

Accidental experiment in mathematics classroom shows how to engage online students

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Melbourne COVID rules in 2021 created a natural experiment on online learning.

Indoor density limits and physical distancing requirements in March 2021 meant that only about half of mathematics students could be accommodated on campus in face-to-face tutorials, while the rest of the students had online tutorials. Unintentionally creating a large comparative study between students learning mathematics entirely online and those with some face-to-face classes.

The accidental experiment

We compared the results from students in large first and second year mathematics subjects at Monash University from semester 1, 2021. The students' tutorial type (online or on-campus), their participation mark and their final mark was extracted for each subject.

The results

In most subjects there was a statistically significant difference between the average final mark of students enrolled in on-campus tutorials and those enrolled in online tutorials. Students enrolled in on-campus tutorials had consistently higher average marks for both the class participation and final result than the online students (see Table 1).

Note: MATH1010 results are not a fair experiment - as the online students and the on-campus students are very different cohorts. The overwhelming majority of the online students in MATH101 are overseas students. These students usually have a strong mathematics background, but their qualifications are not recognised for a variety of reasons.

	No. of students		Final mark %		Participation mark %	
	on-campus	online	on-campus	online	on-campus	online
MATH101	117	127	63 (59, 67)	75 (70, 79)	76 (71, 82)	73 (67, 79)
MATH102	217	353	64 (62, 66)	57 (55, 59)	87 (85, 90)	80 (77, 82)
MATH103	233	202	67 (64, 71)	67 (63, 71)	84 (80, 87)	81 (77, 85)
MATH104	306	240	71 (69, 73)	62 (59, 65)	95 (94, 96)	88 (85, 91)
MATH105	119	91	66 (62, 70)	56 (50, 62)	77 (72, 81)	61 (55, 68)
MATH106	349	435	67 (65, 69)	61 (59, 63)	88	74

Table 1: Average participation and final marks and 95% confidence intervals for students in online and on-campus tutorials, semester 1, 2021.

The exceptions

MATH103, where there was no difference between the two groups of students. There were no differences in the final marks and there were no differences in the participation marks. What was the teaching team for this subject doing that achieved equity for both online and on-campus students?

The keys to online engagement

There are two pronounced features of teaching strategy for this subject, that set it apart from the other first year mathematics subjects.

1. Many opportunities for student participation were built into every facet of the learning activities., with incentives to accumulate marks by keeping up with the work.
2. The tutorials were highly structured into formal cooperative learning groups, creating a learning environment both collaborative and collegiate, facilitating individual accountability, intrapersonal relationships and social support.

This was intended to create an inclusive environment where online students get to participate often, easily and conveniently.

The opportunities for participation

- Skeleton lecture notes were provided with the gaps to be completed by students during lectures.
- Various active learning activities, such as online polls, were incorporated into lectures. To encourage students marks were allocated just for participating. There was no penalty for incorrect answers
- Students were expected to attempt the weekly problem sets in advance, and prepare specific problems to present in small groups as part of the tutorial work.

The tutorial structure

- Each student was assigned to one of 4 groups (named after mathematicians). Students were told at the end of each week what problems they were expected to prepare for the following week. Galois can prepare problems 1 and 5 from next week's problem set, Mirzakhani prepare problems 2 and 6, etc.
- In the tutorials, students are expected to work in tute groups. Ideally each tute group consists of a student from each mathematician group. The students present their prepared problems to their tute group.
- Students are also expected to submit a written solution to one of their prepared problems to their tutor at the end of the tutorial. There were marks allocated to presenting problems and contributing to discussion, which were easy to obtain. There was also a mark allocated to the written problem submitted.