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A Comparative Study of Student Mathematical Performance in three modes of Teaching and Learning Education during the Covid-19 Pandemic

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Abstract

Due to COVID-19 pandemic many educational institutions worldwide have led to the total closures due to lockdowns and the viral spread of the infections. UNICEF had estimated that more than 92% of the students around the world were unable to attend physical schools due to temporary closures and due to periodic lockdown. This study examined the performance of the students in different learning modalities by comparing their mathematics performances over three consecutive semesters at University of Technology and Applied Sciences, Muscat. Furthermore, the researchers sought to quantify the difference in mathematics performances as indicator of effectiveness of the learning modality in two separate streams of math and non-math core specializations. The analysis was carried out using one-way analysis of variance where the mean mathematics performances was considered as the independent variable and the mode of teaching was the factor. Based on the result of the study, the students' scoring performance in Basic Math to Calculus in the three modes of teaching and learning between the F2F, Blended and Online are not significantly affected. The result reveals that due to the student's high scoring performance in Basic Math to Managerial Statistics in the three modes of teaching and learning between the F2F, Blended and Online are significantly affected. Further analysis, will be investigated in detail to find the affecting factors such as Time Management, Assessment, Home Environment, Collaboration, Homework, Teaching Quality, Skill development, Problem solving ability, Motivation, Help received and Student satisfaction, which made them to score high marks in above said courses.

Keywords: Blended learning, Covid-19 pandemic, Face to face learning, Online learning.

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Introduction

Since the Covid-19 pandemic began in December 2019, there has been a tremendous change in the lives of the people all over the world. The face of education has witnessed a major change that was never seen before. Due to lockdown and spread of the pandemic, various schools, colleges and universities were shut down and the classes were conducted online.

Face-to-face Learning

Face-to-face learning is an educational method in which a group of students is taught course content and learning material in person. This allows a learner and an instructor to engage in real time. It is the most common method of educational instruction. Additionally, learners gain from increased interaction with their classmates. Students are held accountable for their progress in face-to-face learning at the class's designated meeting date and time. Face-to-face learning ensures a greater grasp and retention of lesson content, as well as the opportunity for class members to bond.

Face-to-face learning is primarily a teacher-centered mode of education that varies greatly across cultures. Many modern education systems have essentially abandoned conventional face-to-face learning methods. This is the traditional teaching and learning process. Where the teachers are teaching the students in the class room environment and all the assessment is conducted in person in the campus.

Blended learning

The way blended learning training is given is usually determined by the circumstances, therefore there is no one-size-fits-all solution. Blended learning, also known as hybrid learning, is a type of education that mixes traditional place-based classroom methods with online educational materials and chances for interaction. With the support of Ms. Teams and an E-Learning platform, it's a blend of face-to-face and online instruction. Typically, there is a 50/50 split between face-to-face and online instruction. In online teaching, students are taught the course content by Ms. Teams with a video camera on, and 50 percent of the evaluation is completed remotely online, with the remaining 50 percent completed on campus.

There are several approaches to this form of training. Let's look at some of the most popular blended learning approaches. By providing learners with training materials and presentations prior to the actual class, this blended learning methodology allows trainers to prioritize active learning during class time. The content can be shared via a learning management system (LMS), email, or any other method that the trainer chooses.

This is the structure that comes closest to that of a typical classroom. Learner’s log into a webinar or meeting session, such as a Zoom Meeting, instead of attending in a physical classroom. Learning takes place online, with homework assigned thereafter. An LMS can easily deliver this integrated learning strategy. You can use one to offer a training session and distribute tasks with students before or after the event.

An alternative to full-time online training that allows students to complete the majority of their courses online while simultaneously participating in live webinars with an instructor. The learners' attendance is sporadic and at their choice, giving them the freedom to learn at their own speed. You may make blended learning courses as interactive as you desire. You can choose how much of your learning will be done through online training and how much will be done through self-paced learning. You may, for example, assign learners a job to do before to a live webinar training session. You discuss the task and share solutions throughout the webinar.

Online Learning

The term "online learning" refers to education that occurs over the internet. It's also known as "e-learning," among other things. Online learning, on the other hand, is merely one sort of "distance learning," which refers to any learning that takes place at a distance rather than in a traditional classroom. This type of instruction is conducted entirely online utilizing Ms. Teams. The remote option is used for 50% of the online examination, while the remaining 50% is completed online in Campus. In order to guarantee academic integrity, remote mode assessments are completed with the camera turned on.

Online learning is a type of education in which students learn in a completely virtual setting. Online learning (also known as e-learning) was first introduced in the 1990s with the creation of the internet and was used in distance learning. It allows students from all over the world to connect with academic institutions and other students online and learn at their own pace while working toward a degree or certificate

Online learning is an internet-based learning environment that allows students from all backgrounds and perspectives to connect. A learning management system, or LMS, will be used by a higher education institution to facilitate online learning, which can be asynchronous (where students are not required to be online at the same time and complete coursework using discussion threads and e-mails) or synchronous (where students are required to be online at the same time and complete coursework using discussion threads and e-mails) (where students must be online at the same time).

In the University of Technology and Applied Sciences, Higher college of Technology, the academic year consist of three semesters; September to December, January to April and April to July. Since 2019, the university students had witness three different types of teaching and learning process. i.e., during September 2019 to December 2019, academic year 2019-2020, semester 1, students had a completely traditional face to face education (F2F), during January 2020 –April 2020, academic year 2019-20, semester 2, the students had a blended learning (BLD), which was a mix of face to face and online teaching and learning process and finally from September 2020 to December 2020, academic year 2020-21, semester 1, the students had a completely online teaching (ONL) and learning education. In all the above types of study the assessments and examinations were completed with the highest standard of academic integrity. These student’s data are unique of its kind as there has never been a situation like this in the recent past. The data is significant as these students encountered the three different modes of teaching and learning experience in the consecutive three semesters.

This study intends to compare student's mathematical performance in all the above three different modes of teaching and learning. i.e., face to face, blended learning and online teaching and learning during the course of pandemic. The marks of the students who studied Basic Math, Pure Math, Calculus and Basic Math, Applied Math, Managerial Statistics from the year 2019 to 2021 will be analyzed and their performance will be compared and evaluated with respect to three different modes of education. A survey was also conducted among the above students with respect to their experiences in the three different modes of teaching and learning. The survey was related to Time Management, Assessment - Continuous Assessment (Test/Midterm, Class activity, Self-Study) / Final, Home Environment /Collaboration/Homework, Teaching Quality /Skill development/Problem solving ability, Motivation/Help received and Student satisfaction.

Review of Related Studies

In past may researchers studied the various mode of teaching, learning and its effects on student's performances. Now due to the Covid-19 Pandemic, e-learning has gained a prominent role in the field of the education. Hence many researchers are pursuing their research comparing the different modes of teaching and learning process like face to face (F2F), Blended Learning (the mix of traditional face to face and e-learning) and Online education. Jasmine Paul and Felicia Jefferon (2019) had compared face to face and online education with respect to the student studying environmental sciences and their study reports that there is no significant difference in the F2F and Online education. They also suggest to increase the non-stem majors using flexible online education. Kavitha R. K and Jaisingh. W. (2018) studied Student Experiences in Blended Learning Environments. The study was conducted among undergraduate and post graduate students, the results inferred that blended learning approach is more beneficial for students who are skilled in using certain computer programs and applications. Jeffrey. L. M et al., (2014) studied on How Teachers Balance the Blend of Online and Classroom Components. The result showed that Blended learning will not fulfil its promise of better learning unless teachers can be encouraged to re-think and redesign their courses that afford students more and different learning experiences than those offered by either online or classroom alone.

Darkwa, B.F. and Antwi, S. (2021) the author study aimed to compare classroom learning effectiveness during the coronavirus pandemic to the effectiveness before the coronavirus pandemic at the University of Cape Coast. The performance of students in both teaching and learning modes was also compared. This study was case study research, and both primary and secondary data were employed. The effectiveness was measured using course content, pedagogical approaches, interactivity and assessment, feedback and evaluation. Data on effectiveness was collected using a questionnaire, and students' assessment was used to measure their performance. The data were analysed using a paired-sample t-test embedded in Statistical Package for Social Sciences version 26. The results show that classroom learning was more effective than online learning. Additionally, the students exhibited good academic performance in classroom learning than online learning, although the difference was not statistically significant.

T. Muthuprasad et, at. (2021) focused on understanding Agricultural Student's perception and preference towards the online learning through an online survey of 307 students. The author also explored the student's preferences

for various attributes of online classes, which will be helpful to design effective online learning environment. The results indicated that majority of the respondents (70%) are ready to opt for online classes to manage the curriculum during this pandemic. Majority of the students preferred to use smart phone for online learning. Using content analysis, the author found that students prefer recorded classes with quiz at the end of each class to improve the effectiveness of learning. The students opined that flexibility and convenience of online classes makes it attractive option, whereas broadband connectivity issues in rural areas makes it a challenge for students to make use of online learning initiatives. However, in agricultural education system where many courses are practical oriented, shifting completely to online mode may not be possible and need to device a hybrid mode, the insights from this article can be helpful in designing the curriculum for the new normal.

Foo, Cc et. al.(2021) matched 62 students in each group. With four tutorials, there were 490 observations, with 245 in each group. The mean total score for the DL (distance learning) group which was significantly lower than that of the FF (face-to-face) group. The author noted that students in the DL group had a significantly lower scores for all five areas of proficiency: participation, communication, preparation, critical thinking and group skills. The author concluded that their study revealed that the performance of students utilizing the DL PBL (distance learning problem-based learning) tutorials was lower than that of students participating in the conventional FF approach. Further studies are needed to ascertain the underlying cause.

Jitendra Singh et. al (2021) studied an in-depth review of the history of blended learning, evolution of hybrid model of instruction, preparedness of faculty with minimal or no experience in online teaching, and lessons learned as faculty worked on navigating COVID-19 situation since early 2020. A fish-bone analysis, a visual and structured approach to identify possible causes of problem, has been used to present the problems faced by faculty during the pandemic. A detailed Strength–Weakness– Opportunities–Threat analysis of blended/hybrid learning has been presented. An evidence-based approach on how instructors can combine the best of both traditional and online instruction to offer engaging learning experiences for students

Chisadza. C et.al (2021) investigated the factors that predict students' performance after transitioning from face-to-face to online learning as a result of the Covid-19 pandemic. The study uses students' responses from survey questions and the difference in the average assessment grades between pre-lockdown and post-lockdown at a South African university. The author found that students' performance was positively associated with good wifi access, relative to using mobile internet data. The author also observes lower academic performance for students who found transitioning to online difficult and who expressed a preference for self-study (i.e. reading through class slides and notes) over assisted study (i.e. joining live lectures or watching recorded lectures). The findings suggest that improving digital infrastructure and reducing the cost of internet access may be necessary for mitigating the impact of the Covid-19 pandemic on education outcomes.

Mugenyi Justice Kintu et al. (2017) studied the effectiveness of Blended learning among students and found that the results indicate that some of the student characteristics/backgrounds and design features are significant predictors for student learning outcomes in blended learning. Magaji et al. (2015) investigated the Effect of entry grades on academic performance of students, with particular reference to proficiency in Mathematics and English

Language as requisite condition for student's academic performance in Financial Accounting. The study inferred the following: Gender differences were significant when effect of Mathematics and English language background on academic achievement, there is significant difference occurred when background in Mathematics/English was taken as basis for academic achievement of students in Financial Accounting. The study also showed there was a positive association/relationship between proficiency in Mathematics and English and mean academic performance. The researchers recommended that teachers would need to encourage students in requisite subjects like Mathematics and English as this will aid them in understanding Financial Accounting.

Thelal Iqab Oweis (2018) studied the Effects of Using a Blended Learning Method on Students Achievement and Motivation to Learn English in Jordan. The analysis of Covariance (ANCOVA) revealed statistically significant differences in achievement between the two groups, indicating that the experimental group performed better than the control group. Significant differences were also found in the respective group's motivation to learn English. Arias J et al. (2018) investigated online vs. Face-to-Face: A Comparison of Student Outcomes with Random Assignment. The author showed that Students in the face-to-face section have statistically significantly higher exam scores and statistically significantly greater improvement on the post-test instructor questions. Jeffrey L.

Helm (2014) Comparing Student Performance in Online and Face-to-face Delivery Modalities and found that Online students had significantly lower grade point averages, missed significantly more grade opportunities, and were significantly more likely to fail the course compared to their F2F counterparts. Nigel V Smith (2013) studied on Face-to-face vs. blended learning: Effects on secondary student's perceptions and performance. This quasi-experimental study explored the impact of blended vs. face-to-face tuition over one year in a K-12 school in Auckland. No difference between the classes on any item of assessed work was observed. However, differences emerged between the classes in their perceptions of learning, connectedness, enjoyment and teacher support. Concerns about the effects of technology mediated instruction may be partly allayed by these findings. While the displacement of the teacher from the centre of the learning process may be uncomfortable for teachers, the provision of a rich online learning environment may have positive benefits for students. Many other researchers such as Antonio Jose et al. (2020), Peteros et al. (2020), Lan S (2011), Ruchi Shivam et al. (2015), Shahzad, A et al. (2021) had studied the different modes of education and their impact on student performances. Arias J et al. (2018) investigated online vs. Face-to-Face. Here in this paper, we consider one more mode of study i.e., blending learning. This paper is an analysis of Face-to-Face vs. Blending Learning vs. online. Shahzad, A et al. (2021) study reveal that males and females have a different level of in terms of usage of towards E-learning portals in Malaysian Universities.

In this paper we had considered the situation of COVID 19 impacting the learning process of the students. Our study is the classic example of COVID-19 situation where the student study in three different more of education. Thelal Iqab Oweis (2018) studied the Effects of Using a Blended Learning Method on Students Achievement and Motivation. The authors in the [1, 13, 14] have studied and analyzed either one mode or comparing the two modes of education. Hence there is a significant need to compare the all three different modes of learning which will lead to understand and implement the appropriate modes of learning in appropriate situations.

Significance of the Study

This study examined the performance of the students in different learning modalities by comparing their mathematics performances over three consecutive semesters at University of Technology and Applied Sciences, Muscat. Furthermore, the researchers sought to quantify the difference in mathematics performances as indicator of effectiveness of the learning modality in two separate streams of math and non-math core specializations. The result of this study will exemplify and quantify the most effective learning modality for our students based on their specific specialization stream. In contrast, we will also be able to identify areas where we can improve our course delivery and mainly our course's assessment schemes that is suited for a particular learning modality.

Objectives of the Study

Research Objectives

The objective is to study and analysis whether there is any significant difference in the three mode of teaching which are Face to Face, Blended Learning and Online Teaching based on the student's performance and Learning Education during the period of the Covid-19 Pandemic

Research Questions

- Do we have any significant difference in Student's Mathematical Performance for Face to Face, Blended Learning and Online Teaching and Learning Education while they study from Basic Math to Calculus during the Covid-19 Pandemic?
- Do we have any significant difference in Student's Mathematical Performance for Face to Face, Blended Learning and Online Teaching and Learning Education while they study from Basic Math to Managerial Statistics during the Covid-19 Pandemic?

Hypotheses of the Study

- The mean score of student's performance in the three modes of teaching and learning (Face to Face, Blended Learning and Online Teaching) are considered to be equal.
- There is no significant difference between the mean score of the student's performance in BASIC MATHEMATICS (BM)-F2F (Mode of Teaching), students' performance in PURE MATHEMATICS (PM) - BLD (Mode of Teaching), and students' performance in CALCULUS (CAL)-ONL (Mode of Teaching).
- There is no significant difference between the mean score of the student's performance in BASIC MATHEMATICS (BM)-F2F (Mode of Teaching), students' performance in APPLIED MATHEMATICS (AM)- BLD (Mode of Teaching), and the students' performance in MANAGERIAL STATISTICS (MS)-ONL (Mode of Teaching)

Method

The study was conducted among two different type of specialization such as Information Technology, Engineering and Applied Sciences where student study Basic Math (BM), Pure Math (PM) and Calculus (CAL), Basic Math is perquisite to study Pure Math and Pure Math is perquisite for studying Calculus. Similarly, for specialization such as Business Studies, Photography and Fashion where student study Basic Math, Applied Math and Business Math/ Managerial Statistics (MS). Basic Math is perquisite to study Applied Math and Applied Math is the perquisite for studying Business Math/ Managerial Statistics. The same is given in the figure below.

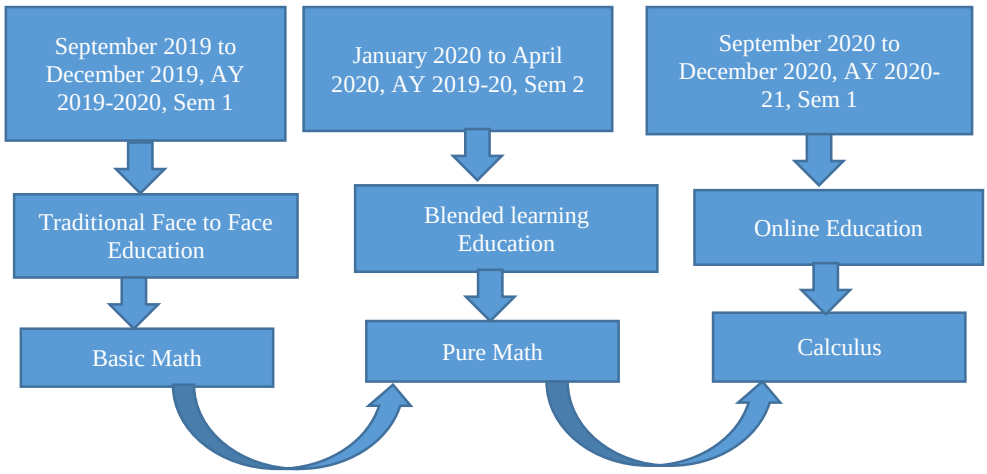

Figure 1. Foundation Math Courses with their perquisite for Information Technology, Engineering and Applied Sciences Department.

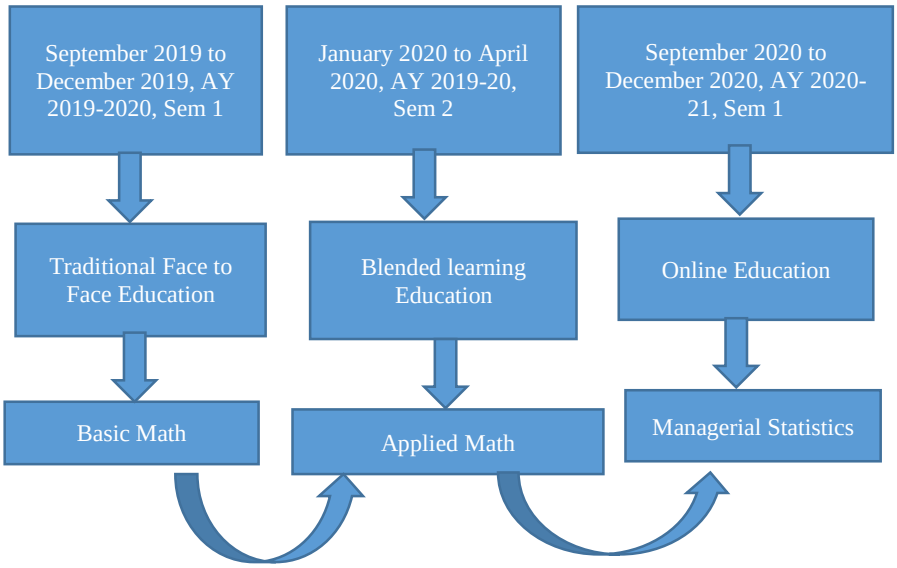

Figure 2. Foundation Math Courses with their perquisite for Business Studies, Photography and Fashion Department

Research Design

This research was anchored in quantitative-descriptive design of research. This research design enabled the researchers to use the existing dataset such as the marks of the students to undergo quantitative analysis and generate important insights out of this. In addition, the design enabled the use of finding statistical significance between and among group means of interest. Compare them simultaneously or pairwise depending on the result of the apriority tests of significance.

Measures

The study used historical pertinent data of the respondents. A permission to use the dataset with a condition of anonymity was established to protect the students' identity and avoid data privacy violations. Marks in Basic Mathematics, Pure Mathematics and Calculus were the main source of data. Validation and inclusion to the final dataset of the study was undertaken by considering respondents with complete marks in these mathematics courses. In addition, marks were courter checked from the result analysis reports which is the main and official database of student's mark.

Mark in these courses were the direct measure of performance of the students on that particular course. As a rule of thumb in education, the higher the mark the better the relative performance of the students in the subject matter. Equivalent grade letter and corresponding grade point average were not considered in the study since previous study suggests that either dataset will result to the same conclusion under the assumption of parametric hypothesis testing.

Population and the Sample

The study sample data (203 students) was collected from the foundation entry level students between the age limit 18 years and 22 years, after the school graduation. Number of female's students under this study are likely to be more than the males, who are enrolled for their Bachelor degree in the University of Technology and Applied Sciences, Higher College of Technology, for the three consecutive semesters, Muscat, Sultanate of Oman.

Statistical Techniques Used in the Present Study

In this paper, Single Factor ANOVA and a paired sample t- test comparing the means is carried out for the analysis. Mean, Variance, Person Correlation, Hypothesized Mean Difference and one-tail t-Test were sued to analyze the date.

Results

Initial test of normality had been carried out to the group to determine whether a parametric test warrants the

correct statistical approach to present the statistical significance. The figure on the next shows the boxplot of the marks in three mathematics courses, namely Basic Mathematics, Pure Mathematics and Calculus I. Clearly, we see that the distribution of the three groups approximately resembles a normal distribution. It can be noted however, that the Calculus group potentially had an outlier on the lower extremes. In addition, the Pure Mathematics dataset is slightly skewed base on the uneven distance of the median value to the first and third quartile. With this exploratory data analysis, the researchers decided to undertake a parametric testing of hypothesis and leaving other assumption to be true.

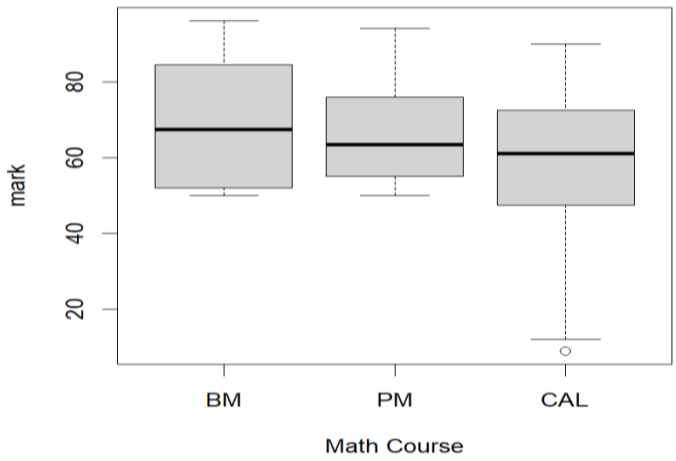

Figure 3. Graph of the Distribution of Marks in Basic Mathematics, Pure Mathematics and Calculus I

Compare the Basic Math, Pure Math, and Calculus Courses

Testing of hypothesis using the Single Factor ANOVA table is carried out for this analysis. The mean score performance of the three different mean student's performance in BASIC MATHEMATICS (BM)-F2F (Mode of Teaching) is equal to mean students' performance in PURE MATHEMATICS (PM) - BLD (Mode of Teaching), and also is equal to the mean students' performance in CALCULUS (CAL)-ONL (Mode of Teaching).

Table.1. Mean Mathematics Performance of the Students with Respect to the Different Learning Modalities for Math Core Specialization

Source of Variation	SS	df	MS	$F_{calculated}$	$F_{tabulated}$	Remarks*
Between Groups	3260	2	1630.4	6.47	3.00	S
Within Groups	50631	201	251.9			
Total	53891	203				

p-value is approximately 0.002

Table 1 above, illustrates that the decision is to reject the null hypothesis. It is noted that there is a statistically significant difference between the group means, which shows that the output of the significance value is below 0.05, ($F(2, 201) = 6.472$), $p < 0.001$). One mean is different from other was seen. To investigate further, it is required to proceed with multiple comparisons.

Table.2. Difference between the Basic Math (F2F) and Calculus I (Online) Academic Performances for Math Core Specialization

Variable	Categories*	N	Mean	SD	$t_{calculated}$	$t_{tabulated}$	Remarks
Courses	Basic Math (BM)	68	68.8	16.2	-0.201	1.65	NS
	Calculus I (CAL)	68	59.3	18.5			

**Hypothesize mean difference is 10 marks; p-value is 0.421; one-tailed test*

A Paired sample t-Test compares the means of two score between BM and CAL courses, which is given in Table 2. The passing grades of both the courses having the mean difference of 10. There is no significance difference in the scores for BM and CAL, since the value is above 0.05. This proves that we are maintaining the same standards in the Assessments for BM and CAL courses.

Table.3. Difference between the Pure Math (Blended) and Calculus I (Online) Academic Performances for Math Core Specialization

Variable	Categories*	N	Mean	SD	$t_{calculated}$	$t_{tabulated}$	Remarks
Courses	Pure Math (PM)	68	66.2	12.4	1.251	1.65	NS
	Calculus I (CAL)	68	59.3	18.5			

**Hypothesize mean difference is 10 marks; p-value is 0.108; one-tailed test*

A Paired sample t-Test compares the means of two score between PM and CAL courses, which is given in Table 3. The passing grades of both the courses having the mean difference of 10. There is no significance difference in the scores for BM and CAL, since the value is above 0.05.

Table.4. Difference between the Basic Math (F2F) and Pure Math (Blended) Academic Performances for Math Core Specialization

Variable	Categories*	N	Mean	SD	$t_{calculated}$	$t_{tabulated}$	Remarks
Courses	Basic Math (BM)	68	68.8	16.2	1.717	1.65	S
	Pure Math (PM)	68	66.2	12.4			

**Hypothesize mean difference is 0 mark; p-value is 0.045; one-tailed test*

A Paired sample t-Test compares the means of two score between BM and PM courses, which is given in Table 4. Since, the passing grades of both the courses are same. There is a significance difference in the scores for BM and PM at boundary level, since the value is exactly closer to boundary of 0.05.

Compare the Basic Math, Applied Math and Managerial Statistics

Testing of hypothesis using the Single Factor ANOVA table is carried out for this analysis. The mean score performance of the three different mean students' performance in BASIC MATHEMATICS (BM)-F2F (Mode of

Teaching) is equal to mean students' performance in APPLIED MATHEMATICS (AM)- BLD (Mode of Teaching), and also equal to the mean students' performance in MANAGERIAL STATISTICS (MS)-ONL (Mode of Teaching).

Table.5. Mean Mathematics Performance of the Students with Respect to the Different Learning Modalities for Non-Math Core Specialization

Source of Variation	SS	df	MS	$F_{calculated}$	$F_{tabulated}$	Remarks*
Between Groups	5145	2	2572	25.4	3.00	S
Within Groups	14604	144	101			
Total	19749	146				

p-value is < 0.001

Table 5 below, illustrates that the decision is to reject the null hypothesis. It is noted that there is a statistically significant difference between the group means, which shows that the output of the significance value is below 0.05, (F (2, 144) =25.4), p < 0.001). One mean is different from other was seen. To investigate further, it is required to proceed with multiple comparisons.

Since, there is a significance difference between the group means, we can investigate further by three Post Hoc test to find where the difference happens between BM and AM, or AM and MS or BM and MS.

Table.6. Difference between the Basic Math (F2F) and Applied Math (Blended) Academic Performances for Non-Math Core Specialization

Variable	Categories*	N	Mean	SD	$t_{calculated}$	$t_{tabulated}$	Remarks
Courses	Basic Math (BM)	49	59.8	10.6	0.665	1.65	NS
	Applied Math (AM)	49	61.2	10.9			

Hypothesize mean difference is 0 mark; p-value is 0.255; one-tailed test

A Paired sample t-Test compares the means of two scores between BM and AM courses, given in Table 6. The passing grades of both the courses are same and having the zero-mean difference. There is no significance difference in the scores for BM and AM, since the value is above 0.05.

Table.7. Difference between the Basic Math (F2F) and Managerial Statistics (Online) Academic Performances for Non-Math Core Specialization

Variable	Categories*	N	Mean	SD	$t_{calculated}$	$t_{tabulated}$	Remarks
Courses	Basic Math (PM)	49	59.8	10.6	15.745	1.65	S
	Managerial Statistics (MS)	49	73.0	8.5			

Hypothesize mean difference is 10 marks; p-value is < 0.001; one-tailed test

A Paired sample t-Test compares the means of two scores between BM and MS courses, is given in Table 7. The passing grades of both the courses having the mean difference of 10. There is significantly higher difference in the scores for BM and MS, since the value is Less 0.05.

Table.8. Difference between the Applied Math (Blended) and Managerial Statistics (Online) Academic Performances for Non-Math Core Specialization

Variable	Categories*	N	Mean	SD	$t_{calculated}$	$t_{tabulated}$	Remarks
Courses	Applied Math (BM)	49	61.2	10.9	10.850	1.65	S
	Managerial Statistics (MS)	49	73.0	8.5			

Hypothesize mean difference is 10 marks; p-value is < 0.001; one-tailed test

A Paired sample t-Test compares the means of two scores between AM and MS courses, given in Table 8. The passing grades of both the courses are same and having the zero-mean difference. There is significantly higher difference in the scores for AM and MS, since the value is less 0.05.

Discussion

This paper ambition to uncover the relationship between the mathematics performance in three different modes of teaching using a dedicated cohort of students. It was found out that there is difference in the mathematics performance, if the learning modalities used were face to face, blended, and online learning. Face to face being superior in the later. This result has been supported by a number of recent studies in literature. One of them concluded that Face to Face modality is the only modality of teaching that preserves the teaching - student relationship in an informal teaching and learning environment. Moreover, the results of this paper fully support this teaching ideology and anchored to the most common School of Thoughts in Education.

This paper however is limited in terms of context, since only the marks of the students are readily available for research consumption. It would be a good exercise to look into the segmentation of the students by gender and by a prior variable like their performance in elementary school as a mediating or compounding variable.

Conclusion

As a result of the Comparative Study on Student's Mathematical Performance in Face to Face, Blended Learning and Online Teaching and Learning Education during the Covid-19 Pandemic. The students' scoring performance in Basic Math to Calculus in the three modes of teaching and learning between the F2F, Blended and Online are not significantly affected. The result reveals that due to the student's high scoring performance in Basic Math to Managerial Statistics in the three modes of teaching and learning between the F2F, Blended and Online are significantly affected. Further analysis, will be investigated in detail to find the affecting factors such as Time Management, Assessment, Home Environment, Collaboration, Homework, Teaching Quality, Skill development,

Problem solving ability, Motivation, Help received and Student satisfaction, which made them to score high marks in above said courses.

Recommendations

Based on the findings of the study, the following recommendations were developed;

- Face to face is still preferred than online/blended course as it reflect is the true perspective of the student
- Establish a good assessment methodology while maintaining the integrity regardless of the mode of teaching
- Non-core math track needs more attending in different type of mode of education.

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