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Students' academic performance before, during, and after COVID-19 in F2F and OL learning: The impact of gender and academic majors

Abdoulaye Kaba[a], Shorouq Eletter[b], Ghaleb A. ElRefae[b], Abdul Razzak Alshehadeh[c] and Haneen Aqel Al-khawaja[d,e]*

[a]*College of Education, Al Ain University, Al Ain, United Arab Emirates*
[b]*College of Business, Al Ain University, Al Ain, United Arab Emirates*
[c]*Faculty of Business, Al-Zaytoonah University of Jordan, Amman, Jordan*
[d]*Faculty of Business, Amman Arab University, Amman, Jordan*
[e]*Swiss FinTech Innovation Lab, University of Zurich, Switzerland*

CHRONICLE	ABSTRACT
	The main purpose of this study was to investigate students' academic performance (SAP) before, during, and after the COVID-19 pandemic in face-to-face (F2F) and online learning (OL) instructions. The study also attempted to determine the impact of gender and academic major on students' academic performance. For the results of semester grade point average (SGPA), the findings of the study showed better SAP in F2F learning as compared to OL learning, while the results of grade point average (GPA) indicated better SAP in OL learning than in F2F learning. The findings supported the stated hypotheses by indicating the positive impact of gender and academic major on SAP in F2F and OL learning, before, during, and after the COVID-19 pandemic. The regression analysis revealed that the demographic variables can predict up to 18% variations in the student's academic performance. These findings offer valuable insights for practical strategies to improve SAP in F2F and OL learning.

1. Introduction

The COVID-19 pandemic has significantly disrupted the educational systems that were already under pressure. Closing schools, Colleges, and universities as a social distancing measure to reduce the crowd interrupted students' learning and disrupted the internal and public assessments for qualifications (Tarkar, 2020). The epidemic has hurt students' academic performance and development, but the exact repercussions are uncertain. Growing socioeconomic gaps harm students' ability to get a quality education. (García & Weiss, 2020). Educators have utilized innovative tools and methodologies to engage students effectively, which have presented limitations of accessibility and affordability for various students (Rashid & Yadav, 2020) .

Students' academic performance varies as schools shift to online or hybrid learning environments. Several factors have contributed to the variation in the students' outcomes. Gender, academic major, culture, and socio-economic status are among the variables that may affect academic results (Refae *et al.*, 2021; Wrigley-Asante *et al.*, 2023). Historically, gender is associated with various degrees of academic success in a variety of disciplines. It is worth remembering that females are not always behind males in academic performance at universities. Females routinely outperform males in the classroom. The greater the negative effect of COVID-19 on female students' performance, the more likely the gender gap will narrow (Bratti & Lippo, 2022; Al-Khawaja et al., 2023)

With the consideration of OL opportunities and challenges, educators, researchers, and decision-makers have conducted much scientific research to identify and understand the impact of COVID-19 and OL on SAP (Kulal & Nayak, 2020). Some of these research have reported SAP in OL only (Park *et al.*, 2022; Ajibade *et al.*, 2022), while others compared students' performance in F2F and OL (Elfaki *et al.*, 2019; Alghamdi *et al.*, 2020). Certainly, understanding the impact of OL on SAP can help educators and decision-makers to make appropriate decisions toward OL, and increase or decrease the provision of OL courses for students. The main purpose of this study is to examine how demographic variables influence SAP before, during, and after the COVID-19 pandemic. By focusing on gender and academic majors, the study compares SAP in F2F (before and after COVID-19) to OL (during COVID-19). Most of the previous studies have reported SAP during COVID-19 only, or before and during COVID-19. This study could be the first study reporting SAP before, during, and after the COVID-19 pandemic. The findings of the study should make valuable contributions to the expanding body of literature on understanding SAP during COVID-19 and offer valued insights for practical strategies to improve SAP in F2F and OL learning. (Abu Eyadah & Al Khatib, 2022), (Al-Shafei, 2022)

The study is attempting to find answers to the following three research questions:

1.   Are there differences in SAP before, during, and after the COVID-19 pandemic?
2.   Is there a relationship between gender and SAP before, during, and after the COVID-19 pandemic?
3.   Is there a relationship between academic majors and SAP before, during, and after the COVID-19 pandemic?

2. Hypotheses development

Human beings are naturally different in many things such as gender, color, language, culture, religion, and education. These differences may have an impact on people's performances and achievements including students' academic performance. As stated by Amparo et al. (2018), gender and SAP are topics of strong interest to researchers. Therefore, scholars and researchers have conducted much research investigating the impact of gender on SAP in F2F and OL learning (Al-Mously et al., 2013a; Stegers-Jager et al., 2020; Wrigley-Asante et al., 2023). Amro et al. (2015) conducted a study to determine the impact of gender on SAP in F2F and OL learning. The findings of the study showed the impact of gender on SAP in F2F learning but not in OL learning. Similar findings were reported by Kör et al. (2016).

In a comparative study, Christmann (2017) found that female students performed better in OL learning than male students however, in F2F learning male students outperformed female students. The author believes that the nature of courses and the method of teaching online could be the possible factors contributing to gender differences in F2F and OL learning. Amparo et al. (2018) used students' GPAs to identify gender differences in F2F and OL learning. The authors collected data from more than 95,00 students in a two-year institution and more than 50,000 students from a four-year institution. The findings of the study revealed the better academic performance of female students in F2F learning, while no gender differences were found in the two groups in OL learning.

An interesting study conducted by Alghamdi et al. (2020) verified the impact of multitasking on SAP in F2F and OL learning. The authors used gender as a moderating variable between multitasking behaviors and grade point average (GPA). The findings of the study suggested a significant indirect effect for female students only. Female students experienced a limited impact of online multitasking on GPA, resulting in better academic performance. However, the results of the study did not support the relationship between gender and F2F learning. By examining academic performance across gender, Tsaousis and Alghamdi (2022) reported gender differences in students' academic performance.

Similar to gender, academic major has also been a subject of research interest regarding its impact on academic performance (Al-Mously *et al.*, 2013a; Yousef, 2017; Wrigley-Asante *et al.*, 2023). In Saudi Arabia, Al-Mously et al. (2013b) conducted a cross-sectional study to explore how gender and English language proficiency affect the academic performance of medical students. The study findings revealed that both gender and English language proficiency significantly influence students' academic performance (Omeish, 2022). Another study conducted for a business school in the United Arab Emirates by Yousef (2017) highlighted the significant impact of English language proficiency on the academic performance of business students. More recently, a study conducted at the University of Ghana by Wrigley-Asante et al. (2023) investigated gender differences in STEM subjects. The study revealed notable gender disparities in STEM subjects, with male students outperforming female students at the senior high school level. Interestingly, at the tertiary level, the academic performance of female students showed improvement (Kasasbeh et al., 2022).

The literature review provides a concise overview of significant empirical studies that have examined and documented the influence of demographic factors on students' academic performance. These studies have thoroughly investigated the impact of various variables on academic outcomes, particularly focusing on gender and academic major, within both face-to-face (F2F) and online learning (OL) settings before, during, and after the COVID-19 pandemic. Based on the insights from these relevant studies, we have formulated the following hypotheses:

H₁: *There are significant differences in SAP before, during, and after the COVID-19 pandemic.*

H₂: *Male and female students differ in academic performance before, during, and after the COVID-19 pandemic.*
H₃: *Science and humanities students differ in academic performance before, during, and after the COVID-19 pandemic.*
H₄: *Gender has an impact on SAP before, during, and after the COVID-19 pandemic.*
H₅: *Academic major has an impact on SAP before, during, and after the COVID-19 pandemic.*

3. Conceptual framework

In addition to the development of hypotheses, the review of related studies guided us in proposing a conceptual framework. The framework consists of two independent variables and three dependent variables. The study examines how gender and academic major serve as independent variables, while SAP before COVID-19 (F2F), during COVID-19 (OL), and after COVID-19 (F2F) are the dependent variables. Like the stated hypotheses, the framework assumes a relationship between demographic variables and students' academic performance. The theoretical model put forth by Tinto (1975) reinforces our conceptual assumption. According to Tinto's model, students in higher education possess diverse attributes, experiences, and family backgrounds, which can significantly influence their academic performance.
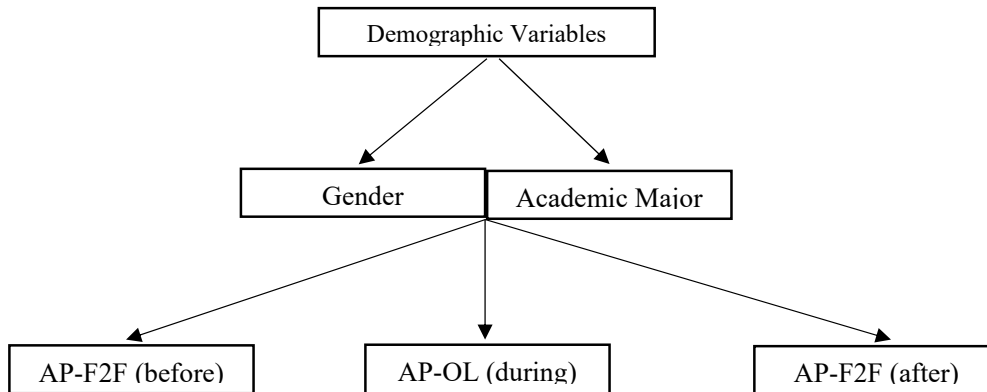
Fig. 1. Conceptual Framework
Note. AP = academic performance; F2F = face-to-face learning; OL = online learning; before, during, and after the COVID-19 pandemic.

4. Research method

The main purpose of this study is to investigate the impact of gender and academic major on SAP before, during, and after the COVID-19 pandemic. A student's academic performance was measured using Semester Grade Point Averages (SGPA) and Grade Point Averages (GPA) in F2F and OL learning (see Table 1). Tables 2 and 3 present the AAU grading system for bachelor, diploma, and master's degrees. After AAU authority approval, the researchers received the required data from the Admission and Registration Unit in May 2023. (Barqawi, 2023)

As presented in Table 1, the category of data is based on 645 students' SGPA and GPA before, during, and after the COVID-19 pandemic. It includes eight semesters, two F2F semesters before COVID-19 (AY2019-2020), four OL semesters during the COVID-19 pandemic (AY2020-2021 and AY 2021-2022), and two F2F semesters after the COVID-19 (AY2022-2023). The researchers coded and analyzed the collected data using the Statistical Package for the Social Sciences (SPSS). In addition to descriptive statistics, t-tests, Spearman's Rho of correlation, partial least squares structural equation modeling (PLS-SEM), and regression analysis are performed in this study to not only answer the research questions but also to validate the stated hypotheses.

On the other hand, the researchers categorized the six colleges of AAU into two groups: (a) STEM group and (b) Humanities and Social Sciences. The first group consists of three colleges, i.e., Business, Engineering, and Pharmacy. The second group also consists of three Colleges, Communication and Media, Education, and Law. Table 4 summarizes the demographic characteristics of students in this study.

Table 1
Collected data.

Data	Number of students	Before COVID-19 (F2F)	During COVID-19 (OL)		After COVID-19 (F2F)
SGPA					
	645	AY2019-2020	AY2020-2021	AY2021-2022	AY2022-2023
GPA					

Note: AY = Academic year. Each academic year consisted of two semesters, Fall and Spring Semesters.

Table 2
AAU grading System for Bachelor and Diploma degrees.

Grade Point	Description
3.6 - 4.00	Excellent
3.0 - 3.59	Very Good
2.5 - 2.99	Good
2.0 - 2.49	Satisfactory
Less than 2.0	Unsatisfactory

Source: https://aau.ac.ae/en/admission/undergraduate/course-grading-system

Table 3
AAU grading System for Master Degrees.

Grade Point	Description
3.70 - 4.00	Excellent
3.30 - 3.69	Very Good
3.00 - 3.29	Good
Less than 3.00	Unsatisfactory

Source: https://aau.ac.ae/en/admission/undergraduate/course-grading-system

Table 4
The students

Demographic	n	%
Gender		
Male	279	43.3
Female	366	57.7
Total	645	100
Academic Major		
STEM	217	33.6
HSS	428	66.4
Total	645	100

5. Findings

5.1 SGPA before, during, and after COVID-19

The analysis of SAP in this section is based on semester grade point average (SGPA) before, during, and after the COVID-19 pandemic. As presented in Table 5, the results of the analysis indicate that more than 55% of the students achieved 3.0 to 4.0 SGPA in Semester two for the AY2019-2020 in F2F learning before COVID-19, followed by Semester one of the same academic years (45.52%), and Semester two of the AY2022-2023 (39.48%) in F2F learning after COVID-19 pandemic. Accordingly, less than 37% of students achieved 3.0 to 4.0 SGPA in OL learning during the COVID-19 in Semester one or two, for the two academic years, 2020-2021 and 2021-2022. On the other hand, more than 50% of the students achieved 2.0 to 2.99 SGPA in Semester one for the AY2020-2021, in OL learning during COVID-19, followed by Semester two of the same academic year (47.74%), and Semester one and two (41.54%, 40.37%) respectively of the AY2021-2022 (39.48%), in OL learning during CONVID-19 pandemic. In this category, less than 40% of the students achieved 3.0 to 4.0 SGPA in F2F learning before and after COVID-19 in Semester one or two, for the two academic years, 2019-2020 and 2022-2023. However, it is interesting to mention that more students (26.80%, 27.90%) received <2.0 SGPA points in Semesters one and two respectively of the AY2021-2022, in OL learning during the CONVID-19 pandemic than the F2F learning after COVID-19 (23.91%, 21.12%) in Semester one and two respectively of the AY2022-2023. Moreover, a Kruskal-Wallis test presented in Table 6 showed that the students achieved better performance in F2F learning after COVID-19 (Mean Rank = 298.08), followed by OL learning during the COVID-19 pandemic (Mean Rank = 252.38), and then F2F learning before COVID-19 (Mean Rank = 196.79). However, there were statistically no significant differences in the SGPA of SAP in F2F learning before COVID-19 pandemic (H = 2.260, $\chi2$ = 0.266, p = 0.133), in OL during the COVID-19 (H = 1.014, $\chi2$ = 1.080, p = 0.314), and in F2F learning after COVID-19 (H = 1.082, $\chi2$ = 0.913, p = 0.298).

Table 5
Students' SGPA before, during, and after the COVID-19 pandemic

Grade points	Before (F2F)		During (OL)				After (F2F)	
	AY 2019-2020		AY2020-2021		AY2021-2022		AY2022-2023	
	Sem1(%)	Sem2(%)	Sem1(%)	Sem2(%)	Sem1(%)	Sem2(%)	Sem1(%)	Sem2(%)
3.56-4.0	72(17.91)	112(18.09)	65(11.07)	60(10.34)	53(8.87)	74(12.82)	81(13.54)	96(15.96)
3.0-3.50	111(27.61)	234(37.80)	147(25.04)	146(25.17)	136(22.78)	109(18.89)	145(24.24)	147(23.52)
2.5-2.99	92(22.88)	127(20.51)	160(27.25)	139(23.96)	112(18.76)	113(19.58)	104(17.39)	115(18.40)
2.0-2.49	84(20.89)	85(13.73)	134(22.82)	138(23.78)	136(22.78)	120(20.79)	125(20.90)	135(21.60)
<2.0	43(10.69)	61(9.85)	81(13.79)	97(16.72)	160(26.80)	161(27.90)	143(23.91)	132(21.12)
Total	402(100)	619(100)	587(100)	580(100)	597(100)	577(100)	598(100)	625(100)

Note: AY = Academic year, Sem1 = Semester one, Sem2= Semester two. **Source:** Table by authors.

Table 6
Results of the Kruskal-Wallis Text for SGPA

Period	Teaching Approach	N	Mean Rank	df	H	X²	Sig.
Before COVID-19	F2F	376	196.79	1	2.260	0.266	0.133
During COVID-19	OL	491	252.38	1	1.014	1.080	0.314
After COVID-19	F2F	581	298.08	1	1.082	0.913	0.298

5.2 GPA before, during, and after COVID-19

The analysis in this section is based on grade point average (GPA) before, during, and after the COVID-19 pandemic. It consists of four years or eight semesters. One year or two F2F semesters before COVID-19 (2019-2020), two years or four OL semesters during COVID-19 (2020-2021, and 2021-2022), and one year or two F2F semesters after the COVID-19 (2022-2023). More than 49% of students achieved a 3.0 to 4.0 GPA in the second semester of F2F learning before the COVID-19 pandemic for the AY2019-2020, followed by the first semester of the same academic year (45.52%) and the first and second semesters (40.54%, 36.89%) of OL learning during the COVID-19 pandemic for the AY2020-2021 (Table 7). On the other hand, less than 34% of students achieved 3.0 to 4.0 GPA points in OL learning during COVID-19 (AY2021-2022), and also in F2F learning after COVID-19 (AY2022-2023).

For a GPA ranging from 2 to 2.99 points, between 55-60% of the students achieved this grade points in six semesters of three academic years, two years during the COVID-19 pandemic (2020-2021, 2021-2022), and one year after COVID-19 pandemic (2022-2023). Meanwhile, for a GPA <2.0, between 8-12% of the students received this grade points in F2F learning before and after COVID-19 (AY2019-2020, AY2022-2023), compared to less than 8% of the students in OL learning during the COVID-19 pandemic (AY2020-2021, 2021-2022).

For identifying the significant differences in SAP before, during, and after COVID-19, we performed a Kruskal-Wallis test. As reported in Table 8, the findings of the analysis indicate that students achieved better academic performance in OL learning during COVID-19 (Mean Rank = 241.18), followed by F2F learning after the COVID-19 pandemic (Mean Rank = 189.14), and F2F learning before COVID-19 (Mean Rank = 180.75). However, there were statistically no significant differences in the GPA of SAP in F2F learning before COVID-19 (H = 2.641, $\chi2$ = 2.795, p = 0.104), in OL during the COVID-19 (H = 0.832, $\chi2$ = 1.518, p = 0.362), as well as in F2F learning after COVID-19 (H = 0.099, $\chi2$ = 0.627, p = 0.753).

Table 7
Students' GPAs before, during, and after the COVID-19 pandemic

Grade Points	F2F (Before COVID-19)		OL (During COVID-19)				F2F(After COVID-19)	
	AY 2019-2020		AY2020-2021		AY2021-2022		AY2022-2023	
	Sem1(%)	Sem2(%)	Sem1(%)	Sem2(%)	Sem1(%)	Sem2(%)	Sem1(%)	Sem2(%)
3.56-4.0	72(17.91)	98(15.83)	58(9.88)	54(9.31)	50(8.37)	50(8.66)	54(9.03)	51(8.16)
3.0-3.50	111(27.61)	207(33.44)	180(30.66)	160(27.58)	151(25.29)	141(24.43)	146(24.41)	137(21.92)
2.5-2.99	92(22.88)	153(24.71)	181(30.83)	179(30.86)	178(29.81)	169(29.28)	155(29.91)	160(25.60)
2.0-2.49	84(20.89)	108(17.44)	143(24.36)	155(26.72)	173(28.97)	176(30.50)	185(30.93)	198(31.68)
<2.0	43(10.69)	53(8.56)	25(4.25)	32(5.51)	45(7.53)	41(7.10)	58(9.69)	79(12.64)
Total	402(100)	619(100)	587(100)	580(100)	597(100)	577(100)	598(100)	625(100)

Note: AY = Academic year, Sem1 = Semester one, Sem2= Semester two.

Table 8
Results of the Kruskal-Wallis Text for GPA

Period	Teaching Approach	N	Mean Rank	df	H	X²	Sig.
Before COVID-19	F2F	376	180.75	1	2.641	2.795	0.104
During COVID-19	OL	491	241.18	1	0.832	1.518	0.362
After COVID-19	F2F	581	189.14	1	0.099	0.627	0.753

5.3 Gender differences

The first research question in this study addressed the issue of differences in SAP before, during, and after the COVID-19 pandemic. We used an independent sample t-test to answer the question. As presented in Table 9, the analysis of mean score values indicates that female students outperformed male students in academic performance (SGPA or GPA), F2F or OL learning method before, during, and after the COVID-19 pandemic. Moreover, the t-test analysis showed that the mean score differences in academic performance between males and females are statistically significant (p-value <0.05) with students' SGPA before, during, and after the COVID-19 pandemic. The results support the stated hypotheses (H2). However, no significant differences were found in students' GPA (p-value >0.05) before, during, and after COVID-19.

Table 9
Gender differences

Academic Year	Teaching Method	Academic performance	Gender	N	Mean	SD	t-value	p-value
2019-2020	F2F	SGPA_B	Male	141	3.7936	1.06408	-6.446	0.000*
			Female	235	4.4912	0.98593		
2020-2021 2021-2022	OL	SGPA_D	Male	198	7.8729	1.85654	-6.539	0.000*
			Female	293	9.0388	1.99105		
2022-2023	F2F	SGPA_A	Male	246	3.3777	1.26031	-9.057	0.000*
			Female	335	4.2810	1.13156		
2019-2020	F2F	GPA_B	Male	165	4.2093	1.02771	-0.527	0.598
			Female	211	4.2671	1.07590		
2020-2021 2021-2022	OL	GPA_D	Male	209	9.2140	1.74211	0.234	0.815
			Female	282	9.1769	1.74197		
2022-2023	F2F	GPA_A	Male	252	4.0401	0.88233	0.379	0.705
			Female	329	4.0116	0.91121		

Note: * Significant at 0.05 (two-tailed). SGPA_B / GPA_B = Academic performance before COVID-19 (AY2019-2020); SGPA_D / GPA_D = Academic performance before during COVID-19 (AY2020-2021, AY2021-2022); SGPA_A / GPA_A = Academic performance after COVID-19 (AY2022-2023).

5.4 Academic major differences

Like gender, the academic major is used as a demographic variable in investigating the differences in academic performance before, during, and after the COVID-19 pandemic. As reported in Table 10, the analysis of mean score values indicates that students of humanities and social sciences (HSS) outperformed students (in SGPA or GPA) majoring in science, technology, engineering, and math (STEM), through F2F or OL learning method before, during, and after COVID-19 pandemic. The t-test analysis revealed that the mean score differences between HSS and STEM students are statistically significant (p-value <0.05) with SGPA of the F2F learning method before and after the COVID-19 pandemic. The results support the stated hypotheses (H3). On the other hand, no significant differences (p-value >0.05) were found in students' SGPA of OL learning method during COVID-19 and students' GPA before, during, and after COVID-19.

Table 10
Academic major differences

Academic Year	Teaching Method	Academic performance	Major	N	Mean	SD	t-value	p-value
2019-2020	F2F	SGPA_B	STEM	141	4.4502	0.95265	3.474	0.001*
			HSS	235	4.0679	1.12230		
2020-2021 2021-2022	OL	SGPA_D	STEM	198	8.4317	2.08835	-1.114	0.266
			HSS	293	8.6439	1.97904		
2022-2023	F2F	SGPA_A	STEM	246	3.7355	1.31227	-2.306	0.021*
			HSS	335	3.9881	1.23564		
2019-2020	F2F	GPA_B	STEM	165	4.1796	1.01122	-0.797	0.426
			HSS	211	4.2720	1.07488		
2020-2021 2021-2022	OL	GPA_D	STEM	209	9.1186	1.78028	-0.656	0.512
			HSS	282	9.2285	1.72230		
2022-2023	F2F	GPA_A	STEM	252	3.9992	0.90048	-0.474	0.636
			HSS	329	4.0365	0.89786		

Note: * Significant at 0.05 (two-tailed). STEM = Science, Technology, engineering, and mathematics. HSS = Humanities and social sciences. SGPA_B / GPA_B = Academic performance before COVID-19 (AY2019-2020); SGPA_D / GPA_D = Academic performance before during COVID-19 (AY2020-2021, AY2021-2022); SGPA_A / GPA_A = Academic performance after COVID-19 (AY2022-2023).

5.6 Relationship between variables

Table 11 presents the outcomes of Spearman's rho correlation analysis, examining the association between demographic characteristics and academic performance. The results reveal a significant positive relationship between gender and SGPA for both F2F and OL teaching methods before the COVID-19 pandemic ($rs = 0.319$), during COVID-19 ($rs = 0.273$), and after the COVID-19 pandemic ($rs = 0.345$). Similarly, the results of the study revealed a positive significant relationship between student's academic major and SGPA in F2F teaching before and after COVID-19 ($rs = -0.173$, $rs = 0.095$) respectively. On the other hand, both gender and major were found not related to the student's GPA with F2F or OL teaching before, during, and after the COVID-19 pandemic.

Table 11
Spearman's Rho of correlation between Variables

Variable	1	2	3	4	5	6	7	8
1. Gender	1							
2. Major	-0.019	1						
3. SGPA_B	.319**	-.173**	1					
4. SGPA_D	.273**	0.062	.665**	1				
5. SGPA_A	.345**	.095*	.677**	.783**	1			
6. GPA_B	0.038	0.057	0.109	-0.053	0.011	1		
7. GPA_D	-0.008	0.034	.148*	-0.016	0.032	.859**	1	
8. GPA_A	-0.007	0.016	0.099	-0.035	0.016	.805**	.938**	1

Note: **Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed).

Based on Spearman's rho correlation results, a linear regression analysis was performed to determine the impact of gender and academic major on SAP in SGPA before, during, and after the COVID-19 pandemic. This analysis is based on the student's academic performance in SGPA. The researchers excluded GPAs because of no relationship between gender and academic major. The researchers assumed that gender and academic major positively impact a student's academic performance. Besides linear regression, we also used partial least squares structural equation modeling (PLS-SEM) to formulate the following models:

$$\text{Model 1: } Y_1 = \beta_0 + \beta_1 \text{ Gender} + \beta_2 \text{Major} + \varepsilon$$
$$\text{Model 2: } Y_2 = \beta_0 + \beta_1 \text{ Gender} + \beta_2 \text{ Major} + \varepsilon$$
$$\text{Model 3: } Y_3 = \beta_0 + \beta_1 \text{ Gender} + \beta_2 \text{Major} + \varepsilon$$

Table 12
Variables

Variable	Definition
Y1	= AP before COVID-19 (F2F)
Y2	= AP during COVID-19 (OL)
Y3	= AP after COVID-19 (F2F)
Gender	= 1 if the respondent is male, 2 if female
Major	= 1 if the respondent is from a STEM major, 2 if an HSS major
ε	= errors

Note: AP = academic performance, STEM = Science, technology, engineering, and math; HSS: Humanities and social sciences.

As presented in Table 13, the findings of regression analyses indicate that gender and academic major have a positive and significant impact on student's academic performance in the F2F teaching before COVID-19 (p-value = <.05), in OL teaching method during COVID-19 (p-value = <.05), and also in F2F teaching after COVID-19 (p-value = <.05). These results support the stated hypotheses (H4 & 5) and models of the study. Besides, the findings reveal that gender and academic major explain at least 8-13% of the variation of SAP in both F2F and OL teaching before, during, and after the COVID-19 pandemic. The findings confirm the impact of gender and academic major on students' academic performance. Figure 2 summarizes the nature of the relationship between gender and academic major and academic performance.

Table 13
Gender, academic major, and Academic performance

Model	Variable	Coefficient	R	R²	F-value	p-value
	Constant	3.685				
1	Gender	.687	.358	.128	27.399	<.001
	Major	-.363				
	Constant	6.206				
2	Gender	1.183	.292	.085	22.683	<.001
	Major	.288				
	Constant	2.042				
3	Gender	.905	.366	.134	44.638	<.001
	Major	.261				
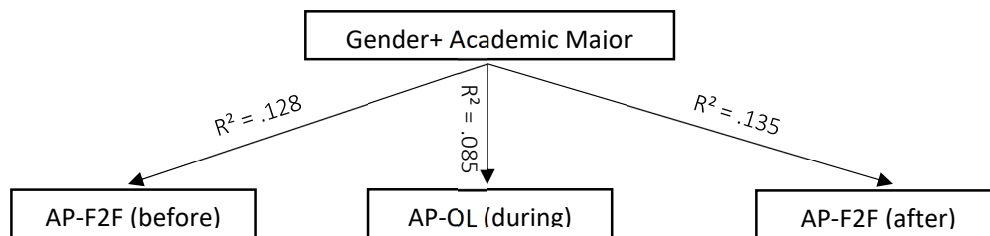
Fig. 2. Illustrates the impact of gender and academic major on SAP before, during, and after the COVID-19 pandemic.

6. Discussions

The recent COVID-19 pandemic was an exceptional experience that resulted in the implementation of online learning (OL) by thousands of schools, colleges, and universities all over the world (Crawford et al., 2020; Almahasees et al., 2021). This experience opens many opportunities and challenges for academic institutions (Masalimova et al., 2022; Stecuła and Wolniak, 2022). The opportunities include flexibility in teaching and learning, access to a variety of learning resources, and networking with teachers and other students all over the world. On the other hand, the challenges of online learning include financial challenges, challenges related to facilities and equipment, and also technical challenges.

This study has investigated the impact of gender and academic major on SAP before, during, and after the COVID-19 pandemic. SAP was measured using semester grade point average (SGPA) as well as grade average point (GPA). For the SGPA, the findings of the study show that the students achieved better performance in F2F learning after COVID-19, followed by OL learning during COVID-19, and F2F learning before the COVID-19 pandemic. For the GPA, students achieved better academic performance in OL learning during COVID-19, followed by F2F learning after COVID-19, and F2F learning before COVID-19.

Since GPA is more important than SGPA (Van Overschelde & López, 2018), we consider better performance for students in OL learning during COVID-19 than the F2F learning before and after the COVID-19 pandemic. Our findings are in line with the previous studies that reported better students' performance in OL learning as compared to F2F learning (Alghamdi et al., 2020; Asarta and Schmidt, 2020). One of the reasons behind better achievement in OL learning could be related to flexibility and convenience. Unlike F2F learning, OL learning allows students to access course resources and materials and study anytime and anywhere (Georgiadou & Siakas, 2006). Other reasons include access to diverse learning materials and global networking (Koutsoupidou, 2014; Leontyeva, 2018). In OL learning, instructors tend to expose students to a variety of resources and tools and also instruct students to do a variety of tasks that encourage networking and collaboration among students.

For the gender differences, the findings of the study indicate that female students outperformed male students in academic performance before, during, and after the COVID-19 pandemic and also in both F2F and OL learning methods. The differences are statistically significant in SGPA, but not in GPA before, during, and after the COVID-19 pandemic. The results support the stated hypotheses (H2), and also the findings of the previous studies (Andreou *et al.*, 2007; Al-Mously *et al.*, 2013; Amparo *et al.*, 2018; ElRefae *et al.*, 2021b; Tsaousis and Alghamdi, 2022), and suggest the impact of gender on students' academic performance. The reason for these differences could be related to the socio-economic status of the parents, parental involvement in children's education, and also differences in culture. A study by Van Houtte (2004) found that female students are more oriented to learning and education than male students. Similarly, a recent report by Wrigley-Asante et al. (2023) found that teaching methodologies, motivation, and support from parents, improved the academic performance of female students.

For the academic major, the findings of the study showed that students of humanities and social sciences (HSS) outperformed (in SGPA or GPA) students majoring in science, technology, engineering, and math (STEM), through F2F or OL learning method before, during, and after COVID-19 pandemic. In addition, the t-test analysis revealed that the differences between HSS and STEM students are statistically significant with SGPA of the F2F learning method before and after the COVID-19 pandemic. The results support the stated hypotheses (H3) and suggest the impact of academic majors on students' academic performance. The findings are in line with the previous studies that reported factors affecting SAP(Arora and Singh, 2017; Yousef, 2017; Briones *et al.*, 2022).

The findings of the study indicate that gender and academic major have a positive and significant impact on student's academic performance in F2F learning before COVID-19, in OL learning during COVID-19, and also in F2F learning after COVID-19. These results support the stated hypotheses (H4 & H5) and models of the study and reveal that gender and academic major explain up to 13% of the variation in SAP in both F2F and OL teaching before, during, and after COVID-19 pandemic. Although the impact of gender and academic major appeared relatively medium, they support prior studies that suggested the impact of demographic variables on SAP(Joseph *et al.*, 2015; Amparo *et al.*, 2018; Heo and Toomey, 2020). According to previous studies (Hassanbeigi *et al.*, 2011; Nogueira Gossenheimer *et al.*, 2017; Briones *et al.*, 2022), teaching methods, learning environments, personal motivation, and parental involvement are among the factors contributing to demographic differences in students' academic performance. Table 14 summarizes the findings of the tested hypotheses.

Table 14
Results of tested hypotheses

Code	Hypothesis	Finding
H1	There are significant differences in SAP before, during, and after the COVID-19 pandemic.	Not Supported
H2	Male and female students differ in academic performance before, during, and after the COVID-19 pandemic.	Partially Supported
H3	Science and humanities students differ in academic performance before, during, and after the COVID-19 pandemic.	Partially Supported
H4	Gender has an impact on SAP before, during, and after the COVID-19 pandemic.	Supported
H5	Academic major has an impact on SAP before, during, and after the COVID-19 pandemic.	Supported

7.   Conclusion

A student's academic performance is a major concern for parents, educators, and decision-makers. Therefore, it is essential and trustworthy to investigate and understand factors affecting students' academic performance. The study has been successful in measuring SAP using SGPA and GPA before, during, and after the COVID-19 pandemic. The study has investigated and compared SAP in F2F learning (before and after COVID-19) and OL learning (during COVID-19). Considering SGPA, students recorded better academic performance in OL learning (during COVID-19) compared to F2F learning (before or after COVID-19). As suggested by the previous studies (Georgiadou and Siakas, 2006; Koutsoupidou, 2014; Leontyeva, 2018), flexibility, accessibility, diverse course options, customized learning experience, and self-directed learning are among the factors contributing to better SAP in OL learning.

For the demographic factors, in this study, gender and academic major demonstrated a statistically significant impact on student's academic performance in F2F and OL learning. Moreover, both academic majors demonstrated the ability to predict up to 18% variation in the student's academic performance. The study provided valuable insight into differences in SAP before, during, and after the COVID-19 pandemic.

As implications, since students performed better in OL learning, educators and decision-makers of academic institutions should introduce more online courses for different programs and specializations and encourage students' enrollment in these courses. Likewise, parents also should play an important role in supporting and encouraging students' enrollment in OL courses. On the other hand, heads of departments and deans of colleges should ensure that faculty members receive sufficient knowledge and skills needed for conducting efficient and effective online teaching and instructions.

Regarding limitations, the study investigated the impact of two demographic variables, gender and academic major, on students' academic performance. Further studies may include not only more demographic variables but also non-demographic variables. This study did not attempt to investigate factors contributing to gender and academic major differences in academic performance among students. Therefore, future studies may investigate factors contributing to gender and academic major differences in academic performance. Method of instruction, learning environment, culture, and socioeconomic status of parents, are among the factors that may contribute to gender and academic major differences in academic performance.

Declarations of Interest

1.   Data Availability Statement

   Before the data collection, the researchers assured the data providing institution that the data will be used for this research only and will not be shared with a third party.

2.   Informed consent

   The informed consent was not needed because of the nature of data.

3.   Conflicts of interests
   The author(s) declare no conflict of interests.
4.   Funding

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