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RESEARCH ARTICLE

Did Home-Based Exams during COVID-19 Affect Student Ranking? A Case from a Business School

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ABSTRACT

Background/purpose – Home-based exams were introduced during COVID-19 with an open-book format and limited control over dishonest student behavior. Such exams were used in lieu of traditional, closed-book school-based exams as a necessity due to the pandemic. This article investigates whether or not students' grades from home-based assessment exams differed from the grades they achieved in traditional school-based exams.

Materials/methods – Using administrative data from 2017 to 2020 from a business school in Norway, a quantitative approach that compared differences, correlation analysis, and regression models was applied in the study.

Results – By switching from school-based to home-based exams, students' academic success during their second year of business school showed a smaller association with students' outcomes from their first year. One interpretation is that skilled students achieved weaker performance in home-based exams.

Conclusion – Home-based exams without any control mechanisms appear to result in different student rankings. This knowledge may be useful for employers looking to hire applicants who graduated during the COVID-19 pandemic.

Keywords – COVID-19, home-based exam, business students, students' performance.

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1. INTRODUCTION

Due to the coronavirus pandemic, universities worldwide had to implement a rapid change from face-to-face teaching to digital instruction (Guo, 2021; Karakose, 2021; König & Frey, 2022). A survey from the Norwegian University of Science and Technology's (Norges Teknisk-Naturvitenskapelige Universitet; hereafter NTNU) business school in Norway showed that the majority of students missed in-person instruction (NTNU, 2021). Another result of the COVID-19 pandemic was that traditional school-based exams at the bachelor's level were replaced, at only very short notice, with home-based exams, and an open-book exam with access to other materials and tools may have impacted on the outcome of the assessment process. A large majority of students at the NTNU Business School reported that the threshold for cheating increased substantially with the introduction of home-based exams. They also believed that home-based exams were less fair than traditional school exams. In the choice between traditional and home-based exams, student opinion appears to be divided equally, with half preferring school exams, while the other half would opt for home-based exams to become a permanent arrangement even beyond the COVID-19 era and the return to face-to-face teaching. Other authors have confirmed that students are divided in their view of switching over to online exams (Eurboonyanun et al., 2021).

In countries with a national grading system, these measurements are supposed to indicate uniformity among candidates' qualifications, regardless of the quality of the individual educational institution attended. It is therefore of critical importance to achieve equal grading practices across the board in order that students are equally ranked irrespective of where they studied. Despite this, research has shown that not all colleges apply the grading scale the same in practice (Opstad, 2021). Smaller schools with students who are academically weaker than the national average tend to award higher grades. However, the consequence of this approach is that students with equal qualifications receive can different grades depending simply upon which school they attended. International surveys have shown the same tendency (Brookhart et al., 2016) and that this may undermine the system, because it results in the incorrect ranking of students and thus may send the wrong signal to universities and employers. Candidates may risk being displaced by less qualified applicants, which contributes to a less effective utilization of resources.

As such, the question addressed in the current study is, does the introduction of home-based exams increase this phenomenon. The effect of home-based exams implemented during COVID-19 on student academic ranking is of significant interest, especially if one considers changing the exam design on a more permanent basis. The current study seeks to gain more insight into this topic. What is the impact of replacing a traditional in-class exam (ICE) with a take-home (open-book) exam (THE) (Bengtsson, 2019)? Can student rankings differ as a result of such a practice? Studying the achievements of students at a Scandinavian business school (NTNU Business School) may help to provide insight into this issue. By comparing students' performance and letter grades before and after the COVID-19 pandemic, the aim is to provide an indicator of whether or not THEs present a potential problem to the provision of accurate academic student rankings.

2. LITERATURE REVIEW

Different forms of examination have been discussed in the literature. The impact probability depends on the type of subject, field, and level of study. One advantage of THEs is that they are more similar to the kind of assignments students will probably face in their subsequent working life (Dave et al., 2021). They can also capture more advanced levels of

Bloom's taxonomy (Krathwohl, 2002; Spiegel & Nivette, 2021) and provide a different form of learning and reflection than traditional school-based exams, especially if students are given more time to complete the assignments (Dave et al., 2021; Johanns et al., 2017). Moreover, students may appear less nervous and more able to relax if they are able to work within their familiar home environment (Akulwar-Tajane et al., 2021; Dave et al., 2021). Stress and psychosocial factors can cause already tense students to underperform with traditional exam formats. From a learning perspective, there are many arguments for practicing take-home exams, including affording students a more positive learning experience (Senel & Senel, 2021). Several studies have also reported that students are better able to focus on understanding a subject instead of simply aiming to memorize the content (Dave et al., 2021), so they spend less time preparing for final exams as a result. On the other hand, the application of THEs can result in less intensive learning, which may be considered a strike against the use of such exams (Rummer et al., 2019). THEs can also create challenges in measuring performance and the ranking of students, because students have open access to numerous tools and materials excluded during traditional school-based exams (Raman et al., 2021). In addition to the use of open-book exams and personal notes, today's students have access to the Internet and can easily communicate with their peers or others, although it may vary from student to student as to what extent such options are both available and employed.

Some studies in the literature have compared students' academic performance based on the two relevant exam formats. One important contribution has been from Eurboonyanun et al. (2021), in whose study the exam consisted of 120 multiple-choice questions, six essays, and 10 short-answer questions. This format made it possible to apply similar yet different types of assignments for open- and closed-book exams, and with equal time allocation during the exam. They found higher mean scores for multiple-choice type examinations and essays, but not for short-answer questions, while they also found a weak correlation between multiple-choice exams and the students' grade point average (GPA) from open-book exams. Eurboonyanun et al. (2021) interpreted this as indicating that open-book exams favor students with a lower GPA. However, there are mixed results about how moving to an open-book exam format affects student academic performance, with several researchers having reported being unable to detect any differences (Guangul et al., 2008; Spiegel & Nivette, 2021).

One important reason for having ICEs is the ability and ease to which control functions may be applied during the exam, such as invigilators ensuring that all students present their results under equal conditions. Of course, in the case of THEs, much of that control element is lost with home exams. What instruments the candidates may utilize in their home environment effectively become unobserved variables, and the ubiquitous use of technology in today's world may of course favor some students over others (Bawarith et al., 2017; Cluskey et al., 2011). This situation increases the probability of cheating since there is virtually no active monitoring. Permission to use the Internet during THEs may vary from subject to subject, although in most cases, there are strong guidelines that only answers from the individual exam taker should be submitted. Communication with fellow students, with other experts, or allowing others to answer the exam on a student's behalf are of course forbidden, yet largely go uncontrolled. Bilen and Matros (2021) suggested that COVID-19 and the widespread implementation of online exams have led to student cheating to a significantly greater extent than seen during the pre-pandemic era. If dishonest students receive academic benefit from this procedural change, it is at the expense of the more

honest students, and this alone create significant difficulties in measuring the correct performance of candidates for employment or programs of further study. In the absence of controls and penalties for those caught cheating, more and more students may be tempted to take the risk and do likewise. Also, if students expect their fellow students are likely to be dishonest in their exams, they too are more likely to consider behaving similarly. This has become a significant concern for many instructors and educational institutions. Bilen and Matros (2021) found significantly different values in student performance when comparing face-to-face exam results with those of online exams, which may be a strong indicator of widespread cheating.

There are, however, certain methods that may be used in order to reduce the extent of cheating during online exams. One such procedure is to design exams so that there are no concrete or simple answers (Guangul et al., 2020; Roelle & Berthold, 2017). Individual long essay answers are preferable compared to exams that are calculation-based or reliant on multiple-choice questions with only one correct answer. Another method is to employ technological monitoring systems such as webcams, microphones, or the registration of home or mobile Internet usage during an online exam or THE (Abdelrahim, 2021; Kedem-Yemini & Katz, 2021; Schoenmakers & Wens, 2021).

Many researchers have suggested that a strong inter-relationship exists between students' first-year GPA and their academic achievement in subsequent years (Allen & Robbins, 2008; Opstad & Årethun, 2020b) – that is, student achievement in the first year is a good predictor of further success in the same field of study. Oguntunde et al. (2018) reported finding a correlation coefficient of around .7 between students' first year GPA and the GPA over the subsequent 2 years, and their regression model showed a strong positive link between students' first year GPA and their final grades. Within economic and administrative subjects there is a high degree of heterogeneity in the composition of the subjects. Students who are good at quantitative subjects tend to perform well in quantitative subjects later in their course of study, while other students prefer non-quantitative courses. There is, for instance, significant correlation between students' outcomes in organizational theory from the first and second year of bachelor-level studies (Opstad & Årethun, 2020a).

3. METHODOLOGY

3.1 Participants (inclusive descriptive statistics)

The administrative data used in the current study provided information about the performance of undergraduate students at a business school in Norway over a 4-year period from 2017 to 2020. The same data also provided details about the students' age, gender, mathematical background, and the GPA received from upper secondary school (i.e., HSGPA = high school grade point average). Prior to the pandemic-related shutdown in 2020, the school employed a standard 4-hour closed-book school exam. Due to the COVID-19 pandemic, all exams in 2020 were conducted as home-based, with limited time available for their planning and implementation. It was mostly left up to individual instructors to choose an appropriate arrangement for the standard enforced 4-hour open-book exam. In several quantitative subjects (e.g., statistics, mathematics, macroeconomics), the instructors chose to switch to a pass/fail grading scale, whilst those from some subject areas changed the questions and content, and others made no modifications at all. However, as the students had access to various new instruments, the requirements for achieving a certain grade increased.

The following courses are taken as compulsory during the first year of the bachelor's program in Business Administration: Business Mathematics (BA), Managerial Economics and Accounting (MEA), Organizations and Management (OM,) and Marketing–Basic Course. Table 1 presents the GPA information from the first year and data for three subjects used in the analysis.

Table 1. Descriptive statistics for course exams taken during the first year (ICE)

	N	Min	Max	Mean	SD
Age	900	19	49	23.40	3.00
Theoretical math (0: Non-theoretical, 1: Theoretical)	900	.00	1.00	.6811	.47
Gender (0: F, 1: M)	900	.00	1.00	.5600	.50
HSGPA (high school grade point average) (1 to 6, 6 is top)	856	3.50	5.73	4.72	0.33
Managerial Economics and Accounting (MEA) (0: F, 1: E, 2: D, 3: C, 4: B, 5: A)	842	0	5.0	3.48	1.20
Business Math (BM) (0: F, 1: E, 2: D, 3: C, 4: B, 5: A)	733	0	5.0	3.18	1.54
Organizations and Management (OM) (0: F, 1: E, 2: D, 3: C, 4: B, 5: A)	900	0	5.0	3.01	1.23
First semester GPA (GPA for all four courses, first year (MEA, BM, OM + Marketing-Basic Course)	779	0	5.0	3.20	0.94
N	681				

Most students in the analyzed data were around 23 years old, and due to the significant competition to gain admission to the NTNU Business School, the average HSGPA value was found to be quite high. During upper secondary school, students may choose to study either practical or theoretical mathematics. The theoretical part is then either linked to the social sciences or the natural sciences. Among the business students at NTNU, around 70% have a background in theoretical mathematics from upper secondary school. The following courses from the second and third year of the Business Administration bachelor's program are included in this study: Cost Accounting and Budgeting (CAB), Business Strategy (BS), Investment and Financial Analysis (IFA), and Organizational Psychology (OP).

With normal progress, there is a 1-year time lag between the exams usually held in the first year and those for the CAB and BS courses due to those students having taken introductory courses during their first year. Similarly, normal progress creates a 2-year gap between the exams normally held in the first year and exams held for students taking the IFA and OP courses. This variation allows us to consider scenarios based on different time periods. Table 2 presents the exam results for each course for the year before COVID-19 (2019) and the year of the shutdown where face-to-face learning and exams were replaced by alternative arrangements (2020).

Table 2. Descriptive statistics for second and third year exams

	2019 (ICE)		2020 (THE)	
	Mean	Std. Dev.	Mean	Std. Dev.
Business Strategy (BS)	3.10	1.14	3.19	0.77
Investment and Financial Analysis (IFA)	3.59	1.23	3.01	1.35
Cost Accounting and Budgeting (CAB)	3.60	1.33	2.99	1.52
Organizational Psychology (OP)	2.51	1.08	3.01	0.88

Notes: 0: F, 1: E, 2: D, 3: C, 4: B, 5: A. Same instructor for both 2019 and 2020.

Notice that for 2020, the year when exams were applied as THE, the mean grade decreased by around half of one grade point for both the IFA and CAB courses. Prior to 2020, the mean grade for both these courses was around 3.5, and there are no obvious explanations for the decline from 2019 to 2020 apart from the change in examination format. As such, one explanation may be that the instructors raised the requirements for achieving a certain grade because of the altered form of the exams. However, for the OP course the opposite effect can be seen, with the mean grade having risen by 0.5 between 2019 and 2020. For the BS course, the level held the same for both years. Another interesting observation is that the standard deviation increased for the quantitative subjects (CAB and IFA) from 2019 to 2020, while it decreased for the non-quantitative subjects (BS and OP).

3.2 Instruments, procedures, and data analysis

In this study we explored the difference in student success between compulsory first-year courses and for more advanced courses where they are held in the second and third year of study. Two different situations were examined based on these exam arrangements:

1) Second and third year subjects: ICE (2019) – first year: ICE (ICE–ICE)
2) Second and third year subjects: THE (2020) – first year: ICE (THE–ICE)

The difference ($Y_{ICE-ICE}$) between a student's exam performance in a course during their second or third year ($C2_{ICE}$) and the first year course ($C1_{ICE}$) when ICE is applied for the whole period is calculated as:

$$(1) \quad Y_{ICE-ICE} = C2_{ICE} - C1_{ICE}$$

whilst switching over to THE after the first year results in the following calculation:

$$(2) \quad Y_{THE-ICE} = C2_{THE} - C1_{ICE}$$

By analyzing the difference in student performances from Equation (1) and (2), we can compare the impact of applying examinations according to THE and ICE formats. Where no difference in exam outcomes is seen, the following holds true:

$$(3) \quad Y_{THE-ICE} = Y_{ICE-ICE}$$

Changes in the exam format applied in the second and third year would therefore have no impact on the performance between courses where the exams are held during the first year or subsequent years. However, if COVID-19 had an influence on student performance, $Y_{THE-ICE}$ would show a different value than $Y_{ICE-ICE}$ – that is, ICE and THE do not yield the same measure for assessment. In order to answer this research question, three different approaches were used:

A. Compare the distribution differences in assessment outcomes between ICE–ICE and THE–ICE.
B. Compare the correlation coefficients among second and third year exams and first year exams between ICE–ICE and THE–ICE.

C. Compare the difference in performance for the second and third years exams and the first year exams between ICE–ICE and THE–ICE by applying a standard linear regression model.

Accordingly, both approaches A and B are in line with the method applied in the studies by Hickson et al. (2012) and Oguntunde et al. (2018). The following regression model was applied:

$$(4)\ Y_{ij} = a_0 + a_1X1_i + a_2X2_i + a_3X3_i + a_4X4_i + \varepsilon_i$$

where Y is the difference in the grade attained in courses where the exams are held later in the bachelor's program and those where the exams are held in the first year (the following differences are therefore included in this model: I = IFA–MEA, IFA–BM, IFA–OM, IFA–GPA, CAB–MEA, CAB–BM, CAB–OM, CAB–GPA (0: F, 1: E, 2: D, 3: C, 4: B, 5: A); j = 2109, 2020 (year); α_0 = constant; X_1 = gender (0: F, 1: M); X_2 = HSGPA, mean score for all subjects (1: Fail, 6: Top grade); $X_{3\ =}$ dummy variable for theoretical mathematics (T-math) (0: non-T-math student, 1: T-math student); X_4 = student age in years (1: 18-21, 2: 22, 3: 23, 4: 24, 5: 25-26, 6: 27-30, 7: 31-60); and ε = stochastic error.

Due to of the very skewed age distribution and the skewness and kurtosis values, the age of the students was divided into intervals. In order to limit the number of regression models, we excluded both the OP and BS courses as these are non-quantitative subjects and therefore less impact is expected from the introduction of open-book exams. Large gaps in the results from the first year exams may have significantly influenced the estimates; therefore, an alternative version (Model 2) was constructed where the differences in grades are at a maximum of 2 points. By using regression analysis, we were able to further study factors that could explain the differences seen in the results by comparing ICE–ICE and THE–ICE.

4. FINDINGS

4.1 Distribution of differences (Approach A)

Table 3 presents the distribution and mean value of the differences in student performance for the selected courses' second and third year and the introductory courses. With a few exceptions, the tendency is quite clear for the standard deviation to show higher values in 2020 (THE) than in 2019 (ICE). The variation in results between the subjects tends to be greater when combining the two exam formats (THE–ICE), than in cases with only school-based exams (ICE–ICE). A higher proportion of students tended to achieve different grades when switching from ICE–ICE to THE–ICE – that is, fewer students have unchanged grades in the two comparable subjects. This effect varies from course to course, and the impact is particularly large for IFA-MEA and OP-OM. For other subjects, the change is small and there are also examples of a percentage increase following a switch to THE (see OP-MEA).

Table 3a. Distribution of % difference between IFA and first semester courses before (ICE–ICE) and during COVID-19 (THE–ICE)

	IFA–MEA		IFA–BM		IFA–OM	
	2019	2020	2019	2020	2019	2020
	ICE–ICE	THE–ICE	ICE–ICE	THE–ICE	ICE–ICE	THE–ICE
< -1	4.4	9.5	2.2	10.5	1.4	4.5
-1	24.7	25.7	18.7	23.3	13.7	16.0
0	46.8	34.6	32.4	27.6	33.6	29.3
1	18.4	19.6	28.1	17.8	36.3	28.2

> 1	5.8	10.7	18.7	20.8	26.0	22.2
	100	100	100	100	100	100
Mean	-0.04	-0.03	0.50	0.23	0.53	0.51
SD	0.95	1.25	1.21	1.53	1.02	1.35
N	158	179	139	163	146	181

Table 3b. Distribution of % difference between OP and first semester courses before (ICE−ICE) and during COVID-19 (THE−ICE)

	OP−MEA		OP−BM		OP−OM	
	2019	2020	2019	2020	2019	2020
	ICE−ICE	THE−ICE	ICE−ICE	THE−ICE	ICE−ICE	THE−ICE
< -1	35.0	24.9	32.8	30.3	22.9	6.5
-1	35.6	33.3	32.8	23.6	33.1	24.9
0	19.9	23.8	24.1	16.8	37.9	37.3
1	8.9	16.7	10.9	14.9	6.9	24.9
> 1	0.7	5.4	5.8	28.6	2.8	7.1
	100	100	100	100	100	100
Mean	-1.08	-0.5	-0.72	-0.21	-0.65	0.03
SD	1.18	1.23	1.45	1.67	1.06	1.06
N	146	168	137	161	145	169

Table 3c. Distribution of % difference between BS and first semester courses before (ICE−ICE) and during COVID-19 (THE−ICE)

	BS−MEA		BS−BM		OP−OM	
	2019	2020	2019	2020	2019	2020
	ICE−ICE	THE−ICE	ICE−ICE	THE−ICE	ICE−ICE	THE−ICE
< -1	13.8	15.8	16.7	19.0	3.6	6.8
-1	29.0	28.1	26.3	30.0	15.3	25.0
0	32.5	36.0	28.5	21.7	40.9	33.0
1	19.0	15.7	13.6	10.0	30.3	21.6
> 1	5.9	4.5	14.9	18.3	9.9	13.6
	100	100	100	100	100	100
Mean	-0.30	-0.38	-0.16	-0.15	0.27	0.09
SD	1.17	1.13	1.46	1.66	1.00	1.22
N	252	89	275	60	275	88

Table 3d. Distribution of % difference between CAB and first semester courses before (ICE−ICE) and during COVID-19 (THE−ICE)

	CAB−MEA		CAB−BM		CAB−OM	
	2019	2020	2019	2020	2019	2020
	ICE−ICE	THE−ICE	ICE−ICE	THE−ICE	ICE−ICE	THE−ICE
< -1	8.8	25.0	9.	18.5	5.6	18.7
-1	21.7	25.5	17.5	16.9	12.6	19.8

0	38.7	33.8	37.8	30.9	27.4	24.7
1	24.9	13.1	21.1	19.8	32.6	24.3
> 1	4.4	2.7	15.4	13.9	21.8	12.4
	100	100	100	100	100	100
Mean	0.04	-.65	0.16	-0.07	0.57	-0.10
SD	1.09	1.23	1.34	1.55	1.26	1.49
N	217	275	209	243	215	268

4.2 Correlation analysis (Approach B)

The application of traditional school exams (ICE–ICE) yielded a high correlation between students' achievement for the subjects where the exam was taken during the first year and those taken at a later point in the program. For the BS and IFA subjects, the correlation coefficient was found to be around .6, whilst for CAB the value was slightly higher (.65). The correlation was also found to be significantly related to OM (around .50).

Table 4 shows a substantial decrease in the correlation coefficients for 2020 (THE–ICE). The scores from the school-based exam in the first year were found to be considerably weaker as an indicator in predicting success later in the bachelor's program when home-based exams were implemented. GPA from the first year was not revealed as a good predictor to the same extent for students' achievements in the second and third years of the bachelor's program. The impact varies slightly from subject to subject, with BS showing the greatest drop (decreased correlation coefficient of .2) and OP the lowest reduction (decreased correlation coefficient of .05). Thereby, students who exhibited skills in their first year's exam will, to a lesser extent, achieve high grades later on in the same program. Notably, Math was no longer strongly correlated with performance, as the correlation coefficient almost halved from 2019 to 2020.

Table 4. Correlation between courses second- and third-year courses, and first year before/during COVID-19

		Cost Accounting & Budgeting (CAB) (third semester)		Business Strategy (BS) (third semester)		Investment & Financial Analysis (IFA) (fourth semester)		Organizational Psychology (OP) (fifth semester)	
		2019 ICE–ICE	2020 THE–ICE	2019 ICE–ICE	2020[1] THE–ICE	2019 ICE–ICE	2020 THE–ICE	2019 ICE–ICE	2020 THE–ICE
EA	Corr.	.580	.590	.503	.327	.496	.342	.425	.311
	Sig	.000	.000	.000	.002	.000	.000	.000	.000
	N	217	275	252	89	145	293	146	168
BM	Corr.	.563	.458	.463	.224	.496	.314	.254	.219
	Sig	.000	.000	.000	.085	.000	.000	.003	.005
	N	209	243	228	60	129	259	137	161
OM	Corr.	.438	.397	.607	.324	.362	.182	.472	.399
	Sig	.000	.000	.000	.002	.000	.002	.000	.000
	N	215	268	256	88	145	282	145	169
GPA (first semester)	Corr.	.648	.589	.615	.415	.590	.465	.488	.447
	Sig	.000	.000	.000	.002	.000	.000	.000	.000

N	191	235	216	52	1116	155	124	150

(1) Due to a change in the bachelor's program, fewer students graduated from this course in this year

4.3 Regression models (Approach C)

The regression models provided some interesting results (see Tables 5-6), with Model 2 yielding some different effects from Model 1. This confirms the assumption that extreme values can affect the estimation of the parameters in our analysis. Our results showed no significant age-related impact of exam form ICE–ICE for the different subjects. Our findings also revealed some differences for THE–ICE; however, the impact was not considered substantial. For the CAB-OM and IFA-OM variables, there were significant correlations noted with age to the detriment of older students. There were no significant relationships for the four other dependent variables.

The gender effect was found to be mixed. The significant gender correlation in favor of females dissipated when replacing ICE–ICE with THE–ICE for CAB-MEA; however, the gender effect was revealed to be the opposite for IEA-MEA. Only ICE–THE was significant with the highest score for female students. Our findings were unable to confirm any clear gender difference in the students' exam performance from comparing ICE–ICE with THE–ICE. These results suggest that HSGPA may have some influence on grade measurements between ICE–ICE and THE–ICE. However, this applies for only some of the cases presented in Tables 5 and 6.

Table 5a. Regression Model 1. Dependent variable: Performance difference between fourth and first semester courses before/during COVID-19

	IFA–MEA				IFA–BM				IFA–OM			
	2019 (ICE–ICE)		2020 (THE–ICE)		2019 (ICE–ICE)		2020 (THE–ICE)		2019 (ICE–ICE)		2020 (THE–ICE)	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig
Age	-.07	.410	-.18	.037 *	.00	.990	-.02	.828	.02	.862	-.24	.006 ***
Gender	-.14	.109	-.14	.082 *	.23	.008 ***	.03	.758	-.13	.149	.04	.631
HSGPA	-.10	.301	-.05	.585	.011	.902	-.02	.870	-.29	.004 ***	-.06	.489
Math	.00	.972	-.07	.356	-.32	.000 ***	-.38	.000 ***	.18	.027 **	.00	.995
	$N = 151$		$N = 170$		$N = 132$		$N = 152$		$N = 140$		$N = 171$	
	$R^s = -.003$		$R^s = .026$		$R^s = .136$		$R^s = .117$		$R^s = .079$		$R^s = .028$	

*Notes: *** p < .01, ** p < .05, * p < .1, Standardized B*

Table 5b. Regression Model 2. Dependent variable: Performance difference between fourth and first semester courses before/during COVID-19

	IFA–MEA				IFA–BM				IFA–OM			
	2019 (ICE–ICE)		2020 (THE–ICE)		2019 (ICE–ICE)		2020 (THE–ICE)		2019 (ICE–ICE)		2020 (THE–ICE)	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig

	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Age	-.08	.354	-.10	.272	.02	.815	-.01	.935	.00	.992	-.19	.042 **
Gender	-.14	.110	-.14	.099 *	.17	.046 **	.06	.480	-.10	.303	.08	.326
HSGPA	-.07	.490	-.06	.518	-.04	.671	-.10	.921	-.27	.009 ***	-.03	.764
Math	.06	.462	-.08	.332	-.32	.000 ***	-.27	.003 ***	.15	.072 *	.03	.749
	$N = 148$		$N = 159$		$N = 124$		$N = 133$		$N = 135$		$N = 154$	
	$R^s = .003$		$R^s = .005$		$R^s = .119$		$R^s = .077$		$R^s = .054$		$R^s = .018$	

Notes: *** $p < .01$, ** $p < .05$, * $p < .1$, Standardized B

Table 6a. Regression Model 1. Dependent variable: Performance difference between third and first semester courses before and during COVID-19

	CAB–MEA				CAB–BM				CAB–OM			
	2019 (ICE–ICE)		2020 (THE–ICE)		2019 (ICE–ICE)		2020 (THE–ICE)		2019 (ICE–ICE)		2020 (THE–ICE)	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig
Model 1												
Age	-.03	.475	-.05	.518	.15	.059	-.11	.138	.01	.863	-.14	.064 *
Gender	-.13	.074 *	-.07	.265	.03	.625	.04	.470	.02	.831	.08	.189
HSGPA	.08	.376	-.03	.733	.06	.461	-.15	.042 **	.09	.252	-.14	.063 *
Math	.06	.400	-.00	.957	-.34	.000 ***	-.44	.000 ***	.12	.102	.01	.837
	$N = 200$		$N = 265$		$N = 191$		$N = 236$		$N = 196$		$N = 259$	
	$R^s = .013$		$R^s = -.009$		$R^s = .147$		$R^s = .169$		$R^s = .001$		$R^s = .014$	

Notes: *** $p < .01$, ** $p < .05$, * $p < .1$, Standardized B

Table 6b. Regression Model 2. Dependent variable: Performance difference between third and first semester courses before and during COVID-19

	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
Age	.11	.183	-.08	.298	.15	.082 *	-.06	.457	.04	.632	-.15	.042 **
Gender	.14	.049 **	-.01	.937	.032	.657	.02	.804	.08	.274	.06	.390
HSGPA	.12	.141	.01	.926	.09	.266	-.09	.293	.13	.118	-.19	.014 **
Math	.17	.027 **	.01	.897	-.30	.000 ***	-.27	.000 ***	.13	.087 *	-.04	.588
	$N = 196$		$N = 245$		$N = 178$		$N = 207$		$N = 186$		$N = 235$	
	$R^s = .036$		$R^s = -.009$		$R^s = .114$		$R^s = .050$		$R^s = .010$		$R^s = .018$	

Notes: *** $p < .01$, ** $p < .05$, * $p < .1$, Standardized B

As can be seen, CAB-BM and CAB-OM are significantly and negatively linked to HSGPA in applying THE−ICE, while ICE−ICE revealed no significant relationship. This means that a higher GPA score during upper secondary school negatively relates to the difference in performance of those subjects. Tables 5 and 6 also suggest that the mathematical background from upper secondary schools is meaningful. There is a substantial difference in the correlation between math and the two dependent variables (IFA-OM and CAB-OM) when comparing ICE−ICE and THE−ICE; this also occurs for CAB-MEA. In applying ICE−ICE, a positive relationship with math was evident, but when switching to THE−ICE, this effect notably disappeared.

5. DISCUSSION

5.1 Age and gender

Klein et al. (2007) reported that younger students were more likely to cheat, while other researchers found no relationship between student age and cheating (Whitley, 1998). Other possible explanations of the age correlation could be that younger students benefit from THEs because they know how to use the software better and have better access to a network of student peers and others with whom they could consult with, albeit dishonestly as in acts of cheating. If age matters, THEs present a disadvantage for older students. The correlation revealed between age and performance in the current study was not found to be statistically strong, whether analyzing ICE−ICE or THE−ICE, but the findings seem to indicate (weakly) that THEs do not benefit older students.

The published literature reveals a mixed relationship between gender and misbehavior during exams. Some suggested that male students tend to cheat more than females (Dodeen, 2012; King & Case, 2014; Lin & Wen, 2007), whilst others reported there being no gender difference (Arnold, 2016; Watson & Sottile, 2010). The current study found no clear difference between ICE−ICE and THE−ICE based on student gender. With a high degree of gender equality in Norway and given that most of the students at NTNU Business School are female, this result is not seen as particularly surprising.

5,2 Mathematical background and skill

The composition of subjects included in a business degree is heterogeneous. It is therefore not surprising that a high correlation was found in terms of student performance for subjects that are closely related (e.g., OL and OM). For quantitative subjects such as IFA, knowledge of mathematics is seen as a critical factor for success (Opstad, 2018). This explains the strong link between the academic performance of students in the BM and IFA courses. The connection between mathematics and performance in other subjects is significantly weaker in THE−ICE when compared to ICE−ICE (see Table 4). The regression models based on students' math background from upper secondary school also showed the same tendency (see Tables 5 and 6). However, when moving from ICE−ICE to THE−ICE, the students' high school math knowledge revealed a lesser impact on academic outcomes. This means that mathematical skills no longer result in the same success in quantitative courses. THEs do not afford the same benefits for success in these fields. Students with weaker mathematical skills from upper secondary school achieve greater success by taking a bachelor's degree in business administration if the school arranges THEs, which do not provide the same advantages for success in these fields.

5.3 Academic skills

It is well documented in the literature that performance and first year GPA are a good indicator of further success in higher education (Namoun & Alshanqiti, 2021; Tatar & Düştegör, 2020), and Table 4 confirms this result. The link between first-semester GPA and later achievement is much weaker for THE–ICE than for ICE–ICE. This also applies if GPA is replaced with a single subject from the first semester (see Table 4).

The regression model confirmed that academic skill (HSGPA) has less of an impact when comparing THE–ICE with ICE–ICE, and that a strong positive correlation exists between HSGPA and IFA–OM. However, this link disappears with THE in 2020. For other subjects, there were no relationships revealed between the dependent variables and HSGPA, but this effect turned to become significantly negative for THE–ICE (see CAB-OM and CAB-BM) . Such exams were used in lieu of traditional, closed-book school exams. By switching to THEs due to COVID-19, factors other than good performance at the start of the course or a high HSGPA helps to explain academic success later on in the bachelor's program. The introduction of THEs thus appears to favor weaker students – that is, candidates with a lower level of success in the first semester or during upper secondary school.

5.4 Cheating and other factors

One possible explanation for these findings is the degree of unethical assistance that may have been involved. Arnold (2016) suggested that the temptation to engage in academic misconduct is more prevalent among less motivated students, whilst Klein et al. (2006) affirmed that business students with a lower GPA tended to be more dishonest. If academically weaker students cheat more than other students, it might justify why the link in performance to GPA (first year) is no longer so close. NTNU's internal newspaper contains several articles about COVID-19 and THEs. Students have reported that a significant motivator for cheating is the strong competition among students, and that grades are vital in Norway to gain access to further studies and in job seeking (Kjølseth, 2021). In a survey at another department at NTNU (Mathematical Institute), 30% of students stated that they had cheated in THEs (Mikkelsen, 2021). There are many indications that the possibility of cheating may therefore increase should universities continue to apply THEs. One lecturer at NTNU checked into this by pretending to be a student. Through the Internet he was offered solutions online translated into Norwegian that would receive top grades (A). People with a doctorate from abroad offer such services for a fee of around US$ 70 (Mikkelsen, 2022). The extent of cheating is probably a factor that would explain the results of the current study's findings. Due to Norwegian law, there is limited opportunity to monitor (via camera or otherwise) student activities during THEs. However, if students believe it is easier to answer questions in THEs, this may influence their effort in preparing for and during their final exams (Parker et al., 2021), and this could also result in the changes seen in performance when comparing THE with ICE.

5.5 Contribution, limitations, and validity

Data analyzed in the current study were taken from only one business school. The topic is nevertheless of general interest and is relevant to other campuses in terms of examinations held during the COVID-19 pandemic. The study has shown that differences exist in assessment outcomes by switching from school-based to home-based exams due to community closure, which resulted in influencing the ranking of students. The pandemic may have also affected the students' learning processes. At the NTNU Business School, in-person teaching was combined with online streaming (Panopto) during the pandemic, because the

number of attendees on campus had to be strictly limited. There were, as a result, far fewer students on campus, and so it is difficult to know how this affected the students' learning environment. THEs weaken the link between academic skills and success in business subjects. Good results from upper secondary school mean lower grade achievement later on. THEs do not favor academically well-qualified students to the same degree. The winners, when it comes to THEs, are those who appear less qualified at the outset. Hence, THEs may be said to provide an opportunity for students who are poorly served by ICE to perform better. There may be some bias inherent to ICE, and one interpretation is that underprivileged students overcome such bias where THEs are applied.

6. CONCLUSION

The study provided new insight into a current topic. Due to COVID-19, society had to largely shut down for an extended period, with universities forced to introduce new forms of examination during this time. Using data from a business school in Norway, the current research considered how this change affected student ranking. Our analysis found substantial differences between ICE–ICE and THE–ICE, which suggests that home-based exams at the bachelor's level led to a different ranking of students. Achieving good grades at the upper secondary school level and during the first year of study at university were, to a much lesser extent, correlated with the achievements of students later in the bachelor's program. Therefore, it appears that students with weaker academic skills may benefit from the introduction of home-based exams. The result may also indicate that this form of examination may create disadvantages for older-aged students, as grades are used to rank students when applying for further studies or to gain employment, and as such incorrect rankings could contribute to ineffective resource allocation.

7. SUGGESTIONS

Educational managers should take note that switching from ICE to THE can influence student ranking. If the grades awarded for a diploma provide only a poor indicator of the qualifications of candidates, it is difficult to defend the arrangement of a common national grading system. Introducing THEs for undergraduate students can place the integrity of this scheme under pressure, and this must be taken into account if universities are to consider changing exam methods. Due to a lack of data, we were unable to observe how THEs influence student behavior, so we can only indicate to a limited extent who wins and who loses where home-based exams are implemented. As such, further research is needed in this field.

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