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Analyzing Students Performance in Online, Hybrid and Offline Mode –A Cross-Sectional Study

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***Abstract*— Background Study: Covid-19 pandemic had affected thousands of students by the closure of institutions, which has led to the largest online transition in education history. The institutions had to adapt quickly to virtual and digital strategies. A new hybrid learning model has emerged after the pandemic is over, but in addition to this hybrid model, the offline model is slowly returning to the original. Objective: In this study, we conducted a comparative analysis over a three-year period 2020 (online mode), 2021 (hybrid mode), 2022 (offline mode) to examine the effect on the students' performance for a project-based course, Problem Solving and Design Thinking. Methods: Descriptive and inferential statistical measures are used and specifically by using t-test and Welch's ANOVA, it is concluded that over the years there is a significant contrast in the performance of the online mode compared to the other two modes (hybrid and offline) across the years. Results: Students' scores were dropped post pandemic, therefore presenting that post pandemic scores reveals more precise results about students' knowledge. This study also provides insights into how students are performing and how their performance varies across different modes of education. Conclusion: The findings reveal that the future of higher education should incorporate a hybrid approach for a better teaching-learning and quality education.**

***Index Terms*— Hybrid mode, Blended Mode, descriptive statistics, offline mode, Welch's Anova, Welch's t-test and Online mode.**

I. INTRODUCTION

Since its origination in December 2019, COVID-19 has led to a global catastrophe. Education, like all major activities, has been severely affected [1]. Students, schools, colleges, and universities are greatly affected. As per the data from the United Nations Educational Scientific and Cultural Organization (UNESCO), over 800 million students globally have been impacted. This translates to one out of every five students unable to attend school, with one in four unable to access higher education classes. Moreover, more than 102 countries have issued nationwide closures of schools and universities, while an additional 11 have implemented localized school shutdowns [2]. When we look back at the past three years and the great impact of the pandemic to date, one of the hardest hit sectors is education. The swift shift to online platforms has caught both the world and educational institutions unprepared. Schools around the world had responded quickly to the global pandemic by shifting online. In record time, pupils moved from a physical space that provides social interaction to sitting behind a screen for hours. The effectiveness of online education is still a matter of debate. Experts examined student retention and how online learning affects children's development and social skills [3].

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They concluded the effectiveness of online education hinges on the following three factors:

- The availability of internet access and computers for both students and teachers.
- Teachers receive the necessary training to manage online classrooms.
- Provide a platform for personalized learning tailored to each student's learning.

These three situations presented many challenges for schools, universities, teachers, and students – the latter will have a significant impact on the transition online.

II. Literature Review

Such educational events caused by epidemics are more likely to occur in the future, affecting students' learning and performance. Understanding the impact on student learning is critical to a school's emergency preparedness, especially when creating effective policies for online instruction or assessment. These efforts can help clarify options for whether to continue online mode, reopen in-person mode, and opt for short-term or long-term reopening.

Here we focus on three types of learning: online, offline, and hybrid. Hybrid or blended teaching is a combination of traditional teaching methods, that is, offline teaching and online teaching. University English teachers use modern information technology to create blended learning to make English lessons more effective [4]. Other studies show that the results of online learning are not good, and students have trouble adjusting. Offline education is still the most popular form of education [5]. Similar studies on online and offline hybrid teaching as "PAD" (Presentation-Assimilation-Discussion) show that teachers play a role of guide in the classroom and students play the most principal role. This teaching model draws on all learning resources, expands the time and scope of instruction, and creates collaboration, discussion, innovation, and debate in the classroom [6].

Many online tools have improved the teaching process during the pandemic. All learning depends on the student's curiosity and the teacher's ability to convey knowledge, as well as the skills of the student and the teacher. The value of teacher-student interaction in offline classrooms is widely expected [7].

Other studies have implemented hybrid teaching models, combining online and offline approaches in English classrooms, and analyzed the outcomes while brainstorming potential solutions. The experiments have conclusively demonstrated that the integration of online and offline teaching is essential and cannot be divorced from each other. We cannot rely too much on online teaching; We need to carefully use online activities and study designs to monitor the results of offline teaching. Only by combining online and offline teaching can better results be achieved, and better skills can be developed [8].

Other studies show that blended activities can increase students' listening scores. Additionally, students' perceptions of English listening also changed from negative to positive. At the same time, students' interest continues to grow and learning strategies become more diverse. These discoveries hold significant implications for the development of English language teaching methods aimed at younger individuals [9].

According to the ARCS motivation model, which focuses on attention, affect, trust and satisfaction, blended learning surpassed online learning in terms of capturing attention, building trust, and overall satisfaction. Moreover, blended learning also resulted in higher levels of satisfaction when compared to traditional face-to-face learning methods [10].

The study revealed that the employed blended learning approach had a favorable impact on student performance. There may be face-to-face interaction with existing teachers and e-learning with teaching methods. In some e-learning environments, the absence of a teacher in the classroom can be detrimental, especially when students are exposed to traditional teaching methods. There is a difference in student performance between the three methods that support blended learning [11].

Online education has the potential to offer substantial advantages in advancing numerous sustainable education objectives. For instance, since education is open to students from different cultures, non-formal education is provided. Additionally, online education applications are often more carbon efficient, providing additional employment benefits to online education. In addition to these listed benefits, we also need to determine whether the content of online education is good from the student's perspective [12].

Students' perceptions of their own comfort and performance depend on variables such as lack of online communication, interest in online course materials, clarification of questions or concerns regarding both, level of practice, and listening, speaking, and comprehension. and write. Although understanding is gained through online mode, most students prefer offline learning to online depending on their learning. Learning English offline seems to be more effective than online learning because students' knowledge, understanding of information, communication, interaction, and general learning are the same, different between the two types of studies [13].

In the ever-evolving landscape of today's information technology, an increasing number of courses are amalgamating online and offline teaching methodologies. So, English teaching methods in vocational schools should take advantage of the convenience of the internet to obtain more information and improve their English teaching methods. Secondly, home deliveries and home repairs are done online. Micro classrooms and flipped classrooms represent innovative forms of online teaching. By recording video, data reusability can be increased [14].

Online education and offline blended education increase student success. Blended teaching also reduces teachers' workload; teachers' offline teaching time decreases from 36 hours to 18 hours. Simultaneously, student satisfaction data also indicate a noteworthy disparity between the online teaching group and the traditional teaching group. [15]

One of the key features of the blended learning model is that it can improve students' starting point and enable students to think on their own while learning. University English teachers can utilize software to instruct mobile English. Learners can also employ mobile devices for fragmented learning. In offline classes, teachers take on the responsibility of addressing questions and evaluating students' skills, enabling them to actively engage in the classroom. [16].

Researchers have said that hybrid teaching should continue after the epidemic [17]. With the help of rich teaching material on the online platform, students can learn and understand independently. While offline communication can be made between teachers and students and aims to teach students knowledge, foster relationships, increase student interest, and help promote their education and development [**Error! Reference source not found.**]. It is difficult to replace the offline education model with online education model in India. Both models have some advantages and disadvantages and can complement each other [19].

These Studies have some gaps like these don't compare all the three modes together and they don't have proper analysis of student performance based on their grades and marks. In our study, we have taken proper data for marks of students in the three modes, we conducted a thorough analysis of the data to draw our study to a conclusive end.

III. Proposed Methodology

In this paper, we delved into the impact of various learning modes on students' performance in Problem Solving and Design Thinking course studying in The NorthCap University, Gurugram, India. In this research, we performed descriptive statistics and inferential statistics on the data set of student's marks and grades. We used Python to perform these statistics methods with efficiency. We have used simple and basic descriptive and inferential statistics to understand the trends in the data. We have compared the performance in the three modes to get to our results. Fig. 1 demonstrates the statistical methods performed in this analysis.

IV. About The Dataset

There were 334 students' registrations in the online mode, 460 in hybrid mode, and 455 in offline mode. Table I records the descriptive measures of this dataset. The average marks recorded a decline from 67.27 in online mode to 64.01 in hybrid mode to 60.40 in the offline mode. Also, a declining trend in the median marks also speaks about the effects of covid-19 on education from online to offline after pandemic. This shows the student ability to learn and perform has reduced after pandemic. Whereas the standard deviation seems to show an incremental trend i.e., from 9.91 in online mode to 13.93 in hybrid mode to 16.36 in offline mode. This implies that the variation of marks obtained by students are quite less in online mode. The students' performance was like one another.

TABLE I: STUDENTS' MARKS DURING THE THREE MODES OF LEARNINGS

	Online (2020)	**Hybrid (2021)**	**Offline (2022)**
Number of students	334	460	455
Average marks	67.27	64.01	60.40
Standard Deviation	9.91	13.93	16.36
Minimum marks	0	0	0
25th Percentile	64.25	58	56
50th Percentile	68	67	63
75th Percentile	72	73	70
Maximum marks	84	87	86

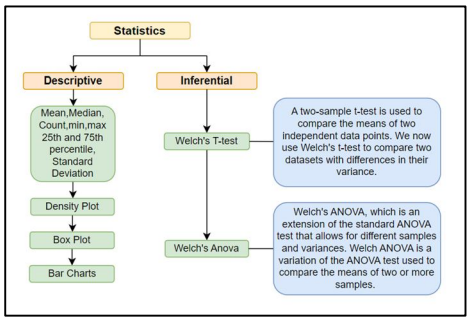

Figure 1: Flow chart of methods used to derive results.

V. About The Course

Problem Solving and Design Thinking course is a project-based course specifically designed for the first semester Engineering students of The NorthCap University. Various technological online tools with Microsoft Teams platform have added fun to the online experience of students and teachers. This included Quizizz, Kahoot, SurveyMonkey, Mentimeter, Padlet, Polly, Canva, Microsoft and google forms, Jam Board, Mind meister, Miro, Coggle, Flipgrid and many more. Students enjoyed doing individual and group activities using breakout rooms over Teams. There were two individual assignments, two group presentations, four objective online tests, a subjective major test, and a group project to assess the overall performance in the course.

They learned to work on various tasks and assigned projects in groups. The students in different groups are given different real-world problems ranging from psychological, socio-cultural, ecological, social, environmental, political to any wicked one from sustainable development goals. Using design thinking principles, they developed innovative ideas for finding solutions for problems, keeping in mind the end user. Using a design thinking mindset this course touched upon the attitude of the students to make them innovative problem-solvers.

This kind of practice continued in hybrid as well as offline mode. The major difference was the subjective major test which was conducted in proctored mode using cloud-based online assessment platform Mercer | Mettl. Whereas in hybrid and offline it was an invigilated pen-paper test.

VI. Results And Discussion

This study is looking at the effects on the performance of students to compare the three modes of learning i.e., online mode, hybrid mode, offline mode. The study examined the disparities in academic performance, specifically about course grades, among the three modes in the following years 2020, 2021, 2022, respectively.

Fig. 2 shows the density plots of the marks in the three modes, respectively. We can clearly see that during the online mode the values of the marks are more concentrated than the latter two modes and the mean value decreases year on year, respectively.

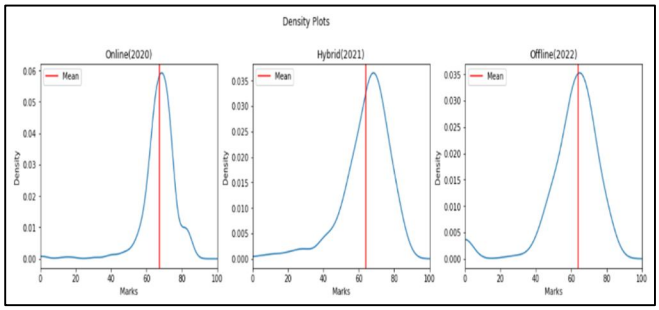

Figure 2: Density Plots and mean of marks during the three modes.

Fig. 3 shows the box plot of students marks in the three modes, we could study and learn about the skewness of the data and the number of outliers in the data from these kinds of plots. We can see that the plot of hybrid mode is more skewed than the other two modes i.e., this mode leads to a fluctuating student performance. In hybrid mode there are maximum number of outliers which suggests that in hybrid mode it is difficult to conduct any analysis because the data has too many outliers.

Fig. 4 shows the frequency of students in each grade in all the three modes of learning. As we can clearly see that the number of students failing the course are very less in the online mode of learning (only 1.8% students) but they have significantly increased when it comes to hybrid mode (5% students) and offline mode of learning (5.3% students). These statistics have proved that pandemic had a very deep effect on the students performance post covid. It had effected the ability of students to learn, think, understand, and remember the things taught duruing the lectures. Moreover, as mentioned earlier, the pen-paper test also led to this finding.

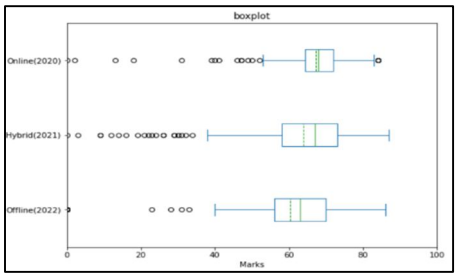

Figure 3: Box plot and mean of marks during the three modes.

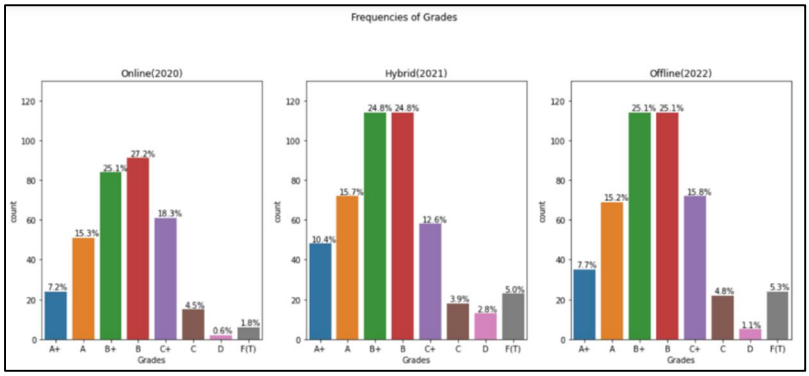

Figure 4: Bar graph for number of students securing each grade during three modes.

A. Welch's T-test

This test is used to compare two different means for significant differences. Out of the complete data we have taken out sample from each mode of learning. Two hundred equal samples have been considered from each mode of learning. Then these modes of learning are compared two at a time with each other to find out differences in them. Table II illustrates the results of this test.

TABLE II: RESULTS FOR WELCH'S T-TEST.

Welch's T-test on	t-statistic value	p- Value
Online and Hybrid Modes	2.78	0.0056
Online and Offline Modes	5.01	0.00000091
Offline and Hybrid Modes	-2.25	0.025

Given that the p-value for the online and hybrid mode is 0.0056, which is below the 0.05 threshold, we can conclude that a significant difference exists in students' performance between the online and hybrid modes. Furthermore, the p-value for the online and offline mode is 0.00000091, significantly lower than 0.05, indicating a substantial difference in students' performance between the online and offline modes as well. And lastly, the p-value for offline and hybrid mode is 0.0245 which is very much closer to 0.05 therefore, based on the p-value analysis, we can conclude that there is no significant difference in students' performance between the offline and hybrid mode which is actually true as discussed in the course description also.

B. Welch's Anova

This test is used to compare more than two different means for significant differences. Out of the complete data we have taken out sample from each mode of learning. Two hundred equal samples have been considered from

each mode of learning. Then these modes of learning are compared at the same time with each other to find out differences in them. First, we conducted a Bartlett's test to test for equal variances. Table III illustrates these test results.

TABLE III: RESULT FOR BARTLETT'S TEST AND WELCH'S ANOVA.

Bartlett's Test	
Statistic value	62.698
p-value	2.427e-14

Welch's Anova	
Source	Mode
ddof1	2
ddof2	398.0
F value	5.921260e-28
p-value	1.0
np2	0.0

In Bartlett's test, we got the p-value as 2.427×10^{-14} which is less than 0.05 therefore the variances have difference among them. Hence, we can go for Welch's Anova.

In the results of Welch's Anova, the p-value is calculated as 1, which is greater than the significance level of 0.05. Therefore, we can conclude that while there may have been a significant difference in the means when these modes were compared individually, when all these modes were compared simultaneously, no significant difference was found.

The above statistical results demonstrates that students have performed well in the online mode but as soon we started shifting back to the original face to face mode the students' performance had declined significantly. These outcomes have shown that the pandemic had a negative effect on the students' performance and their capacity to learn and understand things and innovate novel ideas. We can also say that students have found a way to perform well in the online mode while failing to maintain their performance in the latter two years. This can also lead us to point out that students might have been involved in using unfair means during exams in the online mode and when the things came back to normal, they could not continue their unfair practice further, which had led to their poor performance.

VII. CONCLUSIONS

Online education could not effectively compete with traditional offline methods but formed the basis of the modernization of education. With the effective use of technology, teachers can play an important role in the assessment of all students. The abundance of high-quality content and well-crafted educational materials available on various online learning platforms has been one of the most conspicuous changes in education during the COVID-19 pandemic. However, it has also underscored the irreplaceable value of traditional schooling. Education is a continuous process aimed at developing children's knowledge, thinking and skills along with emotional development.

Simultaneously, it's important not to overlook the potential of online education as a valuable tool for imparting not only informative content but also essential communication skills to students. Leveraging online artificial intelligence tools, we have the means to effectively address educational disparities among our students. So, we can focus on a hybrid model of online mode combined with traditional education that will help to better use resources and meet the need to conserve resources, save time, and protect the environment. Therefore, looking at the holistic benefit, we can say that the hybrid mode of learning is the best mode of learning for the future because it will lead to better student performance ensuring that there is no knowledge gap between the students' learning, and it will lead to better foundation among the students. This can also help the teacher to reduce the use of unfair means during the exams. The authorities should prioritize investments in technology infrastructure to ensure equitable access to online education for all students, bridging the digital divide. Also, the institutions should provide comprehensive training and support for teachers in using online teaching tools and platforms effectively. As a

future scope of this research, different courses, subgroups, and different regions data can be taken into consideration.

CONFLICT OF INTEREST

The authors assert that there are no conflicts of interest.

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