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Analysis of academic performance in continuing education programs: An evaluation of synchronous and asynchronous online platform usage

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Abstract
Important advances in information and communication technologies in the last few decades, specifically given the emergence of the Internet, led to conceiving and developing e-learning platforms. Rapid diversification in online teaching environments ensued, where synchronous and asynchronous modalities became differentiated. The appearance of these modalities has facilitated aspirations for further specialization by adult students, while also continuing with their work commitments. In these last two years, given the Covid-19 pandemic, has seen online education become a vital resource in furthering academic activity in the majority of educational centers in the world. Traditional face-to-face classes were adapted as much as possible to a synchronous virtual environment, where students and teachers go to virtual meetings for classroom related activities. Thus the teacher has an opportunity for direct student interaction. They can take advantage of various synchronous technologies, including slideshows, raising their (virtual) hand for special attention, public and private chatrooms, desktop sharing, whiteboard sharing, and more. While asynchronous e-learning is where the student is able to self-regulate their learning, their times and progress, as under this modality, course contents are uploaded onto a platform, while the the student also uploads a return schedule for deliverables, including activities and evaluations. So the interaction with the student becomes asynchronous, through tools such as the forum or in work feedback tools. In some cases, there are optional online (synchronous) meeting sessions with a teacher to clarify doubts or further comment specific issues. At the University where this study was undertaken, continuing education students can choose any of the above modalities for industrial engineering programs, unlike regular students, whose only option is synchronous classes. The format of the continuing education program (which is known as the Advance study program) is a shorter, continuous university degree, when compared to the traditional one. Students who enroll in an *Advanced* study program already have work experience, a professional degree and a prior body of knowledge, all of which has been validated and recognized by the University. This allows students in this program to obtain their industrial engineering degree in 2 or 3 years, compared with the 4 or 5 years a regular program would take, plus supported by an accredited university in Chile and the United States. The present work analyses if the type of modality, synchronous or asynchronous, bears any influence on the academic performance of students in the Advance study program. Variables involved in analyzing academic performance are average grades, percentage of assignments failed and overall dropout rate. The sample is made up of 1,021 students enrolled in the Advance Industrial Engineering program in both modalities, synchronous or asynchronous. A variance analysis reveals there are no statistically significant differences in academic performance between students from either group under analysis.
Keywords: online learning; synchronous and asynchronous instruction; academic performance; continuing studies

I. Introduction

It is remarkable how the development of information technologies and their importance have taken a leading role in our daily lives. In the educational field, one of the most

outstanding results of these advances is that higher education institutions assume teaching modalities that favor more people in a globalized technological age [1]. One of the tools that have promoted online studies are the Massive Online Open Courses (MOOCs), which allows institutions to develop a more strategic approach to online learning. MOOCs include improving existing teaching practices in the classroom, promoting institutional reputation, and developing new revenue models [2]. Proponents of these courses argue that one of the main criteria for successful distance learning is student motivation. Although motivation is a product arising from several factors, grades play an important role when students decide to continue their professional careers [3].

Although online education was already an educational offer in several institutions, the Covid-19 pandemic accelerated some processes. Institutions focused on educational modalities such as maintaining in-class teaching with social distancing, creating hybrid models, or moving to online instruction [4]. Online instruction has been the lifeline for institutions to continue their training processes in this context. Furthermore, there has been no historical precedent for such an absolute and total closure of educational facilities in multiple countries worldwide, as occurred in 2020 due to the Covid-19 pandemic [5]. In a very ad-hoc reflection, the United Nations Educational, Scientific and Cultural Organization (UNESCO) stated that *"the world was not prepared for an educational disruption on such an unprecedented scale, where schools and universities had to close their doors overnight, hastening to deploy distance education solutions to ensure pedagogical continuity"* [6].

Despite the above, Fada et al. [7] state that the educational community made considerable efforts to continue educational processes, aligning themselves with new scenarios and deploying the best possible solutions for students. As presented in [8], research findings may identify resources or support that instructors may take advantage of in adapting their instruction under crisis mode; thus, many instructors engaged in learning new skills and participating in informal conversations on teaching. However, the self-directed and community-based activities that instructors reported engaging themselves in during the first two weeks in crisis mode were identified as atypical compared to a semester without Covid-19. While Diaz [9] points out that student desertion is one of the problems that most higher education institutions in Latin America have addressed. In another investigation [10], a significant number of students were seen to fail to complete their university studies, with the consequent social cost that comes with this phenomenon. Due to the above, some countries have begun to design in-depth improvement processes to increase first-year university study retention rates.

Online instructional modalities uses communication and learning tools such as synchronism and asynchronism [4], which adapts to the time and needs of each student. Synchronous education requires that participants are connected in real time, where information and conversations occur in a live format. While asynchronous education is an interaction and construction network that does not need all parties to be connected simultaneously, the information or conversation is received and processed at any time that the student may find appropriate due to their specific conditions. Both synchronous and asynchronous learning allow being fully connected with technology, using these means and techniques to improve the quality of current education. These tools become very relevant and can be used to

facilitate the educational process, leading to better learning opportunities and enhancing our functional performance in each task performed. The objective of this work is to analyze how the type of modalities, synchronous or asynchronous, influences the academic performance of adult students, through variables such as average grade, percentage of class failure and percentage of students who abandoned subjects; so as to be able to compare students having synchronous classes with the students having asynchronous classes. The study was carried out at the School of Engineering of the Universidad Andres Bello in Santiago, Chile, which has more than 33 years of experience, and a 5-year accreditation at the national level and is acknowledged internationally by authoritative world rankings.

II. Methodology

The present study focuses on a quantitative investigation analyzing variables such as approval rate, average grades, dropout rate, and maximum and minimum grades through an ANOVA variance analysis used to evaluate the hypothesis that population means are equal. The sample was N=1021 students in the Industrial Engineering degree, the Advance modality, divided into two groups, those enrolled in the synchronous modality and those in the asynchronous modality. Following is a description of the sample participants and results.

A. Participants

The participants were Industrial Engineering students enrolled in the Advance continuing study program. The continuity of studies modality is when a student has already completed a university degree and decides to study another to specialize and obtain a second degree [11]. Two groups were considered for this study, the first group of students participated in synchronous online classes (n=387), while the second group of students participated in asynchronous online courses (n=634). This sample was selected as both groups of students have the same subjects, from the same study program, having the same content and type of evaluation (based on learning objectives). The courses in the curriculum analyzed numbered 27, taught in 259 sections, representing 100% of subjects taught, originating from the second quarter of 2020, the third quarter of 2020, and the first quarter of 2021.

B. Analysis of results

The research considers academic results based on Asynchronous and Synchronous study modalities, including a report per modality, axis, and period for each of the 27 subjects studied. Data was obtained from the university's management and academic registry platform under reference. Data were first analyzed using an inferential statistical analysis using SPSS software. Subsequently, a descriptive analysis was made using PowerBI software, a business intelligence tool. Finally, data on academic results were gathered and converted into graphics and visually simple tables to process. The following section shows the results obtained from the analyses mentioned above.

III. Results

Research findings are presented below. The assumption of data normality is confirmed, making tests carried parametric with a 95% confidence interval. An analysis of variance with the null hypothesis of median equality shows the following results. An ANOVA was used to indicate significant differences between asynchronous and synchronous online teaching modes based on academic indicators of pass rate, average grades, dropout rate, and

top and lowest grades. The p-value was >0.05 for all cases, so any differences were not statistically significant. Based on these results, we conducted a descriptive analysis to prove deeper into the details of each indicator of interest to the study.

A. Descriptive analysis

Table 1 shows the descriptive data according to the modality (asynchronous and synchronous), and the academic indicators analyzed. It can be seen that the most remarkable percentage difference between the modalities is the approval rate, at 2.01%. At the same time, the grading points correspond to the minimum grade, with 0.33 points.

TABLE 1

DESCRIPTIVE STATISTICAL ANALYSIS RESULTS

Indicator	*Modality*	*Half*	*Dev. Deviation*	*Dev. Error*
Pass Rate	Asynchronous	91.3585%	6.0014%	1.1549%
	Synchronous	93.3656%	5.8274%	1.1215%
Average Grade	Asynchronous	5,489	0.3704	0.0713
	Synchronous	5,663	0.4152	0.0799
Maximum Grade	Asynchronous	6,670	0.2216	0,0426
	Synchronous	6,674	0.2030	0.391
Minimum Grade	Asynchronous	2,263	1.1741	0.2260
	Synchronous	2,593	1.1786	0.2268
Dropout Rate	Asynchronous	5.8344%	4.32218%	0.83180%
	Synchronous	6.6963%	2.73294%	0.52595%

Own elaboration.

Table 1 shows general data on academic indicators: approval rate, grade point average, dropout rate, maximum and minimum grade point average, broken down by modality; online synchronous or asynchronous. An analysis is subsequently made per academic period, contemplating the second quarter of 2020 to the first quarter of 2021. Finally, we report results per degree curricular axis and findings commented.

B. Analysis of academic indicators

The first analysis stage focused on comparing primary student academic indicators. Based on subjects taught in asynchronous and synchronous online modalities, the results of these indicators are summarized in the following table.

TABLE 2
SUMMARY OF ACADEMIC INDICATORS BY DELIVERY MODALITY

	Online Mode	
	Asynchronous	*Synchronous*
Approval Percentage	90%	93.1%
Grade Average	5.5	5.6
Dropout Rate	5.8%	6.8%
Average Maximum Grade	6.7	6.6
Average Minimum Grade	1.9	2.6

Own elaboration.

As can be seen from Table 2, the average grade for students under synchronous modality is one tenth higher than students under an asynchronous mode. In other words, students who take classes online in real time have a better average than those who follow classes at their own pace and time. Regarding student dropout rates, a greater difference is seen between modalities. The proportion of enrolled students who, during the school year, for various reasons, abandon their studies without completing their degree is higher in the synchronous modality (6.8%) than in the asynchronous modality (5.8%), a full percentage point difference. Regarding average top grades obtained by these two groups of students, it is seen that those whose learning modality is asynchronous earned a top grade one tenth higher than the top grade for students belonging to the synchronous group.
When comparing average grades or minimum grades obtained by these students, a greater difference is seen, namely in that synchronous students have a minimum average grade of 2.6, while the corresponding minimum average grade for the asynchronous group is only 1.9.

C. Results by academic period

Below are results based on percentage approval, average grades, dropout rate and average top and bottom grades, for the second Quarter 2020, third Quarter 2020 and first Quarter 2021 for synchronous and asynchronous modality students.

TABLE 3
SUMMARY OF ACADEMIC INDICATORS BY TEACHING MODALITY AND ACADEMIC PERIOD

	Online Mode: Asynchronous			*Online mode: Synchronous*		
	Quarter II 2020	*Quarter III 2020*	*Quarter I 2021*	*Quarter II 2020*	*Quarter III 2020*	*Quarter I 2021*
Approval Percentage	89.7%	89.1%	90.1%	95.6%	92.1%	92.3%
Grade Average	5.5	5.5	5.5	5.8	5.6	5.6
Dropout Rate	4.4%	6.1%	6.4%	6.9%	6.1%	7.4%
Average Top Grade	6.7	6.7	6.7	6.7	6.7	6.6

Own elaboration.

Table 3 shows that the highest approval percentage for the Asynchronous modality occurred during the first academic quarter. The highest approval results are seen in the second academic quarter regarding synchronous modality. The average grade remains constant in the asynchronous mode with a rate of 5.5, while the synchronous mode sees a higher average grade in the second quarter. The dropout rate for students in asynchronous mode is higher at the beginning of the academic year, in the first trimester. In contrast, this rate is also higher for students in the synchronous mode in the academic period. Concerning top grades, Table 3 indicates uniformity in results for both Asynchronous and Synchronous modes, the latter showing a slight decrease in grade average.

D. Results by degree subject areas

The number of curricular subjects analyzed totaled 27, these subjects can in turn be grouped into six broad knowledge areas, based on the grouping seen in Table 4.

TABLE 4
CURRICULAR SUBJECT AREA FOR AN ENGINEERING DEGREE

Axis	*Name of curricular subject*
Basic sciences	Physics complementary subjects
	Mathematics I
	Mathematics II
Engineering Education	Effective communication
	Complementary Professional Training
	Introduction to Engineering

Business Studies	Costs and Budgets
	Economy
	Project preparation and evaluation
	Engineering for Economics
	Marketing
Operation management	Fundamentals of Industrial Processes
	Environmental and Energy Management
	Quality management
	Production management
	Logistics Management
	Operations research
	Production Planning
	Manufacturing processes
	Industrial Engineering Issues
Strategic management	Strategic management
	Organizational Management
English	English I
	English II
	English III
Information Technology	Information systems management
	Information technology

Own elaboration.

According to the analysis per career axis (Table 4), it is seen in Figure 1 below that the highest approval rates were obtained in subjects within the Strategic Management area (97.60%) and in Business Studies (92.66 %), while subjects with a lower approval rate are located in the axis of English and Engineering Education (85.06% and 89.74%, synchronous and asynchronous modality, respectively).

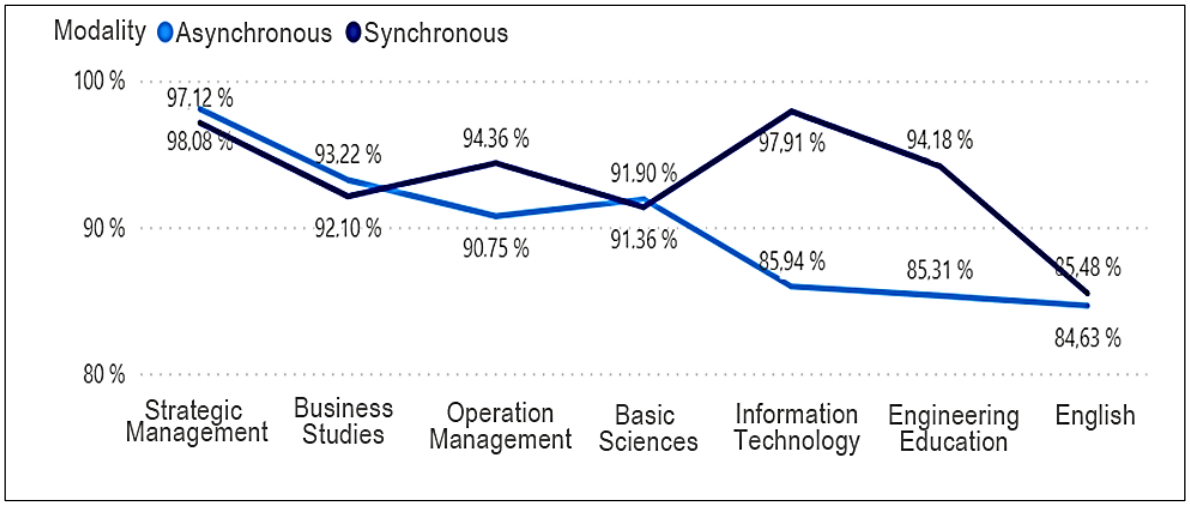

Fig. 1. Approval percentage by degree axis and delivery mode. (Source: own elaboration.)

Regarding differences in results per teaching mode, the main differences are seen in Engineering Education, Information Technology and Operation Management, where approval rates for subjects taught in synchronous online mode are 8.87%, 11.97% and 3.61%, respectively, higher than when taught in asynchronous mode. In subject areas relating to Strategic Management, Business Studies and Basic Sciences, subjects taught in asynchronous mode showed a slightly higher approval rate than subjects taught in a synchronous mode, with a difference of 0.96%, 1.12% and 0.56 %, respectively.
Figure 2 shows academic results based on average grades per subject. The graph shows that subjects in which the students obtained the highest average grades are in the subject areas of Strategic Management and Information Technology (5.9 and 5.8, respectively). Subjects with lowest approval averages are in Business Studies subject areas, with an average of 5.5 and 5.3, respectively.

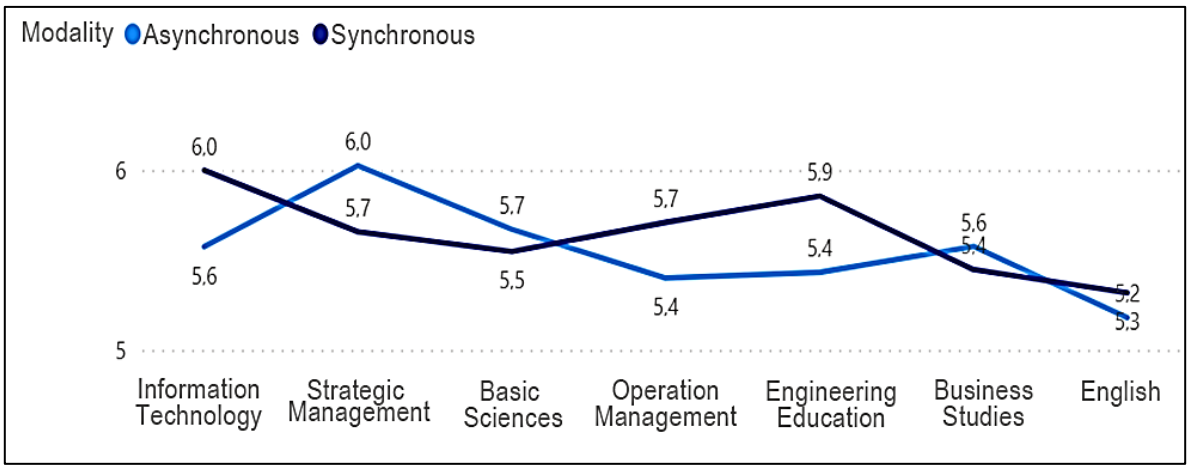

Fig. 2. Average grades per degree subject area and teaching mode. (Source: own elaboration.)

As seen in Fig. 2, when analyzing the average grade differences based on teaching mode, differences of up to 0.5 points were seen in the average final grade. Differences favor

synchronous studies in 4 areas (Operations Management, Information Technology, Engineering Education and English), while asynchronous grades are higher in 3 areas (Strategic Management, Business Studies, and Basic Sciences). Synchronous students earn higher grades on average than asynchronous students in the following areas: Information technologies with 0.4 points (7.1%), Operations Management with 0.3 points (5.6%), Engineering Education with 0.5 points (9.3%), and English with 0.1 points (1.9%). Asynchronous students earn higher grades on average than synchronous students in the following areas: Strategic Management with 0.3 points (5%), Basic Sciences with 0.2 points (3.5%), and Business Studies with a difference of 0.2 points (3.6%).

Drop-out rate results are seen in Figure 3. It is seen that subjects taught in asynchronous mode obtain better results. The average dropout rate is 5.3%, 1.3% less than synchronous studies, where drop-out rate was 6.8% on average. When analyzing results per degree study area, the lowest dropout rates were in Strategic Management with 4.9% and Business Studies with 5.4%. Subjects with the highest dropout rate are Information Technology and Operations Management with 7.6% and 6.8%, respectively.

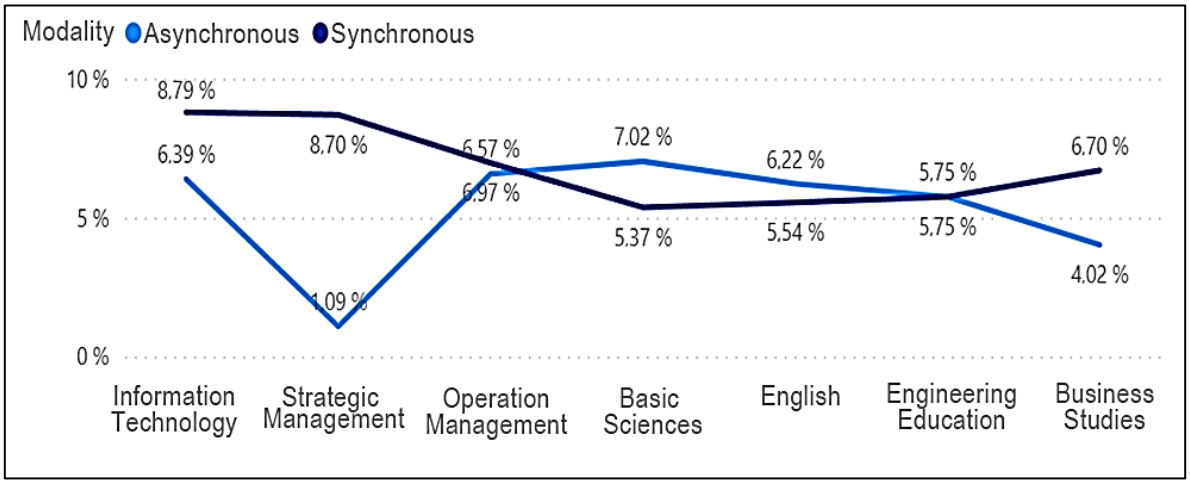

Fig. 3. Average dropout rate by degree study area and delivery modality. (Source: own elaboration.)

As can be seen in Fig. 3, the main differences in dropout rates based on delivery mode favor asynchronous studies, in Strategic Management and Business Studies, where a lower rate of 7.6% and 2.7% is seen in comparison to when these subjects are taught in synchronous modality. While synchronous studies presented a lower rate than asynchronous modality subjects in the Basic Sciences and English study areas, with a difference of 1.7% and 0.7%, respectively.

Figure 4 shows a graph of highest average study grades, grouped by degree study area. It is seen that both asynchronous and synchronous study modes obtain the same results, the average being 6.7. While maximum grades obtained by students are generated in study areas of Basic Sciences and Engineering Education, both with an average of 6.8. These results are followed by English, Information Technology and Operations Management with an average of 6.7. Finally, Business Studies and Strategic Management follow up with an average of 6.6.

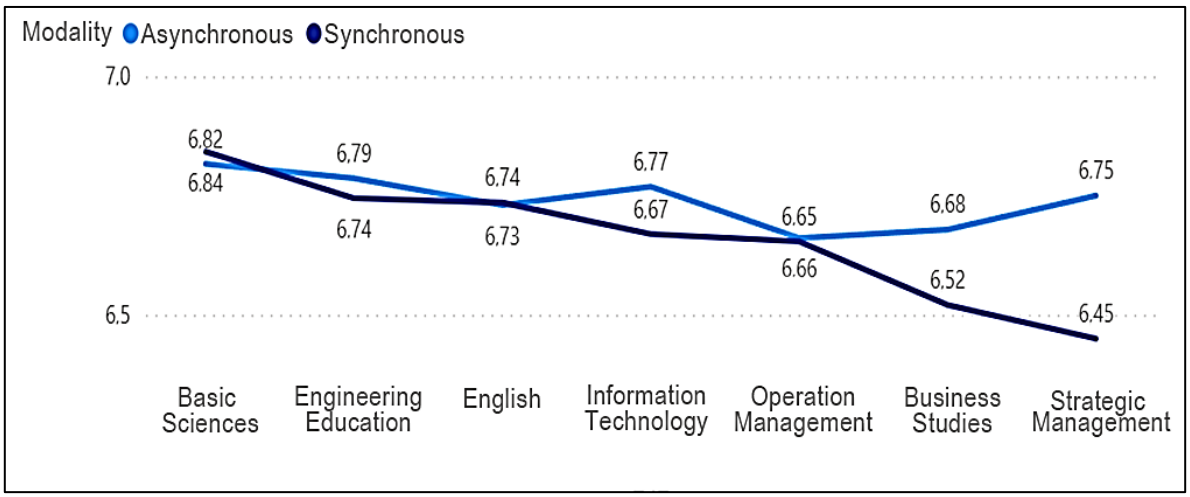

Fig. 4. Average top grade per degree study area and study mode (Source: own elaboration.)

As can be seen in Fig. 4, main differences in results are favorable to asynchronous teaching of subjects such as Strategic Management, having an average grade higher than 0.30 points and in Business Studies with average grades 0.16 higher than when comparing with subjects taught under a synchronous modality. Finally, in relation to minimum study grades obtained, it can be seen in Fig. 5 that in subjects taught in synchronous mode, the average minimum grade is higher than the average grade of those same subject taught in asynchronous mode, with an average of 2.5 and 2.0, respectively. While top average grades in this analysis are in Strategic Management with 3.9 and in Business Studies with 2.6. Lowest results are seen in Engineering Education and English, both with average grade of 1.5.

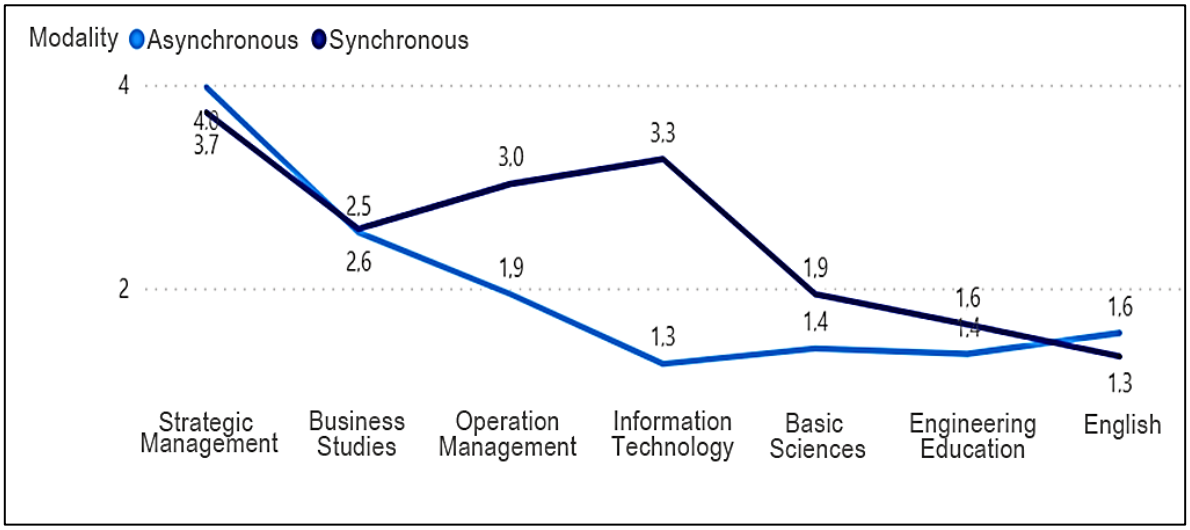

Fig. 5. Minimum average grade per degree study area and teaching mode (Source: own elaboration.)

As shown in Fig. 5, main differences are seen in Information Technology, Operations Management and Basic Sciences, where subjects taught under synchronous mode obtained

average grades which were 2.0, 1.1 and 0.5 points higher than the same subjects taught under asynchronous mode.

IV. Discussion

Based on results obtained in this research work, the null hypothesis of equality of means is rejected. They ascertain that students who were part of this analysis enrolled in either synchronous or asynchronous online modalities have comparable academic performance. However, the descriptive analysis identifies some differences in academic indicators that show better results in the group of students under a synchronous study mode. According to Palma [3], "interactivity under synchronous media (in real-time) must be accompanied by asynchronous learning (in deferred time), where students are instructed at a slower pace, especially when there is no self-discipline, which is one of the many educational problems that these modalities present when in times of Covid." In the study carried out, students under synchronous study mode also have the tools and advantages of the asynchronous model, having the educational tools and resources available throughout their subject study period, complemented by the synchronous sessions their teachers provide.

An important aspect to highlight is that the student dropout rate is higher in the asynchronous group. Student dropout is an important issue for educational entities as [9] points out, "high dropout rates and low graduation rates have become a matter of growing interest for higher education institutions and educational authorities" in the last fifty years, given that this phenomenon widens the social and economic gap, as well as limiting the development of the nation. Thus it is interesting when studying dropout causes to consider that a face-to-face environment in real-time reduces the dropout rate concerning autonomous learning where each student decides when to access their subject content.

Although the present study does not delve into searching for causes that may generate better performance and lower student desertion in the virtual environment, there is evidence pointing to the fact that, given a non-face-to-face modality. Still, with synchronous classes, an environment more conducive to success is produced, yet to a lesser degree than students who interact with their classmates and teachers in real-time. This situation is considered positive, contributing widely to academic results, enabling further studies that may address how communications in synchronous online classes can be an essential factor in generating success that contributes to better performance and lower student dropout rates.
From a positive perspective, it can be stated that Covid-19 accelerated and disseminated distance learning and hybrid education, and the follow-up question would be: are they here to stay? [9]. This dilemma has been given an immediate response by educational entities that have stood up to the challenge by developing online courses and even offering full e-learning degrees or internet-enabled teaching-learning processes.

It should also be noted that online education has been branded as underachieving concerning face-to-face education. Yet, as Aguilar [12] mentions, "when all players perform their roles in an ethical, professional and adequate manner, these processes can be carried out successfully and with a similar quality that face-to-face processes." Furthermore, the experience gathered on online education indicates that this type of education will remain in time, continuously adapting to technological progress and

educational trends. Therefore, innovating in online education tools and conditions becomes a sizeable challenge and a tremendous opportunity for student institutions [13].

V. Conclusions

This article aimed to analyze how the type of modalities, synchronous or asynchronous, influences the academic performance of adult students, through variables such as average grade, percentage of class failure and percentage of students who abandoned subjects; so as to be able to compare students having synchronous classes with the students having asynchronous classes.Through a quantitative exploratory methodology and using the SPSS and Power BI software, the data for 1021 students was analyzed, where 387 studied under a synchronous modality and 634 studied in asynchronous online classes. A variance analysis determined that the academic performance of both synchronous and asynchronous students was comparable. Given a descriptive analysis, it was concluded that:

- The approval percentage in the synchronous mode is two percentage points higher than in the asynchronous mode.
- Students from the synchronous mode showed a higher average grade than students from the asynchronous mode, with averages amounting to 5.64 and 5.56, respectively.
- Dropout rates favor asynchronous study mode.
- In synchronous mode, average minimum grades are higher than for asynchronous mode, while average top grades are higher in asynchronous mode.

Concerning results based on the academic period, the biggest difference in indicators occurred in Quarter II of 2020. The approval rate for the synchronous mode was higher by 5.84% than for the asynchronous mode, while the difference in dropout rate was 2.46%, lower in the asynchronous mode.

The main differences concerning curricular subjects were seen in favor of synchronous mode, namely in; Information Technology (in pass rate and grade average), Engineering Education (in pass rate and grade average), Operations Management (in pass rate and grade average), and Strategic Management (in pass rate and average top grade). On the other hand, regarding asynchronous mode, the main differences favoring this modality were in; Strategic management (grade average, average top grade, and dropout rate) and Business administration (dropout rate).

The issue of how to study is an emerging issue that needs to be addressed, further probed, and discussed, dealing with an enormous and complex problem as education is, which may require new IT and information base, requiring teachers and students to incorporate new skill sets. These competencies are related to developing an ability to adapt and be flexible in the face of change, bearing in mind that adapting is the only mechanism that allows us to make progress in a meaningful measure.

Some scientific reports have identified significant differences between both study modes, so our future work will focus on determining the factors that favor one modality over another. However, it is important to take as a starting point the differences found and stated in the descriptive analysis per academic period and study area.

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