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Online vs in-person learning in higher education: effects on student achievement and recommendations for leadership

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This study is a comparative analysis of online distance learning and traditional in-person education at King Saud University in Saudi Arabia, with a focus on understanding how different educational modalities affect student achievement. The justification for this study lies in the rapid shift towards online learning, especially highlighted by the educational changes during the COVID-19 pandemic. By analyzing the final test scores of freshman students in five core courses over the 2020 (in-person) and 2021 (online) academic years, the research provides empirical insights into the efficacy of online versus traditional education. Initial observations suggested that students in online settings scored lower in most courses. However, after adjusting for variables like gender, class size, and admission scores using multiple linear regression, a more nuanced picture emerged. Three courses showed better performance in the 2021 online cohort, one favored the 2020 in-person group, and one was unaffected by the teaching format. The study emphasizes the crucial need for a nuanced, data-driven strategy in integrating online learning within higher education systems. It brings to light the fact that the success of educational methodologies is highly contingent on specific contextual factors. This finding advocates for educational administrators and policymakers to exercise careful and informed judgment when adopting online learning modalities. It encourages them to thoroughly evaluate how different subjects and instructional approaches might interact with online formats, considering the variable effects these might have on learning outcomes. This approach ensures that decisions about implementing online education are made with a comprehensive understanding of its diverse and context-specific impacts, aiming to optimize educational effectiveness and student success.

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Introduction

The year 2020 marked an extraordinary period, characterized by the global disruption caused by the COVID-19 pandemic. Governments and institutions worldwide had to adapt to unforeseen challenges across various domains, including health, economy, and education. In response, many educational institutions quickly transitioned to distance teaching (also known as e-learning, online learning, or virtual classrooms) to ensure continued access to education for their students. However, despite this rapid and widespread shift to online learning, a comprehensive examination of its effects on student achievement in comparison to traditional in-person instruction remains largely unexplored.

In research examining student outcomes in the context of online learning, the prevailing trend is the consistent observation that online learners often achieve less favorable results when compared to their peers in traditional classroom settings (e.g., Fischer et al., 2020; Bettinger et al., 2017; Edvardsson and Oskarsson, 2008). However, it is important to note that a significant portion of research on online learning has primarily focused on its *potential* impact (Kuhfeld et al., 2020; Azevedo et al., 2020; Di Pietro et al., 2020) or explored various perspectives (Aucejo et al., 2020; Radha et al., 2020) concerning distance education. These studies have often omitted a comprehensive and nuanced examination of its concrete academic consequences, particularly in terms of test scores and grades.

Given the dearth of research on the academic impact of online learning, especially in light of Covid-19 in the educational arena, the present study aims to address that gap by assessing the effectiveness of distance learning compared to in-person teaching in five required freshmen-level courses at King Saud University, Saudi Arabia. To accomplish this objective, the current study compared the final exam results of 8297 freshman students who were enrolled in the five courses in person in 2020 to their 8425 first-year counterparts who has taken the same courses at the same institution in 2021 but in an online format.

The final test results of the five courses (i.e., University Skills 101, Entrepreneurship 101, Computer Skills 101, Computer Skills 101, and Fitness and Health Culture 101) were examined, accounting for potential confounding factors such as gender, class size and admission scores, which have been cited in past research to be correlated with student achievement (e.g., Meinck and Brese, 2019; Jepsen, 2015) Additionally, as the preparatory year at King Saud University is divided into five tracks—health, nursing, science, business, and humanity, the study classified students based on their respective disciplines.

Motivation for the study

The rapid expansion of distance learning in higher education, particularly highlighted during the recent COVID-19 pandemic (Volk et al., 2020; Bettinger et al., 2017), underscores the need for alternative educational approaches during crises. Such disruptions can catalyze innovation and the adoption of distance learning as a contingency plan (Christensen et al., 2015). King Saud University, like many institutions worldwide, faced the challenge of transitioning abruptly to online learning in response to the pandemic.

E-learning has gained prominence in higher education due to technological advancements, offering institutions a competitive edge (Valverde-Berrocoso et al., 2020). Especially during conditions like the COVID-19 pandemic, electronic communication was utilized across the globe as a feasible means to overcome barriers and enhance interactions (Bozkurt, 2019).

Distance learning, characterized by flexibility, became crucial when traditional in-person classes are hindered by unforeseen circumstance such as the ones posed by COVID-19 (Arkorful and Abaidoo, 2015). Scholars argue that it allows students to learn at their own pace, often referred to as self-directed learning (Hiemstra, 1994) or self-education (Gadamer, 2001). Additional advantages include accessibility, cost-effectiveness, and flexibility (Sadeghi, 2019).

However, distance learning is not immune to its own set of challenges. Technical impediments, encompassing network issues, device limitations, and communication hiccups, represent formidable hurdles (Sadeghi, 2019). Furthermore, concerns about potential distractions in the online learning environment, fueled by the ubiquity of the internet and social media, have surfaced (Hall et al., 2020; Ravizza et al., 2017). The absence of traditional face-to-face interactions among students and between students and instructors is also viewed as a potential drawback (Sadeghi, 2019).

Given the evolving understanding of the pros and cons of distance learning, this study aims to contribute to the existing literature by assessing the effectiveness of distance learning, specifically in terms of student achievement, as compared to in-person classroom learning at King Saud University, one of Saudi Arabia's largest higher education institutions.

Academic achievement: in-person vs online learning

The primary driving force behind the rapid integration of technology in education has been its emphasis on student performance (Lai and Bower, 2019). Over the past decade, numerous studies have undertaken comparisons of student academic achievement in online and in-person settings (e.g., Bettinger et al., 2017; Fischer et al., 2020; Iglesias-Pradas et al., 2021). This section offers a concise review of the disparities in academic achievement between college students engaged in in-person and online learning, as identified in existing research.

A number of studies point to the superiority of traditional in-person education over online learning in terms of academic outcomes. For example, Fischer et al. (2020) conducted a comprehensive study involving 72,000 university students across 433 subjects, revealing that online students tend to achieve slightly lower academic results than their in-class counterparts. Similarly, Bettinger et al. (2017) found that students at for-profit online universities generally underperformed when compared to their in-person peers. Supporting this trend, Figlio et al. (2013) indicated that in-person instruction consistently produced better results, particularly among specific subgroups like males, lower-performing students, and Hispanic learners. Additionally, Kaupp's (2012) research in California community colleges demonstrated that online students faced lower completion and success rates compared to their traditional in-person counterparts (Fig. 1).

In contrast, other studies present evidence of online students outperforming their in-person peers. For example, Iglesias-Pradas et al. (2021) conducted a comparative analysis of 43 bachelor courses at Telecommunication Engineering College in Malaysia, revealing that online students achieved higher academic outcomes than their in-person counterparts. Similarly, during the COVID-19 pandemic, Gonzalez et al. (2020) found that students engaged in online learning performed better than those who had previously taken the same subjects in traditional in-class settings.

Expanding on this topic, several studies have reported mixed results when comparing the academic performance of online and in-person students, with various student and instructor factors emerging as influential variables. Chesser et al. (2020) noted that student traits such as conscientiousness, agreeableness, and extraversion play a substantial role in academic achievement,
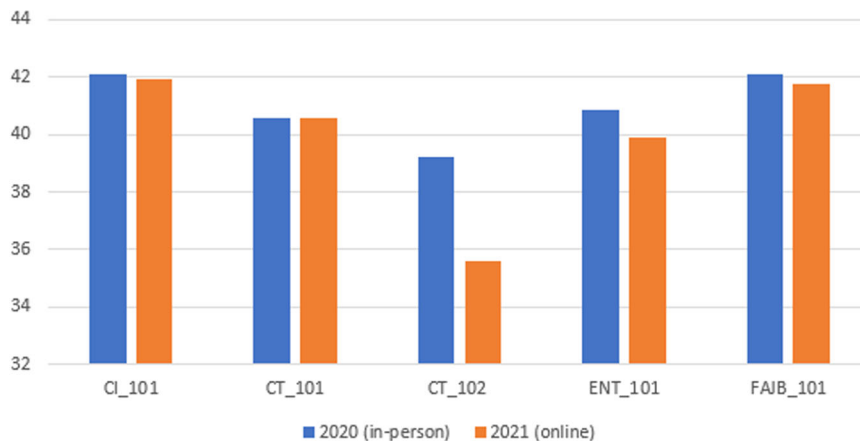
Fig. 1 Comparison of Final Exam Results for the Five Courses Mandatory Freshman Courses in King Saud University by Year (2020 and 2021). The figure compared student achievement in the final tests in the five courses by year, using independent-samples t-tests; the results show a statistically-significant drop in test scores from 2020 (in person) to 2021 (online) for all courses except CT_101.

regardless of the learning environment—be it traditional in-person classrooms or online settings. Furthermore, Cacault et al. (2021) discovered that online students with higher academic proficiency tend to outperform those with lower academic capabilities, suggesting that differences in students' academic abilities may impact their performance. In contrast, Bergstrand and Savage (2013) found that online classes received lower overall ratings and exhibited a less respectful learning environment when compared to in-person instruction. Nevertheless, they also observed that the teaching efficiency of both in-class and online courses varied significantly depending on the instructors' backgrounds and approaches. These findings underscore the multifaceted nature of the online vs. in-person learning debate, highlighting the need for a nuanced understanding of the factors at play.

Theoretical framework. Constructivism is a well-established learning theory that places learners at the forefront of their educational experience, emphasizing their active role in constructing knowledge through interactions with their environment (Duffy and Jonassen, 2009). According to constructivist principles, learners build their understanding by assimilating new information into their existing cognitive frameworks (Vygotsky, 1978). This theory highlights the importance of context, active engagement, and the social nature of learning (Dewey, 1938). Constructivist approaches often involve hands-on activities, problem-solving tasks, and opportunities for collaborative exploration (Brooks and Brooks, 1999).

In the realm of education, subject-specific pedagogy emerges as a vital perspective that acknowledges the distinctive nature of different academic disciplines (Shulman, 1986). It suggests that teaching methods should be tailored to the specific characteristics of each subject, recognizing that subjects like mathematics, literature, or science require different approaches to facilitate effective learning (Shulman, 1987). Subject-specific pedagogy emphasizes that the methods of instruction should mirror the ways experts in a particular field think, reason, and engage with their subject matter (Cochran-Smith and Zeichner, 2005).

When applying these principles to the design of instruction for online and in-person learning environments, the significance of adapting methods becomes even more pronounced. Online learning often requires unique approaches due to its reliance on technology, asynchronous interactions, and potential for reduced social presence (Anderson, 2003). In-person learning, on the other hand, benefits from face-to-face interactions and immediate feedback (Allen and Seaman, 2016). Here, the interplay of constructivism and subject-specific pedagogy becomes evident.

Online learning. In an online environment, constructivist principles can be upheld by creating interactive online activities that promote exploration, reflection, and collaborative learning (Salmon, 2000). Discussion forums, virtual labs, and multimedia presentations can provide opportunities for students to actively engage with the subject matter (Harasim, 2017). By integrating subject-specific pedagogy, educators can design online content that mirrors the discipline's methodologies while leveraging technology for authentic experiences (Koehler and Mishra, 2009). For instance, an online history course might incorporate virtual museum tours, primary source analysis, and collaborative timeline projects.

In-person learning. In a traditional brick-and-mortar classroom setting, constructivist methods can be implemented through group activities, problem-solving tasks, and in-depth discussions that encourage active participation (Jonassen et al., 2003). Subject-specific pedagogy complements this by shaping instructional methods to align with the inherent characteristics of the subject (Hattie, 2009). For instance, in a physics class, hands-on experiments and real-world applications can bring theoretical concepts to life (Hake, 1998).

In sum, the fusion of constructivism and subject-specific pedagogy offers a versatile approach to instructional design that adapts to different learning environments (Garrison, 2011). By incorporating the principles of both theories, educators can tailor their methods to suit the unique demands of online and in-person learning, ultimately providing students with engaging and effective learning experiences that align with the nature of the subject matter and the mode of instruction.

Course description
The Self-Development Skills Department at King Saud University (KSU) offers five mandatory freshman-level courses. These courses aim to foster advanced thinking skills and cultivate scientific research abilities in students. They do so by imparting essential skills, identifying higher-level thinking patterns, and facilitating hands-on experience in scientific research. The design of these classes is centered around aiding students' smooth transition into university life. Brief descriptions of these courses are as follows:

University Skills 101 (CI 101) is a three-hour credit course designed to nurture essential academic, communication, and

personal skills among all preparatory year students at King Saud University. The primary goal of this course is to equip students with the practical abilities they need to excel in their academic pursuits and navigate their university lives effectively. CI 101 comprises 12 sessions and is an integral part of the curriculum for all incoming freshmen, ensuring a standardized foundation for skill development.

Fitness and Health 101 (FAJB 101) is a one-hour credit course. FAJB 101 focuses on the aspects of self-development skills in terms of health and physical, and the skills related to personal health, nutrition, sports, preventive, psychological, reproductive, and first aid. This course aims to motivate students' learning process through entertainment, sports activities, and physical exercises to maintain their health. This course is required for all incoming freshmen students at King Saud University.

Entrepreneurship 101 (ENT 101) is a one-hour- credit course. ENT 101 aims to develop students' skills related to entrepreneurship. The course provides students with knowledge and skills to generate and transform ideas and innovations into practical commercial projects in business settings. The entrepreneurship course consists of 14 sessions and is taught only to students in the business track.

Computer Skills 101 (CT 101) is a three-hour credit course. This provides students with the basic computer skills, e.g., components, operating systems, applications, and communication backup. The course explores data visualization, introductory level of modern programming with algorithms and information security. CT 101 course is taught for all tracks except those in the human track.

Computer Skills 102 (CT 102) is a three-hour credit course. It provides IT skills to the students to utilize computers with high efficiency, develop students' research and scientific skills, and increase capability to design basic educational software. CT 102 course focuses on operating systems such as Microsoft Office. This course is only taught for students in the human track.

Structure and activities. These courses ranged from one to three hours. A one-hour credit means that students must take an hour of the class each week during the academic semester. The same arrangement would apply to two and three credit-hour courses. The types of activities in each course are shown in Table 1.

At King Saud University, each semester spans 15 weeks in duration. The total number of semester hours allocated to each course serves as an indicator of its significance within the broader context of the academic program, including the diverse tracks available to students. Throughout the two years under study (i.e., 2020 and 2021), course placements (fall or spring), course content, and the organizational structure remained consistent and uniform.

Data

Participants. The study's data comes from test scores of a cohort of 16,722 first-year college students enrolled at King Saud University in Saudi Arabia over the span of two academic years: 2020 and 2021. Among these students, 8297 were engaged in traditional, in-person learning in 2020, while 8425 had transitioned to online instruction for the same courses in 2021 due to the Covid-19 pandemic. In 2020, the student population consisted of 51.5% females and 48.5% males. However, in 2021, there was a reversal in these proportions, with female students accounting for 48.5% and male students comprising 51.5% of the total participants.

Regarding student enrollment in the five courses, Table 2 provides a detailed breakdown by average class size, admission scores, and the number of students enrolled in the courses during the two years covered by this study. While the total number of students in each course remained relatively consistent across the two years, there were noticeable fluctuations in average class sizes. Specifically, four out of the five courses experienced substantial increases in class size, with some nearly doubling in size (e.g., ENT_101 and CT_102), while one course (CT_101) showed a reduction in its average class size.

In this study, it must be noted that while some students enrolled in up to three different courses within the same academic year, none repeated the same exam in both years. Specifically, students who failed to pass their courses in 2020 were required to complete them in summer sessions and were consequently not included in this study's dataset. To ensure clarity and precision in our analysis, the research focused exclusively on student test scores to evaluate and compare the academic effectiveness of online and traditional in-person learning methods. This approach was chosen to provide a clear, direct comparison of the educational impacts associated with each teaching format.

Methods. Descriptive analysis of the final exam scores for the two years (2020 and 2021) were conducted. Additionally, comparison of student outcomes in in-person classes in 2020 to their online platform peers in 2021 were conducted using an independent-samples t-test. Subsequently, in order to address potential

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Table 1 Learning activities and total course hours per semester.

Courses	Learning Activities		Total Semester Hours
	Lecture	Laboratory	
CT_101	50%	50%	45
CT_102	50%	50%	45
ENT_101	100%	0%	15
FAJB_101	100%	0%	15
CI_101	100%	0%	45

CI_101 University Skills 101, *CT_101* Computer Skills 101, *CT_102* Computer Skills 102, *ENT_101* Entrepreneurship 101, *FAJB_101* Fitness and Health 101.

Table 2 Class size, gender distribution, and admission scores by courses in 2020 and 2021.

Courses	Average Class Size		Gender Distribution		Admission Scores	
	2020	2021	2020	2021	2020	2021
FAJB 101	23.1	46.1	M = 53.8%, F = 46.2%	M = 58.3%, F = 41.7%	89.58	87.95
CI 101	21.6	35.2	M = 54%, F = 46%	M = 58%, F = 42%	89.57	87.96
ENT 101	33.7	66.7	M = 68.1%, F = 31.9%	M = 69.7%, F = 30.3%	87.94	90.19
CT 101	42.7	22.3	M = 62.7%, F = 37.3%	M = 64.2%, F = 35.8%	90.84	88.22
CT 102	21.1	46.5	M = 51.4%, F = 48%	M = 57%, F = 43%	87.85	86.85

Source: Deanship of Admission and Registration Affairs at King Saud University.
CI_101 University Skills 101, *CT_101* Computer Skills 101, *CT_102* Computer Skills 102, *ENT_101* Entrepreneurship 101, *FAJB_101* Fitness and Health 101.

disparities between the two groups arising from variables such as gender, class size, and admission scores (which serve as an indicator of students' academic aptitude and pre-enrollment knowledge), multiple regression analyses were conducted. In these multivariate analyses, outcomes of both in-person and online cohorts were assessed within their respective tracks. By carefully considering essential aforementioned variables linked to student performance, the study aimed to ensure a comprehensive and equitable evaluation.

Study instrument. The study obtained students' final exam scores for the years 2020 (in-person) and 2021 (online) from the school's records office through their examination management system. In the preparatory year at King Saud University, final exams for all courses are developed by committees composed of faculty members from each department. To ensure valid comparisons, the final exam questions, crafted by departmental committees of professors, remained consistent and uniform for the two years under examination.

Table 3 provides a comprehensive assessment of the reliability of all five tests included in our analysis. These tests exhibit a strong degree of internal consistency, with Cronbach's alpha coefficients spanning a range from 0.77 to 0.86. This robust and consistent internal consistency measurement underscores the dependable nature of these tests, affirming their reliability and suitability for the study's objectives.

In terms of assessing test validity, content validity was ensured through a thorough review by university subject matter experts, resulting in test items that align well with the content domain and learning objectives. Additionally, criterion-related validity was established by correlating students' admissions test scores with their final required freshman test scores in the five subject areas, showing a moderate and acceptable relationship (0.37 to 0.56) between the test scores and the external admissions test. Finally, construct validity was confirmed through reviews by experienced subject instructors, leading to improvements in test content. With guidance from university subject experts, construct validity was established, affirming the effectiveness of the final tests in assessing students' subject knowledge at the end of their coursework.

Collectively, these validity and reliability measures affirm the soundness and integrity of the final subject tests, establishing their suitability as effective assessment tools for evaluating students' knowledge in their five mandatory freshman courses at King Saud University.

Procedure. After obtaining research approval from the Research Committee at King Saud University, the coordinators of the five courses (CI_101, ENT_101, CT_101, CT_102, and FAJB_101) supplied the researchers with the final exam scores of all first-year preparatory year students at King Saud University for the initial semester of the academic years 2020 and 2021. The sample encompassed all students who had completed these five courses during both years, resulting in a total of 16,722 students forming the final group of participants.

Limitations. Several limitations warrant acknowledgment in this study. First, the research was conducted within a well-resourced major public university. As such, the experiences with online classes at other types of institutions (e.g., community colleges, private institutions) may vary significantly. Additionally, the limited data pertaining to in-class teaching practices and the diversity of learning activities across different courses represents a gap that could have provided valuable insights for a more thorough interpretation and explanation of the study's findings.

Findings

To compare student achievement in the final tests in the five courses by year, independent-samples *t*-tests were conducted. Table 4 shows a statistically-significant drop in test scores from 2020 (in person) to 2021 (online) for all courses except CT_101. The biggest decline was with CT_102 with 3.58 points, and the smallest decline was with CI_101 with 0.18 points.

However, such simple comparison of means between the two years (via *t*-tests) by subjects does not account for the differences in gender composition, class size, and admission scores between the two academic years, all of which have been associated with student outcomes (e.g., Ho and Kelman, 2014; De Paola et al., 2013). To account for such potential confounding variables, multiple regressions were conducted to compare the 2 years' results while controlling for these three factors associated with student achievement.

Table 5 presents the regression results, illustrating the variation in final exam scores between 2020 and 2021, while controlling for gender, class size, and admission scores. Importantly, these results

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Table 3 Test of reliability (Cronbach's Alpha) and number of items for the five required freshman tests.

Courses	Cronbach's Alpha		Number of Items	
	2020 (In Person)	**2021 (Online)**	**2020 (In Person)**	**2021 (Online)**
FAJB 101	0.84	0.79	40	40
CI 101	0.78	0.84	40	40
ENT 101	0.83	0.75	40	40
CT 101	0.81	0.86	50	50
CT 102	0.77	0.78	50	50

Source: Preparatory Year Exams Center at King Saud University.
CI_101 University Skills 101, *CT_101* Computer Skills 101, *CT_102* Computer Skills 102, *ENT_101* Entrepreneurship 101, *FAJB_101* Fitness and Health 101.

Table 4 Comparison of Final Exam Results by Years and Subjects Among Freshman Classes at King Saud University (2020 and 2021).

Subjects	2020 (in-person)			2021 (online)					
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*	*ES*
CI_101	5497	42.13	6.56	5564	41.95	6.88	1.37	0.171	0.026
CT_101	4131	40.59	8.16	4365	40.57	8.35	0.12	0.901	0.003
CT_102	2663	39.20	7.96	2528	35.62	9.03	15.18	<0.001	0.422
ENT_101	3826	40.88	4.79	3966	39.87	6.34	7.92	<0.001	0.180
FAJB_101	5465	42.08	6.22	5590	41.79	6.11	2.45	0.014	0.047

CI_101 University Skills 101, *CT_101* Computer Skills 101, *CT_102* Computer Skills 102, *ENT_101* Entrepreneurship 101, *FAJB_101* Fitness and Health 101.

diverge significantly from the outcomes obtained through independent-sample t-test analyses.

Taking into consideration the variables mentioned earlier, students in the 2021 online cohort demonstrated superior performance compared to their 2020 in-person counterparts in CI_101, FAJB_101, and CT_101, with score advantages of 0.89, 0.56, and 5.28 points, respectively. Conversely, in the case of ENT_101, online students in 2021 scored 0.69 points lower than their 2020 in-person counterparts. With CT_102, there were no statistically significant differences in final exam scores between the two cohorts of students.

Discussion

The study sought to assess the effectiveness of distance learning compared to in-person learning in the higher education setting in Saudi Arabia. We analyzed the final exam scores of 16,722 first-year college students in King Saud University in five required subjects (i.e., CI_101, ENT_101, CT_101, CT_102, and FAJB_101). The study initially performed a simple comparison of mean scores by tracks by year (via t-tests) and then a number of multiple regression analyses which controlled for class size, gender composition, and admission scores.

Overall, the study's more in-depth findings using multiple regression painted a wholly different picture than the results obtained using t-tests. After controlling for class size, gender composition, and admissions scores, online students in 2021 performed better than their in-person instruction peers in 2020 in University Skills (CI_101), Fitness and Health (FAJB_101), and Computer Skills (CT_101), whereas in-person students outperformed their online peers in Entrepreneurship (ENT_101). There was no meaningful difference in outcomes for students in the Computer Skills (CT_102) course for the two years.

In light of these findings, it raises the question: why do we observe minimal differences (less than a one-point gain or loss) in student outcomes in courses like University Skills, Fitness and Health, Entrepreneurship, and Advanced Computer Skills based on the mode of instruction? Is it possible that when subjects are primarily at a basic or introductory level, as is the case with these courses, the mode of instruction may have a limited impact as long as the concepts are effectively communicated in a manner familiar and accessible to students?

In today's digital age, one could argue that students in more developed countries, such as Saudi Arabia, generally possess the skills and capabilities to effectively engage with materials presented in both in-person and online formats. However, there is a notable exception in the Basic Computer Skills course, where the online cohort outperformed their in-person counterparts by more than 5 points. Insights from interviews with the instructors of this course suggest that this result may be attributed to the course's basic and conceptual nature, coupled with the availability of instructional videos that students could revisit at their own pace.

Given that students enter this course with varying levels of computer skills, self-paced learning may have allowed them to cover course materials at their preferred speed, concentrating on less familiar topics while swiftly progressing through concepts they already understood. The advantages of such self-paced learning have been documented by scholars like Tullis and Benjamin (2011), who found that self-paced learners often outperform those who spend the same amount of time studying identical materials. This approach allows learners to allocate their time more effectively according to their individual learning pace, providing greater ownership and control over their learning experience. As such, in courses like introductory computer skills, it can be argued that becoming familiar with fundamental and conceptual topics may not require extensive in-class

Table 5 Regression Summary of Freshman Final Exam Results in 2020 (In Person) and 2021(Online) by Courses, Controlling for Gender Composition, Class Size, and Admission Scores in King Saud University.

	CI_101		FAJB_101		ENT_101		CT_101		CT_102	
	β	Standardized Beta	β	Standardized Beta	β	Standardized Beta	β	Standardized Beta	β	Standardized Beta
Constant	−1820.97***	--	−1145.93***	--	1382.01***	--	−10709.12***	--	−1360.93***	--
Year	0.89***	0.07	0.56**	0.05	−0.69***	−0.06	5.28***	0.32	0.66	0.04
Gender	4.18***	0.31	4.20***	0.34	3.80***	0.31	2.38***	0.14	4.07***	0.23
Class Size	0.01	0.01	0.01	0.02	0.02***	0.08	0.16***	0.23	−0.13***	−0.20
Admission Scores	0.62***	0.42	0.55***	0.41	0.44***	0.35	0.75***	0.43	0.78***	0.37
Adjusted-R^2	0.32		0.35		0.30		0.28		0.24	

Gender was represented with male = 0 and female = 1. Year was represented with 2020 = 0 and 2021 = 1. Class size was reporting using raw numbers. Admissions scores are a composite of high school grades and college entrance exams used to admit students into King Saud University.

CI_101 University Skills 101, CT_101 Computer Skills 101, CT_102 Computer Skills 102, ENT_101 Entrepreneurship 101, FAJB_101 Fitness and Health 101.

*$p < 0.05$, **$p < 0.01$, *** $p < 0.001$.

collaboration. Instead, it may be more about exposure to and digestion of materials in a format and at a pace tailored to students with diverse backgrounds, knowledge levels, and skill sets.

Further investigation is needed to more fully understand why some classes benefitted from online instruction while others did not, and vice versa. Perhaps, it could be posited that some content areas are more conducive to in-person (or online) format while others are not. Or it could be that the different results of the two modes of learning were driven by students of varying academic abilities and engagement, with low-achieving students being more vulnerable to the limitations of online learning (e.g., Kofoed et al., 2021). Whatever the reasons, the results of the current study can be enlightened by a more in-depth analysis of the various factors associated with such different forms of learning. Moreover, although not clear cut, what the current study does provide is additional evidence against any dire consequences to student learning (at least in the higher ed setting) as a result of sudden increase in online learning with possible benefits of its wider use being showcased.

Based on the findings of this study, we recommend that educational leaders adopt a measured approach to online learning—a stance that neither fully embraces nor outright denounces it. The impact on students' experiences and engagement appears to vary depending on the subjects and methods of instruction, sometimes hindering, other times promoting effective learning, while some classes remain relatively unaffected.

Rather than taking a one-size-fits-all approach, educational leaders should be open to exploring the nuances behind these outcomes. This involves examining why certain courses thrived with online delivery, while others either experienced a decline in student achievement or remained largely unaffected. By exploring these differentiated outcomes associated with diverse instructional formats, leaders in higher education institutions and beyond can make informed decisions about resource allocation. For instance, resources could be channeled towards in-person learning for courses that benefit from it, while simultaneously expanding online access for courses that have demonstrated improved outcomes through its virtual format. This strategic approach not only optimizes resource allocation but could also open up additional revenue streams for the institution.

Considering the enduring presence of online learning, both before the pandemic and its accelerated adoption due to Covid-19, there is an increasing need for institutions of learning and scholars in higher education, as well as other fields, to prioritize the study of its effects and optimal utilization. This study, which compares student outcomes between two cohorts exposed to in-person and online instruction (before and during Covid-19) at the largest university in Saudi Arabia, represents a meaningful step in this direction.

Data availability
The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Author contributions

Dr. Bandar Alarifi collected and organized data for the five courses and wrote the manuscript. Dr. Steve Song analyzed and interpreted the data regarding student achievement and revised the manuscript. These authors jointly supervised this work and approved the final manuscript.

Competing interests

The author declares no competing interests.

Ethical approval

This study was approved by the Research Ethics Committee at King Saud University on 25 March 2021 (No. 4/4/255639). This research does not involve the collection or analysis of data that could be used to identify participants (including email addresses or other contact details). All information is anonymized and the submission does not include images that may identify the person. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

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