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Understanding Diversity in Undergraduate Learning of Cost-Benefit Analysis

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Understanding Diversity in Undergraduate Learning of Cost-Benefit Analysis

Abstract

This paper presents a case study that reflects on teaching an economic unit, Cost-benefit analysis (CBA), to a diverse undergraduate student body at the researcher's institution. CBA is an applied economic technique that attempts to assess the economic efficiency of proposed public policies through the systematic prediction of social costs and social benefits. Students in this CBA unit are required to complete an online test, CBA report and a final examination. In the CBA Report, the students perform analytical work to explain the relationships among events, identify options, evaluate choices, and predict the effects of actions. This paper investigates the performance of four different student cohorts from 2019 to 2022. This paper aims to understand the differences in undergraduate students' learning of CBA based on the diversity among students, and in particular whether any specific student demographic (defined by gender, age, course progress level, study load and domestic vs international students) experienced a disproportional impact. The findings are then used to contribute improvement in the teaching and learning of the unit in higher education.

Practitioner Notes

1. The paper investigates student performance from 2019 to 2022 in CBA
2. The paper looks at diverse student demographics and its impact on learning
3. The paper notices gender difference in student performance
4. The paper finds that students' aptitude with mathematical and knowledge of economic concepts have a strong impact on the CBA performance
5. The paper finds no consistent difference between domestic and international students' performance

Keywords

Cost-Benefit Analysis, Higher Education, Teaching and Learning, Economic Education and Teaching of Economics, Case Study

Introduction

This paper looks at the teaching and learning of an undergraduate unit, Cost-Benefit Analysis (CBA), at the researcher's institution. Cost-benefit analysis is a policy assessment method that quantitatively compares the costs and benefits of a proposed public policy measure with the status quo to assess whether the measure provides a net benefit to society (Boardman et al., 2018; Draper, 2003; Yu, 2021b). The CBA unit at the researcher's institution is an advanced level undergraduate unit, which is a core unit in Bachelor of Business (International Business) and Bachelor of Commerce degrees. The unit is also available to students in other degrees as an optional elective. Full-time students normally enrol in the CBA unit in their second- or third-year studies. Part-time students prefer to undertake the unit in their final year of studies due to the perceived difficulties shared among students.

The CBA unit provides an investment analysis of the viability of social and economic projects or programs with a view of informing and guiding decision making (Yu, 2022). CBA uses microeconomic theory to determine whether society will be better off or worse off in aggregate if a particular project goes ahead. Particular attention is paid to incorporating the non-monetary costs and benefits of a project. Students who complete the unit successfully will be able to write a Cost Benefit Analysis report that is suitable for public policy, and explain the principles behind cost benefit analysis (Yu, 2022). The CBA unit was first offered in 2019 and has since been offered annually. The delivery mode of the unit was designed and offered as face to face in 2019. However, due to the impact of COVID-19, the unit was delivered face to face initially and changed to online delivery during the lockdown in 2020 (Australian Government Department of Health, 2020; Yu, 2021a). The unit remained as online delivery in 2021 and 2022.

Student assessment is the centrepiece of the teaching and learning process, which provides information on whether students are developing the desired knowledge and skills (Fisher & Bandy, 2019). Assessment tasks need to be designed and implemented appropriately to support student learning. Table 1 summarises the assessment items and their weightings from 2019 to 2022. There were only two pieces of assessment in 2019, each contributing 50 per cent to the overall mark. With only one coursework assignment over the semester and one examination at the end of the semester, the usefulness of feedback provided to students could be improved.

Therefore, to align the unit's learning objectives, activities and outcomes, a progressive assessment scheme was introduced. From 2020 onwards, the number of assessment items increased to three pieces. An additional test (in-class or online) was introduced early in the semester, contributing 10-15 per cent to the overall mark. The test examined contents from the first three lectures (out of 12 lectures) and the results were released to the students before the census date – the date (a few weeks into the start of a teaching period) before which students may withdraw from a unit without penalty (University

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of Canberra, 2022). Students had opportunity to understand where they need to improve at this earlier stage of the learning process.

Table 1

Assessment Items and Weightings

2019	2020	2021	2022
Cost Benefit Analysis Report (50%)	In-class Test (10%)†	Online Test (15%)	Online Test (15%)
Final Exam (50%)	Cost Benefit Analysis Report (40%)	Cost Benefit Analysis Report (35%)	Cost Benefit Analysis Report (30%)
	Take-home Exam (50%)†	Take-home Assessment (50%)†	Take-home Assessment (55%)†

†Math-intensive assessment

In the CBA Report, students perform analytical skills to explain the relationships among events, identify options, evaluate choices, and predict the effects of actions. Students completed the CBA report individually in 2019 and 2020. To promote collaboration skills to achieve shared learning goals, students were recommended to attempt the CBA report assessment in a group of no more than 5 students in 2021 and 2022 (Kagan, 2014). Group work provides students avenues to incorporate diverse viewpoints and to develop communication and teamwork skills (Lamm et al., 2012). The final assessment is a take-home piece. Students were given a certain amount of time to submit the assessment once the questions were released. Both the test and the take-home assessment were math-intensive. Students were tested on calculating changes in social surplus, discounting future values to find net benefits, comparing projects with different time frames, constructing decision trees and so on. The unit requires common mathematical techniques, such as algebra, geometry, order of operations, balancing equations and statistics. However, the only pre-requisite unit is Introduction to Economics, which only covers basic microeconomic principles and theories.

This paper aims to understand the differences in undergraduate students' learning of CBA based on the diverse demographics among students. The student demographic is defined by gender, age, course progress level, study load and domestic vs international students. This paper analyses the impact of these demographic factors on CBA unit grades. With the understanding of students' learning differences, possible ways to improve teaching and learning of the unit are discussed.

Literature Review

Prior research on undergraduate education suggests that demographic characteristics play an important role in determining students' academic performance (Brubacher & Silinda, 2019; Ortega-Maldonado et al., 2017). Students' characteristics including gender, age, level of study,

and ethnicity are among the most significant factors influencing academic performance (Ahmed Omer et al., 2018).

Economic Students

In Australia, the low interest in economics at university is reflected in the sharp decline in the size and diversity of the economics student population (Dwyer, 2017; Livermore & Major, 2020). Studying economics at school is an important pathway for students majoring economics at university. On average, nearly 10 per cent of year 12 economics students enrolled in a dedicated economics course at university (Lovicu, 2021). Overall enrolments in year 12 economics have fallen by 70 per cent in the last 30 years with a 78 per cent nationwide decline in female students enrolling in economics since 1992 (Livermore & Major, 2020). The unequal enrollment in economics at high school is about 65 per cent males and 35 per cent females (Augustin & Sommer, 2021). Students' interest, perceived competence and whether the subject would be relevant for future study or work played a big role in their decision not to study economics. Male students were more likely than female students to find economics interesting as a field of study and female students had less understanding of whether they could be good at economics or where it might take them (Livermore & Major, 2020). The decline in the size and diversity of student population in economics studying is worrying as diversity has bearing on the economic questions one ask and how one answer them (Dwyer, 2018).

Importance of CBA Study

Cost-benefit analysis is an applied economic technique that provides a systematic evaluation of the impacts of a regulatory proposal. Public sector (governments) is committed to the use of CBA. CBA accounts for not only the immediate or direct effects, financial effects or effects on one group, but all the effects on the community and economy (Office of Best Practice Regulation, 2020). CBA enables comparison relative to a base case of the impacts of proposed options for government intervention to address any problems. Economic costs and benefits are measured from the perspective of society as a whole, and for comparative purposes, they are monetised and discounted to net present value. A challenging aspect of CBA is the presence of significant elements of subjectivity and value judgement (Moosa, 2016). The uncertainties and valuation process indicate that CBA is not a strict quantitative technique.

Gender Difference

Bayer et al. (2020) reported that females received 28.4 per cent of economics degrees (in the US) in 2014, and made the point that this is not reflected in other quantitative, calculation-intensive subjects, with near-parity in mathematics and statistics degrees. Buckles (2019) reported that 56 per cent of all undergraduate students in the US were female, but only 33 per cent of students majoring in economics were female. Similarly, Bayer & Wilcox (2019) found that, across the United States, 68.7 per cent of students graduating from an economics degree were male, which contrasted with 57 per cent of all graduating students being female. In 2020, 28.4 per cent of bachelor's degrees in economics were received by women – this is drawn from a sample of US colleges and universities (Siegfried, 2021). In Spain, Beneito et al. (2021) summarised that the percentage of women in economics degrees declined from a peak of 56.3 percent in 2006,

hovering in the low 40s for most of the following years, and had dipped to 36 per cent in 2017 (the final year reported).

Brückner et al. (2015) administered a standardised test for knowledge of economic concepts to undergraduate students in Germany, the USA and Japan. With two categories of knowledge (macro vs micro economics), two styles of question (calculation required or not) and three countries, which presented 12 different benchmarks where gender differences were compared. In 9 out of 12 cases, male students outperformed female students at a level considered statistically significant. In the remaining three cases, the difference between genders was not significant. The gap between male and female students' results got larger for questions requiring numerical calculation – the style of question most relevant to the CBA course studied in this paper. The background of the students made a difference – out of four benchmarks for each country, Japan had no significant gender difference on three of them.

Student Type

Student populations in higher education are becoming more and more diverse due to increasing student numbers. Australian universities support great diversity and broadly accept that promoting and learning through diversity can enhance all students' university experience (Baker et al., 2022). Prior to the COVID-19 pandemic, international students were a considerable influence on Australian universities' diversity profiles, with international student enrolments representing over 140 countries and 125 languages spoken (Xing et al., 2022).

Course Progress Level

The timing of students' enrolment in a unit such as first-, second- or third-year can have an impact on their academic performance (Christmann, 2018). Studies have shown that quantitative or mathematics scores seem to be especially important for both introductory economics and intermediate micro and macroeconomics course performance (Arnold & Straten, 2011; Elzinga & Melaugh, 2009). Similar findings have also been reported for the Middle East, the Netherlands, South Africa, and the United Kingdom (Arnold & Straten, 2011; Kherfi, 2008; Lagerlöf & Seltzer, 2009; Parker, 2006).

Online Teaching

The common types of interaction method in the online environment are asynchronous and synchronous communication means (Kearns, 2012). Asynchronous communication enables the transmission of messages that can be viewed and responded to at the students' convenience. Whereas, synchronous communication offers real time communication and requires students to be logged online at the same time. Zapalska (2022) investigated how different student demographic groups responded to the shift to online learning - in particular they looked at gender-based difference in learning styles and how this interacted with the design of an online-only engineering economics course. Findings from Zapalska's (2022) study showed that female students were not kinaesthetic learners and preferred verbal or reading mode of learning, whereas male students preferred aural style and African Americans kinaesthetic learning style. However, Zapalska (2022) did not further examine the academic performance difference between male and female students.

Kofoed et al. (2021) found that introducing online learning in an Introductory Economics course was correlated with a decrease in student's final grades. Prokes and Housel (2021) looked at student confidence after the introduction of remote learning, with analysis by demographic groups including gender, age and race. Male students reported a slightly smaller drop in confidence than female participant. Notable declines in confidence across all demographics were found. In particular, students of age 18 to 21 and those without prior online course experience were significantly affected. Tartavulea et al. (2020) surveyed staff and students in economics and business administration courses in universities across 13 EU countries. They looked at the shift in teaching methods and assessment items as a result of the COVID-19 pandemic, as well as perceived effectiveness of online teaching. Contrary to common belief that the overall effectiveness of the online educational experience is lower than face-to-face teaching, respondents viewed the switch to online teaching to have an overall moderate positive impact on the educational process (Tartavulea et al., 2020).

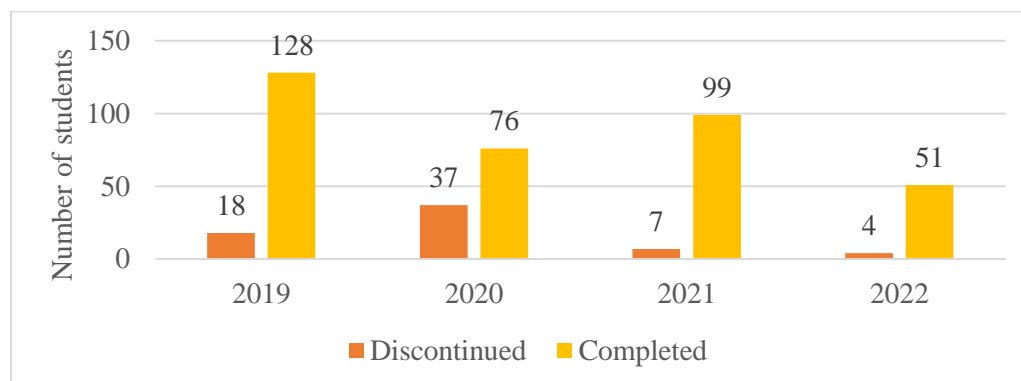
Method

Case study is a research methodology that helps in exploration of a phenomenon within some particular context through various data sources, and it undertakes the exploration through variety of lenses in order to reveal multiple facets of the phenomenon (Baskarada, 2014; Li & Yu, 2012). This paper focuses on a case of the CBA unit teaching at the researcher's institution. This paper investigates the students' performance of four cohorts enrolled in 2019 to 2022. The student cohort demographics are examined across gender, age, course progress level, study load and student type (domestic vs international). Descriptive statistics and regression analysis are employed to explore the associations between these demographic factors and student performance in the unit.

This paper employs secondary data analysis on administrative records. The data used in this paper has been collected by the university as part of routine data management and administration activities. These numeric and non-numeric secondary data are stored in the existing university central student management database (University Education Committee 2021). Identifying information has been appropriately coded to achieve data anonymisation. The study identifies no potential harm to individuals. Therefore, a full review by the ethical board is not required.

Results

The number of students enrolled were 146, 113, 106 and 55 respectively in 2019 to 2022. Figure 1 shows the number of students who completed and discontinued the unit from 2019 to 2022 is shown in. There were 146 students enrolled in the unit, with 128 students completed and 18 students (12 per cent) discontinued in 2019. The percentage of discontinued students increased to 33 per cent in 2020. This reflected the disruption of COVID-19 to students. Interestingly, out of the 37 students who discontinued from the unit, only 12 students were international students and a majority of 25 were domestic students. The number of international students discontinued (or deferred) from the unit in 2020 is fewer than the national level (Australian Government, 2020).

Figure 1*Unit Enrolment Numbers*

The discontinuation rate was reduced to 7 per cent (7 out of 106) in 2021 and remained steady at 7 per cent (4 out of 55) in 2022, indicating students were adapting to the alternative teaching arrangement during COVID-19. There was an increase of completed students (99 students) in 2021, which included students who resumed study from the 2020 deferral and students who were scheduled to graduate from their degrees. The number of students enrolled in 2022 was at the lowest in the four years. Students wanted to resume face-to-face learning (Zhou, 2021). As the delivery of the unit in 2022 remained online, some students decided to defer their enrolment and hoped the unit will revert to face-to-face teaching in 2023.

To measure students' overall unit performance, a numerical grade out of 100 per cent and corresponding letter grade are granted. Table 2 represents the relationship between letter and numerical grades at UC. Students who get a Fail grade are distinguished between NX, NC and NN.

Table 2*Letter Grade and Numerical Grade Conversion*

Grade	Letter Grade	Numerical Grade
High Distinction	HD	85% - 100%
Distinction	DI	75% - 84%
Credit	CR	65% - 74%
Pass	P	50% - 64%
Fail	NX, NC or NN [†]	0% - 49%

[†]NX – Fail result based on failure to reach pass grade in a unit having completed all the unit assessment requirements;

NC – Fail result based on failure to complete one or more of the assessment requirements for a unit;

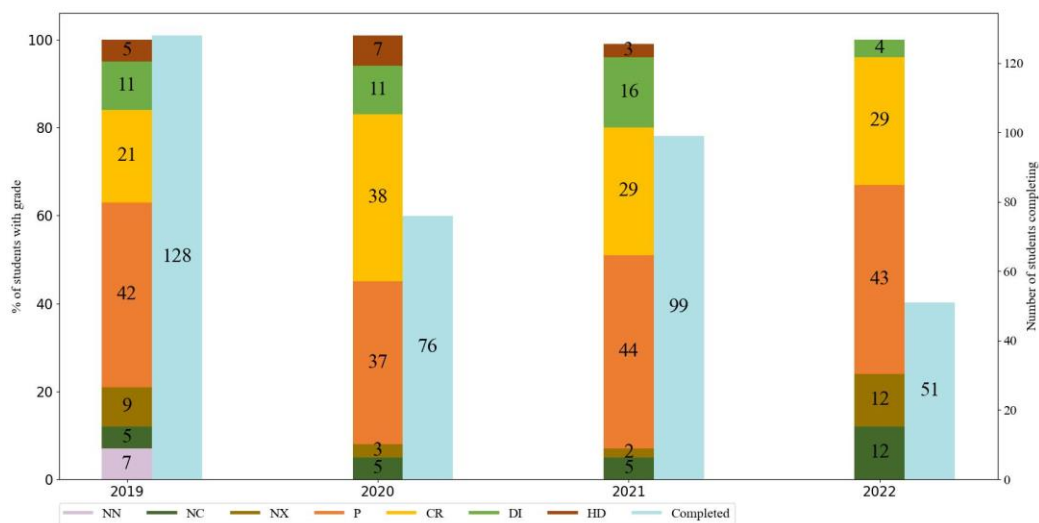
NN – Fail result based on non-participation in a unit

Source: University Education Committee (2021)

Focusing on students who stayed enrolled in the unit till the end of the semester, there were 128, 76, 99 and 51 students respectively completed their studies in 2019 to 2022. The stacked bars in Figure 2 shows the percentage of student grade distribution over four years. One noticeable improvement is the elimination of non-participation fails (NN) since the introduction of the early assessment piece (Table 1). There were 7 per cent of students who received a NN grade in 2019 and no more NN students in 2020 to 2022. The percentage of students receiving a P (ranging from 37 per cent to 44 per cent) or CR (21, 29 and 38 per cent) is mostly consistent across the four years, with an exception of more percentage of CR achievers in 2020 (38 per cent). However, in 2022, the percentage of students receiving higher grades (DI or HD) was substantially reduced and the percentage of students receiving NC and NX (Fails) was the at highest of the four years.

Figure 2

Student Grade Distribution



To measure students' academic achievement, the Grade Point Average (GPA) is a numerical score calculated across all units undertaken by the student. A student's GPA is updated after each unit is finished. Table 3 represents the relationship between grade and grade score to calculate GPA at the researcher's institution.

Table 3

Letter Grade and GPA Score Conversion

Grade	Grade Score
HD	7
DI	6
CR	5
P	4
PX [†]	3

NX, NC, NN

0

†PX – Pass after further assessment

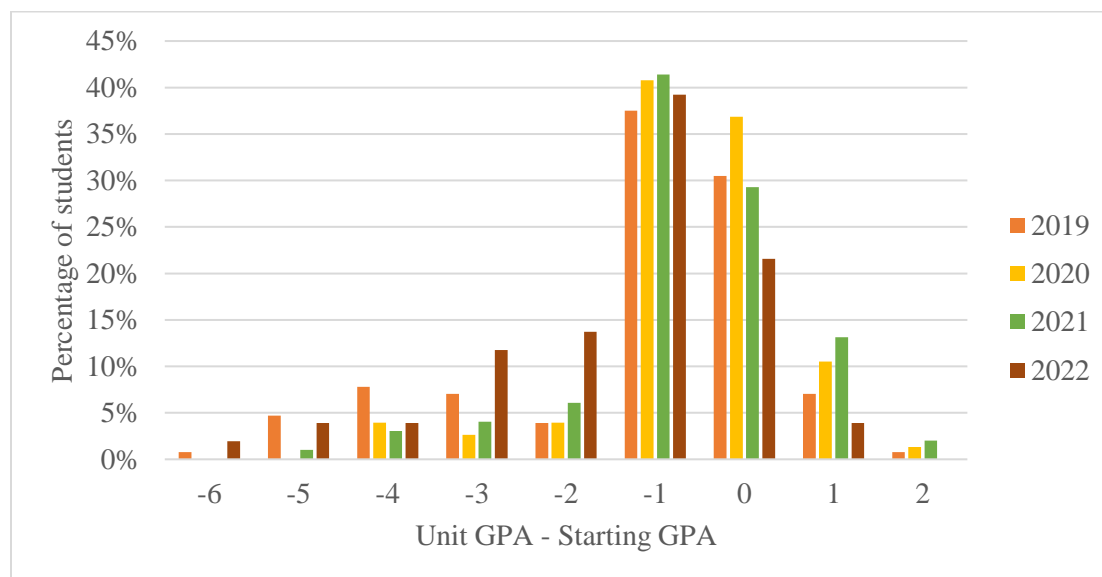
Source: University of Canberra (2018)

To better understand how this unit compares to other units undertaken by students as part of their degree, Figure 3 compares each student's GPA achieved on previous units (ranging from 0 to 7) with the student's final CBA unit GPA (grade achieved converted to a GPA score using Table 3. Figure 3 shows the difference of CBA unit GPA minus student's initial GPA achieved on previous units. A difference of zero means that students' performance in CBA is consistent with their performance in previous units. A difference greater than zero shows that students perform better in CBA than in previous studies. A difference of less than zero means that students achieve a lower grade in CBA than in previous units.

In 2019, 38 per cent of students had a GPA difference of zero and above, and 62 per cent of students had a GPA difference of less than zero. Student cohorts in 2020 and 2021 shared similar patterns, with 51 per cent and 56 per cent of students in the negative GPA difference range. In 2022, only 25 per cent of students had a zero or positive GPA difference. A massive 75 per cent of students achieved a lower unit GPA than their initial GPA. All four-year student cohorts showed more than half of the students find CBA unit challenging and achieved a lower grade compared to their performance in previous units.

Figure 3

Difference between Unit GPA and Starting GPA



To provide a breakdown of the student performance over the four years, statistics on individual assessment items are presented in Table 4.

Table 4*Statistics on Individual Assessment Items*

Year	Assessments	Max	Mean	Min	Count	Non-submissions
2019	CBA Report	88	58.24	10	112	16
	Final Exam	100	62.39	4	118	10
2020	In-class Test	95	51.02	20	76	0
	CBA Report	92.5	64.5	11.25	73	3
	Take-home	96	67.33	29	72	4
2021	Online Test	100	76.03	20	99	0
	CBA Report (group)	80	56.91	14	27	1
	Take-home	98	60.67	24	94	5
2022	Online Test	100	74.13	33.33	50	1
	CBA Report (group)	85	56.38	20	13	3
	Take-home	81.82	49.45	4.55	46	5

Note: Highlighted rows have lower counts as they represent group assessment items

The effect of CBA report group assessment on students' individual performance is examined in Figure 4 and Figure 5. The ratio of individual take-home exam score to the CBA report group score is calculated. The number of dots in each group represents the number of students. Although students were recommended to attempt the assessment in a group, some students chose to complete the CBA report on their own (5 students in 2021 and 4 students in 2022). The order of groups on the horizontal axis is in ascending order of the CBA report group score. A ratio greater than 1 indicates the student performed better in the individual take-home assessment than in the CBA group assessment. A ratio of zero indicates the student did not submit the take-home assessment. Most of the groups in 2021 have a mix of ratios, suggesting that students formed groups with mixed academic ability. In 2022, most students performed better in the group assessment than in the individual take-home assessment. The best performing groups (group 1, 2 and 3) demonstrate the benefit of team collaboration. The group assessment score contributes positively towards students' overall unit result.

Figure 4

Ratio of Take-home Assessment Score over CBA Report Score 2021

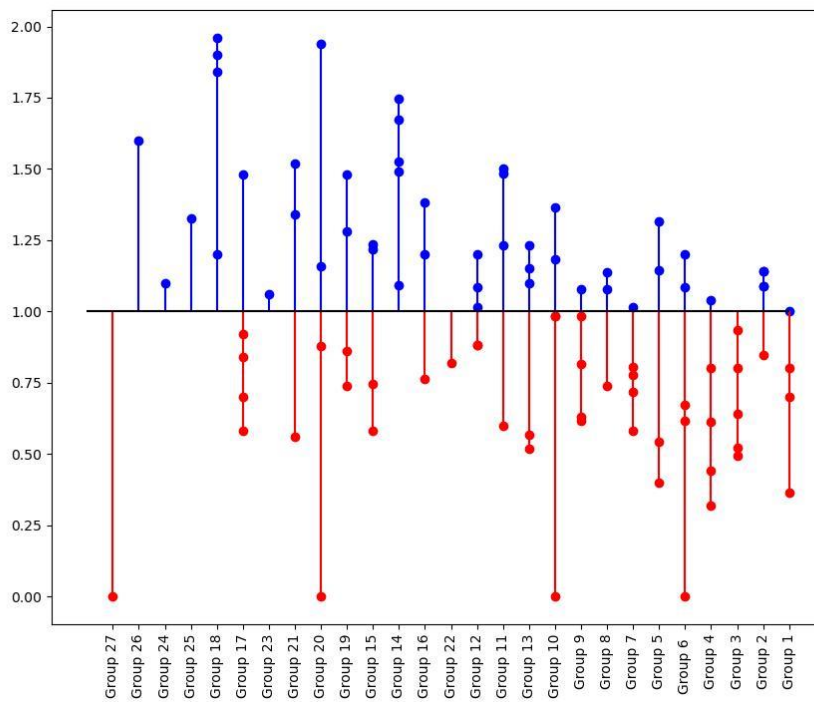
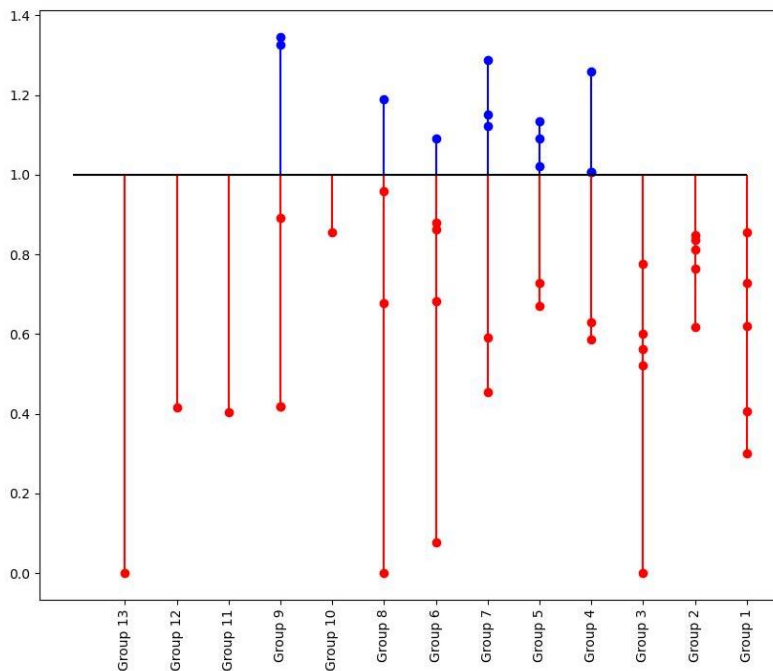


Figure 5

Ratio of Take-home Assessment Score over CBA Report Score 2022



The following sections provide a detailed analysis on different demographic groups within the student cohorts.

Gender

Table 5 shows the number of male and female students and the percentage of male and female students who completed the unit each year. The ratio of male to female students is consistent. There are generally twice as many male students as female students in the unit.

Table 5

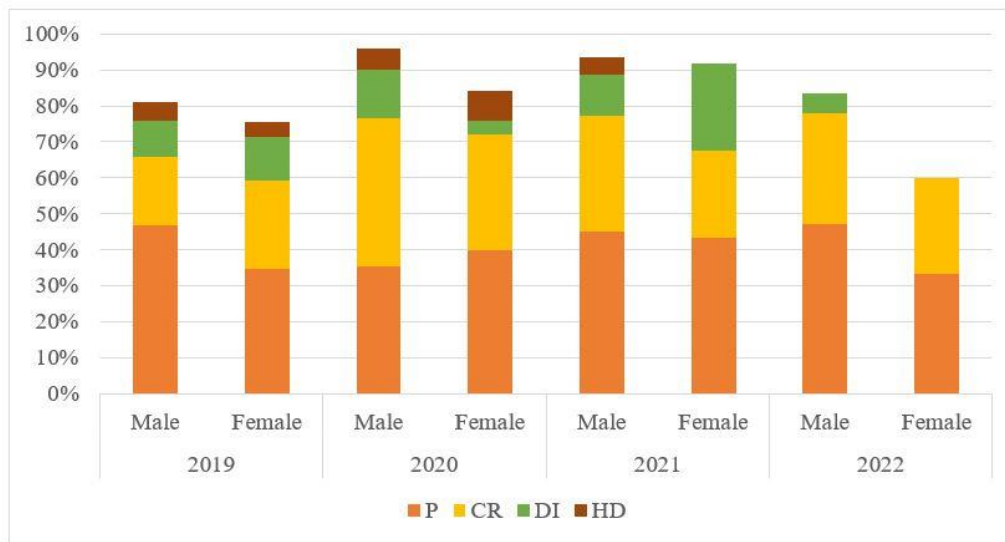
Number and Percentage of Male and Female Students Enrolled

	Male	Female	Male %	Female %
2019	79	49	62%	38%
2020	51	25	67%	33%
2021	62	37	63%	37%
2022	36	15	71%	29%

Looking only at students who successfully completed the unit, the percentage of male students receiving a passing grade (P, CR, DI or HD) is higher than female students in all four years (Figure 6). The difference between male and female students achieving a passing grade was small in 2019 (6 per cent) and 2021 (2 per cent). However, it is noted that the percentage of female students received high-level grades (DI) is more than male students (DI and HD) in 2021. In 2020, 96 per cent of male students and 84 per cent of female students received a passing grade. Both male (83 per cent) and female (60 per cent) students’ performance reduced in 2022, with female students’ performance declining more dramatically, achieving no DI or HD.

Figure 6

Grade Distribution by Gender



Focusing on the how male and female students performed in each grade from 2019 to 2022, Table 6 shows the percentage of male and female students achieving each letter grade in each year.

Table 6

Percentage of Male and Female Students at Each Letter Grade

		Male	Female
2019	HD	67%	33%
	DI	57%	43%
	CR	56%	44%
	P	69%	31%
2020	HD	60%	40%
	DI	88%	13%
	CR	72%	28%
	P	64%	36%
2021	HD	100%	0%
	DI	44%	56%
	CR	69%	31%
	P	64%	36%
2022	HD	0%	0%
	DI	100%	0%
	CR	73%	27%
	P	77%	23%

To look for unbalanced results across demographic groups, this paper calculates the factor

$$K = \frac{P}{D}$$

where P is the proportion of students in a demographic group receiving a particular grade, and D is the proportion of students in a demographic group as a whole. For example, Table 5 and Table 6 show that 67 per cent of HD students in 2019 were male, and 62 per cent of all students in 2019 were male. The value of K for male HD students in 2019 is thus

$$\frac{67}{62} = 1.08.$$

To interpret F , the key question is whether the value is greater or less than 1. A value greater than 1 indicates that the demographic group is over-represented at that grade in that year. A value less than 1 indicates under-representation. Table 7 shows the ratio for male and female students at all grades.

Table 7*Value of K by Gender*

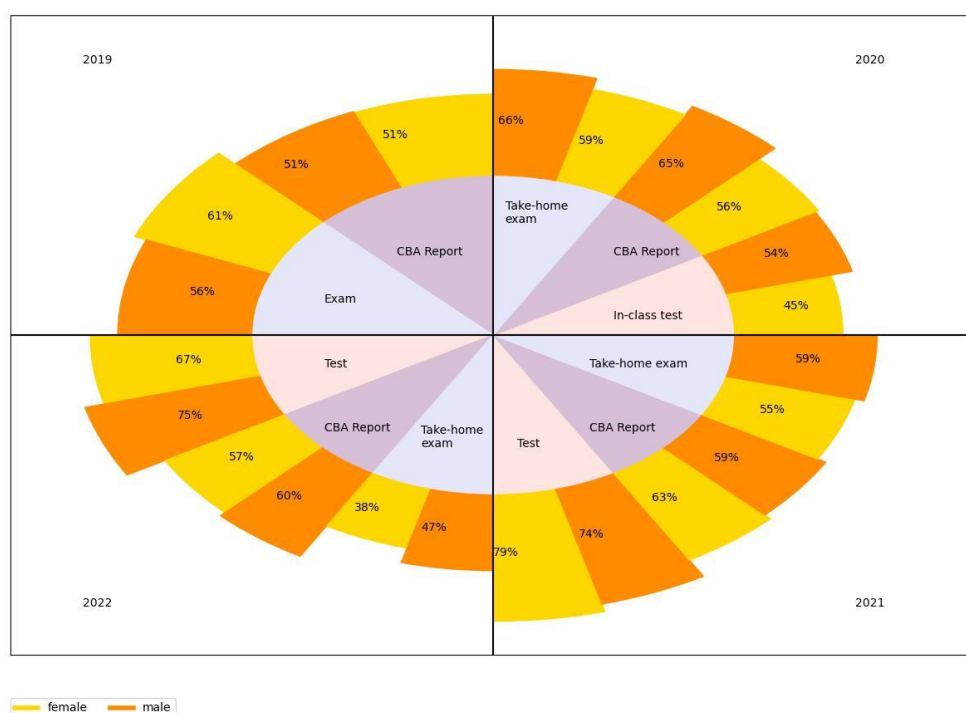
		Male	Female
2019	HD	1.08	0.87
	DI	0.93	1.12
	CR	0.90	1.16
	P	1.11	0.82
2020	HD	0.89	1.22
	DI	1.30	0.38
	CR	1.08	0.84
	P	0.96	1.09
2021	HD	1.60	0.00
	DI	0.70	1.51
	CR	1.10	0.83
	P	1.02	0.97
2022	HD		
	DI	1.42	0.00
	CR	1.04	0.91
	P	1.09	0.77

In 2019, the male students were over-represented at the high and low ends of the grade distribution; and female students were over-represented in the middle grades. In 2020, the pattern was reversed. The male students were over-represented in the middle grades and the female students were over-represented at the high and low passing grades. In 2021, female students were over-represented at the distinction grade. Male students were over-represented at other passing grades. In 2022, male students were over-represented in all passing grades. Female students were over-represented in failing grades. There is no consistent difference in gender-based performance.

Figure 7 presents the mean score on individual assessment items from 2019 to 2022, distinguishing between male and female students. For the test (in-class or online) introduced in 2020 to 2022, no consistent gender performance difference can be seen. For the CBA report, neither gender performed consistently better, and neither gender benefited disproportionately from the shift to a group assessment in 2021 and 2022. While females out-performed males on the 2019 final exam, the shift to take-home examinations from 2020 led to a consistent trend where males achieved a higher average score. However, there is only one data point for the on-campus, proctored final exam, so it is unknown if female performance was consistently better in that setting.

Figure 7

Mean Score by Gender



Age

Table 8 presents the number of students in different age groups. The majority of students in 2019 were from the 25-30 age group. There was a shift towards a younger cohort, the 20-24 age group, in 2020 and 2021 since the outbreak of COVID-19. The trend continued in 2022, with even younger students from the 15-19 age group enrolled in the unit.

Table 8

Number of Students in Different Age Groups

	15-19	20-24	25-30	30+
2019	0	35	80	13

2020	0	55	19	2
2021	0	70	21	8
2022	4	34	11	2

The percentage of students receiving a passing grade (P, CR, DI or HD) in different age groups is shown in Figure 8. A higher pass rate in the 30+ age group is noticed in 2019, 2020 and 2021. This could be explained by students in the higher age group have more life experience and are more motivated to learn. The higher pass rate in the 30+ age group was missing in 2022. However, there were only two 30+ age group students in 2022. Hence, the sample was not representative enough.

Figure 8

Grade Distribution by Age Group



Table 9 shows the value of K for age group. Over the four years, the 25-30 age group is constantly under-performing, tending to scrape through with pass and credit grades. The 30+ age group usually performs strongly, being over-represented at the higher grade levels. The 20-24 age group shows no consistent trend, and the 15-19 age group in its one sample (2022) performed lower than expected.

Table 9

Value of K by Age Group

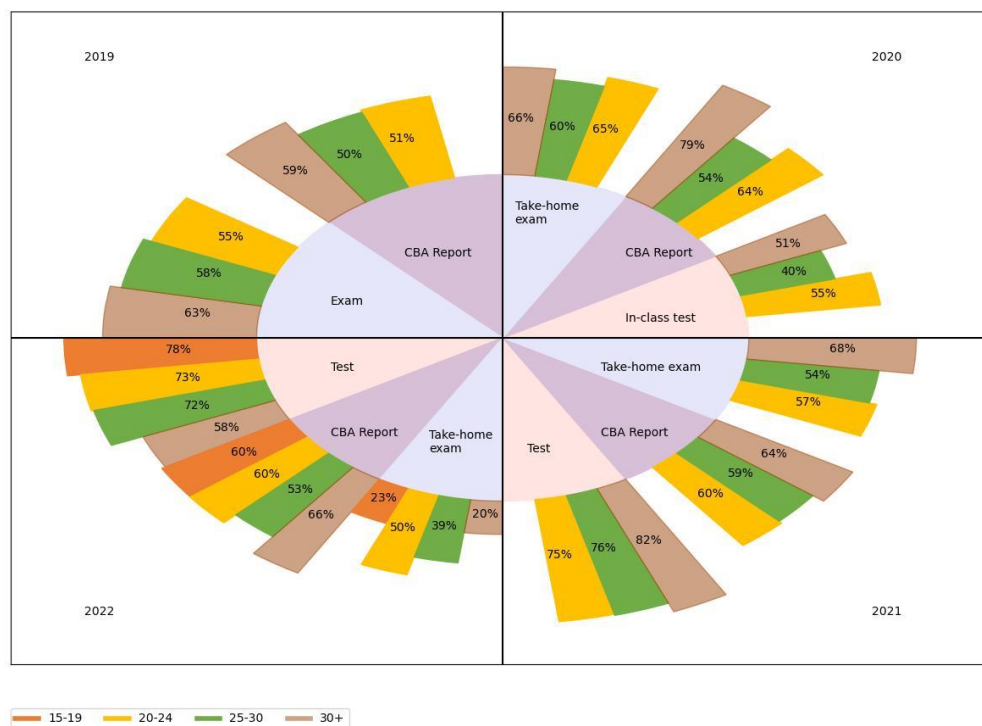
		15-19	20-24	25-30	30+
2019	HD		1.22	0.80	1.64
	DI		1.04	0.91	1.41
	CR		0.68	1.01	1.82
	P		1.08	1.04	0.55

2020	HD		0.83	0.80	7.60
	DI		1.21	0.50	0.00
	CR		1.14	0.69	0.00
	P		0.89	1.29	1.36
2021	HD		1.41	0.00	0.00
	DI		1.06	0.29	2.32
	CR		0.93	1.14	1.28
	P		0.96	1.29	0.56
2022	HD				
	DI	0.00	1.50	0.00	0.00
	CR	0.00	1.20	0.93	0.00
	P	1.16	1.02	0.84	1.16

Figure 9 presents the mean score on individual assessment items from 2019 to 2022, distinguishing by age groups. The 30+ age group performed consistently better than other age groups in CBA report both individually and as part of a group. No other strong age-related trends were observed.

Figure 9

Mean Score by Age Group



Course Progress Level

Four cohorts of students between 2019 and 2022 were investigated on the timing of enrolment in CBA throughout their degrees. Table 10 shows the number of students enrolled in CBA at different stages of their degree such as in first-, second- or later year. The majority of students in 2019 and 2020 were in their fourth year of studies. There was a shift towards a less experienced student cohort (2nd and 3rd year) in 2021 and 2022, and even some first-year students enrolling.

Table 10

Number of Students at Each Course Progress Level

	1st	2nd	3rd	4th	5th	6th
2019	2	9	22	71	18	6
2020	2	16	21	32	5	0
2021	3	9	46	34	6	1
2022	1	20	23	7	0	0

Focusing on students who successfully completed the unit, the percentage of students receiving a passing grade (P, CR, DI or HD) at different course progress level is shown in Figure 10. A higher pass rate by the later year students can be observed across all four years. It is rare for a first or second-year student to receive a DI grade, and none of them have received a HD grade.

Figure 10

Grade Distribution by Course Progress Level

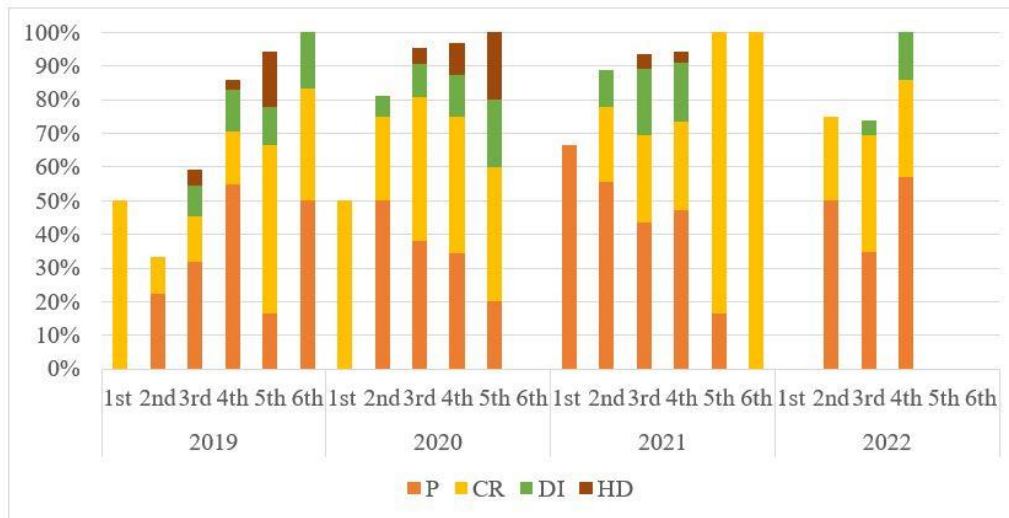


Table 11 presents the value of *K* by course progress level. Students enrolled in 4th, 5th and 6th year of their degree were over-represented at most grades and performed better than students enrolled in 1st and 2nd year. This is because senior students have more knowledge, skills, and experience in the higher education environment as compared to junior students (Hassanbeigi et al., 2011).

Table 11

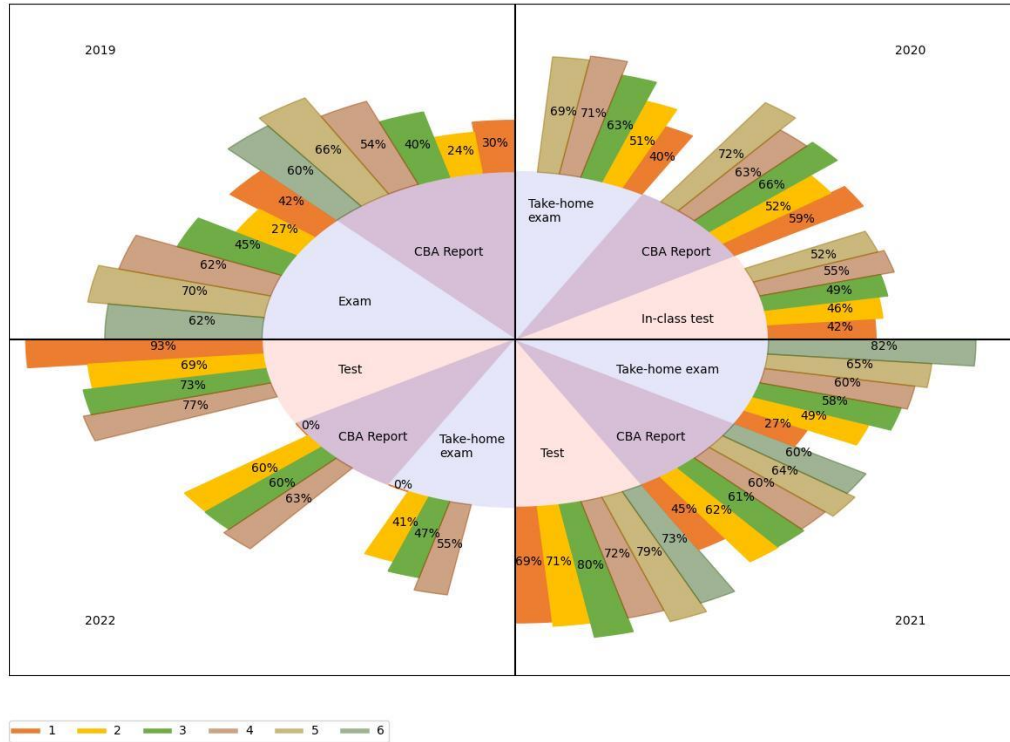
Value of K by Course Progress Level

		1st	2nd	3rd	4th	5th	6th
2019	HD	0.00	0.00	0.97	0.60	3.56	0.00
	DI	0.00	0.00	0.83	1.16	1.02	1.52
	CR	2.37	0.53	0.65	0.73	2.37	1.58
	P	0.00	0.53	0.75	1.30	0.40	1.19
2020	HD	0.00	0.00	0.72	1.43	3.04	
	DI	0.00	0.59	0.90	1.19	1.90	
	CR	1.31	0.66	1.12	1.06	1.05	
	P	0.00	1.36	1.03	0.93	0.54	
2021	HD	0.00	0.00	1.43	0.97	0.00	0.00
	DI	0.00	0.69	1.21	1.09	0.00	0.00
	CR	0.00	0.76	0.89	0.90	2.84	3.41
	P	1.50	1.25	0.98	1.06	0.38	0.00
2022	HD						
	DI	0.00	0.00	1.11	3.64		
	CR	0.00	0.85	1.18	0.97		
	P	0.00	1.16	0.81	1.32		

The mean score is calculated for individual assessment items from 2019 to 2022, distinguishing by course progress level (Figure 11). The later year students consistently performed better on the exam assessment item.

Figure 11

Mean Score by Course Progress Level



Study Load

Table 12 shows the distribution of study load across the student cohort and how this changes year to year. A full study load for an undergraduate semester is generally made up of 4 units. There were very few students over-enrolled over the years. The majority of students were on part-time study load in 2019. Since COVID-19 in 2020, the proportion of students on part-time study load has been declining.

Table 12

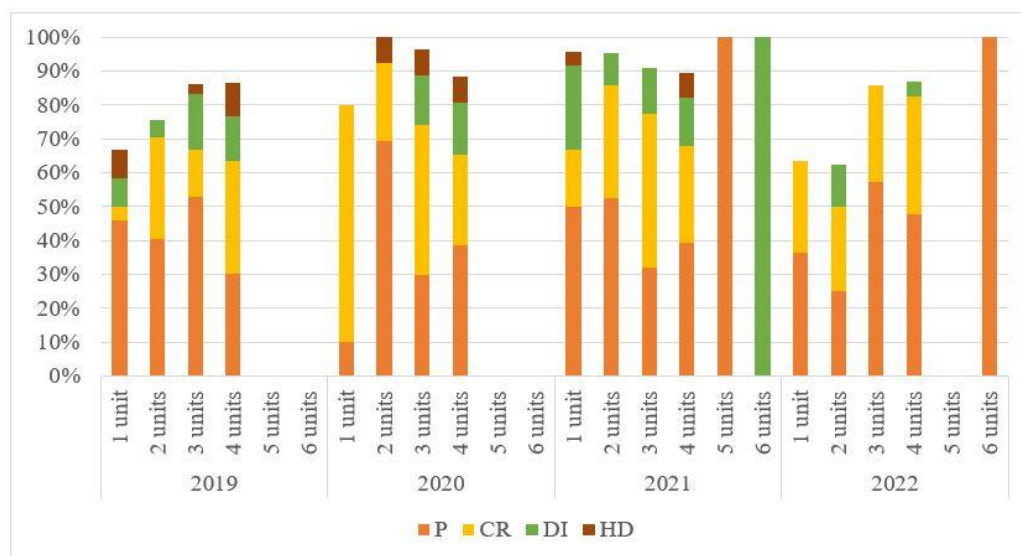
Number of Students with Different Study Load

	1 unit	2 units	3 units	4 units	5 units	6 units
2019	24	37	36	30	1	0
2020	10	13	27	26	0	0
2021	24	21	22	28	3	1
2022	11	8	7	23	1	1

There is not a consistent trend between the percentage of students who successfully completed the unit and the number of units they enrolled in (Figure 12).

Figure 12

Grade Distribution by Study Load



The value of *K* by study load further illustrated lack of consistent trend in study load related performance (Table 13).

Table 13

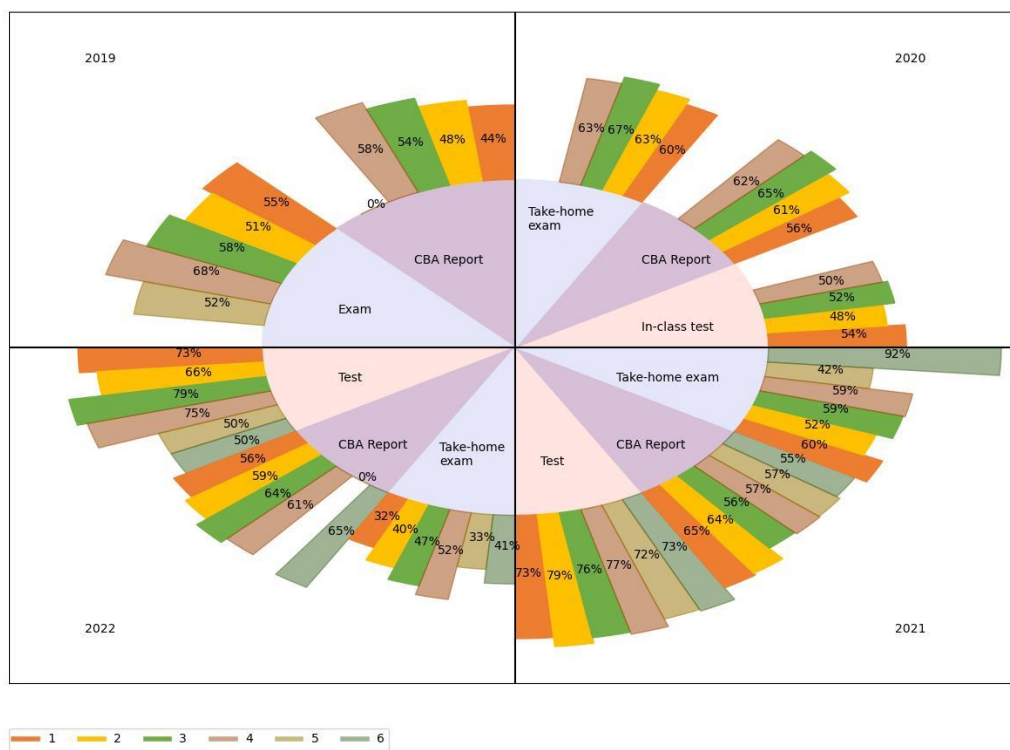
Value of K by Study Load

		1 unit	2 units	3 units	4 units	5 units	6 units
2019	HD	1.78	0.00	0.59	2.13	0.00	
	DI	0.76	0.49	1.52	1.22	0.00	
	CR	0.20	1.41	0.66	1.58	0.00	
	P	1.09	0.96	1.25	0.71	0.00	
2020	HD	0.00	1.17	1.13	1.17		
	DI	0.00	0.00	1.41	1.46		
	CR	1.83	0.60	1.16	0.71		
	P	0.27	1.88	0.80	1.04		
2021	HD	1.38	0.00	0.00	2.36	0.00	0.00
	DI	1.55	0.59	0.84	0.88	0.00	6.19
	CR	0.57	1.14	1.55	0.98	0.00	0.00
	P	1.13	1.18	0.72	0.88	2.25	0.00
2022	HD						
	DI	0.00	3.19	0.00	1.11	0.00	0.00

CR	0.93	0.85	0.97	1.18	0.00	0.00
P	0.84	0.58	1.32	1.11	0.00	2.32

Figure 13 shows the mean score for individual assessment items from 2019 to 2022, distinguishing by students' study load. In 2020 and 2021, students' performance in the test assessment were similar in all study loads. In 2022, students with full study load or less performed better than over-enrolled students. However, only 2 students over-enrolled in 2022, making the sample less representative. There is no apparent divergence in CBA report performance with different number of units enrolled.

Figure 13
Mean score by Study Load



Student Type

The student type (domestic vs international) is identified based on the type of tuition fee. It is known that some domestic fee-paying students might have a foreign background. However, the university central database does not provide the level of detail to distinguish the origin of domestic fee-paying students.

Table 14

Student Type Diversity in the Unit

	Domestic	International
2019	75	53
2020	54	22
2021	76	23
2022	30	21

Table 14 shows the number of domestic and international student in each year. The percentage of international students enrolled in 2020 and 2021 was much lower than in 2019, reflecting the impact of COVID-19 on international students’ study. In 2022, a recovery of the percentage similar to pre-COVID level in 2019 can be seen.

Figure 14 shows the percentage of domestic and international students receiving a passing grade (P, CR, DI or HD). Since COVID-19 in 2020, domestic students have experienced a higher passing rate than international students. Given only one pre-COVID data point is available, it is unknown whether or not international students’ performance would be less disparate from domestic students when the unit is delivered face-to-face.

Figure 14

Grade Distribution by Student Type

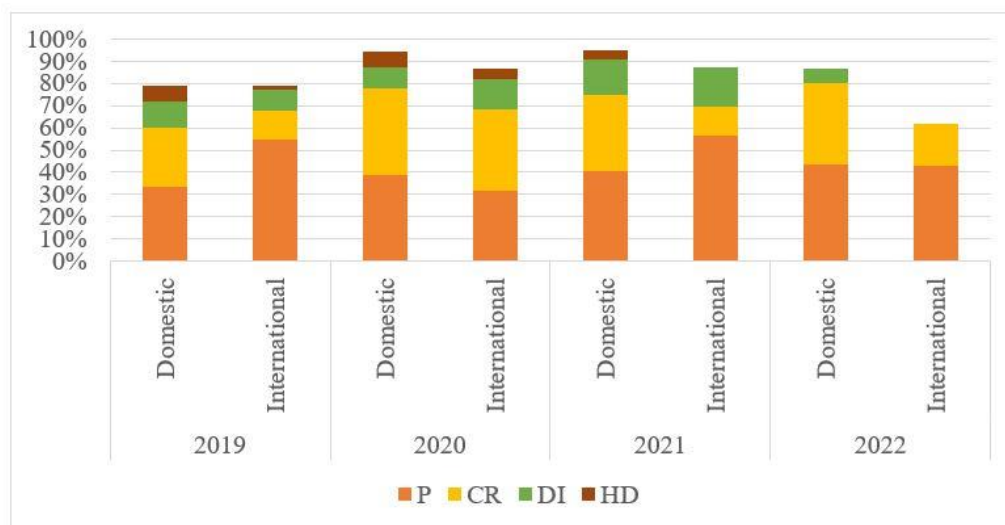


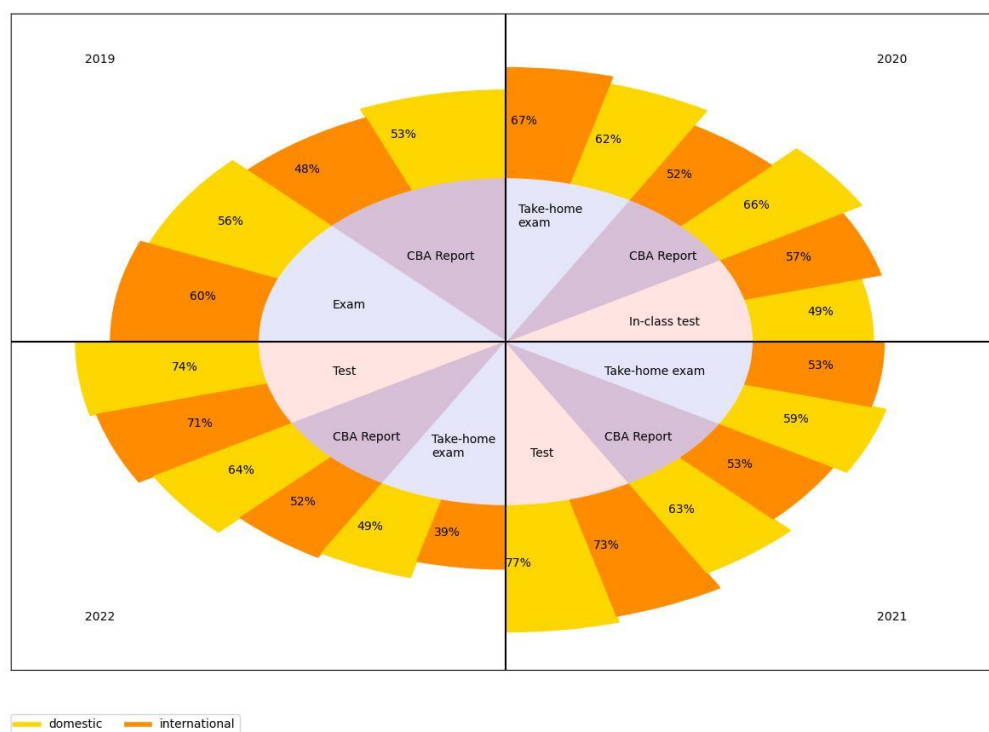
Table 15 shows the value of K by student type. In 2019 and 2022, with a higher percentage of international students enrolled in the unit, international students were under-represented in the higher passing grades. In 2020 and 2021, this pattern did not appear – however, this could be due to reduced sample size where one student's good result inflated the percentages of the international student cohort.

Table 15*Value of K by Student Type*

		Domestic	International
2019	HD	1.42	0.40
	DI	1.10	0.86
	CR	1.26	0.63
	P	0.79	1.30
2020	HD	1.13	0.69
	DI	0.88	1.30
	CR	1.02	0.95
	P	1.06	0.86
2021	HD	1.30	0.00
	DI	0.98	1.08
	CR	1.17	0.45
	P	0.92	1.27
2022	HD		
	DI	1.70	0.00
	CR	1.25	0.65
	P	1.00	0.99

Figure 15 presents the mean score on individual assessment items from 2019 to 2022, distinguishing between domestic and international students. Domestic students consistently outperformed international students on the CBA report assessment item. This trend applies regardless of whether the CBA report is an individual or group assessment.

Figure 15
Mean Score by Student Type



Regression Analysis

In this section, the data are examined for linear relationships by fitting a multivariate linear model:

$$M = yW_y + gW_g + LW_L + pW_p + fW_f + sW_s + aW_a + b$$

where

M is the student's final numerical mark for the unit

g is a variable reflecting the student's gender

y is the year of the unit

L is the year level of the student

p is the student's GPA before starting the unit

f is a variable reflecting the student's fee type

s is a variable reflecting the student's study load

a is a variable reflecting the student's age bracket

b is a constant offset

$W_g, W_y, W_L, W_p, W_f, W_s, W_a$ are weights

The non-numeric variables are mapped in Table 16.

Table 16

Definition of Non-numeric Variables

Variable	Definition
g	0 if female, 1 if male
f	0 if domestic, 1 if international
a	0 if 15-19, 1 if 20-24, 2 if 25-30, 3 if 30+

The fit is done using the “Ordinary Least Squares” model from econometrics software package *gretl* (version 2022a, obtainable from <https://gretl.sourceforge.net/>), with results shown in Table 17.

Table 17

Regression Analysis Results

Weight	Reflecting	Value	p-value
W_p	GPA	11.45	2e-47
W_L	Year level	1.80	0.0315
W_g	Gender	1.75	0.2438
W_f	Fee type	1.58	0.3239
W_y	Year of course	0.87	0.2388
W_s	Study load	-0.00053	0.9980
W_a	Age	-0.34	0.7729

These weights indicate two linear dependencies, significant at the 5% level:

- between prior GPA and final mark, and
- between year level and final mark

The coefficient of correlation from the model is $R^2 = 0.535$, which indicates a moderately direct linear relationship between the predictive variables and the dependent variable. This is largely due to GPA and year level which is confirmed by fitting a second model including only those variables, which yielded $R^2 = 0.530$.

These results indicate that, unsurprisingly, students with a history of solid academic achievement did well in this unit. Prior familiarity with economic concepts (as indicated by a higher year level) was also beneficial. However, the data shows neither gender, age nor fee type had a statistically significant linear relationship to the student’s final mark.

The observed R^2 values indicate that the GPA and year level explain only 53% of the variance in final mark. Assuming that the GPA is a proxy variable reflecting the student's innate talent or ability at academic studies, there are other factors which could be in play, such as a student's aptitude with mathematics, particularly of the type used in the unit. GPA only reflects performance in a student's chosen units, and if the bulk of their units did not require the same kinds of calculations, the final mark may not be predicted by prior GPA. In addition, a student's interest in, and engagement with, the unit material would also be worth investigating for further studies.

Conclusions

As presented in the data, the clearest trend is that students' prior learning experience counts. This is expected as the CBA unit involves a mix of analysis and calculation which requires mathematical background and knowledge of economic concepts to carry out. As currently designed, the unit has only a single introductory economic unit as a pre-requisite. To improve student outcomes, there are following options: 1. change the student by insisting more pre-requisites to instil background concepts; 2. change the unit by shifting the balance between math-intensive assessment and economic analysis.

The pass rate of female students is consistently less than their male peers. Further exploration and analysis are required to uncover the underlying reasons for this trend. The results of these further investigations can shape unit design to remove this disparity. It might be expected that the COVID-induced shift to remote teaching would particularly impact international students. However, the data in section 4.5 shows that a higher percentage of international students passed the unit in 2020 and 2021 than in 2019. One reason might be international students, especially Asian students, have received better mathematics curriculum education in their previous qualification than domestic students (Zhao & Singh, 2011). For instance, the top five regions on the OECD global education report are Singapore, Hong Kong, South Korea, Japan, and Taiwan (Gladwell, 2008). Another possible explanation is that only the most motivated and talented students undertook the unit (as reflected in reduced student numbers). However, it is noted that this is an area to be further explored.

The CBA unit examined in this paper represents a broader group of units, defined by: requiring both quantitative calculation and qualitative analysis; senior-year undergraduate units, which assume prior knowledge or experience; having a student population which varies on many demographic dimensions; and requiring a mixture of group work and individual assessment items. When attempting to understand and improve student outcomes in such units, researchers might draw on the results in this paper. The paper finds that student demographic factors (such as student age, student type or study load) do not have a significant predictive value on the final results. Therefore, researchers might focus their investigations on other possible factors. The key lesson drawn about avenues to improve the CBA teaching results (that is, the evidence for requiring suitable pre-requisites) is applicable generally, especially in units facing the challenge of taking on under-prepared students.

Most importantly, cost-benefit analysis is the fundamental analytic tool of economics used by students and economists when trying to justify the past, explore the present and forecast the future. It helps not only on how to make the best use of scarce resources to achieve individual or social goals, but also make decisions and understand decisions by policy makers and economists.

Therefore, continuous reflection on teaching and learning the CBA unit has great benefits to academics and students.

Conflict of Interest

There is no conflict of interest to declare.

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