USING STATISTICAL TESTS TO EVALUATE STUDENT PERFORMANCE FROM AN ONLINE INTERACTIVE TOOL (ZyBooks)

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1. INTRODUCTION:

Now a days, many universities are taking advantage of using online interactive textbooks to improve their level of teaching and help the students to understand the concept into depth. Online interactive textbooks are providing the students with the reading materials and its related programming assignments that the students must finish within the due time. These tools provide an advantage to the instructor who teaches the course can download each student activity report to monitor the student performance. This report incorporates about date and time of each student like, when did the student started the assignment and when did they finished that assignment. These reports can be helpful to determine whether each student had the tendency to complete the assignments on time. In this project, a first-year programming course named Computer Science I which uses an online interactive textbook to assign the students with the three types of activities. First one is the participation activities, that has to be completed by the students before the material was presented in the class. Next one is the challenge activities, that has to be done after the material was presented in the class. Third one is the programming assignments, where a student must use their knowledge in the material to code and execute the output. Each student has to finish these activities to get the grade that will be added to the final grade.

1.1 Motivation:

Our goal in this project is to evaluate the student performance by looking into the relationship between the online interactive tools and the management of time to start and finish the assignments. Performing the statistical tests like F-test, T-test and paired T-test for two sample variances can help us to find the significant difference between the two categories of students and evaluate their performance for the other grade categories.

1.2 Problem Statement:

In this work, primary analysis was done based on the completion of the reading assignments. Reading assignments are the one that has to be finished by the students before that particular material was presented in the class. Data for the reading assignments was collected from the official ZyBooks website. Next is the length of the time taken by each student to complete the reading assignment. This category was based on the amount of time taken by each student to finish each reading assignment and then calculated the average time taken for each student to perform the tests. Later, the analysis was made based on the starting time of the challenge activities and then lab assignments which has to be finished by the students after the material was explained in the class. These two categories were analyzed to evaluate the student performance. From the results, we found that there is a statistically significant difference between the students who performed the reading assignments early and this happened because the reading assignments are finished before the material was explained in the class and students got better knowledge by reading the material before class and thus given a significant difference.
Paired T-test for paired samples is applied on the students to check for any behavior change before corona virus and after corona virus. Results show that there is a significant difference in the attendance and the midterm exams showing that the students paid less attention towards the online classes and thus performed worse in the midterm exams.

This report includes: (i) Related work that discusses about the previous research that was made to evaluate the student performance with online interactive books and explaining about the statistical tests are represented in Section 2. (ii) Collection of data from students and ZyBooks are represented

in Section 3. (iii) List of course components that were analyzed are described in Section 4. (iv) Explanation about the list of statistical tests (methodology) that were performed are represented in Section 5. (v) Description about the experimentation and the results for all the grade categories are represented in Section 6. (vi) Overall discussion about the results acquired from Section 6 are represented in Section 7, which is followed by (vii) Section 8 with conclusion and future work. Appendix contains the list of tables of student grades and statistical results.

2. RELATED WORK:

There had been a lot of research made in evaluating the student performance with the time management through online interactive books. Alshammari et al. [1] performed the statistical tests on the student data for two computer science courses which uses ZyBooks, an online interactive tool and found the significant difference between the student groups. Schneider et al. [2] made a student performance evaluation on Java course, that uses zynante.com an online interactive tool for three years. Results show that there is no improvement in the student performance, but there is a significant difference in the student data. Skalka et al. [3] performed the analysis on the student data that was collected for three years in an introductory programming course and found the significant difference in the student performance through automated assessment source code tool. Adkins et al. [4] performed statistical tests on the student's final course grade and found that there is a significant difference in using the online interactive tools and thus improved the student's overall course grade. Entenzari et al. [5] made a brief analysis on the student overall data and concluded that there is a significant difference in the students who completed their assignments one or two days before the due date performed better than the students who finished their assignments before 24 hours to the due date. Benotti et al. [6] analyzed the student perceptions in two universities by introducing a new online interactive tool and found that there is a significant difference in the dropout rate is much lower in the course that uses an interactive tool to learn.

All the previous research that has been made was trying to prove that there will be an improvement in the student performance by taking the advantage of online interactive tools that can help the students to read the material to understand the concept and complete online programming assignments. In this work, ZyBooks is an online interactive tool with reading material and programming exercises. Student performance was evaluated based on the management of time to start and finish the activities by applying statistical tests, which will be discussed in the upcoming sections.

3. DATA COLLECTION:

In this project, the data was collected from 43 students who registered for an introductory programming course named as Computer Science I that teaches Java Programming to the students. This course also uses an online interactive tool named as ZyBooks [13], which consists of three types of activities. One is the participation activities which is a reading material that must be studied and finished by the students before the material was presented in the class. Next one is the challenge activities, which includes programming quizzes and other activities. Third one is the lab assignments which are programming assignments that the student must write their own source code to get the output and submit. One advantage with the ZyBooks is that it records that start date, start time and end date, end time for each activity of each student. Based on that, each student start date, time and end date, time for each participation, challenge activity and lab assignments

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are recorded. First two activities were ignored because, the students had little issues with getting the textbook and completely registering for the course.

4. COURSE COMPONENTS:
In this project, a single programming course is considered, which is titled as CS 172 Computer Science I programming course that helps the students to learn about java programming. This course uses the online interactive tool called ZyBooks to provide reading material with quizzes and programming assignments. There are other course components that take part in giving a final grade to a student. First one is the participation activity assignment which is a reading material with few quizzes that also displays the answers when the student gives incorrect answer. These activities must be finished before the reading material was presented in the class. This grade category contains 7 percent of the overall grade in the course. Next one is the challenge activities, that consists of quizzes, which was to be completed by the students after the material was presented in the class. This grade category contains 8 percent of the overall grade in the course. Attendance by carries 2 percent of the overall grade. It is each student percentage of attending classes throughout the semester.

Next one is the lab assignments which are taken as the programming assignments that has to be finished within the due date after the material was explained. This grade category contains 35 percent of the overall grade in the course. Midterm 1 carries 12 percent and Midterm 2 carries 12 percent of the overall grade. These are the examinations that were conducted on before mid-semester syllabus and after mid-semester syllabus. Then comes the final exam where the student must prepare for entire syllabus and give the exam. This grade category contains 16 percent of the overall grade in the course. Students who did not gave the final exam were considered as they did not finish the course completely and the data of those students was ignored. Finally, each grade category was tested in this project to check for significant difference between two associated groups.

5. METHODOLOGY:

5.1 List of Statistical Tests Performed:
A hypothesis is a proposed explanation for a phenomenon [12]. There are two types of hypothesis available. One is the null hypothesis and the other one is the alternate hypothesis. A null hypothesis is a general statement or a default position that there is no association among groups or no relation between two measured phenomena [12]. It is a type of hypothesis that is mostly used in statistics determines that there is no proper significance between the observations measured. On the other hand, alternate hypothesis is quite opposite to null hypothesis which implies that there is a relation between the two measured phenomena. While performing the statistical tests, it is important to have null hypothesis and alternate hypothesis. Rejecting the null hypothesis plays an important role in finding the significant difference between two associated groups. Always the null hypothesis was assumed to be true initially.

Statistical significance is determined by using the alpha value or the significance level which is usually taken as 0.05. The significance level can range between 0 to 1 and an alpha value of 0.05 is most commonly used as it provides 95 percent of accuracy to find the significance. Once the alpha value was set, statistical tests can be applied. P-value is defined as the probability of rejecting the null hypothesis especially when the null hypothesis is considered as true. The p-value is the probability value that plays a major role in determining whether the two associated groups are

significantly differ or not. In order to check for the significant difference between the two groups, the p-value must be less than or equal to the given alpha value. If not, the null hypothesis will be accepted, and the output will be considered to as statistically insignificant result.

In statistical tests, there are two types of hypothesis tests. First one is the one-tailed test and second one is the two-tailed test [10, 14, 15]. One-tailed test provides the result that is associated with only one direction which means to check whether there is a significant difference between the two groups in a specific direction. For example, determining whether group A has performed better than group b. While the two-tailed test is a non-directional hypothesis test that determines whether there is a difference between the two groups in either the direction. For example, determining whether group A has performed better or worse than group B [14]. In this project, we consider two-tailed test to check whether there exists any significant difference between two measured populations. Once the alpha value is set, F-test for two sample variances will be applied to check for the violation of homogeneity. If the p-value of the F-test is less than the alpha value, the T-test Two-Sample Assuming Unequal Variances test will be applied. If the p-value of the F-test is greater than the alpha value, the T-test Two-Sample Assuming Equal Variances test will be applied. Either of the T-test will be applied to check for the statistically significant result between the two groups. Paired T-test for two sample means is applied to the same set of students to check their behavior before and after COVID-19.

5.2 F-test Two-Sample Variances:

F-test is a statistical test that has an F-distribution under null hypothesis [12]. F-test is used to check for the violation of homogeneity. When the variances of the two populations are considered to be equal, then it is defined as the homogeneity of variances. F-test has F-statistic that is mainly used to check whether the variances of the two populations are same or not. This can be determined by using the p-value in the F-test. If the p-value is less than the given alpha value, then the variances of the two populations are not equal and violating the homogeneity of variances, thus we apply T-test Two-Sample Unequal Variances test to check for the significant difference. If not, which means if the p-value is greater than the given alpha value, then the variances of the two populations are equal and not violating the homogeneity of variances, thus we apply T-test Two-Sample Equal Variances test to check for the significant difference. The in-depth knowledge about F-test is explained in [7, 9, 11].

5.3 T-test: Two Independent Samples:

The independent sample T-test is used to determine whether the means of the two associated groups that were being tested were equal or not. This test mainly helps in providing the evidence to show that the two tested groups were statistically significant or not. In this test, there are three categories. First one is the T-test for unequal variances, second one is the T-test for equal variances and finally, the third one is the T-test for paired samples. In T-test, the results can be paired or unpaired. If unpaired, then T-test for equal or unequal variances will be applied. If paired, then paired sample T-test will be applied. In this project, both the paired and unpaired samples were considered, and tests were applied accordingly.

Paired sample T-test does not require to check for the violation of homogeneity as the same set of data being tested as before data with after data. Coming to the application of T-test for equal or unequal variances depends on the violation of homogeneity which is described in the previous subsection. If the p-value is less than the given alpha value, then the variances of the two populations are not equal and occurs violating the homogeneity of variances, thus we apply T-test

Two-Sample Unequal Variances test to check for the significant difference. If not, which means if the p-value is greater than the given alpha value, then the variances of the two populations are equal and does not violate the homogeneity of variances, thus we apply T-test Two-Sample Equal Variances test to check for the significant difference. The in-depth knowledge about T-test for equal and unequal variances and paired samples are explained in [8, 9, 11, 15].

5.4 Tools Used: Microsoft Excel

The F-test for two sample variances, the T-test for equal, unequal and paired sample tests are preinstalled in the Microsoft Excel. These tests are included in a toolbar named Data Analysis in the Excel. Once the variable ranges and the alpha values are given, it automatically performs the F-test and T-test and generated the results. The output window for each test is described in the following tables.

5.4.1 F-Test for Two Sample Variances:

	Variable 1	Variable 2
Mean	84.8708	76.40166667
Variance	70.20509933	166.4687088
Observations	25	18
df	24	17
F	0.421731506	
P(F<=f) one-tail	0.025842799	
F Critical one-tail	0.483025528	

Table 1: Sample F-test Output Window

The list of parameters in the F-test are described as follows:

Variable 1: Variable 1 includes the values of the first category of students.

Variable 2: Variable 2 includes the values of the second category of students.

Mean: The average value of each variable is calculated and placed in their corresponding variables. Average for first category is 84.8708, second category is 74.40166667.

Variance: It is defined as the average of the squares of the difference between the observed value and expected value [12]. Variance for first category is 70.20509933 and second category is 166.4687088.

Observations: It is the number of numerical values that are included in each category. First category has 25 observations and second category has 18 observations.

Df (Degree of Freedom): Degree of freedom is defined as the number of values that are free to vary. In this case, df is n-1 (no. of observations – 1).

F-value: It is a value that is calculated from the variances. Ratio of the first variable variance to the second variable variance.

P-value: It is the probability value to reject the null hypothesis. If the p-value is less than alpha value, then null hypothesis will be rejected. If not, null hypothesis will be accepted. In this case, p value is 0.02584 which is less than 0.05.

F-critical: F-critical value is calculated by using the degree of freedom, p-value and F-value. This parameter helps to check if p<=0.05 or not. If F<F then p-value is greater than 0.05. If not, p<=0.05.

5.4.2 t-Test: Two-Sample Assuming Unequal Variances:

	Variable 1	Variable 2
Mean	98.302	87.16944444
Variance	13.968875	410.6689232

Observations	25	18
Hypothesized Mean Difference	0	
df	18	
t Stat	2.302667244	
P(T<=t) one-tail	0.016723534	
t Critical one-tail	1.734063607	
P(T<=t) two-tail	0.033447067	
t Critical two-tail	2.10092204	

Table 2: Sample T-test Output Window for Unequal Variances

The list of parameters in the T-test for unequal variances are described as follows:

Variable 1: Variable 1 includes the values of the first category of students.

Variable 2: Variable 2 includes the values of the second category of students.

Mean: The average value of each variable is calculated and placed in their corresponding variables. Average for first category is 98.302, second category is 87.16944444.

Variance: It is defined as the average of the squares of the difference between the observed value and expected value [12]. Variance for first category is 13.968875 and second category is 410.6689232.

Observations: It is the number of numerical values that are included in each category. First category has 25 observations and second category has 18 observations.

Hypothesized Mean Difference: The value of this parameter is assumed to be 0 when the means of the two populations are equal.

Df (Degree of Freedom): Degree of freedom is defined as the number of values that are free to vary. In this scenario, value for df is 18.

T Stat: The t stat is a statistic value that is calculated based on extreme level of a statistical estimate. T stat helps in determining the significant difference between the two associated groups.

P(T<=t) one-tail: This is a probability value for one direction to reject the null hypothesis. Here, p-value is 0.016 which is less than 0.05. Thus, the result in one direction is found to be significant.

T-Critical one-tail: The critical value for the T-test is calculated based on the chosen alpha value and degree of freedom. It is similar to F-critical and if T<T, then p-value>0.05 and null hypothesis becomes true.

P(T<=t) two-tail: This is a probability value for either the direction to reject the null hypothesis. Here, p-value is double the p-value of one-tail, but still less than 0.05. Thus, the result is found to be significant.

T-Critical two-tail: The critical value for the T-test is calculated based on the chosen alpha value and degree of freedom. It is similar to F-critical and if T<T, then p-value>0.05 and null hypothesis becomes true.

5.4.3 t-Test: Two-Sample Assuming Equal Variances:

	Variable 1	*Variable 2*
Mean	74.36	65.61111111
Variance	272.49	487.0751634
Observations	25	18
Pooled Variance	361.464336	
Hypothesized Mean Difference	0	

df	41	
t Stat	1.488648634	
P(T<=t) one-tail	0.072116032	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.144232065	
t Critical two-tail	2.01954097	

Table 3: Sample T-test Output Window for Equal Variances

The list of parameters in the T-test for unequal variances are described as follows:

Variable 1: Variable 1 includes the values of the first category of students.

Variable 2: Variable 2 includes the values of the second category of students.

Mean: The average value of each variable is calculated and placed in their corresponding variables. Average for first category is 272.49, second category is 65.61111111.

Variance: It is defined as the average of the squares of the difference between the observed value and expected value [12]. Variance for first category is 13.968875 and second category is 487.0751634.

Observations: It is the number of numerical values that are included in each category. First category has 25 observations and second category has 18 observations.

Pooled Variance: pooled variance is a method for estimating variance of several different populations when the mean of each population may be different, but one may assume that the variance of each population is the same [12].

Hypothesized Mean Difference: The value of this parameter is assumed to be 0 when the means of the two populations are equal.

Df (Degree of Freedom): Degree of freedom is defined as the number of values that are free to vary. In this scenario, value for df is 41.

T Stat: The t stat is a statistic value that is calculated based on extreme level of a statistical estimate. T stat helps in determining the significant difference between the two associated groups.

P(T<=t) one-tail: This is a probability value for one direction to reject the null hypothesis. Here, p-value is 0.016 which is less than 0.05. Thus, the result in one direction is found to be significant.

T-Critical one-tail: The critical value for the T-test is calculated based on the chosen alpha value and degree of freedom. It is similar to F-critical and if T<T, then p-value>0.05 and null hypothesis becomes true.

P(T<=t) two-tail: This is a probability value for either the direction to reject the null hypothesis. Here, p-value is double the p-value of one-tail, but still less than 0.05. Thus, the result is found to be significant.

T-Critical two-tail: The critical value for the T-test is calculated based on the chosen alpha value and degree of freedom. It is similar to F-critical and if T<T, then p-value>0.05 and null hypothesis becomes true.

5.4.4 t-Test: Paired Two-Sample for Means:

	Variable 1	*Variable 2*
Mean	70.69767442	62.8372093
Variance	371.9302326	238.3181063
Observations	43	43
Pearson Correlation	0.516613975	
Hypothesized Mean Difference	0	
df	42	

t Stat	2.962941106	
P(T<=t) one-tail	0.002500139	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.005000277	
t Critical two-tail	2.018081703	

Table 4: Sample Paired T-test Output Window for Means

The list of parameters in the T-test for unequal variances are described as follows:

Variable 1: Variable 1 includes the values of the first category of students.

Variable 2: Variable 2 includes the values of the second category of students.

Mean: The average value of each variable is calculated and placed in their corresponding variables. Average for first category is 70.69767442, second category is 62.8372093.

Variance: It is defined as the average of the squares of the difference between the observed value and expected value [12]. Variance for first category is 371.9302326 and second category is 238.3181063.

Observations: It is the number of numerical values that are included in each category. First category has 43 observations and second category has 43 observations.

Pearson Correlation: This value is used to find the linear correlation between the two variables that range between -1 to 1 [12].

Hypothesized Mean Difference: The value of this parameter is assumed to be 0 when the means of the two populations are equal.

Df (Degree of Freedom): Degree of freedom is defined as the number of values that are free to vary. In this scenario, value for df is 41.

T Stat: The t stat is a statistic value that is calculated based on extreme level of a statistical estimate. T stat helps in determining the significant difference between the two associated groups.

P(T<=t) one-tail: This is a probability value for one direction to reject the null hypothesis. Here, p-value is 0.016 which is less than 0.05. Thus, the result in one direction is found to be significant.

T-Critical one-tail: The critical value for the T-test is calculated based on the chosen alpha value and degree of freedom. It is similar to F-critical and if T<T, then p-value>0.05 and null hypothesis becomes true.

P(T<=t) two-tail: This is a probability value for either the direction to reject the null hypothesis. Here, p-value is double the p-value of one-tail, but still less than 0.05. Thus, the result is found to be significant.

T-Critical two-tail: The critical value for the T-test is calculated based on the chosen alpha value and degree of freedom. It is similar to F-critical and if T<T, then p-value>0.05 and null hypothesis becomes true.

6. Experimentation & Results:

6.1 Division of Students into Two Categories

6.1.1 Completion of Reading Assignments Early vs. Late:

The first-year programming course is CS 172 Computer Science I, with 43 students in total. The division of the students into two categories was made according to the completion of reading assignments early. Category 1 are the students who finished their reading assignments before 12 hours in advance to the due date and Category 2 are the students who finished their reading assignments within 12 hours to the due date. There are 7 reading assignments in total. Categories

were divided based on the median of the times of students who performed early in each reading assignment. If the same students finished 4 or more assignments before 12 hours to the due date, they were taken as category 1. If students finished less than 4 or students who performed late in every assignment or students who skipped some assignments are placed in the second category. Taking the same categories of students, statistical tests had been applied to all other grade categories to find the statistically significant difference. Primarily, F-test for two sample variances was performed to compare the variances and check to apply the T-test with equal variances or unequal variances based on the probability value of the F-test.

The two categories for performing the statistical tests based on their completion of reading assignments are: Category 1 has 25 students (who finished early) and Category 2 has 18 students (who finished late).

Grade Categories	Significant/Non-Significant
Participation Activities	Significant
Challenge Activities	Non-Significant
Attendance	Non-Significant
Lab Assignments	Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Non-Significant
Overall Grade	Significant

Table 129: Significant Results for all grade categories for participation activities (PA) (finishing early)

From the above table, the students were divided into two groups and the result shows that there is a significant difference in the categories for the students in participation activities, lab assignments and overall grade. In this scenario, two-tailed test was used to determine the significance between two categories. Since the participation activity assignments are to be finished before the material was presented in the class, the students gained a good knowledge in the programming concepts and thus performed good in getting an overall course grade. Brief details about the analysis for two categories of students who finished their reading assignments early are described Appendix–I.

6.1.2 Length of Time Taken to Complete the Reading Assignments:

This section consists of the two categories of students who were divided based on the length of the time taken to complete each reading assignment before the due date. Average length of time was calculated for each student for each assignment and divided the students into two equal categories. Once the average was calculated, students and their scores were sorted according to the average value. If the average value is high, that means those students took more time to finish the assignments than the students who took less time to finish the reading assignments will get less average value. Since, there are odd number of students in the course, first group has 22 students who took less amount of time to finish the reading assignment having less average value, while the second group has 21 students who took more amount of time to finish the reading assignments having high average value. Based on these two categories of students, other grade categories were also tested to see if the length of the time taken does really shows any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check significant difference.

Grade Categories	Significant/Non-Significant

Participation Activities	Non-Significant
Challenge Activities	Non-Significant
Attendance	Non-Significant
Lab Assignments	Non-Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Non-Significant
Overall Grade	Non-Significant

Table 130: Significant Results for all grade categories for length of time taken for PA

Based on the above significance results, it shows that none of the grade categories has shown any statistically significant difference based on the length of the time taken to complete each reading assignment. In this scenario, two-tailed test was used to determine the significance between two categories. This happened because, even though the assignments were asked to finish before the material was explained in class, students did finish their assignments and scored good. This does not really show any effect in the performance improvement. Brief details about the analysis for two categories of students for length of time taken to finish their reading assignments are described Appendix–II.

6.1.3 Starting the Challenge Activities Early vs. Late:

This section consists of two categories of students who started their challenge activity assignments early. Length of time is calculated according to days for each assignment for each student. Average of each student for each assignment is calculated and the students with the higher average value had started much earlier and the students with the low average value had started their assignments late when compared to the first category of students. Once the average was calculated, students and their scores were sorted according to the average value. If the average value is high, that means those students started their challenge activity assignments much earlier than the students who started late will get less average value. As per consideration of two groups, students were divided into two parts based on their average value. There are 21 students who started early and 22 students who started their challenge activity assignments late. Based on these two categories of students, other grade categories were also tested to see if the length of the time taken does really shows any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check for significant difference.

Grade categories	Significant/Non-Significant
Challenge Activities	Significant
Attendance	Non-Significant
Lab Assignments	Non-Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Non-Significant
Overall Grade	Non-Significant

Table 131: Significant Results for all grade categories for starting challenge activity (CA) early

From the above significant results, it shows that there is no significant difference for any of the categories except for the challenge activities itself. In this scenario, two-tailed test was used to determine the significance between two categories. It happened because, these activities are

assigned after the material was presented in the class and students already had a good knowledge about the concepts. Thus, it shows no significant difference between the two categories of students who started their challenge activities early. Brief details about the analysis for two categories of students who started their challenge activities early are described Appendix–III.

6.1.4 Starting the Lab Assignments Early vs. Late:
This section consists of two categories of students who started their lab assignments early. Length of time is calculated according to days for each assignment for each student. Average of each student for each assignment is calculated and sorted based on the average value from higher to lower value. Students with the higher average value had started much earlier and the students with the low average value had started their assignments late when compared to the first category of students. Students are divided into two categories after they got sorted and divided them into two equal parts. There are 22 students who started early and 21 students who started their challenge activity assignments late. Based on these two categories of students, other grade categories were also tested to see if the length of the time taken does really shows any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check for significant difference.

Grade categories	Significant/Non-Significant
Lab Assignments	Non-Significant
Attendance	Non-Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Non-Significant
Overall Grade	Non-Significant

Table 132: Significant Results for all grade categories for starting lab assignments early
From the above significant results, it shows that there is no significant difference for any of the categories. In this scenario, two-tailed test was used to determine the significance between two categories. It happened because, these assignments are given after the material was presented in the class and students already had a good knowledge about the concepts through participation and challenge activities. Thus, it shows no significant difference between the two categories of students who started their lab assignments early. Brief details about the analysis for two categories of students who started their lab assignments early are described Appendix–IV.

6.2 Division of Students into Three Categories

6.2.1 Completion of Reading Assignment Early vs. Late:
Since, there is no statistically significant difference found between the two categories of students mentioned in section 6.1.1, the analysis was made by dividing the students into three categories. First category has 14 students, second category has 15 students and the third category has 14 students. Initially, the students were divided into two groups based on the median of the times of students who performed early in each reading assignment. If the students finished 4 or more assignments before 12 hours to the due date, they were taken as category 1. If students finished less than 4 or students who performed late in every assignment or students who skipped some assignments are placed in the second category. Then, first 14 students are taken from first group are category 1 students and last 14 students are taken from the second group are third category students. First category and third category students were compared to check for the statistically

significant difference. Based on these categories of students, other grade categories were also tested to see if the first and last group of students does really show any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check for significant difference.

Grade Categories	Significant/Non-Significant
Participation Activities	Significant
Challenge Activities	Significant
Attendance	Significant
Lab Assignments	Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Significant
Overall Grade	Significant

Table 133: Significant Results for all grade categories for participation activities (PA) finishing early

From the above table, the students were divided into two groups and the result shows that there is a significant difference in the categories for the students in challenge activities, lab assignments, final exam and overall grade. In this scenario, two-tailed test was used to determine the significance between two categories. Since the participation activity assignments are to be finished before the material was presented in the class, the students gained a good knowledge in the programming concepts and thus performed good in getting an overall course grade. Brief details about the analysis for category 1 and 3 of students who finished their reading assignments early are described Appendix–V.

6.2.2 Length of Time Taken to Complete the Reading Assignments:

The analysis on the student grades based on the length of the time taken to complete the reading assignments is same as the previous section 6.1.2. But the results show that there is no statistically significant difference between the two categories of students. In this section, the students were divided into three categories based on the sorted average completion of time from lower to higher. Average of all assignments for each student is calculated and sorted from lower to higher average value. First category has 14 students who took very less amount of time having less average value, second category has 15 students having medium average value and the third category has 14 students who took more amount of time having very high average value. First category and third category students were compared to check for the statistically significant difference. Based on these two categories of students, other grade categories were also tested to see if the first and last group of students does really show any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check for significant difference.

Grade Categories	Significant/Non-Significant
Participation Activities	Non-Significant
Challenge Activities	Non-Significant
Attendance	Non-Significant
Lab Assignments	Non-Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Non-Significant

Overall Grade	Non-Significant

Table 134: Significant Results for all grade categories for length of time taken for PA

Based on the above significance results, it shows that none of the grade categories has shown any statistically significant difference based on the length of the time taken to complete each reading assignment. In this scenario, two-tailed test was used to determine the significance between two categories. This happened because, even though the assignments were asked to finish before the material was explained in class, students did finish their assignments and scored good. This does not really show any effect in the performance improvement. Brief details about the analysis for two categories of students for length of time taken to finish their reading assignments are described Appendix–VI.

6.2.3 Starting the Challenge Activities Early vs. Late:

The analysis on the student grades based on the time taken to start the challenge activities early is same as the previous section 6.1.3. But the results show that there is no statistically significant difference between the two categories of students. In this section, the students were divided into three categories based on the sorted average completion of time from higher to lower. Average of all assignments for each student is calculated and sorted from higher to lower average value. First category has 14 students who started their assignments much early, second category has 15 students who started their assignments in medium and the third category has 14 students who started their assignments much late. First category and third category students were compared to check for the statistically significant difference. Based on these two categories of students, other grade categories were also tested to see if the first and last group of students does really show any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check for significant difference.

Grade Categories	Significant/Non-Significant
Challenge Activities	Significant
Attendance	Non-Significant
Lab Assignments	Significant
First Midterm	Non-Significant
Second Midterm	Non-Significant
Final Exam	Non-Significant
Overall Grade	Non-Significant

Table 135: Significant Results for all grade categories for starting challenge activity (CA) early

From the above significant results, it shows that there is no significant difference for any of the categories except for the challenge activities itself. In this scenario, two-tailed test was used to determine the significance between two categories. It happened because, these activities are assigned after the material was presented in the class and students already had a good knowledge about the concepts. Thus, it shows no significant difference between the two categories of students who started their challenge activities much earlier vs. much late. Brief details about the analysis for two categories of students who started their challenge activities early are described Appendix–VII.

6.2.4 Starting the Lab Assignments Early vs. Late:

The analysis on the student grades based on the time taken to start the lab assignments early is same as the previous section 6.1.4. But the results show that there is no statistically significant difference between the two categories of students. In this section, the students were divided into three categories based on the sorted average completion of time from higher to lower. Average of all assignments for each student is calculated and sorted from higher to lower average value. First category has 14 students who started the assignments much early, second category has 15 students who started their assignment in medium time, and the third category has 14 students who started their assignments much late. First category and third category students were compared to check for the statistically significant difference. Based on these two categories of students, other grade categories were also tested to see if the first and last group of students does really show any statistically significant difference. Data analysis was done same as the previous one. First, performing the F-test to check for violation of homogeneity and then perform the T-test to check for significant difference.

Grade categories	Significant/Non-Significant
Lab Assignments	Non-Significant
Attendance	Non-Significant
First Midterm	Non-Significant
Second Midterm	Significant
Final Exam	Significant
Overall Grade	Significant

Table 136: Significant Results for all grade categories for starting lab assignments early

From the above significant results, it shows that there is no significant difference for any of the categories. In this scenario, two-tailed test was used to determine the significance between two categories. It happened because, these assignments are given after the material was presented in the class and students already had a good knowledge about the concepts through participation and challenge activities. Thus, it shows no significant difference between the two categories of students who started their lab assignments early. Brief details about the analysis for two categories of students who started their lab assignments early are described Appendix–VIII.

6.3 Comparing the Average of Student Grades Before vs. After COVID-19:

This section consists of the results of the analysis of total student grades data that was collected before corona virus and after corona virus by using Paired T-Test, which is a statistical test that is used to compare the same categories of data to check statistically significant between the same groups for different variables. Average of each assignment scores before and after corona virus have been calculated. When COVID-19 has occurred, university was shut down and students took online classes to learn the concept by staying at home and complete their assignments. Paired T-Test was performed to check for significant difference before corona virus and after corona virus. In this scenario, two-tailed test was used to determine the significance between two categories. Results for each grade category are shown in the following tables.

Grade categories	Significant/Non-Significant
Participation Activities	Non-Significant
Challenge Activities	Non-Significant
Lab Assignments	Non-Significant
Attendance	Significant
Midterm	Significant

Table 137: Significant Results for all grade categories for before vs. after COVID-19

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Primarily, this test was done to check for the change in the student behavior during corona virus period. Based on the significance results of the paired samples of data, results show that there is a significant difference for attendance and midterm for the same group of students before corona virus and after corona virus period. In this scenario, two-tailed test is used to determine the significant difference between the two groups. This result implies that the students paid less attention towards classes after COVID-19 has started and thus performed worse in the midterm exams, since the second midterm was conducted online. Brief details about the analysis for paired samples of students before and after corona virus are described Appendix–IX.

6.4 Percentage of Students Who are Willing to do the Extra Work for Lab Assignments:
For the lab assignment grade category, assignments are given on only a few problems, but the students have the access to do the other questions to do the additional exercises. For example, if the assignment has a total score of 50 for doing six problems, instead, in the exercise there are extra 2 problems that the student can do the extra work to learn more on the concept. In this section, each lab assignment score for each assignment of each student was tested to see how much percentage of the students are willing to do the additional exercises to earn more knowledge. Lab assignments are considered from third to till end. Initially, number of students who did more than the assigned minimum are calculated, then total number of students who did the assignments are calculated. Finally, the percentage of the students did extra work to the total students was calculated to check the total percentage of students who are willing to do the extra work. Results are shown in the below table.

Lab Assignments	% of Students who did Extra Work
Lab Assignment 3	51.06
Lab Assignment 4	54.34
Lab Assignment 5	26.66
Lab Assignment 6	46.66
Lab Assignment 7	47.72
Lab Assignment 8	29.54

Table 138: Results to check whether students are interested in doing extra work for lab assignments
Based on the above results, it shows that the students are initially interested to do the extra work for lab assignments, later not many students are interested to do the extra work. It means that some of the students are willing to do the extra work, but not more than the students who did not do the extra questions.

7. DISCUSSION:
Based on performing the statistical tests on the student data who completed their reading assignments early does shown the statistically significant difference in overall grade analysis. In this course, students were asked to complete their reading assignments before that particular topic is discussed in class. Thus, students who finished their reading assignments early does read the material more and had a good understanding of the concept than the students who completed their reading assignment late. Students who performed late might not read the material completely and might not had a proper understanding of the concept. The average length of the time taken by the students to complete the reading assignments does not really shown any statistically significant difference as it does not really affect the student performance. While coming to the challenge

activities, there is no statistically significant difference found. This happened because, the students did this assignment after the material was explained in the class and the students already learned the concepts during the reading assignments before class and had a good understanding of the concept.

There is also a good statistically significant difference between the students who started their lab assignments much earlier vs. the students who started much late. Every grade category had shown the difference which implies that starting the lab assignments much earlier helped the students to understand the concept more and performed good in all categories. When paired t-test was performed to check for the student behavior before and after corona virus, there is statistically significant difference in the attendance and midterm grade categories. Even though, online classes were conducted to continue the semester and S/U (Satisfactory/Unsatisfactory) grade option was introduced to not affect the GPA because of COVID-19, the students paid less attention towards the listening to the online classes and thus performed worse in the midterm exams. Finally, these were differences found in the student performance over the entire course schedule throughout the semester. Also, some of the students answered questions for extra work in the lab assignments. In that, during the initial time, most of the students are interested in doing the extra work, later it became less. There are some students who did the extra work for all the lab assignments but not more than the students who did not do the extra questions. Because of the corona virus pandemic, the university course schedule was disturbed by conducting the online classes and online exams. If the results in this work found to be insignificant, does not really mean that it is completely insignificant result, it might also happen because of the changes that occurred due to corona virus. Otherwise, the analysis would have given a different result.

8. CONCLUSION & FUTURE WORK:
Data of 43 students from a first-year computer science programming course was collected to observe the student performance during the entire course period by evaluating their various assignment grades. Three types of statistical tests were performed to see each student performance in a first-year programming course over the entire semester and divide them into groups tow check for significant difference. F-test to compare the statistical models and check for violation of homogeneity and then perform the T-test for two-sample equal and unequal variances to check for the statistically significant difference between the two associated groups. Paired T-test was performed to check for the student behavior before and after COVID-19. There was a good significant difference for the groups who performed their reading assignments early. This happened because the assignment has to be finished before the material was explained in the class. Also, some of the students answered questions for extra work in the lab assignments. In that, during the initial time, most of the students are interested in doing the extra work, later it became less. There are some students who did the extra work for all the lab assignments but not more than the students who did not do the extra questions.
In this work, only one course data was taken to analyze the student performance. Also, because of the corona virus pandemic, the university course schedule was disturbed by conducting the online classes and online exams. If the results in this work found to be insignificant, does not really mean that it is completely insignificant result, it might also happen because of the changes that occurred due to corona virus. Otherwise, the analysis would have given a different result.
For future work, it would be helpful to introduce the online interactive tool like ZyBooks for various programming courses to help the students to understand the concept and apply them in

doing the programming exercises. Perform the similar tests to evaluate the student performance for various courses in the entire semester.

Performing T-test on the overall participation activity grades.

Category1	Category 2
94.96	100
100	70.5
89.93	98.56
97.12	99.28
100	89.93
100	83.45
100	89.93
100	53.24
99.28	94.96
100	100
100	100
100	100
100	92.09
100	94.96
100	95.68
100	94.96
98.56	21.58
92.09	89.93
100	
85.61	
100	
100	
100	
100	
100	

Table 5: Participation activity grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 4.98268E-12 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	98.302	87.16944444
Variance	13.968875	410.6689232
Observations	25	18
Hypothesized Mean Difference	0	
Df	18	
t Stat	2.302667244	
P(T<=t) one-tail	0.016723534	
t Critical one-tail	1.734063607	

P(T<=t) two-tail	0.033447067	
t Critical two-tail	2.10092204	

Table 6: T-test result for the participation activity grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall participation activity grades.

Performing T-test on the student's attendance grades:

Category1	Category2
92	68
28	92
96	100
100	100
100	92
92	100
84	100
100	84
96	84
100	96
92	100
100	100
88	88
100	100
84	84
100	72
16	60
84	84
100	
100	
96	
100	
100	
100	
52	

Table 7: Attendance grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.006847266 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	88	89.11111111
Variance	504	152.1045752
Observations	25	18
Hypothesized Mean Difference	0	

Df	39	
t Stat	-0.207728762	
P(T<=t) one-tail	0.418260857	
t Critical one-tail	1.684875122	
P(T<=t) two-tail	0.836521714	
t Critical two-tail	2.02269092	

Table 8: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on overall student lab assignment grades:

Category1	Category2
96.55	85
96	86.91
83	75.82
100	94.91
93.73	80
90.01	62.55
93.09	93.09
99.09	83.82
90.45	94.82
99.09	98.09
100	97.82
99.55	97.27
95.91	99
100	100
91.09	93.73
99.55	78.91
91.91	58.59
90.91	83.55
96.18	
79.55	
87.82	
97.27	
99.55	
90.45	
97.73	

Table 9: Lab assignment grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.000212993 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*

Mean	94.3392	86.88222222
Variance	30.21922433	149.1046654
Observations	25	18
Hypothesized Mean Difference	0	
df	22	
t Stat	2.4203363	
P(T<=t) one-tail	0.012106007	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.024212014	
t Critical two-tail	2.073873068	

Table 10: T-test result for the lab assignment grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall lab assignment grades.

Performing T-test on student first midterm grades:

Category1	Category2
47	52
91	61
81	74
72	89
77	52
94	70
67	74
73	52
58	87
100	49
43	67
78	83
77	82
75	90
55	88
99	49
91	0
67	62
91	
52	
58	
86	
94	
60	
73	

Table 11: First midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.093794723 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	74.36	65.61111111
Variance	272.49	487.0751634
Observations	25	18
Pooled Variance	361.464336	
Hypothesized Mean Difference	0	
df	41	
t Stat	1.488648634	
P(T<=t) one-tail	0.072116032	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.144232065	
t Critical two-tail	2.01954097	

Table 12: T-test result for the first midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the first midterm grades.

Performing T-test on student second midterm grades:

Category1	Category2
54	43
74	44
60	35
73	76
77	51
71	52
58	67
69	69
58	71
90	73
37	58
65.5	77
81	70
88	65
52	61
97	41
68	65
51	49
47	
36	

39	
81	
83.5	
69	
56	

Table 13: Second midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.149835384 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	65.4	59.27777778
Variance	279.5625	171.0359477
Observations	25	18
Pooled Variance	234.5636856	
Hypothesized Mean Difference	0	
df	41	
t Stat	1.293155437	
P(T<=t) one-tail	0.101598226	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.203196452	
t Critical two-tail	2.01954097	

Table 14: T-test result for the second midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the second midterm grades.

Performing T-test on the student final exam grades:

Category 1	Category 2
56	51
85	54
50	46
84	85
80	42
81	51
69	69
63	72
48	91
91	79
63	64
78	88
83	79
70	73

79	66
98	18
75	51
27	73
72	
39	
60	
68	
92	
60	
54	

Table 15: Final exam grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.343112392 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	69	64
Variance	296.5833333	351.8823529
Observations	25	18
Pooled Variance	319.5121951	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.904895261	
P(T<=t) one-tail	0.185403865	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.37080773	
t Critical two-tail	2.01954097	

Table 16: T-test result for the final exam grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the final exam grades.

Performing T-test on the student overall (total) grades:

Category 1	Category 2
79.22	67.32
83.79	71.55
77.22	66.69
91.64	89.38
88.9	68.72
87.88	64.63
83.16	83.04
86.62	72.1
75.4	88.41
98.04	86.26

79.86	83.51
90.54	92.8
91.31	89.99
91.76	89.66
80.55	83.87
98.81	56.13
87.34	48.08
73.28	73.09
85.69	
62.73	
76.5	
90.57	
96.86	
81.61	
82.49	

Table 17: Overall grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.025842799 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	84.8708	76.40166667
Variance	70.20509933	166.4687088
Observations	25	18
Hypothesized Mean Difference	0	
df	27	
t Stat	2.439096399	
P(T<=t) one-tail	0.010788789	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.021577579	
t Critical two-tail	2.051830516	

Table 18: T-test result for the overall grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall grades.

APPENDIX – II (Section 6.1.2 in Chapter 6)

Performing T-test on student overall participation activities:

Category 1	Category 2
89.93	100.00
100.00	83.45
100	100.00
85.61	94.96

100.00	92.09
100.00	99.28
100.00	89.93
98.56	89.93
100.00	98.56
100.00	100.00
94.96	100.00
100.00	100.00
100.00	100.00
97.12	99.28
53.24	100.00
94.96	100.00
100.00	100.00
100.00	94.96
92.09	89.93
100.00	21.58
95.68	100.00
70.5	

Table 19: Participation activities grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.039299189 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	94.21136364	93.0452381
Variance	131.925879	291.4276162
Observations	22	21
Hypothesized Mean Difference	0	
df	35	
t Stat	0.261577976	
P(T<=t) one-tail	0.397590034	
t Critical one-tail	1.689572458	
P(T<=t) two-tail	0.795180068	
t Critical two-tail	2.030107928	

Table 20: T-test result for the participation activity grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the overall participation activity grades.

Performing T-test on student overall challenge activities:

Category 1	Category 2
31.15	91.8
83.61	54.1

31.15	91.8
26.23	91.8
95.08	93.44
98.36	96.72
95.08	75.41
68.85	68.85
96.72	98.36
100	75.41
45.9	86.69
100	93.44
93.44	85.25
100	80.33
49.18	100
67.21	100
96.72	100
85.25	93.44
98.36	85.25
100	57.38
65.57	65.85
63.93	

Table 21: Challenge activities grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.00426739 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	76.89954545	85.0152381
Variance	658.5129379	194.8604762
Observations	22	21
Hypothesized Mean Difference	0	
df	33	
t Stat	-1.296041752	
P(T<=t) one-tail	0.101976305	
t Critical one-tail	1.692360309	
P(T<=t) two-tail	0.20395261	
t Critical two-tail	2.034515297	

Table 22: T-test result for the challenge activities grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the overall challenge activity grades.

Performing T-test on student attendance grades:

Category 1	Category 2
84	92
92	100

68	96
100	100
96	84
100	96
100	96
100	92
52	16
100	100
72	100
100	84
100	100
100	100
84	100
84	28
88	100
100	92
88	100
100	60
84	84
92	

Table 23: Attendance grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.003848204 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	90.18181818	86.66666667
Variance	164.1558442	555.7333333
Observations	22	21
Hypothesized Mean Difference	0	
df	31	
t Stat	0.603508435	
P(T<=t) one-tail	0.275280642	
t Critical one-tail	1.695518783	
P(T<=t) two-tail	0.550561283	
t Critical two-tail	2.039513446	

Table 24: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on student overall lab assignment grades:

Category 1	Category 2
83.55	100
90.01	62.55

85	98.09
79.55	100
87.82	90.91
90.45	90.45
97.27	83
75.82	80
97.73	91.91
100	97.82
78.91	96.18
99.55	93.09
97.27	93.73
100	94.91
83.82	99.09
94.82	96
95.91	99.55
99.09	96.55
99	93.09
99.55	58.59
93.73	91.09
86.91	

Table 25: Lab assignment grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.049535331 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	91.62545455	90.79047619
Variance	60.85714026	127.8239348
Observations	22	21
Hypothesized Mean Difference	0	
df	35	
t Stat	0.280625954	
P(T<=t) one-tail	0.390324747	
t Critical one-tail	1.689572458	
P(T<=t) two-tail	0.780649493	
t Critical two-tail	2.030107928	

Table 26: T-test result for the lab assignment grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the lab assignment grades.

Performing T-test on student first midterm grades:

Category 1	Category 2
62	43

94	70
52	49
52	90
58	67
60	58
86	81
74	52
73	91
75	67
49	91
99	67
83	77
72	89
52	100
87	91
77	78
73	47
82	74
94	0
88	55
61	

Table 27: First midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.036317424 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	72.86363636	68.42857143
Variance	233.7424242	525.0571429
Observations	22	21
Hypothesized Mean Difference	0	
df	35	
t Stat	0.743032927	
P(T<=t) one-tail	0.231210135	
t Critical one-tail	1.689572458	
P(T<=t) two-tail	0.46242027	
t Critical two-tail	2.030107928	

Table 28: T-test result for the first midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the first midterm grades.

Performing T-test on student second midterm grades:

Category 1	Category 2
49	37

71	52
43	73
36	65
39	51
69	58
81	60
35	51
56	68
88	58
41	47
97	58
77	77
73	76
69	90
71	74
81	65.5
69	54
70	67
83.5	65
61	52
44	

Table 29: Second midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.037881641 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	63.79545455	61.83333333
Variance	333.3014069	148.4333333
Observations	22	21
Hypothesized Mean Difference	0	
df	37	
t Stat	0.416265334	
P(T<=t) one-tail	0.339810341	
t Critical one-tail	1.68709362	
P(T<=t) two-tail	0.679620682	
t Critical two-tail	2.026192463	

Table 30: T-test result for the second midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the second midterm grades.

Performing T-test on the student final exam grades:

Category 1	Category 2

73	63
81	51
51	79
39	73
60	27
60	48
68	50
46	42
54	75
70	64
18	72
98	69
88	80
84	85
72	91
91	85
83	78
63	56
79	69
92	51
66	79
54	

Table 31: Final exam grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.238751462 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	67.72727273	66.04761905
Variance	375.3506494	272.447619
Observations	22	21
Pooled Variance	325.1540492	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.305324688	
P(T<=t) one-tail	0.380831818	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.761663635	
t Critical two-tail	2.01954097	

Table 32: T-test result for the final exam grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the final exam grades.

Performing T-test on Student overall (total) grades:

Category 1	Category 2
73.09	72.1
83.16	83.04
67.32	91.76
62.73	83.87
76.5	56.13
81.61	98.04
90.57	77.22
89.38	86.62
82.49	73.28
83.51	80.55
85.69	87.88
92.8	66.69
89.66	88.9
91.64	68.72
90.54	64.63
91.31	83.79
86.26	88.41
75.4	79.22
89.99	79.86
96.86	48.08
87.34	98.81
71.55	

Table 33: Overall grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.053710582 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	83.60909091	78.93333333
Variance	80.80919913	166.6811733
Observations	22	21
Pooled Variance	122.697967	
Hypothesized Mean Difference	0	
df	41	
t Stat	1.383630296	
P(T<=t) one-tail	0.086979508	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.173959017	
t Critical two-tail	2.01954097	

Table 34: T-test result for the overall grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the overall grades.

Performing T-test on student overall challenge activities grade:

Category 1	Category 2
98.36	93.44
100	96.72
100	83.61
93.44	63.93
95.08	93.44
100	49.18
93.44	91.8
100	91.8
85.25	95.08
100	80.33
65.85	100
65.57	100
96.72	75.41
91.8	26.23
98.36	68.85
85.25	68.85
96.72	31.15
54.1	85.25
31.15	67.21
75.41	45.9
98.36	86.69
	57.38

Table 35: Challenge activities grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.225095883 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	86.89809524	75.10227273
Variance	342.0407062	480.8507517
Observations	21	22
Pooled Variance	413.1385344	
Hypothesized Mean Difference	0	
df	41	
t Stat	1.902248003	
P(T<=t) one-tail	0.032089646	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.064179293	
t Critical two-tail	2.01954097	

Table 36: T-test result for the challenge activities grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall challenge activity grades.

Performing T-test on student attendance grades:

Category 1	Category 2
16	100
28	88
100	92
92	92
96	84
100	84
84	100
100	92
100	100
100	100
84	100
84	100
96	100
96	100
100	92
100	100
52	84
100	100
68	84
96	72
88	100
	60

Table 37: Attendance grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.000228253 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	84.76190476	92
Variance	586.5904762	114.2857143
Observations	21	22
Hypothesized Mean Difference	0	
df	27	
t Stat	-1.257560099	
P(T<=t) one-tail	0.109659799	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.219319598	
t Critical two-tail	2.051830516	

Table 38: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on student overall lab assignment grades:

Category 1	Category 2
91.91	97.27
96	95.91
99.55	90.01
96.55	86.91
87.82	93.09
99.09	83.82
90.91	100
99.55	100
99.09	97.27
99.55	94.91
91.09	100
93.73	100
90.45	97.82
98.09	79.55
90.45	80
93.73	75.82
97.73	83.55
62.55	93.09
85	94.82
83	78.91
99	96.18
	58.59

Table 39: Lab assignment grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.175308205 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	92.61142857	89.88727273
Variance	72.34532286	110.2538113
Observations	21	22
Pooled Variance	91.7618657	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.932153837	
P(T<=t) one-tail	0.178357001	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.356714001	
t Critical two-tail	2.01954097	

Table 40: T-test result for the lab assignment grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the lab assignment grades.

Performing T-test on student first midterm grades:

Category 1	Category 2
91	83
91	77
94	94
47	61
58	67
100	52
67	90
78	43
73	86
99	89
55	75
88	72
58	67
49	52
60	52
77	74
73	62
70	74
52	87
81	49
82	91
	0

Table 41: First midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.131321284 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	73.47619048	68.04545455
Variance	279.0619048	462.9978355
Observations	21	22
Pooled Variance	373.2729912	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.921365958	
P(T<=t) one-tail	0.181124697	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.362249395	
t Critical two-tail	2.01954097	

Table 42: T-test result for the first midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the first midterm grades.

Performing T-test on the second midterm grades:

Category 1	Category 2
68	77
74	81
83.5	71
54	44
39	58
90	69
51	65
65.5	37
69	81
97	76
52	88
61	73
58	58
73	36
69	51
77	35
56	49
52	67
43	71
60	41
70	47
	65

Table 43: Second midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.335669379 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	64.85714286	60.90909091
Variance	216.6035714	262.3722944
Observations	21	22
Pooled Variance	240.0460881	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.835261189	
P(T<=t) one-tail	0.204205869	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.408411738	
t Critical two-tail	2.01954097	

Table 44: T-test result for the second midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the second midterm grades.

Performing T-test for the student final exam grades:

Category 1	Category 2
75	88
85	83
92	81
56	54
60	69
91	72
27	73
78	63
63	68
98	85
79	70
66	84
48	64
79	39
60	42
80	46
54	73
51	69
51	91
50	18
79	72
	51

Table 45: Final exam grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.480957415 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	67.71428571	66.13636364
Variance	321.4142857	328.8852814
Observations	21	22
Pooled Variance	325.2408933	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.286793788	
P(T<=t) one-tail	0.387857303	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.775714607	
t Critical two-tail	2.01954097	

Table 46: T-test result for the final exam grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the final exam grades.

Performing T-test on the overall (Total) grades:

Category 1	Category 2
73.28	89.66
83.79	86.26
96.86	83.16
79.22	71.55
76.5	66.69
64.63	90.54
56.13	83.87
88.41	72.1
75.4	90.57
92.8	68.72
98.81	83.51
87.34	91.64
98.04	80.55
91.76	62.73
81.61	86.62
88.9	89.38
82.49	73.09
83.04	79.86
67.32	91.31
77.22	85.69
89.99	87.88
	48.08

Table 47: Overall grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.48794093 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	82.54952381	80.15727273
Variance	125.9433248	127.8647446
Observations	21	22
Pooled Variance	126.9274666	
Hypothesized Mean Difference	0	
df	41	
t Stat	0.696010376	
P(T<=t) one-tail	0.245174617	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.490349233	
t Critical two-tail	2.01954097	

Table 48: T-test result for the overall grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the total grades.

APPENDIX – IV (Section 6.1.4 in Chapter 6)

Performing T-test on the student lab assignment grades:

Category 1	Category 2
90.45	93.73
93.73	94.82
96.55	62.55
99.55	95.91
96	78.91
91.09	86.91
83	100
90.45	100
75.82	58.59
83.82	90.91
96.18	97.73
97.82	94.91
87.82	97.27
98.09	90.01
99.09	83.55
91.91	100
85	97.27
99.55	93.09
80	93.09
99	99.55
100	99.09
79.55	

Table 49: Lab assignment grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.028736736 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	91.56681818	90.85190476
Variance	56.29019416	132.7191962
Observations	22	21
Hypothesized Mean Difference	0	
df	34	
t Stat	0.239928056	
P(T<=t) one-tail	0.40591335	
t Critical one-tail	1.690924255	

P(T<=t) two-tail	0.8118267	
t Critical two-tail	2.032244509	

Table 50: T-test result for the lab assignment grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the lab assignment grades.

Performing T-test on student attendance grades:

Category 1	Category 2
100	100
16	88
92	100
100	96
28	100
100	92
96	84
100	100
100	60
100	72
92	52
84	92
96	100
100	84
96	84
84	84
68	100
100	100
100	92
88	84
100	100
100	

Table 51: Attendance grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.01106883 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	88.18181818	88.76190476
Variance	524.9177489	183.3904762
Observations	22	21
Hypothesized Mean Difference	0	
df	34	
t Stat	-0.10160899	
P(T<=t) one-tail	0.459831959	
t Critical one-tail	1.690924255	

P(T<=t) two-tail	0.919663919	
t Critical two-tail	2.032244509	

Table 52: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on student first midterm grades:

Category 1	Category 2
100	77
91	77
47	70
94	49
91	91
99	61
81	52
60	67
89	0
78	49
94	73
55	52
58	86
75	67
58	62
67	88
52	90
83	74
73	43
82	87
72	74
52	

Table 53: First midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.155093502 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	75.04545455	66.14285714
Variance	281.474026	442.9285714
Observations	22	21
Pooled Variance	360.2323408	
Hypothesized Mean Difference	0	
df	41	
t Stat	1.537489448	

P(T<=t) one-tail	0.065927988	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.131855976	
t Critical two-tail	2.01954097	

Table 54: T-test result for the first midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the first midterm grades.

Performing T-test on the student second midterm grades:

Category 1	Category 2
90	77
68	81
54	52
83.5	73
74	47
97	44
60	69
69	58
76	65
65.5	41
71	56
52	51
39	81
88	58
58	49
51	61
43	65
77	35
69	37
70	71
73	67
36	

Table 55: Second midterm grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.242088362 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	66.54545455	58.95238095
Variance	263.8549784	192.447619
Observations	22	21
Pooled Variance	229.0221202	
Hypothesized Mean Difference	0	

df	41	
t Stat	1.644620327	
P(T<=t) one-tail	0.053847544	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.107695087	
t Critical two-tail	2.01954097	

Table 56: T-test result for the second midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the second midterm grades.

Performing T-test on the student final exam grades:

Category 1	Category 2
91	80
75	83
56	51
92	79
85	72
98	54
50	72
60	64
85	51
78	18
81	54
79	42
60	68
70	69
48	73
27	66
51	73
88	46
63	63
79	91
84	69
39	

Table 57: Final exam grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.261655315 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	69.95454545	63.71428571
Variance	359.5692641	269.6142857
Observations	22	21
Pooled Variance	315.6887868	

Hypothesized Mean Difference	0	
df	41	
t Stat	1.151224037	
P(T<=t) one-tail	0.128154826	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.256309653	
t Critical two-tail	2.01954097	

Table 58: T-test result for the final exam grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the final exam grades.

Performing T-test on the student overall (total) grades:

Category 1	Category 2
98.04	88.9
87.34	91.31
79.22	64.63
96.86	86.26
83.79	85.69
98.81	71.55
77.22	72.1
81.61	83.51
89.38	48.08
90.54	56.13
87.88	82.49
80.55	68.72
76.5	90.57
91.76	83.16
75.4	73.09
73.28	83.87
67.32	89.66
92.8	66.69
86.62	79.86
89.99	88.41
91.64	83.04
62.73	

Table 59: Overall grades of category 1 and category 2 students

When F-test was performed, the resultant p-value was 0.179410701 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	84.51272727	77.98666667
Variance	94.04717316	141.6466933
Observations	22	21

Pooled Variance	117.2664513	
Hypothesized Mean Difference	0	
df	41	
t Stat	1.97538145	
P(T<=t) one-tail	0.027491365	
t Critical one-tail	1.682878002	
P(T<=t) two-tail	0.054982731	
t Critical two-tail	2.01954097	

Table 60: T-test result for the overall grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the overall grades.

APPENDIX – V (Section 6.2.1 in Chapter 6)

Performing T-test on student participation activity grades:

Category 1	Category 3
100	94.96
100	94.96
100	94.96
100	92.09
100	92.09
100	89.93
100	89.93
100	89.93
100	89.93
100	85.61
100	83.45
100	70.5
100	53.24
100	21.58

Table 61: Participation activity grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	100	81.65428571
Variance	0	429.4204571
Observations	14	14
Hypothesized Mean Difference	0	
df	13	
t Stat	3.312510613	
P(T<=t) one-tail	0.002805517	
t Critical one-tail	1.770933396	
P(T<=t) two-tail	0.005611034	

t Critical two-tail	2.160368656	

Table 62: T-test result for the participation activity grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall participation activity grades.

Performing T-test on student challenge activity grades:

Category 1	Category 3
100	67.21
85.25	91.8
83.61	45.9
93.44	93.44
85.25	98.36
100	75.41
91.8	68.85
100	85.25
96.72	31.15
100	26.23
65.85	54.1
100	63.93
86.69	49.18
95.08	57.38

Table 63: Challenge activity grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.00231215 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	91.69214286	64.87071429
Variance	94.31440275	509.2233456
Observations	14	14
Hypothesized Mean Difference	0	
df	18	
t Stat	4.085015459	
P(T<=t) one-tail	0.000347506	
t Critical one-tail	1.734063607	
P(T<=t) two-tail	0.000695012	
t Critical two-tail	2.10092204	

Table 64: T-test result for the challenge activity grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall challenge activity grades.

Performing T-test on student attendance grades:

Category 1	Category 3
28	84

100	100
92	72
84	84
100	88
100	96
92	92
100	100
88	84
100	100
84	100
100	92
100	84
96	60

Table 65: Attendance grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.046747624 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	90.28571429	88.28571429
Variance	358.6813187	136.5274725
Observations	14	14
Hypothesized Mean Difference	0	
df	22	
t Stat	0.336279072	
P(T<=t) one-tail	0.3699234	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.739846801	
t Critical two-tail	2.073873068	

Table 66: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on the student lab assignment grades:

Category 1	Category 3
96	94.82
93.73	100
90.01	78.91
93.09	90.91
99.09	99
99.09	83
100	80
99.55	93.09
95.91	83.55

100	79.55
91.09	62.55
99.55	86.91
96.18	83.82
87.82	58.59

Table 67: Lab assignment grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.000191817 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	95.79357143	83.90714286
Variance	16.63590165	146.5778527
Observations	14	14
Hypothesized Mean Difference	0	
df	16	
t Stat	3.481264531	
P(T<=t) one-tail	0.001541581	
t Critical one-tail	1.745883676	
P(T<=t) two-tail	0.003083162	
t Critical two-tail	2.119905299	

Table 68: T-test result for the lab assignment grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall lab assignment grades.

Performing T-test on the student first midterm grades:

Category 1	Category 3
91	87
77	90
94	49
67	67
73	82
100	81
43	52
78	74
77	62
75	52
55	70
99	61
91	52
58	0

Table 69: First midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.160765801 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater

than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	77	62.78571429
Variance	293.5384615	516.0274725
Observations	14	14
Pooled Variance	404.782967	
Hypothesized Mean Difference	0	
df	26	
t Stat	1.869230876	
P(T<=t) one-tail	0.036447376	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.072894753	
t Critical two-tail	2.055529439	

Table 70: T-test result for the first midterm grades

The P-value one-tail for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the first midterm grades.

Performing T-test on the student second midterm grades:

Category 1	Category 3
74	71
77	65
71	41
58	51
69	70
90	60
37	51
65.5	67
81	49
88	36
52	52
97	44
47	69
39	65

Table 71: Second midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.047657407 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	67.53571429	56.5
Variance	355.6332418	136.1153846
Observations	14	14
Hypothesized Mean Difference	0	

df	22	
t Stat	1.862056644	
P(T<=t) one-tail	0.03800332	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.076006641	
t Critical two-tail	2.073873068	

Table 72: T-test result for the second midterm grades

The P-value one-tail for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the second midterm grades.

Performing T-test on the student final exam grades:

Category 1	Category 3
85	91
80	73
81	18
69	27
63	79
91	50
63	42
78	69
83	73
70	39
79	51
98	54
72	72
60	51

Table 73: Final exam grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.014951571 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	76.57142857	56.35714286
Variance	121.8021978	431.9395604
Observations	14	14
Hypothesized Mean Difference	0	
df	20	
t Stat	3.214169532	
P(T<=t) one-tail	0.002176539	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.004353078	
t Critical two-tail	2.085963447	

Table 74: T-test result for the final exam grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the final exam grades.

Performing T-test on the student overall (total) grades:

Category 1	Category 3
83.79	88.41
88.9	89.66
87.88	56.13
83.16	73.28
86.62	89.99
98.04	77.22
79.86	68.72
90.54	64.63
91.31	73.09
91.76	62.73
80.55	83.04
98.81	71.55
85.69	72.1
76.5	48.08

Table 75: Overall grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.012565188 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	87.38642857	72.75928571
Variance	42.08916319	155.687161
Observations	14	14
Hypothesized Mean Difference	0	
df	20	
t Stat	3.89167326	
P(T<=t) one-tail	0.000453115	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.00090623	
t Critical two-tail	2.085963447	

Table 76: T-test result for the overall grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall grades.

APPENDIX – VI (Section 6.2.2 in Chapter 6)

Performing T-test on the student participation activity grades:

Category 1	Category 3
89.93	89.93
100.00	98.56

100	100.00
85.61	100.00
100.00	100.00
100.00	100.00
100.00	99.28
98.56	100.00
100.00	100.00
100.00	100.00
94.96	94.96
100.00	89.93
100.00	21.58
97.12	100.00

Table 77: Participation activity grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 1.25E-06 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	97.58428571	92.44571429
Variance	20.19593407	429.3506571
Observations	14	14
Hypothesized Mean Difference	0	
df	14	
t Stat	0.906815764	
P(T<=t) one-tail	0.189923864	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.379847729	
t Critical two-tail	2.144786688	

Table 78: T-test result for the participation activity grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the participation activity grades.

Performing T-test on student challenge activity grades:

Category 1	Category 3
31.15	68.85
83.61	98.36
31.15	75.41
26.23	86.69
95.08	93.44
98.36	85.25
95.08	80.33
68.85	100
96.72	100
100	100

45.9	93.44
100	85.25
93.44	57.38
100	65.85

Table 79: challenge activity grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.005506889 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	76.11214286	85.01785714
Variance	861.8846797	192.5476797
Observations	14	14
Hypothesized Mean Difference	0	
df	19	
t Stat	-1.026179686	
P(T<=t) one-tail	0.158847492	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.317694984	
t Critical two-tail	2.093024054	

Table 80: T-test result for the challenge activity grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the challenge activity grades.

Performing T-test on the student attendance grades:

Category 1	Category 3
84	92
92	16
68	100
100	100
96	84
100	100
100	100
100	100
52	28
100	100
72	92
100	100
100	60
100	84

Table 81: Attendance grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.020677943 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the

alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	90.28571429	82.57142857
Variance	240.5274725	786.7252747
Observations	14	14
Hypothesized Mean Difference	0	
df	20	
t Stat	0.900577478	
P(T<=t) one-tail	0.189264903	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	0.378529807	
t Critical two-tail	2.085963447	

Table 82: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on student lab assignment grades:

Category 1	Category 3
83.55	80
90.01	91.91
85	97.82
79.55	96.18
87.82	93.09
90.45	93.73
97.27	94.91
75.82	99.09
97.73	96
100	99.55
78.91	96.55
99.55	93.09
97.27	58.59
100	91.09

Table 83: lab assignment grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.227849484 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	90.20928571	91.5428571
Variance	73.91296099	112.868745
Observations	14	14
Pooled Variance	93.39085302	
Hypothesized Mean Difference	0	
df	26	

t Stat	-0.365101091	
P(T<=t) one-tail	0.358994595	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.717989191	
t Critical two-tail	2.055529439	

Table 84: T-test result for the lab assignment grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the lab assignment grades.

Performing T-test on student first midterm grades:

Category 1	Category 3
62	52
94	91
52	67
52	91
58	67
60	77
86	89
74	100
73	91
75	78
49	47
99	74
83	0
72	55

Table 85: first midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.045388882 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	70.64285714	69.92857143
Variance	252.8626374	669.9175824
Observations	14	14
Hypothesized Mean Difference	0	
df	22	
t Stat	0.087980585	
P(T<=t) one-tail	0.465344029	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.930688058	
t Critical two-tail	2.073873068	

Table 86: T-test result for the first midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the first midterm grades.

Performing T-test on student second midterm grades:

Category 1	Category 3
49	51
71	68
43	58
36	47
39	58
69	77
81	76
35	90
56	74
88	65.5
41	54
97	67
77	65
73	52

Table 87: second midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.028806606 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	61.07142857	64.46428571
Variance	435.9175824	145.2486264
Observations	14	14
Hypothesized Mean Difference	0	
df	21	
t Stat	-0.526598253	
P(T<=t) one-tail	0.301995463	
t Critical one-tail	1.720742903	
P(T<=t) two-tail	0.603990926	
t Critical two-tail	2.079613845	

Table 88: T-test result for the second midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the second midterm grades.

Performing T-test on student final exam grades:

Category 1	Category 3
73	42
81	75
51	64
39	72
60	69
60	80
68	85

46	91
54	85
70	78
18	56
98	69
88	51
84	79

Table 89: final exam grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.068875625 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	63.57142857	71.14285714
Variance	455.1868132	194.2857143
Observations	14	14
Pooled Variance	324.7362637	
Hypothesized Mean Difference	0	
df	26	
t Stat	-1.111633061	
P(T<=t) one-tail	0.138234947	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.276469895	
t Critical two-tail	2.055529439	

Table 90: T-test result for the final exam grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the final exam grades.

Performing T-test on student overall (total) grades:

Category 1	Category 3
73.09	86.62
83.16	73.28
67.32	80.55
62.73	87.88
76.5	66.69
81.61	88.9
90.57	68.72
89.38	64.63
82.49	83.79
83.51	88.41
85.69	79.22
92.8	79.86
89.66	48.08
91.64	98.81

Table 91: overall grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.11739637 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	82.1535714	78.2457143
Variance	85.3793632	168.196811
Observations	14	14
Pooled Variance	126.788087	
Hypothesized Mean Difference	0	
df	26	
t Stat	0.91822365	
P(T<=t) one-tail	0.18347096	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.36694192	
t Critical two-tail	2.05552944	

Table 92: T-test result for the overall grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the overall grades.

APPENDIX – VII (Section 6.2.3 in Chapter 6)

Performing T-test on the student challenge activity grades:

Category 1	Category 3
98.36	95.08
100	80.33
100	100
93.44	100
95.08	75.41
100	26.23
93.44	68.85
100	68.85
85.25	31.15
100	85.25
65.85	67.21
65.57	45.9
96.72	86.69
91.8	57.38

Table 93: challenge activity grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.009288625 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*

Mean	91.82214286	70.595
Variance	140.2991258	557.4449654
Observations	14	14
Hypothesized Mean Difference	0	
df	19	
t Stat	3.006820322	
P(T<=t) one-tail	0.003625681	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.007251363	
t Critical two-tail	2.093024054	

Table 94: T-test result for the challenge activity grades

The P-value one tail for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall challenge activity grades.

Performing T-test on student attendance grades:

Category 1	Category 3
16	100
28	100
100	100
92	100
96	100
100	100
84	92
100	100
100	84
100	100
84	84
84	72
96	100
96	60

Table 95: Attendance grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.005466258 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	84	92.28571429
Variance	733.5384615	163.6043956
Observations	14	14
Pooled Variance	448.5714286	
Hypothesized Mean Difference	0	
df	26	
t Stat	-1.035054385	
P(T<=t) one-tail	0.155087608	

t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.310175216	
t Critical two-tail	2.055529439	

Table 96: T-test result for the attendance grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the attendance grades.

Performing T-test on student lab assignment grades:

Category 1	Category 3
91.91	97.27
96	94.91
99.55	100
96.55	100
87.82	97.82
99.09	79.55
90.91	80
99.55	75.82
99.09	83.55
99.55	93.09
91.09	94.82
93.73	78.91
90.45	96.18
98.09	58.59

Table 97: lab assignment grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.00022486 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	95.24142857	87.89357143
Variance	17.16387473	146.8016401
Observations	14	14
Hypothesized Mean Difference	0	
df	16	
t Stat	2.147081172	
P(T<=t) one-tail	0.023729002	
t Critical one-tail	1.745883676	
P(T<=t) two-tail	0.047458005	
t Critical two-tail	2.119905299	

Table 98: T-test result for the lab assignment grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall lab assignment grades.

Performing T-test on student first midterm grades:

Category 1	Category 3

91	86
91	89
94	75
47	72
58	67
100	52
67	52
78	74
73	62
99	74
55	87
88	49
58	91
49	0

Table 99: first midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.225954653 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	74.85714286	66.42857143
Variance	365.978022	560.8791209
Observations	14	14
Pooled Variance	463.4285714	
Hypothesized Mean Difference	0	
df	26	
t Stat	1.035885106	
P(T<=t) one-tail	0.154897385	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.30979477	
t Critical two-tail	2.055529439	

Table 100: T-test result for the first midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the first midterm grades.

Performing T-test on the second midterm grades:

Category 1	Category 3
68	81
74	76
83.5	88
54	73
39	58
90	36
51	51

65.5	35
69	49
97	67
52	71
61	41
58	47
73	65

Table 101: second midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.413890842 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	66.78571429	59.85714286
Variance	257.2197802	290.9010989
Observations	14	14
Pooled Variance	274.0604396	
Hypothesized Mean Difference	0	
df	26	
t Stat	1.10731082	
P(T<=t) one-tail	0.139149569	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.278299138	
t Critical two-tail	2.055529439	

Table 102: T-test result for the second midterm grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the second midterm grades.

Performing T-test on student final exam grades:

Category 1	Category 3
75	68
85	85
92	70
56	84
60	64
91	39
27	42
78	46
63	73
98	69
79	91
66	18
48	72
79	51

Table 103: final exam grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.417117597 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	71.21428571	62.28571429
Variance	373.7197802	420.6813187
Observations	14	14
Pooled Variance	397.2005495	
Hypothesized Mean Difference	0	
df	26	
t Stat	1.185293976	
P(T<=t) one-tail	0.123311015	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.246622029	
t Critical two-tail	2.055529439	

Table 104: T-test result for the final exam grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the final exam grades.

Performing T-test on student overall (total) grades:

Category 1	Category 3
73.28	90.57
83.79	68.72
96.86	83.51
79.22	91.64
76.5	80.55
64.63	62.73
56.13	86.62
88.41	89.38
75.4	73.09
92.8	79.86
98.81	91.31
87.34	85.69
98.04	87.88
91.76	48.08

Table 105: overall grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.482877339 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	83.06928571	79.97357143

Variance	165.9943148	162.0129324
Observations	14	14
Pooled Variance	164.0036236	
Hypothesized Mean Difference	0	
df	26	
t Stat	0.639562762	
P(T<=t) one-tail	0.264026228	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.528052457	
t Critical two-tail	2.055529439	

Table 106: T-test result for the overall grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the overall grades.

APPENDIX – VIII (Section 6.2.4 in Chapter 6)

Performing T-test on the student lab assignment grades:

Category 1	Category 3
90.45	100
93.73	58.59
96.55	90.91
99.55	97.73
96	94.91
91.09	97.27
83	90.01
90.45	83.55
75.82	100
83.82	97.27
96.18	93.09
97.82	93.09
87.82	99.55
98.09	99.09

Table 107: lab assignment grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.056818666 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	91.455	92.50428571
Variance	47.21405769	117.2086264
Observations	14	14
Pooled Variance	82.21134203	
Hypothesized Mean Difference	0	
df	26	
t Stat	-0.306180065	

P(T<=t) one-tail	0.380952962	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.761905924	
t Critical two-tail	2.055529439	

Table 108: T-test result for the lab assignment grades

The P-value for the T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the lab assignment grades.

Performing T-test on student attendance grades:

Category 1	Category 3
100	100
16	60
92	72
100	52
28	92
100	100
96	84
100	84
100	84
100	100
92	100
84	92
96	84
100	100

Table 109: Attendance grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.02248599 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	Variable 2
Mean	86	86
Variance	762.4615385	238.1538462
Observations	14	14
Hypothesized Mean Difference	0	
df	20	
t Stat	0	
P(T<=t) one-tail	0.5	
t Critical one-tail	1.724718243	
P(T<=t) two-tail	1	
t Critical two-tail	2.085963447	

Table 110: T-test result for the attendance grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the attendance grades.

Performing T-test on student first midterm grades:

Category 1	Category 3
100	67
91	0
47	49
94	73
91	52
99	86
81	67
60	62
89	88
78	90
94	74
55	43
58	87
75	74

Table 111: first midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.146811754 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	79.42857143	65.14285714
Variance	315.3406593	573.5164835
Observations	14	14
Pooled Variance	444.4285714	
Hypothesized Mean Difference	0	
df	26	
t Stat	1.79287493	
P(T<=t) one-tail	0.042317982	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.084635963	
t Critical two-tail	2.055529439	

Table 112: T-test result for the first midterm grades

The P-value one-tail for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the first midterm grades.

Performing T-test on student second midterm grades:

Category 1	Category 3
90	58
68	65
54	41
83.5	56
74	51
97	81

60	58
69	49
76	61
65.5	65
71	35
52	37
39	71
88	67

Table 113: second midterm grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.243315731 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	70.5	56.78571429
Variance	257.7692308	173.7197802
Observations	14	14
Pooled Variance	215.7445055	
Hypothesized Mean Difference	0	
df	26	
t Stat	2.470315031	
P(T<=t) one-tail	0.010189109	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.020378218	
t Critical two-tail	2.055529439	

Table 114: T-test result for the second midterm grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the second midterm grades.

Performing T-test on student final exam grades:

Category 1	Category 3
91	64
75	51
56	18
92	54
85	42
98	68
50	69
60	73
85	66
78	73
81	46
79	63
60	91

70	69

Table 115: final exam grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.311625358 which is greater than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is greater than the alpha value, it implies that it is not violating the homogeneity and thus performed the T-test: Two-Sample assuming Equal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	75.71428571	60.5
Variance	214.5274725	306.4230769
Observations	14	14
Pooled Variance	260.4752747	
Hypothesized Mean Difference	0	
df	26	
t Stat	2.494119945	
P(T<=t) one-tail	0.009656315	
t Critical one-tail	1.70561792	
P(T<=t) two-tail	0.019312631	
t Critical two-tail	2.055529439	

Table 116: T-test result for the final exam grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the final exam grades.

Performing T-test on student overall (total) grades:

Category 1	Category 3
98.04	83.51
87.34	48.08
79.22	56.13
96.86	82.49
83.79	68.72
98.81	90.57
77.22	83.16
81.61	73.09
89.38	83.87
90.54	89.66
87.88	66.69
80.55	79.86
76.5	88.41
91.76	83.04

Table 117: overall grades of category 1 and category 3 students

When F-test was performed, the resultant p-value was 0.034408215 which is less than the actual significance value, i.e., alpha value, which is 0.05. Since, the probability value is less than the alpha value, it implies that it is violating the homogeneity and thus performed the T-test: Two-Sample assuming Unequal Variances. The results of the test are shown below.

	Variable 1	*Variable 2*
Mean	87.10714286	76.94857143

Variance	57.50351429	164.5354901
Observations	14	14
Hypothesized Mean Difference	0	
df	21	
t Stat	2.550832965	
P(T<=t) one-tail	0.009304954	
t Critical one-tail	1.720742903	
P(T<=t) two-tail	0.018609908	
t Critical two-tail	2.079613845	

Table 118: T-test result for the overall grades

The P-value for the T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall grades.

APPENDIX – IX (Section 6.3 in Chapter 6)

Performing Paired T-test on average of student participation activity data (before vs. after COVID-19):

Category 1	Category 2
100	97.2222222
94.2747512	90.4383026
100	100
100	100
85.8758721	98.7437186
96.1875726	100
100	100
100	100
100	100
98.9837398	100
99.695122	96.7336683
100	95.2261307
100	100
99.1755674	100
100	100
100	50
97.0528455	100
100	100
46.0473122	89.1680625
100	100
93.4099188	91.2711707
95.06832	100
100	100
100	100
100	100
100	100
100	100

100	100
100	100
99.8831776	100
96.7156208	92.6996092
92.3063607	90.8477573
100	100
99.8214286	100
100	100
100	100
100	100
100	100
98.7551432	98.5715615
74.4117647	50
100	100
100	100
100	100

Table 119: participation activity grades of category 1 and category 2 students

Paired T-Test Result:

	Variable 1	Variable 2
Mean	96.92243063	96.30051636
Variance	84.64283231	116.1499147
Observations	43	43
Pearson Correlation	0.384550433	
Hypothesized Mean Difference	0	
df	42	
t Stat	0.365443483	
P(T<=t) one-tail	0.358307229	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.716614458	
t Critical two-tail	2.018081703	

Table 120: Paired T-test result for the participation activity grades

The P-value for the Paired T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the participation activity grades.

Performing Paired T-test on average of student challenge activity data (before vs. after COVID-19):

Category 1	Category 2
28.1547619	73.0308558
79.702381	62.8834169
100	99.2248062
100	99.2248062
82.4702381	86.0465116
96.6220238	100
87.5	99.2248062
100	66.6666667

100	100
80.8333333	87.9160967
95.8333333	62.2222222
91.6666667	93.7984496
89.6875	90.2872777
100	95.3488372
100	100
90.625	33.3333333
91.7559524	88.6912905
96.5327381	97.002584
25.0744048	98.4496124
100	100
92.8869048	66.6666667
93.2291667	100
93.75	100
100	100
83.3482143	83.4716522
62.2916667	96.124031
100	100
94.4494048	96.4888281
98.0952381	100
97.9166667	97.0588235
82.1428571	30.5517556
95.4910714	98.4496124
96.1904762	97.6744186
83.4375	55.3579571
92.1875	84.0857273
32.8720238	0
96.3541667	100
93.75	100
97.0535714	100
99.047619	33.3333333
98.0952381	99.2248062
95.8333333	99.2248062
56.6071429	33.1114151

Table 121: challenge activity grades of category 1 and category 2 students
Paired T-Test Result:

	Variable 1	Variable 2
Mean	87.70902547	83.81803271
Variance	355.4663031	616.2186641
Observations	43	43
Pearson Correlation	0.420505524	
Hypothesized Mean Difference	0	
df	42	

t Stat	1.061214865	
P(T<=t) one-tail	0.147328357	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.294656713	
t Critical two-tail	2.018081703	

Table 122: Paired T-test result for the attendance grades

The P-value for the Paired T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the challenge activity grades.

Performing Paired T-test on average of student attendance grades (before vs. after COVID-19):

Category 1	Category 2
78.5714286	54.5454545
85.7142857	100
100	81.8181818
50	0
100	90.9090909
100	100
100	100
85.7142857	100
78.5714286	90.9090909
100	100
100	100
92.8571429	90.9090909
100	100
100	90.9090909
100	100
100	100
100	100
85.7142857	100
85.7142857	81.8181818
100	100
78.5714286	90.9090909
100	72.7272727
92.8571429	100
100	100
100	100
78.5714286	90.9090909
100	100
100	100
78.5714286	100
100	100
100	63.6363636
28.5714286	0
100	63.6363636

73

100	36.3636364
100	100
100	100
100	90.9090909
100	100
100	100
57.1428571	63.6363636
100	100
50	54.5454545
85.7142857	81.8181818

Table 123: Attendance grades of category 1 and category 2 students

Paired T-Test Result:

	Variable 1	*Variable 2*
Mean	90.53156146	85.83509514
Variance	273.8603747	615.1213128
Observations	43	43
Pearson Correlation	0.716413322	
Hypothesized Mean Difference	0	
df	42	
t Stat	1.775396271	
P(T<=t) one-tail	0.041539577	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.083079154	
t Critical two-tail	2.018081703	

Table 124: Paired T-test result for the attendance grades

The P-value one-tail for the Paired T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the overall attendance grades.

Performing Paired T-test on average of student lab assignment grades (before vs. after COVID-19):

Category 1	Category 2
80.25	94.6666667
100	87
100	98.6666667
100	98.6666667
95	77.6666667
100	100
91.75	97.3333333
100	100
100	100
90	58
100	100
95	100
100	96.6666667
100	100

100	100
52.5	100
100	74.6666667
100	100
75	100
100	100
100	92
100	97.3333333
100	94.6666667
100	100
99	93.3333333
86	88.3333333
100	100
100	94.6666667
100	98
100	100
95	85.3333333
100	98.6666667
100	100
81.25	92.6666667
96	100
95	100
92.75	100
93.75	100
100	100
48.125	41.3333333
100	100
100	100
84.75	60

Table 125: lab assignment grades of category 1 and category 2 students

Paired T-Test Result:

	Variable 1	*Variable 2*
Mean	94.2122093	93.48062016
Variance	135.2072432	164.7899594
Observations	43	43
Pearson Correlation	0.489797455	
Hypothesized Mean Difference	0	
df	42	
t Stat	0.38686365	
P(T<=t) one-tail	0.350405216	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.700810432	
t Critical two-tail	2.018081703	

Table 126: Paired T-test result for the lab assignment grades

The P-value for the Paired T-test is greater than the alpha value which means that the result is not statistically significant. Hence, there is no statistically significant difference between the two categories for the lab assignment grades.

Performing Paired T-test on average of student midterm grades (before vs. after COVID-19):

Category 1	Category 2
52	43
61	44
47	54
91	74
81	60
72	73
77	77
91	47
94	71
67	58
74	35
89	76
52	51
73	69
58	58
100	90
70	52
74	67
43	37
52	69
78	65.5
87	71
77	81
49	73
75	88
67	58
55	52
99	97
83	77
82	70
90	65
88	61
91	68
67	51
49	41
52	36
58	39
86	81

94	83.5
0	65
60	69
73	56
62	49

Table 127: midterm grades of category 1 and category 2 students

Paired T-Test Result:

	Variable 1	*Variable 2*
Mean	70.69767442	62.8372093
Variance	371.9302326	238.3181063
Observations	43	43
Pearson Correlation	0.516613975	
Hypothesized Mean Difference	0	
df	42	
t Stat	2.962941106	
P(T<=t) one-tail	0.002500139	
t Critical one-tail	1.681952357	
P(T<=t) two-tail	0.005000277	
t Critical two-tail	2.018081703	

Table 128: Paired T-test result for the attendance grades

The P-value for the Paired T-test is less than the alpha value which means that the result is statistically significant. Hence, there is a statistically significant difference between the two categories for the midterm grades.

REFERENCES

[1] K. Alshammari and I. V. Pivkina, "Relationship between time management in courses with online interactive textbooks and students' performance," 2017 IEEE Frontiers in Education Conference (FIE), Indianapolis, IN, 2017, pp. 1-5, doi: 10.1109/FIE.2017.8190620.

[2] S. C. Schneider, C. Tamma and C. Perez, "The Impact of Adding an Interactive Textbook on Student Performance and Satisfaction in a Freshman Introduction to Programming Course," 2018 IEEE Frontiers in Education Conference (FIE), San Jose, CA, USA, 2018, pp. 1-5, doi: 10.1109/FIE.2018.8659029.

[3] J. Skalka, M. Drlík and J. Obonya, "Automated Assessment in Learning and Teaching Programming Languages using Virtual Learning Environment," 2019 IEEE Global Engineering Education Conference (EDUCON), Dubai, United Arab Emirates, 2019, pp. 689-697, doi: 10.1109/EDUCON.2019.8725127.

[4] Adkins, Joni K., Diana R. Linville, and Charles Badami. "The Impact of an Interactive Textbook in a Beginning Programming Course." Information Systems Education Journal 18, no. 6 (2020): 38-45.

[5] Entezari, Negin, Amirali Darvishzadeh, and Thomas Stahovich. "Using an Instrumented Learning Environment to Understand Procrastination." 2018 IEEE Frontiers in Education Conference (FIE). IEEE, 2018.

[6] Benotti, Luciana, et al. "The Effect of a Web-based Coding Tool with Automatic Feedback on Students' Performance and Perceptions." Proceedings of the 49th ACM Technical Symposium on Computer Science Education. 2018.

[7] Kanji, Gopal K. 100 statistical tests. Sage, 2006. [f,t-test]

[8] Berk, Kenneth N., and Patrick M. Carey. Data analysis with Microsoft excel: updated for office 2007. Cengage Learning, 2009. [t test]

[9] C. Carlberg. Statistical Analysis: Microsoft Excel 2016. Pearson Education, 2017.

[10] Skuza Pawel. Introduction to Statistical Analysis. Flinders University, 2013.

[11] M. Harmon, t-Tests in Excel The Excel Statistical Master, 1st ed. Mark Harmon, 2011.

[12] "Wikipedia", Wikipedia.org, 2017. [Online]. Available: https://www.wikipedia.org/.

[13] "zyBooks", Zybooks.zyante.com. [Online]. Available: https://zybooks.zyante.com/.

[14] "Statistical Solutions", statisticalsolutions.com. [Online]. Available: https://www.statisticssolutions.com/

[15] T Test (Student's T-Test): Definition and Examples, statisticsshowto.com. [Online]. Available: https://www.statisticshowto.com/