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Comparison of Effectiveness of Different Delivery Modes in a Third-Year Civil Engineering Subject

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ABSTRACT

CONTEXT

This study compares students' experience and performance between fully online and hybrid learning environments in Surface Water Hydrology, a third-year core Civil engineering subject at Western Sydney University (WSU). The online method was implemented in 2021 to cater for the COVID-19 pandemic. All teaching activities were conducted online. All assessments were made open-book and held online using Zoom® as the soft-invigilation mechanism. The hybrid mode was developed and first implemented in 2022. The method involved delivery of face-to-face (F2F) and synchronous online lectures and tutorial sessions. Both the mid-term and final exams were held face-to-face. The delivery method as well as the assessments were replicated in 2023, considering the student feedback from 2022 offering. Both the mid-term and the final exams were held face-to-face on campus. Both assessments were paper based, reverting to the pre-pandemic era.

PURPOSE OR GOAL

The principal aim of this study is to compare student engagement and learning from the two different approaches of content delivery and engagement. Effectiveness of different approaches are assessed considering students' performance, attendance records, and students' response to the end-of-term survey questionnaires.

APPROACH OR METHODOLOGY/METHODS

Online engagement data of a total of 404 students (142, 154 & 108 students from 2021, 2022 & 2023 cohorts) were extracted from WSU's Learning Management System (LMS). The data were analysed and checked to see whether a meaningful relationship exists between LMS engagement and performance. Student Feedback on Subject (SFS) and Student Feedback on Teaching (SFT) were also used to validate relative effectiveness of the different techniques.

ACTUAL OR ANTICIPATED OUTCOMES

While the degree of difficulty of assessment tasks were similar in both online and face-to-face assessments, a comparison of student results in 2021, 2022 and 2023 showed that generally, the students performed better in face-to-face on-campus assessments. It was found that the overall failure rates were similar in three different instructional modes - a higher proportion of online students receiving a passing grade while relatively larger proportion of face-to-face students received higher grades. SFS and SFT data indicate that while the subject provided an opportunity to work on real-life projects, online students faced significant challenges in team work.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The analysis showed student engagement to be marginally better when students attend face-to-face content engagement sessions. Additional strategies need to be developed and implemented in future to improve student engagement for those attending the online sessions.

KEYWORDS

online delivery, hybrid teaching, learning management system, student engagement

Introduction

During the COVID-19 pandemic, educational institutions had to quickly transition into online platforms utilising already existing Learning Management System (LMS). Before COVID-19, LMS were primarily used as a centralized platform where instructors posted learning materials, tracked learner progress, administered assessments and quizzes, and facilitated communications and collaborations among learners. This has since changed dramatically. Online learning activities, and virtual labs are now realities in higher education (Vergara *et al.*, 2022).

The post-COVID-19 education system often has three different modes of teaching – (a) face-to-face (F2F), (b) synchronous online sessions referred to as "hybrid mode" and (c) fully online. Effectiveness of these different modes are often debated (La Ino, 2023). The analysis conducted by La Ino (2023) for three different instructional modes for an English Grammar course indicates that the hybrid mode is more viable as it allows students to have face-to-face interactions with instructors and peers when it is necessary. A similar finding was reported by Bilbeisi and Minsky (2014) where students attending hybrid had better course satisfaction, and improved course grades compared to F2F session students. But, Shelly, Swartz and Cole (2018) reported that online students have similar performance as F2F students whereas Ury (2004) and Terry and Lewer (2003) found that F2F students have significantly higher mean scores compared to students attending online. The difference in findings can be attributed to the difference in learning activities and the nature of the Course (La Ino, 2023). Bilbeisi and Minsky (2014) suggested that should explore all three options of teaching mode. They can then choose the suitable instructional mode that suit them to excel in the subject if the course is delivered in different formats.

The importance of course design for different instructional modes can have a significant impact on students' motivation toward subject content. The higher motivation resulted in better performance (He *et al.*, 2015). Time management could be another issue, especially during the final period for students attending online if they haven't engaged properly from the beginning (He *et al*., 2015). There is an additional challenge for online students to complete group work assignments, as they may not have the same level of engagement during teaching sessions compared to the counterpart F2F student groups. A mixed response was reported for a subject that required high level of technology skills and hands-on practice (Senn, 2008), where some students have indicated their appreciation while others have indicated their objected group work. Further research can guide on improving students' performance in group work activities who are studying in an online environment.

The research on the direct comparison of different modes of teaching and learning to evaluate the learning rates and academic achievements is still limited (Bi, Javadi and Izadpanah, 2023). Furthermore, the effectiveness of conventional, hybrid, and online teaching methods in the context of a core engineering subject's learning, measured by students' grades, remains unaddressed. Further studies are required to understand the effectiveness of different instructional modes in core engineering subjects. This study is an attempt to fill this gap.

Background

This study aims to evaluate the students' performance in three different instructional modes, online, hybrid, and F2F sessions in Surface Water Hydrology, a core third-year Civil Engineering subject delivered at Western Sydney University using three years' of data between 2021 and 2023. All lectures and tutorials were delivered online in 2021. In 2022 and 2023, the lectures were delivered in a hybrid mode, in which F2F and online sessions were conducted synchronously. One tutorial session was delivered in hybrid mode, whereas the rest of the tutorial sessions were delivered F2F. It is to be noted that students were given the option to attend lectures either F2F or online for hybrid lecture sessions. But for hybrid tutorial sessions, students were required to select either F2F or online mode at the beginning of the term which remained the same throughout the semester. The distribution of students in online, hybrid mode, and face-to-face sessions are provided in Table 1. For the purpose of this paper, Hybrid-F2F and F2F have

been dealt differently. Hybrid-F2F represents the session in which students attended F2F session that was also conducted online synchronously. Whereas, F2F was only conducted in-person without a synchronous online session.

There are three main assessments in this subject: group project work (40%), intra-session examination (20%), and final examination (40%). The group project work needed to be submitted through Turnitin submission portal. In 2021, both intra-session and final exams were open-book assessments and held online using Zoom® as the soft-invigilation mechanism. Students were allowed to use every tool they could access to complete assessments, including the final exam. However, in 2022 and 2023, both the mid-term and the final exams were closed-book paper-based exams held in-person and on campus.

Table 1: Number of students in different sessions between 2021 to 2023

Year	Online	Hybrid		Face-to-Face	Total
		Online	Face-to-Face		
2021	142	-	-	-	142
2022	-	74	24	56	154
2023	-	37	27	44	108

Methodology

Three years of data consisting of a total of 404 students (Table 1) in Surface Water Hydrology, a third-year core Civil Engineering subject, delivered at WSU were extracted using the Course Analytics tool in the university's LMS to check the students' experience and their performance between fully online and hybrid learning environments. The data were statistically analysed and checked to see whether a meaningful relationship exists between LMS engagement and student performance. It is important to highlight that the study did not encompass the background factors influencing students' choices between online, F2F and hybrid learning, such as travel distance or their employment status (part-time or full-time). SFS and SFT were used to validate the relative effectiveness of the three different techniques.

Findings

Comparison of subject accesses, submissions and time spent on LMS

Students were required to access LMS primarily for lecture notes, tutorial questions and solutions, lecture and tutorial recordings, weekly quizzes, and to submit the project works. There were no marks allocated for weekly quizzes, as these were used as formative assessment tasks. However, students were encouraged to complete those weekly quizzes to ensure competencies on topics offered each week. Figure 1a presents the comparison of average access to LMS by students in this subject against the School average between 2021 to 2023. The weekly average access in this subject was slightly higher compared to the School average in weeks 1 to 4, sudden peaks occurring at different times for all three years of data. The timing of these peaks coincided with assessment due dates, indicating that the students accessed LMS multiple times before due date of each assessment task - project report submissions, mid-term and final exams. The average access rates for this subject were 64, 66, and 57, whereas the school's averages were 50.7, 41.5, and 40.3, respectively in the years 2021, 2022, and 2023 (Figure 1a).

Figure 1b shows the average number of weekly submissions in this subject against the School average. In 2021, students needed to submit their mid-term and final exams on LMS in addition to weekly quizzes and project reports. This might have been the reason for increase in the number of submissions in weeks 6 and 16 in 2021. The project report was submitted once on week 14 in 2021. Therefore, there was another peak at week 14. It was observed that some of

the groups started to work on projects at the end of the semester and could not prepare better reports. This was despite repeated suggestions to work on projects every week. End-of-term SFS conducted in 2021suggested that if the project report could be split into multiple submissions, it would be helpful to address any feedback from teaching staff on project work and reduce stress at the end of the semester. This feedback was incorporated into 2022 and 2023 deliveries, where project submission was divided into three stages (week 4, 10 and 14). In general, the 2022 cohort made more submissions every week compared to the 2021 and 2023 cohorts excluding the submissions for exams in 2021 at week 16. On average, the number of submissions were 11, 10, and 6 which were higher than the School average of 8.7, 5.7, and 5.5 in 2021, 2022, and 2023, respectively.

The time spent on LMS every week in all three years were also higher than the School averages (Figure 1c). In general, the 2022 cohort spent more time on LMS. The average time spent by students in this subject were 2249, 2571, and 1648 minutes which were higher than the school's averages of 1819, 1225, and 977 minutes, respectively, in three consecutive years 2021, 2022, and 2023. This indicates that the student engagement in LMS in this subject was better when compared with other subjects offered by the School.

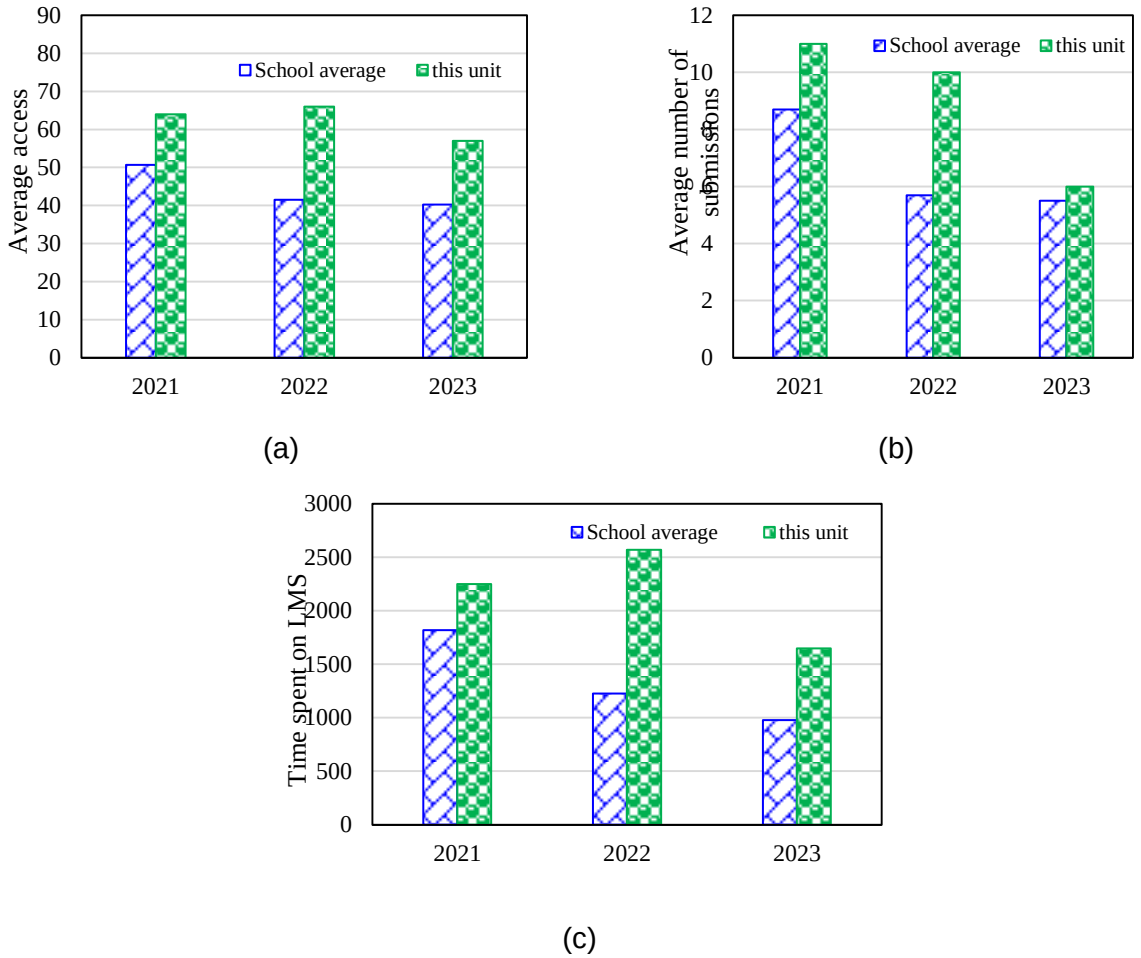


Figure 1: Comparison of average access on LMS, number of submissions and time spent on LMS

Comparison of grade distribution in different instructional modes

The comparison of grades of student cohorts in 2021, 2022, and 2023 is shown in Figure 2.When the subject was delivered completely online in 2021, only 1.5% of students scored high distinction (HD) marks whereas 11% scored distinction (D) marks. When the subjects were delivered in

hybrid and F2F sessions, 23% and 24% of students scored high distinction (HD) and distinction (D) marks in 2022 and 2023, respectively, which is significantly higher than students attending fully online sessions. Approximately, 16% of students got credit grades when the subject was delivered fully online, whereas 18% and 19% of students got credit in 2022 and 2023, respectively, when the subject was delivered in hybrid and F2F modes. Since the HD+D % was lower in online groups in 2021, the number of students scoring passing marks was higher (49%) compared to those in 2022 (35%) and 2023 (26%). The failure rates are similar in all three modes, ranging between 17 to 21%. Another noticeable fact was the Fail Non-Submission (FNS) percentages were relatively higher in 2022 and 2023. On average 8% students did not attempt final exam in 2022 and 2023, which is significantly high when compared to 1.4% FNS rate in 2021. To reduce or eliminate the FNS rate, student engagement can be closely monitored in the first few weeks, and if the engagement is not satisfactory, they can be advised to drop the subject, as it is very difficult for students to catch up in later weeks where they need to progressively implement the knowledge they have gained on weekly basis. It was also noticed that this group of students could not contribute to project work and created additional workload for other group members. It is also worth noting that the experience of online teaching improved over time, but any significant improvement was not observed in terms of student results during the period from 2021 to 2023.

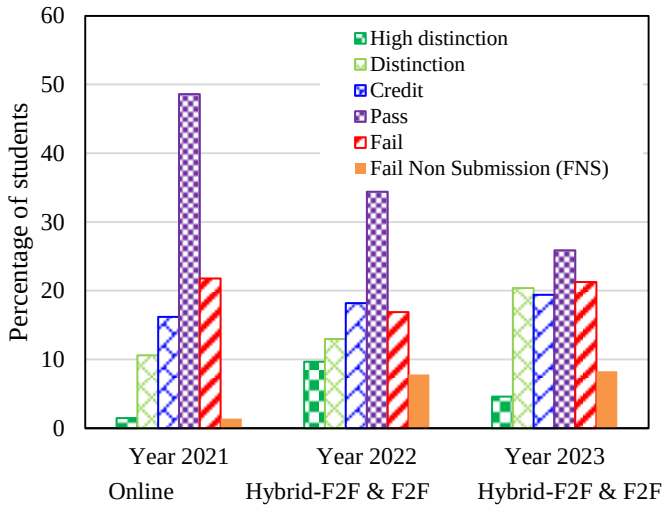


Figure 2: Comparison of grade distribution in online, and combined hybrid & F2F modes

Comparison was also made to check the performance of students attending online sessions versus F2F sessions (Figure 3). This excludes the students attending in-person hybrid mode sessions. The percentages of students scoring higher grades (HD & D) in online sessions were 12.5, 16 and 8% in 2021, 2022 and 2023, respectively. 29% of F2F students scored HD & D in 2022 whereas in 2023, 34% scored HD & D. This indicates that F2F students' performed better than online students. While comparing the online students scoring credit, D and HD grades, the students in 2022 cohort got slightly higher score (38%) than that in 2021 (28%) and 2023 (30%). In 2022, student engagement in LMS was much higher than in 2021 and 2023 which could be the reason for higher proportion of credit, D and HD grades in 2022 in online sessions compared to other years. One typical observation made was that the percentage of students scoring pass grades in online sessions were consistently higher (35–49%) than students in F2F sessions (18–33%) in all three years. Time management could be an issue for these students who did not engage well during teaching sessions and who tried to cram-in during the final period (He *et al.*, 2015).

The performance of students in F2F sessions, in 2022 and 2023, with and without synchronous online sessions were further investigated to check if F2F students in hybrid mode were affected by synchronous online sessions (Figure 4). In general, no particular trend was found.

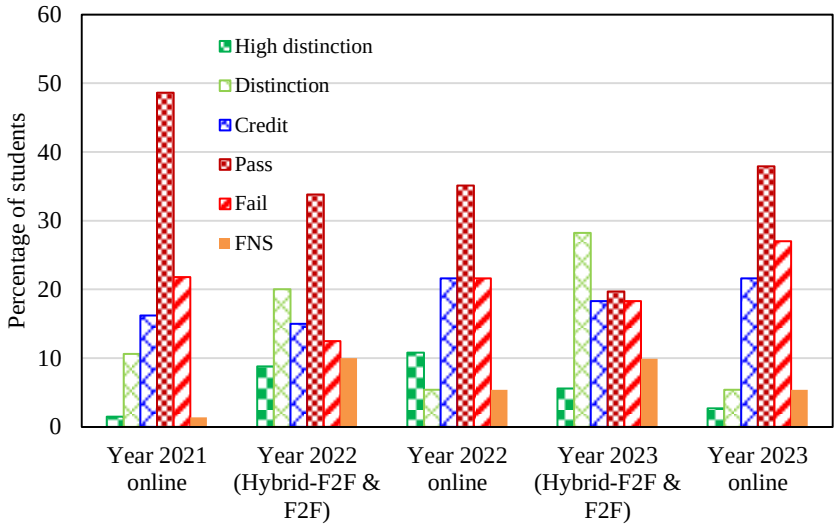
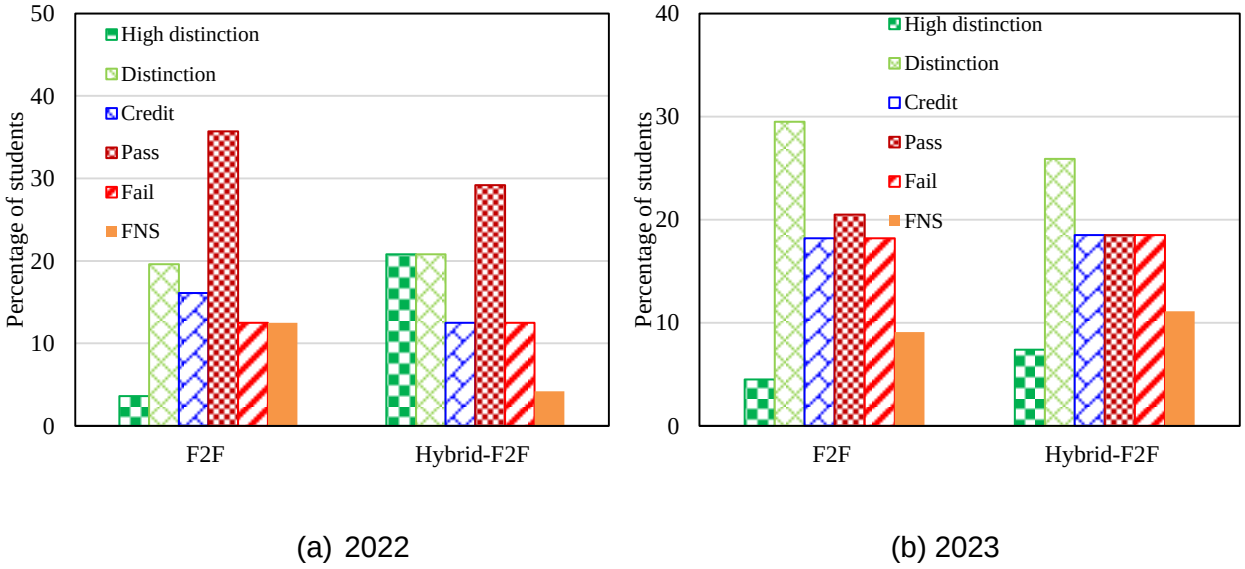


Figure 3: Comparison of grades between online and F2F students



(a) 2022 (b) 2023

Figure 4: Comparison of grades (F2F students with and without synchronous online sessions)

Effectiveness on various aspects of subject delivery

The student feedback on subject (SFS) survey were used to validate the effectiveness of various aspects of subject delivery. The SFS survey for 2023 is not yet available. Therefore, the results presented here are based only on the SFS survey questionnaire responses of 2021 and 2022. The SFS survey questionnaire on effectiveness of subject delivery includes ten aspects shown in Table 2 below. When the subject was delivered online in 2021, the overall effectiveness of subject delivery in terms of broad agreement was same as the School's overall broad agreement (89.2%). The School's overall broad agreement improved from 89.2% to 92.6% in 2022. For this subject in 2022, when the subject was delivered in hybrid and F2F modes, the broad agreement was 95%, which is better than the School average and when the subject was delivered fully online. This indicates that the subject was considered to be better delivered in a hybrid and F2F sessions compared to complete online delivery. Except for the effectiveness in "access timely help and advice" and "a reasonable workload relative to other subjects", all other learning parameters have higher broad agreement than the School averages in 2022. This is attributed mainly to the detailed project work students needed to complete in this subject, which in addition to report writing, requires extensive spreadsheet calculations and use of software to verify their calculations. The project work provide experience working in a project similar to real-life scenario, and greatly helped students to comprehend the concepts delivered in this subject. As a result, the

broad agreement was 100% for two main aspects of this subject “further developed students critical and analytical skills” and “included work-related knowledge and skills”.

The best aspect of this subject mentioned by students in the SFS was that students were able to extend their knowledge and concepts learned in class and apply it to group project work which is like a real-life project. Another aspect the students appreciated in 2022 were the multiple project submissions instead of a single submission, as it allowed them to receive timely feedback from teaching staff and were able to incorporate the feedback. This also relieves stress at the end of the semester because students need to continuously work on the project from the beginning of the semester when they have multiple submissions. Since extensive calculations needed use of spreadsheet, students were also appreciative of the spreadsheet skills they learned through this subject. Some of the challenges students faced were working in a group, where some group members did not communicate and participate well. This was the issue indicated by students in 2021. To address this challenge, students were asked to submit separate self-reflection reports, indicating their contributions. Use of the reflection report in final mark allocation was repeatedly reinforced in classes. The final mark students were allocated used the reflection reports accordingly.

Table 2: Broad agreement percentage on various aspects of subject delivery reflected on student feedback on subject in 2021 and 2022

SN	Learning was effectively supported by:	2021 (Online)		2022 (Hybrid & F2F)	
		School average (%)	This subject (%)	School average (%)	This subject (%)
1	Learning activities	89	86	93	95
2	Learning materials	90	93	93	95
3	Assessments	90	91	94	95
4	Opportunities to work with other students	85	88	86	95
5	Technology	90	91	93	95
6	Access timely help and advice	89	88	92	90
7	A reasonable workload relative to other subjects	90	93	93	90
8	Further developed my critical and analytical skills	90	88	95	100
9	Included work related knowledge and skills	92	88	95	100
10	I was satisfied with the quality of this subject	87	86	92	95
	Overall average %	**89.2**	**89.2**	**92.6**	**95**

Discussions

Discussions based on findings

Based on findings presented in the earlier section, the effectiveness of all three methods appears to be comparable, with no discernible advantage that can be definitively established. The students scoring higher grades and failure rates were similar in all three different modes of

subject delivery, online, F2F and hybrid. However, majority of students scoring just pass grades were online students. This can be attributed to the lack of active engagement during lecture and tutorial sessions. To address this issue, strategies to engage online students during lecture and tutorial sessions need to be developed and implemented. In tutorial sessions, short assessments/group work can be created for the students requiring completing in groups by creating separate Zoom® rooms. This can assist online students for peer discussions, as online students do not have the opportunity for peer discussions during teaching sessions. The group project work can be continued in future delivery for better understanding of the concepts and to give students exposure to a project similar to real-life project work in this field.

Conclusions

This study compared the student experience and outcomes in Surface Water Hydrology, a core third-year subject delivered in three different instructional modes, i.e., online, hybrid, and face-to-face sessions at Western Sydney University. The following conclusions can be drawn based on the limited data for three years.

1. The average number of accesses to LMS, average submissions, and the time spent by students in this subject on LMS were higher than the School averages. This indicates better engagement of students in this subject.
2. In general, students attending in-person classes achieved higher scores compared to their online counterparts. Furthermore, the proportion of online students, including students attending hybrid online mode, who received passing grades were significantly higher than that of students attending face-to-face sessions. The failure rate was similar among students in all three different instructional modes.
3. There is a need to improve engagement of online students on a weekly basis to improve overall performance. This may be achieved by using online platforms to teach where students can actively participate during online sessions. Another strategy could be developing tasks requiring group discussions in teaching sessions to improve peer discussions. This can be done using features of Zoom® to create separate online rooms.
4. To minimise/eliminate the students with Fail Non Submission (FNS) grade, students engagement can be closely monitored in the first few weeks, and if they are not engaging well, they can be advised to drop the subject.
5. Some tasks requiring group discussions can be developed to improve peer discussions in hybrid and online sessions.
6. The group project work can be continued for better learning outcomes, and to give students exposure to a project similar to real-life scenario projects in this field.

The results presented here are based on the limited data from three years of subject delivery. Further research can be conducted with similar subjects to draw a robust conclusion. This study can be expanded to assess the effectiveness by implementing strategies to increase active engagement of students.

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