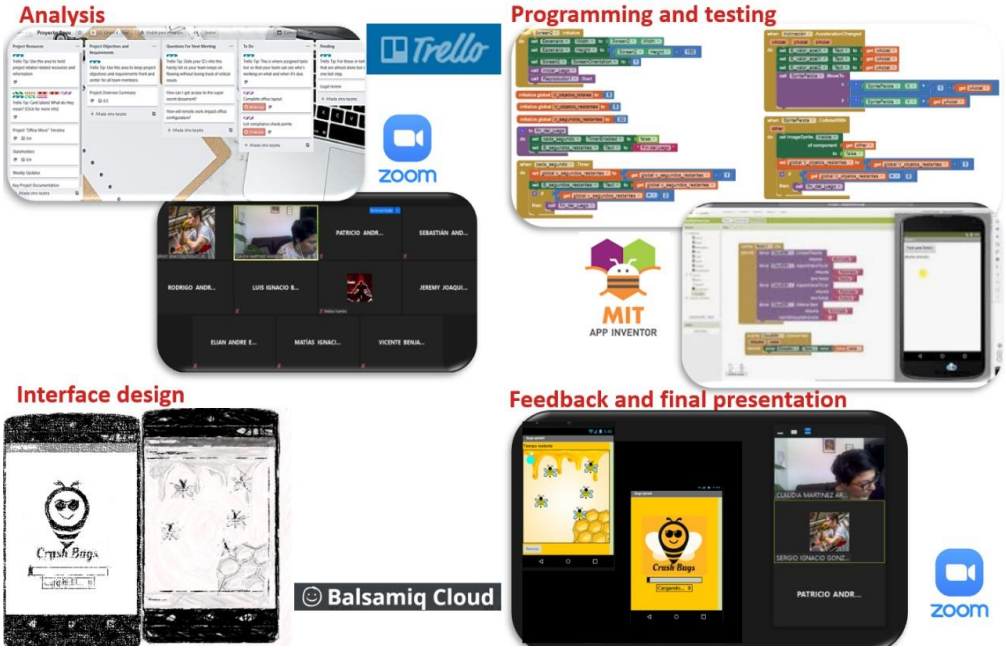

Figure 2. Introduction to Computer Science virtual course overview.

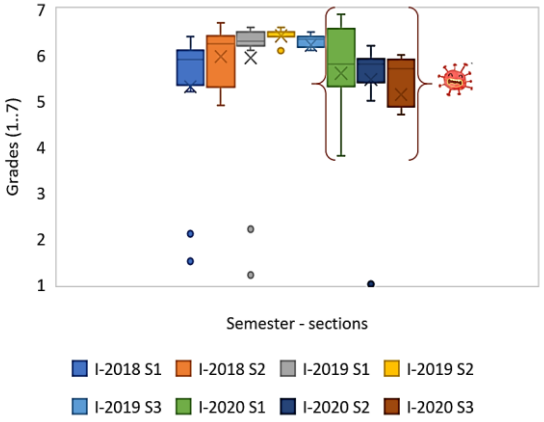

Figure 3. Introduction to Computer Science grades for the last 3 years.

Fundamentals of Mineralogy (IN1011C) in the Geological Engineering Program

This course belongs to the 3rd. semester of the Civil Geological Engineering program, and its main learning strategy has relied on practical activities such as laboratories and teamwork. These activities, which were usually carried out in person, had to be adjusted to this new context. To this end, demonstrations with mineral samples were carried out and filmed through the support of an auxiliary video camera, generating a set of audiovisual material that was

made available to students. Teamwork was handled by using Zoom breakout rooms, in which each team of students worked in solving the course learning guides, under the teacher's permanent monitoring, as shown on the left side of Figure 4. This work was complemented by the creation of schematic maps using Google Jamboard to promote peer learning.

Finally, to monitor the students' learning progress and to improve their motivation and engagement, individual and team formative assessments were applied during the semester, by using tools such as Socrative and Kahoot, as shown on the right side of Figure 4.

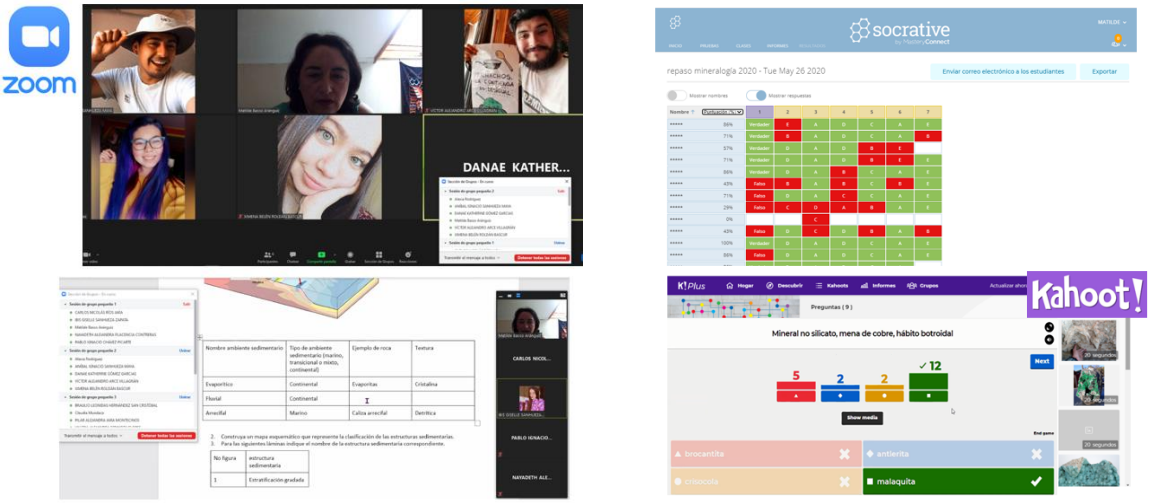

Figure 4. Fundamentals of Mineralogy virtual course overview.

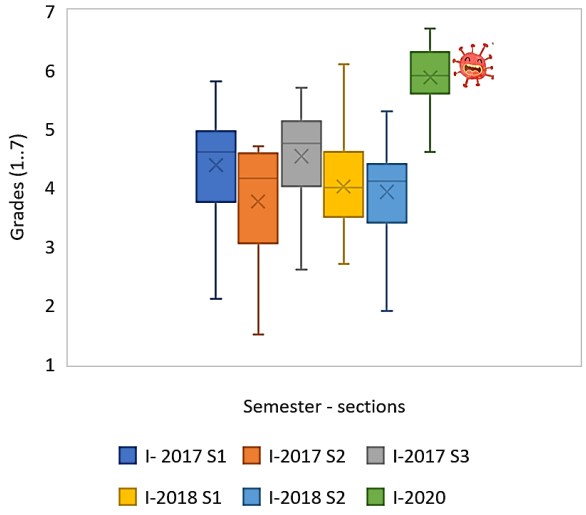

Figure 5. Fundamentals of Mineralogy grades for the last 4 years.

As shown in Figure 5, student performance improved in relation to previous years. This may be explained by the systematic use of formative assessments throughout the semester, which enabled both students and the teacher to make adjustments to the learning process.

Reinforced Concrete (IN1018C) in the Civil Engineering Program

Reinforced Concrete (IN1018C) belongs to the 10th. semester of the Civil Engineering program. The flipped classroom learning strategy traditionally used in this course was adjusted to the new teaching conditions. This course still relies on the use of theoretical content videos uploaded to YouTube and on intentional learning activities (complementary readings, exercises, among others), as shown in the right side of Figure 6. However, methodological changes were carried out by migrating team work to individual work. As shown on the left side of Figure 6, students had to make videos explaining theoretical topics using concrete materials.

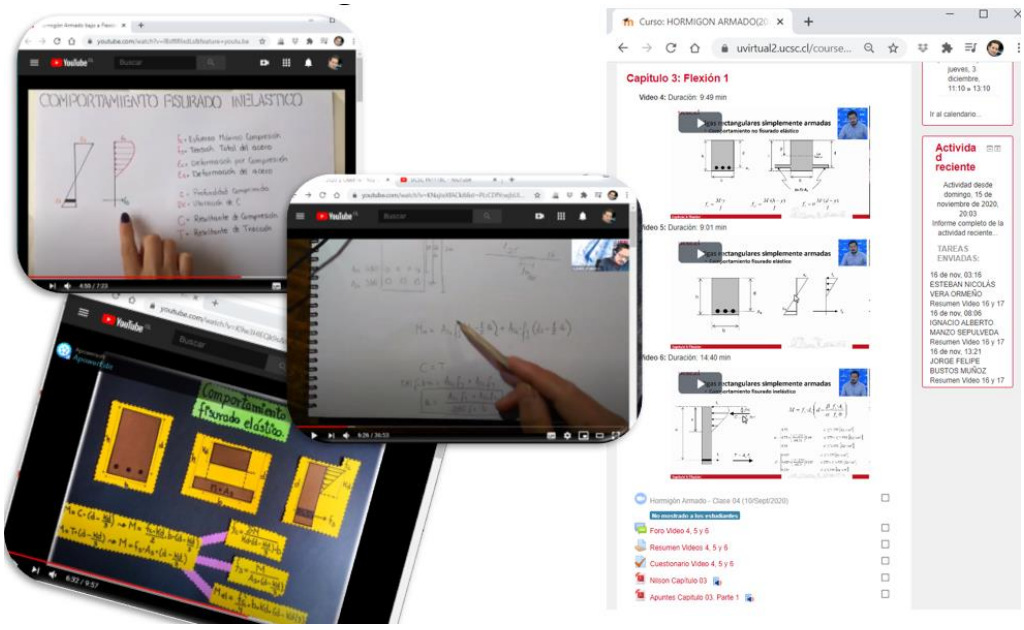

Figure 6. Reinforced Concrete virtual course overview.

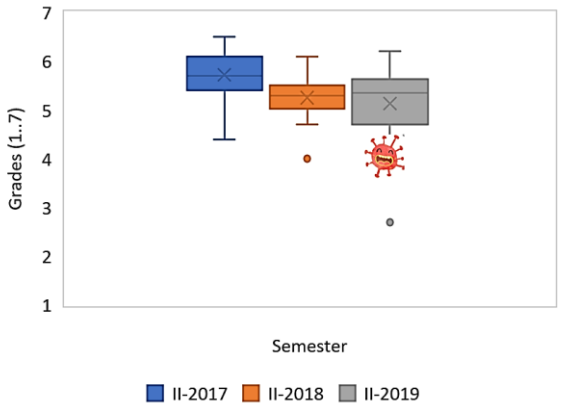

Figure 7. Reinforced Concrete grades for the last 3 years.

Student performance was slightly lower than previous years (Figure 7). This may be due to the methodological changes related to individual work, which may have impacted the peer learning process which had been promoted in previous years.

CONCLUSIONS

We identified two critical factors for student success: internet connectivity and motivation. Regarding the first factor, special efforts were made to provide student connectivity during the first semester. Regarding student motivation, the School of Engineering is currently preparing a teacher training program focused on fostering student motivation and engagement under physical distancing conditions due to the pandemic, supported by the USC 1799, USC 1899 and USC 1999 projects.

One of the lessons learned during the first semester is that having a one-week break every four weeks of class makes it easier to program student coursework and gives teachers more time to prepare their digital materials.

The country's October 2019 social unrest and the following pandemic forced us to transform our current learning activities to an online environment. This change is probably here to stay. The positive assessments of the course adjustments described in this work, positive stakeholder feedback and improvements in student performance are factors to consider in future courses.

REFERENCES

AEQUALIS, Foro de Educación Superior. (2013). Acceso y permanencia en la educación superior: Sin apoyo no hay oportunidad. Eds. Irigoien, María, Del Valle, R. Ayala, C.

Crawley, E. F., Malmqvist, J., Lucas, W. A., & Brodeur, D. R. (2011). The CDIO Syllabus v2.0. An Updated Statement of Goals for Engineering Education. In *Proceedings of the 7th International CDIO Conference*, Technical University of Denmark, Copenhagen, Denmark.

González, A., Barrera, D., León, M., Curiel, M., & Prieto, L.(2018). Student Success: On the Need for A New Standard, *Proceedings of the 14th International CDIO Conference*, Kanazawa Institute of Technology, Kanazawa, Japan.

Loyer, S., Muñoz, M., Cárdenas, C., Martínez, C., Cepeda, M., & Faúndez, V. (2011). A CDIO approach to curriculum design of five engineering programs at UCSC. *Proceedings of the 7th International CDIO Conference*, Technical University of Denmark, Copenhagen, Denmark.

Martínez-Araneda, C., Muñoz, M., Basso-Aránguiz, M. & Oyarzo-Vera, C. (2017). ADPT++ Technology-Based Combined Strategy for Problem Solving. Proceedings of The Ninth International Conference on Mobile, Hybrid, and On-line Learning (eLmL 2017), Nice, France.

Munizaga, F., Cifuentes, M., & Beltrán, A. (2018). Retención y abandono estudiantil en la Educación Superior Universitaria en América Latina y el Caribe: Una revisión sistemática. Archivos Analíticos de Políticas Educativas, 26(61). http://dx.doi.org/10.14507/epaa.26.3348

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