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Investigation of Computing Students' Performances in a Fully Online Environment During COVID-19 Pandemic

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ABSTRACT

COVID-19 hit the world unexpectedly, forcing humans to isolate themselves. It has placed the lives of people in jeopardy with its fury. The COVID-19 has a detrimental effect on the world's education spheres. It has imposed a global lockdown, with a negative impact on the students' lives. Continuing regular classes' on-campus were out of the question. At that moment, online learning came to us as a savior. The quality of online education was yet to be tested on a large scale compared to regular education. This paper reveals the factors that influence four programming courses from Computing students at X University and puts them on the table with an analysis backing it up so that, in future, authorities can design the proper structure for high quality online education.

1. INTRODUCTION

According to computer scientist Daphne Koller, online education may have two objectives. Blended learning will provide better outcomes at the same or reduced cost for students who have access to good teachers. Online education unlocks the doors in places where students do not have access to high-quality education [1]. The world is facing its worst threat since 1920 because of the spread of the COVID-19 virus. Our world has been severely disrupted by the virus. This virus has wreaked havoc on educational institutions, financial services, government services, and a variety of other industries. More significantly, the virus has resulted in a huge number of human fatalities worldwide and continues to infect individuals daily [2]. It has enforced a worldwide lockdown, resulting in many students being unable to finish their academic activities. At first, teachers and students were confused and puzzled about coping with the unforeseen scenario that brought education to an end. People, however, recognized that the lockdown had taught them valuable lessons regarding pandemic onset. It opened the path for educational institutions to accept and promote virtual learning [3]. Most students, however, were finding online education to be an entirely different learning experience. However, most students found online education to be a wholly different learning experience. Nevertheless, the benefits of online learning outweigh the drawbacks.

This paper demonstrates a simple analysis of students' academic performance in an online class. This paper is the first part of an extensive study, where a brief comparison of students' academic performance is conducted between on-campus and online classes. Furthermore, an in-depth analysis is also done on students' online academic performance using Decision Tree [4]. Four distinct programming courses were chosen for the study, allowing for coverage of students from the first year to the final year of the undergraduate program. The paper is divided into five sections, which are arranged in the following order: The introduction is in section 1, followed by a quick overview of the overall scenario of online education in section 2, section 3 contains the data collection portion, section 4 contains the analysis and discussion, and lastly, section 5 consists of the conclusion.

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2. RELATED WORKS

Coronavirus has put the entire world at a standstill. Especially in the education sector, it has some severe impacts. Due to the global pandemic, all the educational institutions were suddenly shut down and they had to switch to the online platform to conduct all the academic activities online such as taking the classes and lab remotely, assessing the students, and so on. If they did not switch to the online platform, several problems would arise, such as session jams, the continuity of education; in general, the whole nation's overall growth would be at a standstill.

A comparative study was conducted on students' performance in face-to-face and virtual classes, and it was found that with proper planning and execution, it is possible to ensure the quality of education in online classes as well [5]. According to the findings of a study conducted by [6], Educational institutions often utilize experiments' results to produce patterns of student behaviors and then apply that new approach to help enhance educational quality.

Virtual Learning Environments (VLEs) are playing a significant role in the educational sector during the global epidemic. It has made it more convenient for students and course instructors to attend classes from home. It has removed the barrier of location. Students can join the classes from any part of the world [7]. In the virtual classes, a downfall was noticed in the interaction between students and teachers. Surprisingly, the interaction between the classmates was much more stable. Thus, students might have some lacking in a particular topic, which the teacher could quickly solve, but it was not the case, as the students did not ask the question in the first place. This inconsistency in the students' participation is an influential factor in students' academic performance [8]. Several factors were used to analyze the most significant factors in the students' academic performance in online classes.

Here many aspects of student grades in a MOOC were examined. They found that the best variables were those related to exercises of the MOOC while analyzing the performance of the students [9]. According to the findings conducted by [10], ten features (student's department, previous academic grades, participation rate, attendance, midterm scores, lab reports, homework grades, seminar score, completion of assignments, and the overall grades) were taken into account to analyze the students' performance. Students face various problems in virtual classes. Some of them include inappropriate study environment, insufficient study material, internet connection problems, load shedding, and so on. These issues deeply affect the students' academic performance. On top of that, they face several physical and mental hazards such as weak eyesight, overweight, sleep deprivation, psychological issues, and many more [11]. Soesmanto and Bonner [12] investigated a dual mode design in which first-year business school students at Griffith University in Australia could attend the same statistics course in online or face to face. The dual mode system's two cohorts showed no significant differences in learning satisfaction or academic performance. According to Lorenzo-Alvarez et al. [13], a radiography course delivered online at a university in Australia was found to have equivalent academic performance to those achieved through face-to-face learning. At Ohio University, Cavanaugh and Jacquemin [14] used a huge dataset of 5,000 courses taught by more than 100 faculty members across ten academic terms to evaluate grade-based learning outcomes between online and face-to-face courses. In the regression analysis of the study, GPA was found to be the most important factor in determining individual course grades. Students with higher GPAs did better in online courses, while students with lower GPAs performed worse.

According to the findings of a study conducted by [15], students are pleased with the university staff and faculty members who agreed on certain online platforms to utilize, grading systems, assessment alternatives, training sessions, online technical help, and more. For lecture delivery, students preferred using Google Hangouts, followed by Google Classroom and a Learning Management System (LMS) such as Moodle. A more in-depth look at how students view online learning can be found in [16] study, where students see online collaborative English language learning as a good and encouraging experience, primarily because of the beneficial peer-feedback engagement in eLearning. A study conducted by [17] reveals that online students who finished the course performed much better than on-campus students as a group.

According to the findings of a study conducted by [18], the online learning environment supports a favorable influence and increases EFL students' writing skills, self-confidence, and power in generating written documents. A study by [19] says that 37% of nursing students were not happy with their online learning during the COVID-19 outbreak. The other 46.3% were satisfied. Academic performance was negatively impacted by the COVID 19 epidemic, with 37% to 50% of students reporting poor or fair results. A study conducted by [20] shows that the online sessions were beneficial in terms of saving time, and students' performance went up because they were able to use more of their time.

3. DATA COLLECTION

In this paper, the data of Bachelor's in Computer Science and Engineering students from four Programming Courses of X University is collected which was conducted virtually. The considered courses are Introduction to Programming (IP), Object Oriented Programming 1 (OOP1), Object Oriented Programming 2 (OOP2), and Web Technologies (WT), which are taught in each year of undergraduate respectively. These four courses are selected, mainly because it gives an overall scenario of all the students' performance from the first year to the final year. Introduction to Programming is taught to the freshmen students. Once they have completed this course, they are eligible to take the course Object Oriented Programming 1 (OOP1) which is offered to them in the second year. Object Oriented Programming 2 (OOP2) is taught to the third-year students prior to completion of the first two programming courses. Finally, Web Technologies (WT) is offered to the final year students once they are done with all the programming courses which were mentioned earlier. Table 1 shows the sample size of the four mentioned courses of computing students undertaken on the four consecutive years of the undergraduate program in an online semester.

Table 1. Sample of Population

Year	Course name	Online Semester
1st	Introduction to Programming (IP)	40
2nd	Object Oriented Programming- 1 (OOP1)	78
3rd	Object Oriented Programming- 2 (OOP2)	127
4th	Web Technologies (WT)	46

The course's results, including the entire breakdown of the Mid Term, Final Term, and Overall Grade, including and excluding Dropped events, are available here. The grades are given based on the marks obtained by the students. In the online semester, fifty percent of the Overall Grade comes from the mid-term, and the other fifty percent comes from the final term. Here, the grades start from 'F' and go all the way up to 'A+.' The grading policy works in the following way-

Table 2. Range of the possible grades

Marks	90-100	85-89	80-84	75-79	70-74	65-69	60-64	50-59	0-49
Grades	A+	A	B+	B	C+	C	D+	D	F

4. Analysis and Discussions

In this section, the data of the four programming courses are analysed and several graphs are illustrated. This section analyses all participating factors that influence students' academic grades throughout the mid and final terms such as their attendance, performance, quiz, viva, projects and so on. To get a clearer picture of the overall scenario, we have converted the marks of all the factors into 100%.

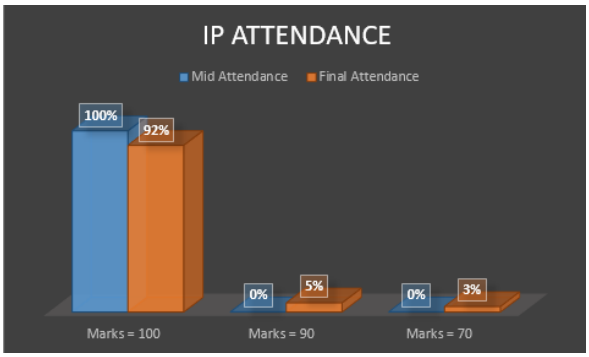

Fig. 1. Attendance for mid & final of Introduction to Programming (IP)

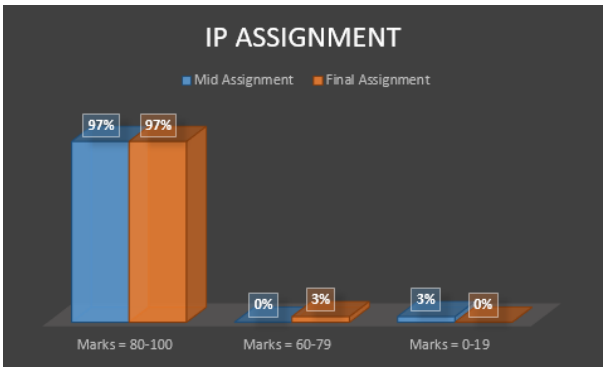

Fig. 2. Assignment for mid & final of Introduction to Programming (IP)

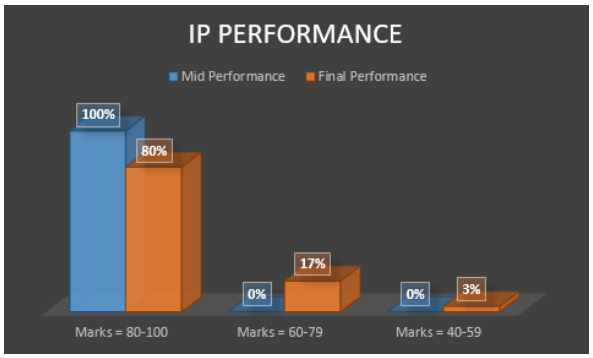

Fig. 3. Performance for mid & final of Introduction to Programming (IP)

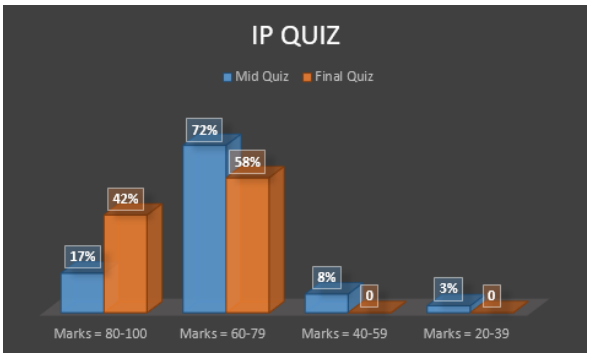

Fig. 4. Quiz for mid & final of Introduction to Programming (IP)

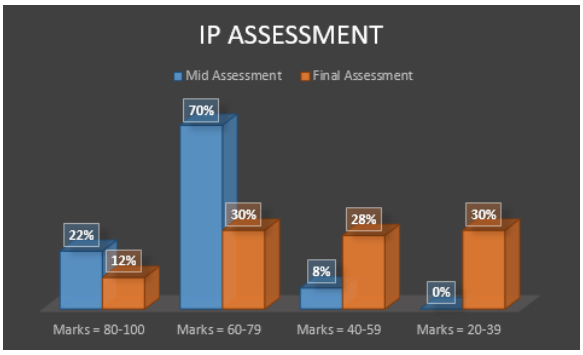

Fig. 5. Assessment for mid & final of Introduction to Programming (IP)

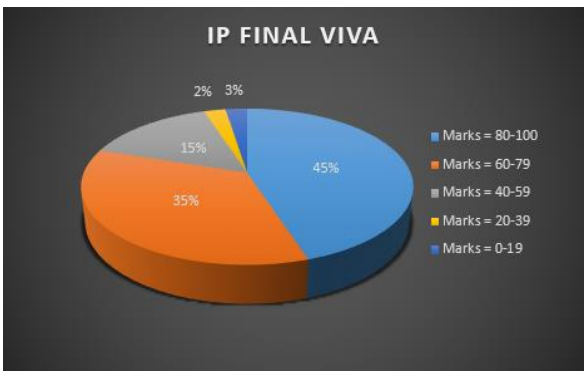

Fig. 6. Viva for final of Introduction to Programming (IP)

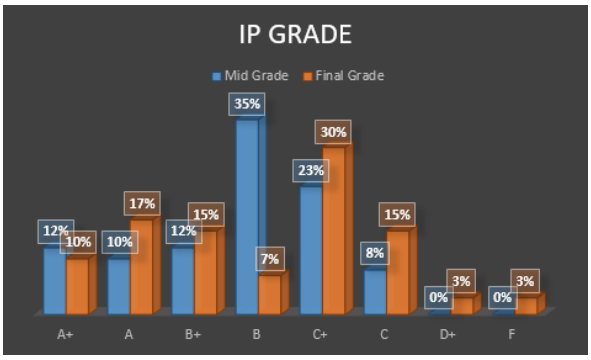

Fig. 7. Grade for mid & final of Introduction to Programming (IP)

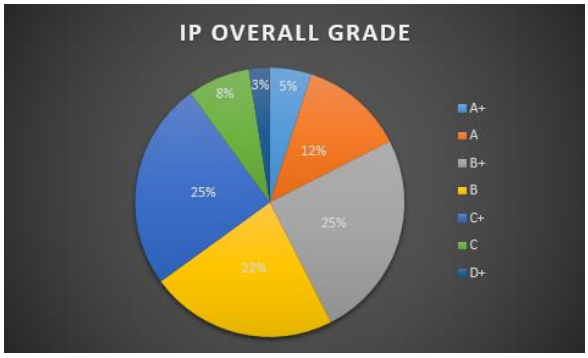

Fig. 8. Overall grade of Introduction to Programming (IP)

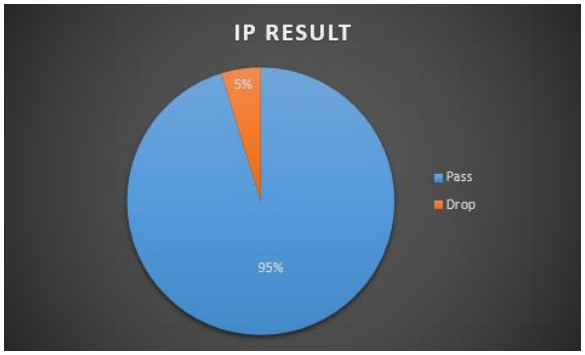

Fig. 9. Pass, fail & drop ratio of Introduction to Programming (IP)

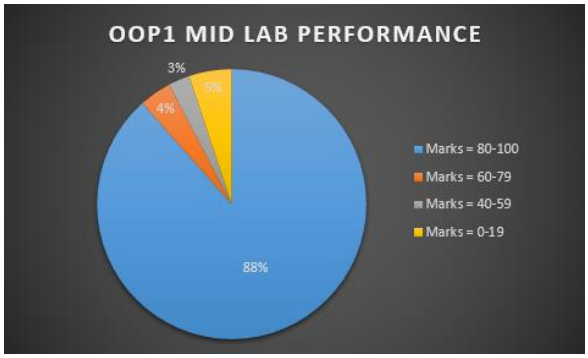

Fig. 10. Lab performance for mid of Object-Oriented Programming 1 (OOP1)

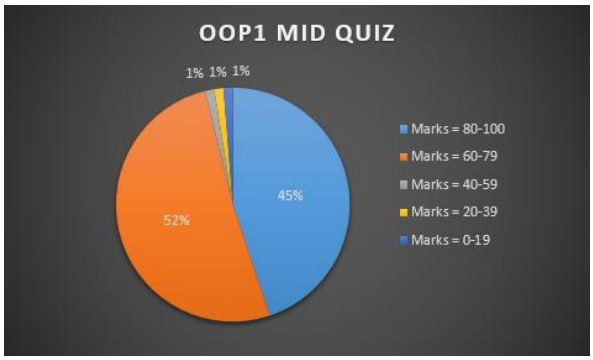

Fig. 11. Quiz for mid of Object Oriented Programming 1 (OOP1)

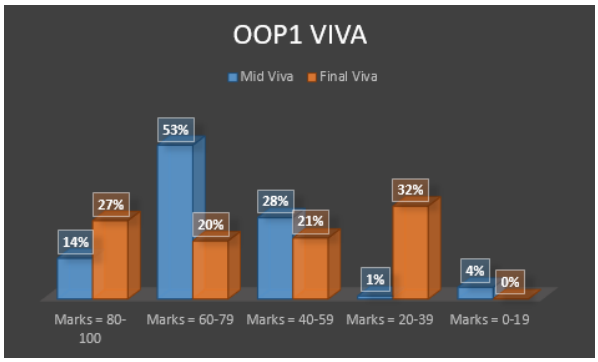

Fig. 12. Viva for mid & final of Object-Oriented Programming 1 (OOP1)

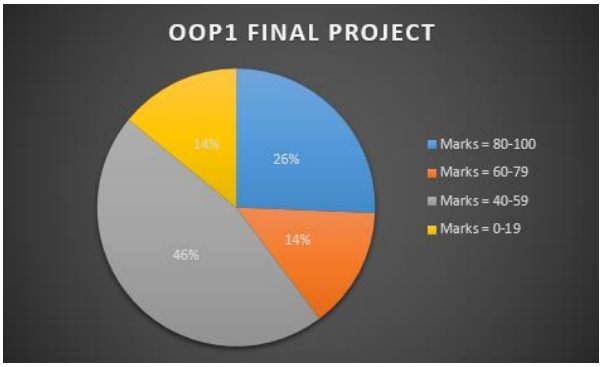

Fig. 13. Project for final of Object-Oriented Programming 1 (OOP1)

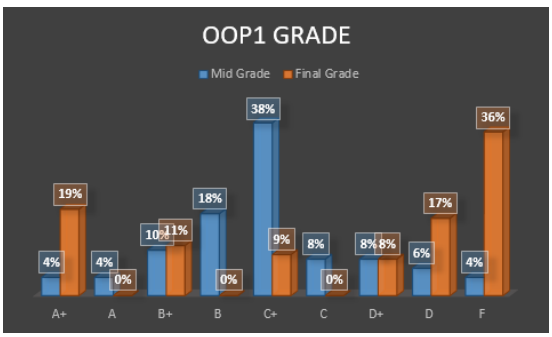

Fig. 14. Grade for mid & final of Object-Oriented Programming 1 (OOP1)

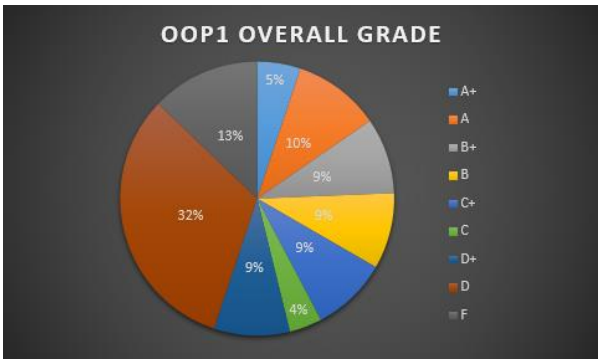

Fig. 15. Overall grade of Object-Oriented Programming 1 (OOP1)

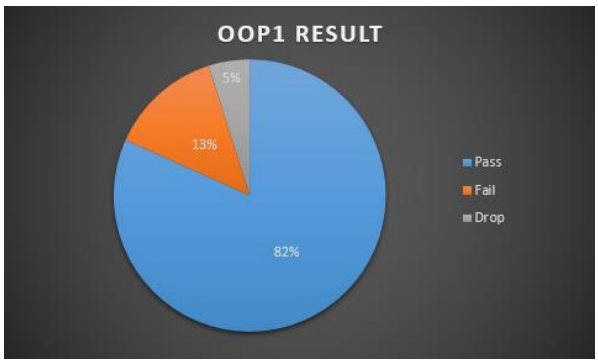

Fig. 16. Pass, fail & drop ratio of Object-Oriented Programming 1 (OOP1)

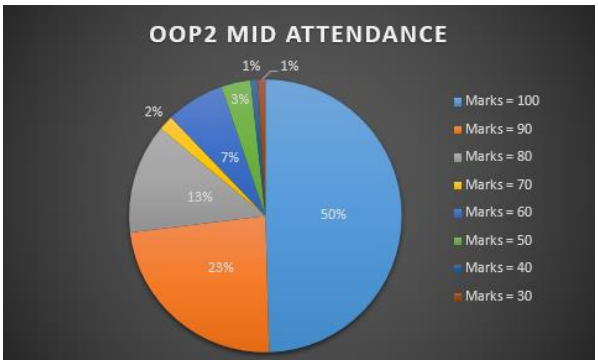

Fig. 17. Attendance for mid of Object-Oriented Programming 2 (OOP2)

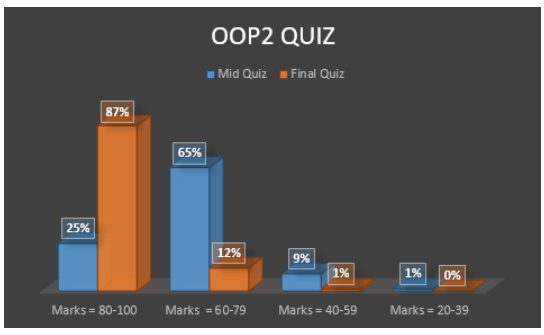

Fig. 18. Quiz for mid & final of Object-Oriented Programming 2 (OOP2)

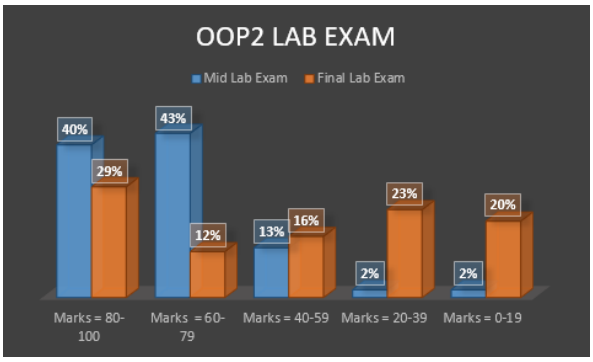

Fig. 19. Lab exam for mid & final of Object-Oriented Programming 2 (OOP2)

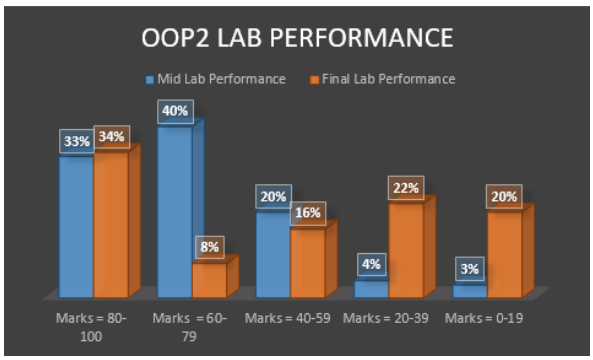

Fig. 20. Lab performance for mid & final of Object-Oriented Programming 2 (OOP2)

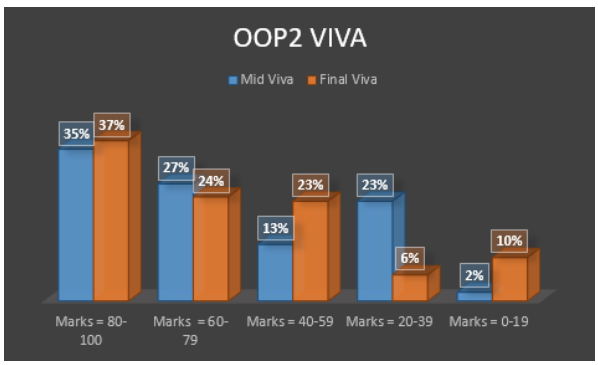

Fig. 21. Viva for mid & final of Object Oriented Programming 2 (OOP2)

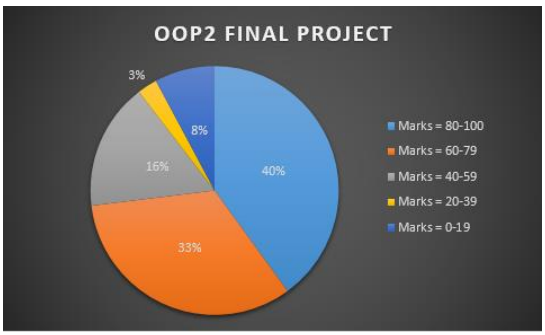

Fig. 22. Project for final of Object-Oriented Programming 2 (OOP2)

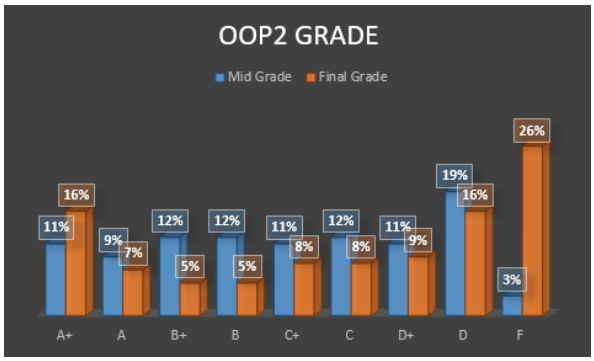

Fig. 23. Grade for mid & final of Object Oriented Programming 2 (OOP2)

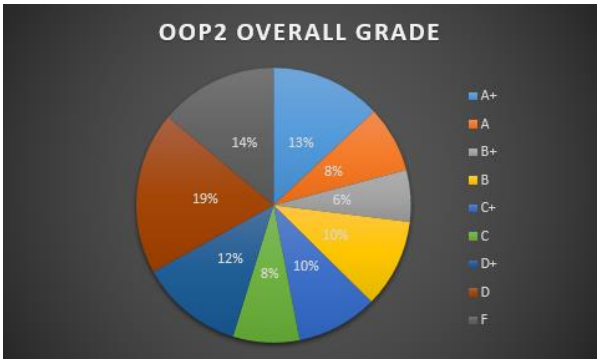

Fig. 24. Overall grade of Object Oriented Programming 2 (OOP2)

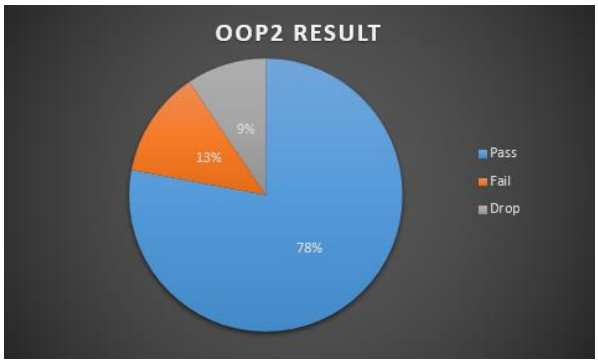

Fig. 25. Pass, fail & drop ratio of Object-Oriented Programming 2 (OOP2)

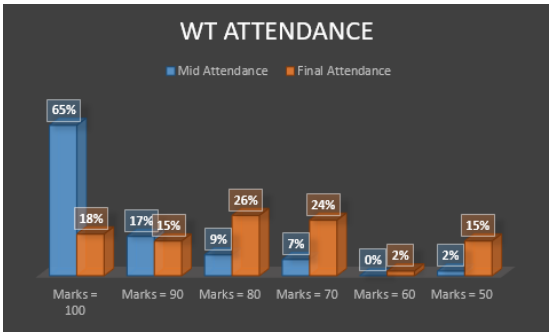

Fig. 26. Attendance for mid & final of Web Technologies (WT)

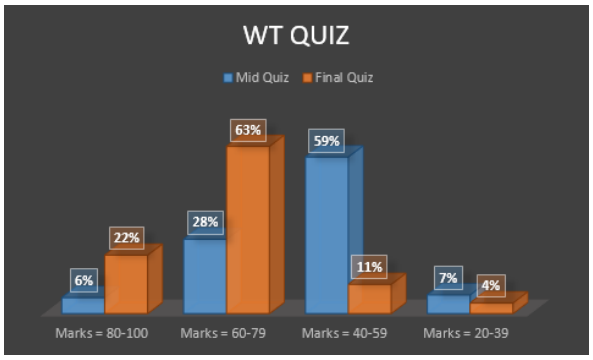

Fig. 27. Quiz for mid & final of Web Technologies (WT)

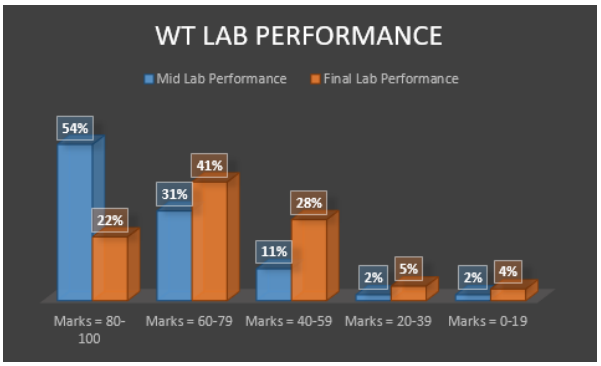

Fig. 28. Lab performance for mid & final of Web Technologies (WT)

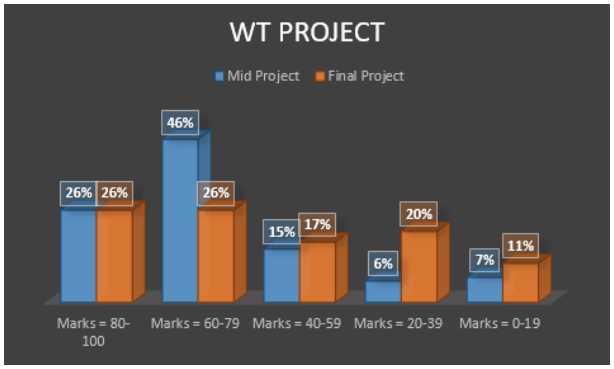

Fig. 29. Project for mid & final of Web Technologies (WT)

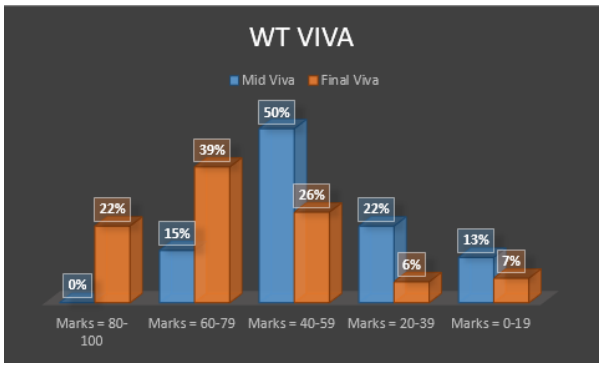

Fig. 30. Viva for mid & final of Web Technologies (WT)

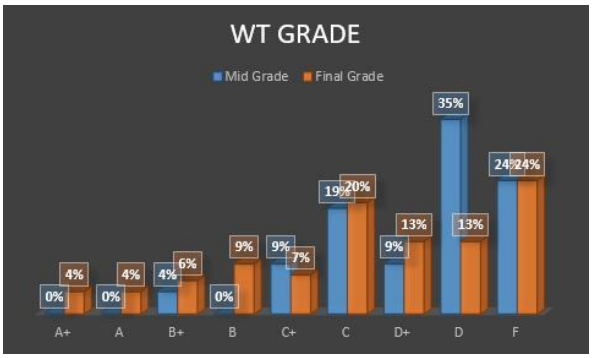

Fig. 31. Grade for mid & final of Web Technologies (WT)

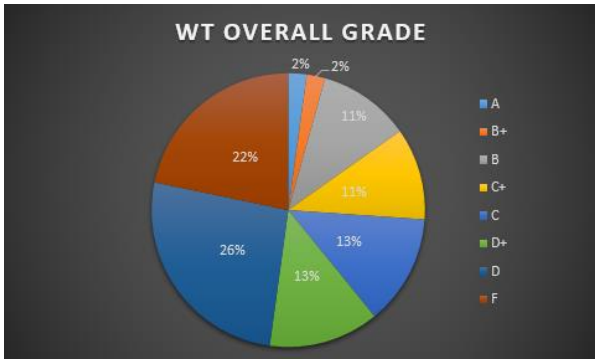

Fig. 32. Overall grade of Web Technologies (WT)

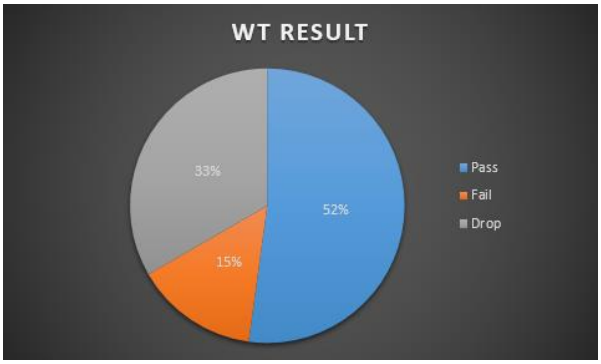

Fig. 33. Pass, fail & drop ratio of Web Technologies (WT)

Nowadays, due to the worldwide pandemic, educational institutions are compelled to move their whole operations online. The viability of online courses is being questioned now. The purpose of this study is to ascertain the answer to this question. The data for four consecutive years of the Computer Science department's four programming courses (Introduction to Programming, Object Oriented Programming 1, Object Oriented Programming 2, and Web Technologies) are analyzed in this study. Students' performances rate in mid tern and final term of Introduction to Programming course are showed from fig 1 to fig 9. Fig 10 to 16, fig 17 to 25 and fig 26 to 33 presented the performance rate of Object-Oriented Programming 1, Object Oriented Programming 2, and Web Technologies respectively.

The results of the experiments with these courses show that a variety of factors affect students' online performance. Due to the online form of the courses, students may simply join the courses remotely. They were not confronted with the barriers that students often encounter while attending courses on-campus, which may explain the high rate of students' 'Attendance', 'Performance' and 'Lab Performance' in online classes (fig: 1, 3, 10, 17, 20, 26, 28). When it comes to the 'Quiz', setting foot on a new online platform has a noticeable effect on students' efforts. Therefore, students obtained good marks in the 'Quiz' and 'Lab Exam' in Introduction to Programming (IP), Object Oriented Programming 1 (OOP1), and Object-Oriented Programming 2 (OOP2). Students learn one language in each course so the course instructor provides apposite basics on those languages so that students do not stumble with these programming languages no matter what 'Quiz' or 'Lab Exam' they sit for (fig: 4, 11, 18, 19), whereas the opposite can be observed in Web Technologies (WT).

Several students from Web Technologies (WT) were unable to get adequate scores in the 'Quiz' since they were new to the online platform, having completed their first three programming courses on campus. Moreover, several languages are taught in this course altogether which might be difficult for some students to be proficient in Web Technologies. This can be a reason behind their poor marks in the 'Quiz' (fig: 27). Some students used internet resources to get a better understanding of the topics. That is why their 'Assignment' and 'Assessment' were graded accordingly (fig: 2, 5). As students are expected to spend a substantial portion of their day in front of a computer to attend their virtual courses, this may be exhausting. Additionally, the mental strain caused by Covid-19 influences students' effort during assessments.

In Introduction to Programming (IP), students are taught some basics of programming where most of them have some previous knowledge on the topics, which makes it easier for them to understand the topics. That is why they achieved good marks in the 'Viva' (fig: 6). In Object Oriented Programming-1 (OOP1), the students did well in their 'Mid Viva' because they had some previous knowledge of the topics from Introduction to Programming (fig: 12). However, in the final term, they had to submit a 'Project' based on the knowledge gained by them throughout the semester. As the course was conducted online, they might have some lacking which they could not sort out due to lack of communication between the groupmates and the course instructor. As it is the first 'Project' of their Undergraduate life, some of the students could not perform up to the mark in the 'Project', which also affected their 'Viva' as it is based on the 'Project' they submitted (fig: 12, 13). In Object Oriented Programming-2 (OOP2), the students obtained good grades in the 'Project' and 'Viva' as they had sound experience with the 'Projects' from previous courses (fig: 21, 22). In Web Technologies (WT), the students scored average in the 'Project', and 'Viva' because, in this course, they had to submit two different projects in both mid and final terms, and they had to deal with multiple languages (fig: 29, 30). Some of the students dropped the course because it was exhausting to deal with multiple languages and two projects in a course (fig: 33). Moreover, the electricity and

network problem cannot be overlooked as a substantial portion of the students is disrupted by these issues during their 'Viva' and 'Project' defense. Therefore, in overall grade, the freshmen students performed significantly better than the seniors did (fig: 8, 15, 24, 32).

5. CONCLUSIONS

COVID-19 affected education communities throughout the world. It compelled the conventional mode of education to shutter its doors, and it would have remained closed had online education not been established. The core objective of this research is to figure out the key factors responsible for students' performance in online classes. A set of data representing students enrolled in four programming courses as part of X University's Bachelor's degree in Computer Science and Engineering was gathered. These four courses have been selected to illustrate the progression of a set of students from year one to year four. This information was obtained from students enrolled in Introduction to Programming (IP), Object Oriented Programming 1 (OOP1), Object Oriented Programming 2 (OOP2), and Web Technologies (WT) classes. An analysis and comparison were concluded within the four mentioned courses with the help of charts. This research helped us to gather information about the different factors that students are stumbling upon in four particularly major courses individually. Freshmen students who are enrolled in Introduction to Programming outperformed senior's students who are enrolled in Object Oriented Programming 1 (OOP1) or Object-Oriented Programming 2 (OOP2) or Web Technologies (WT) classes by a considerable margin. It provides us an overview of the factors that influence students' academic performance. According to our findings, the overall performance of students was adequate in online classes. Therefore, this research will also be beneficial in the future if any situation arises to shift the classes back to online or vice-versa. As mentioned earlier, this paper is the first part of a large study. In the second and third parts, we undertake an in-depth analysis of students' online performance and conducted a brief comparison of students' online and on-campus performance.

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