

Table of Contents

2021 BS Mathematics

Major-NH-MATH-Mathematics (BS) 2021

Institutional Mission	2
Program Mission	2
1 2021	1
1.1 Knowledge of Mathematics	1
1.2 Problem Solving	1
1.3 Mathematical Reasoning	1
1.4 Communication of Mathematics	1
1.5 Application of Mathematics	1
Project Attachments	2

Major-NH-MATH-Mathematics (BS)

2021

Completed

1 GOALS 5 OUTCOMES 6 MEASURES 5 TARGETS 2 FINDINGS 4 ATTACHMENTS

Institutional Mission

Arkansas Tech University is dedicated to student success, access, and excellence as a responsive campus community providing opportunities for progressive intellectual development and civic engagement. Embracing and expanding upon its technological traditions, Tech inspires and empowers members of the community to achieve their goals while striving for the betterment of Arkansas, the nation, and the world.

Program Mission

The mathematics degree provides students with the knowledge and skills in mathematics that prepares them for graduate level work in mathematics or for a career in technological fields.

Program Learning Outcomes	Expectations/Target for this Outcome	Findings/Results
<p>1 Calendar Year Assessment Information 2021</p> <p>***** 2021 ANNUAL REVIEW ***** - DOWNLOAD AND COMPLETE THE "AUDIT TEMPLATE" FORM FOUND IN THE PROJECT ATTACHMENTS SECTION BELOW. - SAVE AND UPLOAD THE COMPLETED FORM IN THE PROJECT ATTACHMENTS *****</p> <p>APPROVALS & INFORMATION BLOCK (**NOTE**. This block provides a brief description of actions taking place (or planned to take place) during the current assessment cycle. If there are more (or less) outcomes assessed, please alter as necessary. Additional comments are also welcome.) Point of Contact for this year's assessment (add additional names as needed): 1) Jeanine Myers 2) Xinli Xiao APPROVALS</p> <p>----- Department Head Approval: Jeanine L. Myers Date: 1.6.22</p> <p>Dean Approval: John Jackson Date: 6/3/2022 Office of Assessment Approval: Amanda Gardner Date: 8/1/22</p> <p>----- Program Level Context: (ex. Second year using Weave Assessment Management System, or ADHE Program Review conducted on 3/15/20) Student Learning Outcomes Assessed during Calendar Year 2021 (Add more as necessary): Outcome 1.1: Program Learning Outcome: Knowledge of Mathematics Curriculum Committee Proposals or Changes (erase choice not used): N Assessment Data Used as Support for Change: (give Outcome #) Is Status of Project Noted in Title Bar Current?</p>		

Program Learning Outcomes		Expectations/Target for this Outcome	Findings/Results
(erase choice not used): Y Change status in title bar above Are All Attachments Noted in Assessment Plan Added Below? (erase choice not used): Y ----- Additional Comments: Supporting material is lacking for the PLO and committee records.			
<p style="text-align: center;">Outcome has action plan</p> <p>1.1</p> <p>Knowledge of Mathematics Students will demonstrate an understanding of calculus, linear algebra, and other areas of mathematics. Courses that this PLO can be assessed: Calculus I, II, and III, Linear Algebra, Differential Equations, Introduction to Analysis, Linear Algebra, Abstract Algebra, Mathematical Modeling and Senior Seminar (MATH 2914, 2924, 2934, 3243, 3203, 4003, 4033, 4123, 4971)</p> <p>ACTION PLAN In Progress</p> <p>DUE</p> <p>no due date set</p>	<p>1.1.1</p> <p>Pretest/Posttest</p> <p>Please see example tests in the attachment section. Two examples are attached, one for 2914 during Spring 2021, and one for 3243 during Fall 2021. There are two versions of the tests, the difficulty level of which are equivalent to each other. Version A is provided here.</p>	<p>1.1.1.1 Met</p> <p>The pretest is given at the beginning of the semester, before any material is covered. All questions are multiple choice questions, and assess the PLO . The problems on the posttest are exactly the same as that of the pretest.</p> <p>We expect to see that from the matched pair t-Test a statistically significant increase of student scores from pretest to posttest for in each course.</p>	<p>For MATH2914, 2924, 2934, 3243, the mean of pre is lower than the mean of post based on a p-value of less than 0.05. Therefore there is quite a significant increase in the learning acquired by our students in these four courses. See report-2021.pdf below.</p> <p>REFLECTION ON FINDINGS AND RECOMMENDATIONS FOR NEXT STEPS</p> <p>Currently we only record the total score of pretest/posttest. We may record the correctness of each individual questions of each students for us to get more information on students learning. (2021 reflection)</p>
<p>1.2 2 FINDING NOT ENTERED</p> <p>Problem Solving</p> <p>Students will demonstrated an ability to formulate, analyze, and solve problems through analytical</p>	<p>1.2.1</p> <p>Pretest/Posttest</p>		


Program Learning Outcomes		Expectations/Target for this Outcome	Findings/Results
<p>techniques. Courses that this PLO can be assessed: Calculus I, II, and III, Linear Algebra, Differential Equations, Mathematical Modeling and Senior Seminar (MATH 2914, 2924, 2934, 3243, 4123, 4971)</p>			
<p>1.2.2 Posttest</p>	<p>1.2.2.1 Not Reported this Period 70% of students will scores at least a 70% or better</p>	<p>Not Entered REFLECTION ON FINDINGS AND RECOMMENDATIONS FOR NEXT STEPS</p>	
<p>1.3 1 FINDING NOT ENTERED Mathematical Reasoning Students will be able to reason and use logic to develop and write valid mathematical proofs. Courses that can be assessed for this PLO : Discrete Mathematics, Foundations of Mathematics, Introduction to Analysis, Abstract Algebra (MATH 2703, 3003, 3203, 4003)</p>	<p>1.3.1 Proof Assignment</p>	<p>1.3.1.1 Not Reported this Period 70% of the students will achieve a 70% or better</p>	<p>Not Entered REFLECTION ON FINDINGS AND RECOMMENDATIONS FOR NEXT STEPS</p>
<p>1.4 Communication of Mathematics Students will be able to communicate mathematics in both written and oral forms. Courses that</p>	<p>1.4.1 Senior Seminar Research Project</p>	<p>1.4.1.1 Met 70% of the students will achieve a 70% or better</p>	<p>The following are the 4 students' grades based on the standard grading scale: A, A, A, F So, 75% of the students achieved a 70% or better. (2020 data)</p>

Program Learning Outcomes		Expectations/Target for this Outcome	Findings/Results
<p>can be assessed for this PLO : Discrete Mathematics, Foundations of Mathematics, Introduction to Analysis, Abstract Algebra, Senior Seminar (MATH 2703, MATH 3003, 3203, 4033, 4971)</p>			<p>REFLECTION ON FINDINGS AND RECOMMENDATIONS FOR NEXT STEPS</p> <p>The COVID pandemic affected the attendance and performance of the student who received an F. Recommendation is in-class weekly meetings with students which is required during non-pandemic years. (2020 reflection)</p>
<p>1.5 1 FINDING NOT ENTERED</p> <p>Application of Mathematics</p> <p>Students will understand how to apply modeling methods and technology to solve real-world problems. Courses that can be assessed for this PLO : Applied Statistics, Differential Equations, Linear Algebra, Mathematics Modeling. (STAT 3153, MATH 3243, 4003, 4123)</p>	<p>1.5.1 Project</p>	<p>1.5.1.1 Not Reported this Period</p> <p>70% of the students will achieve at least a 70% or better</p>	<p>Not Entered</p> <p>REFLECTION ON FINDINGS AND RECOMMENDATIONS FOR NEXT STEPS</p>

Project Attachments (4)

Attachments

File Size

 MATH_2914_Pre_Test_A.pdf

30KB

 MATH_3243_Pre_Test_Form_A.pdf

31KB

 report-21.pdf

350KB

INSTRUCTIONS:

1. **This is an assessment test. Has no grade value.** Please answer to the best of your knowledge.
 2. **Write “Form A” on the provided Scantron in the space for Period.**
 3. Clearly indicate on your Scantron the answer of your choice for each question.
 4. If rounding is necessary, round to 2 decimal places unless otherwise indicated.
 5. Use of cell phones, smart watches, or other internet enabled devices is considered cheating and is not allowed.
 6. You may use only the calculator provided by the instructor.
-

Questions removed to retain integrity of the exam.

INSTRUCTIONS:

1. **This is an assessment test. Has no grade value.** Please answer to the best of your knowledge.
 2. **Write “Form A” on the provided Scantron in the space for Period.**
 3. Clearly indicate on your Scantron the answer of your choice for each question.
 4. If rounding is necessary, round to 2 decimal places unless otherwise indicated.
 5. Use of cell phones, smart watches, or other internet enabled devices is considered cheating and is not allowed.
 6. You may use only the calculator provided by the instructor.
-

Questions removed to retain integrity of the exam.

2021 - Pre vs Post test report

Xinli Xiao

2022-06-08

Overview of the assessment

During both Spring and Fall semester in 2021, we administered a Pre & Post Test to assess that students are learning in our Calculus I, II, III and Differential Equations I. The Pre & Post Test are the same test. The student does not see their results to these same questions at the start or the end of the semester in order to keep the questions a valid gauge of assessment. On the measure of learning, the Paired T-Test was used to measure the before vs after results.

We first pull out the Pre and Post test scores of all students that participated both tests. The before and after results were paired by matching the T-Numbers. For each student, the difference in the Pre/Post tests were calculated as **Post** - **Pre**. A positive value was indicative of the student achieving a higher score on the post test. A negative value for the difference means that the student scored lower on the post test. There were only a few that scored less and those typically are a result seen when a student makes a guess on a multiple choice exam.

Finally, we ran a Paired T-Test on this difference score.

- The Null Hypothesis is the overall before/after score would indicate there was no difference in how the students performed.

$$H_0 : \mu_{(\text{Post}-\text{Pre})} = 0$$

- The Alternative Hypothesis is that there was a difference indicating the learning occurred, indicated by a difference score average that was non-zero.

$$H_a : \mu_{(\text{Post}-\text{Pre})} \neq 0$$

We are checking the P-value for **Post** - **Pre**. Using a significance level of 5%, if P-value is less than 0.05, we were able to reject the null hypothesis in favor of alternative hypothesis that concludes with a 95% level of confidence that the increase in the scores was due to learning and not to random variation.

We also compute the corresponding confidence interval. It suggests that we are 95% confident that the true average difference in **Post** - **Pre** test scores falls in the interval.

The following sections show the details of the Pre & Post test assessment results for each course indicated in each semester. The study below confirms that we had statistically significant learning that took place in each course.

Spring 2021 - MATH 2914 - Calculus I

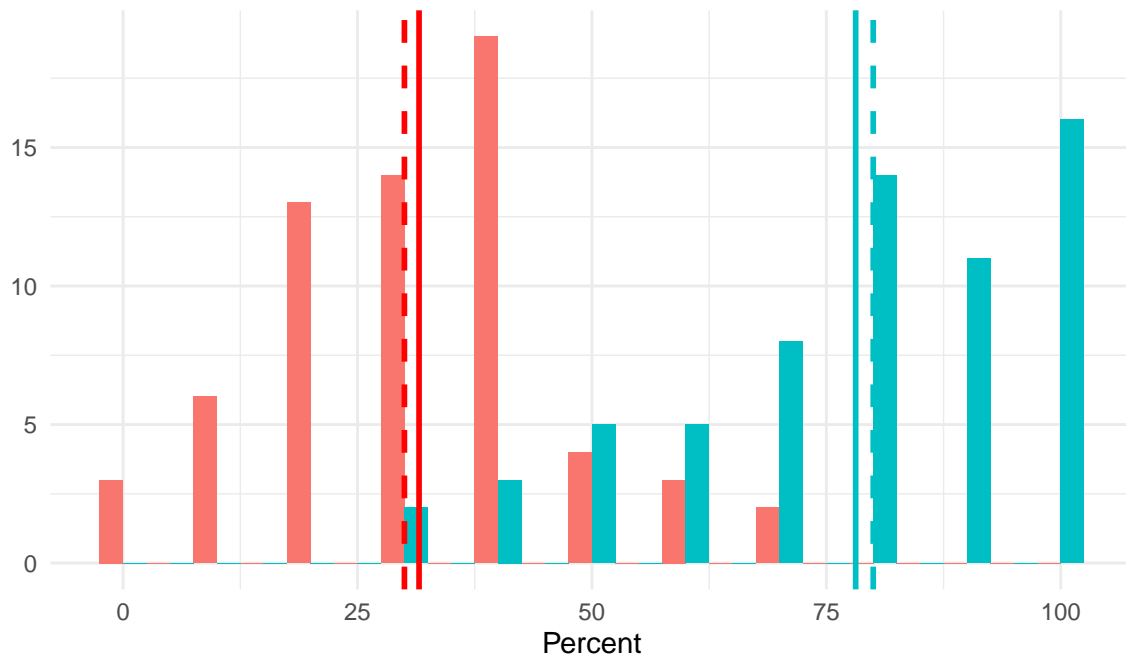
During the Spring semester, there are totally 64 students finished both Pre and Post tests for the course.

Histogram (Spring 2021 - MATH 2914 - Calculus I)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

Histogram – Spring 2021 MATH 2914 – Calculus I

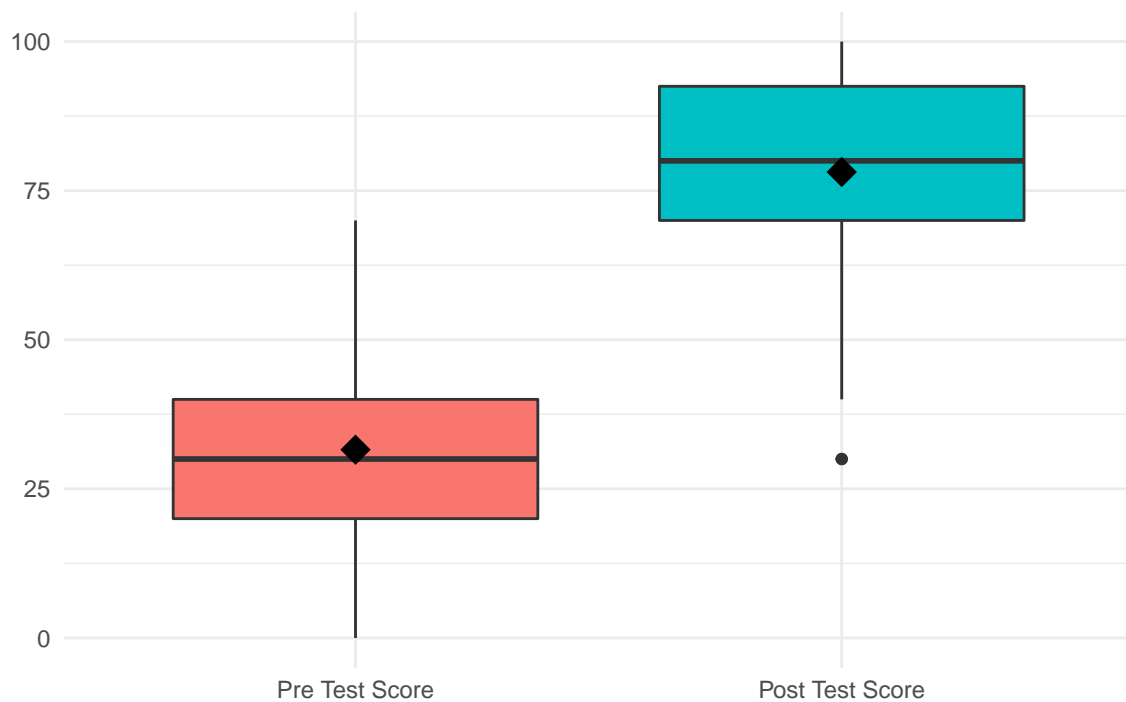


Boxplot (Spring 2021 - MATH 2914 - Calculus I)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.

Box Plot – Spring 2021 MATH 2914 – Calculus I



Summary Statistics (Spring 2021 - MATH 2914 - Calculus I)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	64	31.56	15.76	0	20.00	30.00	40.00	70.00
pst	64	78.12	19.67	30.00	70.00	80.00	92.50	100.0

Matched Pair T-Test Statistics (Spring 2021 - MATH 2914 - Calculus I)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	46.56	3.080	63.00	15.12	123.3×10^{-24}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

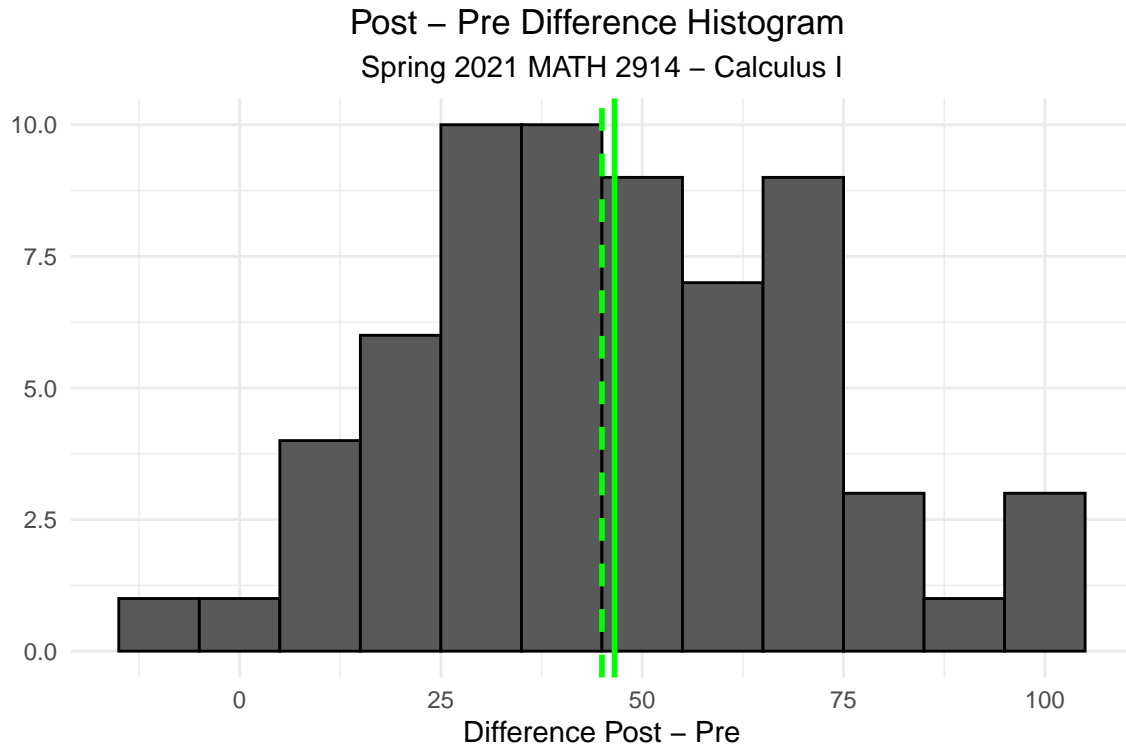
Paired T confidence interval (Spring 2021 - MATH 2914 - Calculus I)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	46.56	3.080	63.00	40.41	52.72

The following histogram represents the distribution in Post - Pre. We could see that while a few scores went down, the majority of scores increased on average of about 47%.

- The green Solid line represents the mean of Post - Pre.
- The green Dashed line represents the median of Post - Pre.



Spring 2021 - MATH 2924 - Calculus II

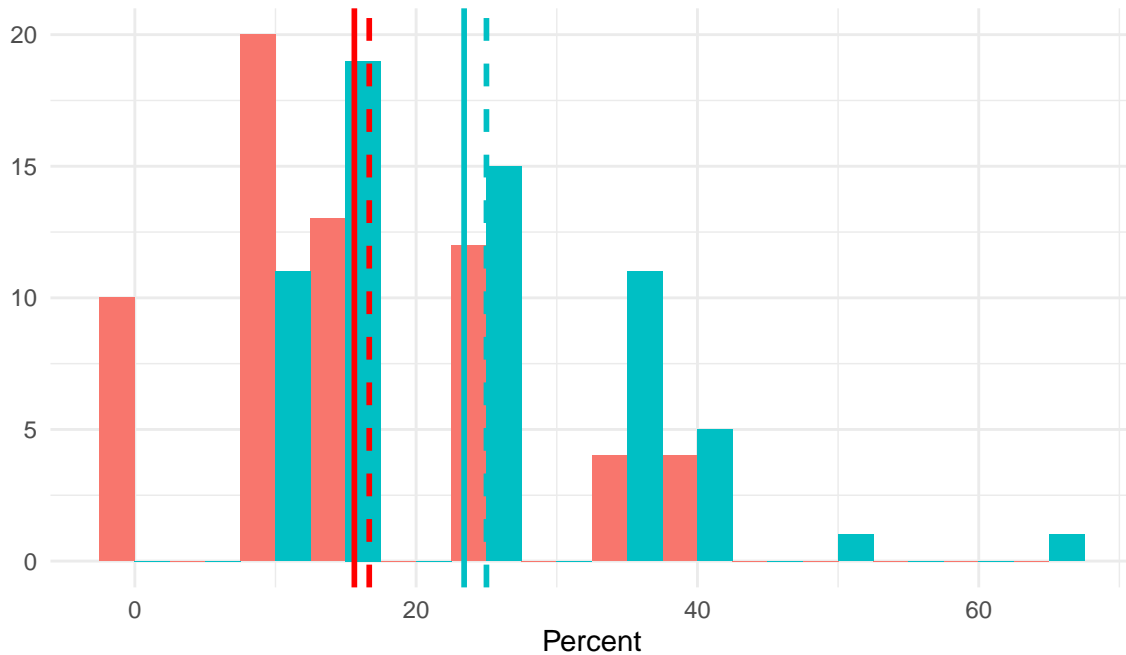
During the Spring semester, there are totally 63 students finished both Pre and Post tests for the course.

Histogram (Spring 2021 - MATH 2924 - Calculus II)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

Histogram – Spring 2021 MATH 2924 – Calculus II

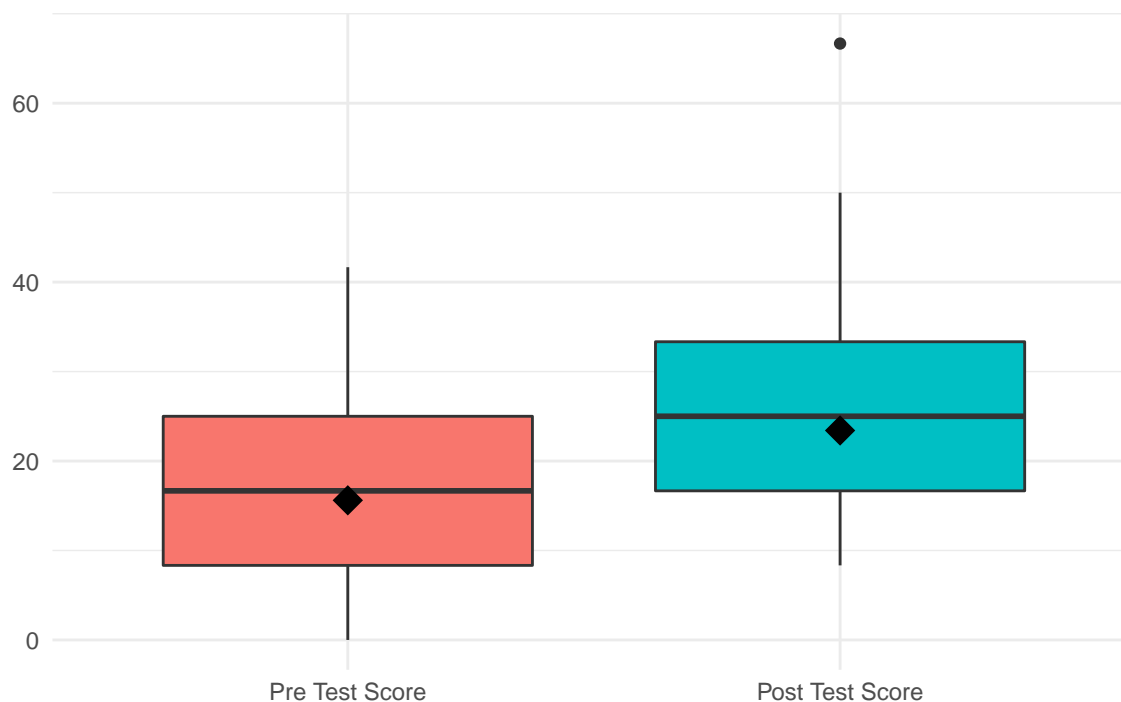


Boxplot (Spring 2021 - MATH 2924 - Calculus II)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.

Box Plot – Spring 2021 MATH 2924 – Calculus II



Summary Statistics (Spring 2021 - MATH 2924 - Calculus II)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	63	15.61	11.74	0	8.333	16.67	25.00	41.67
pst	63	23.41	11.87	8.333	16.67	25.00	33.33	66.67

Matched Pair T-Test Statistics (Spring 2021 - MATH 2924 - Calculus II)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	7.804	1.837	62.00	4.249	73.41×10^{-6}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

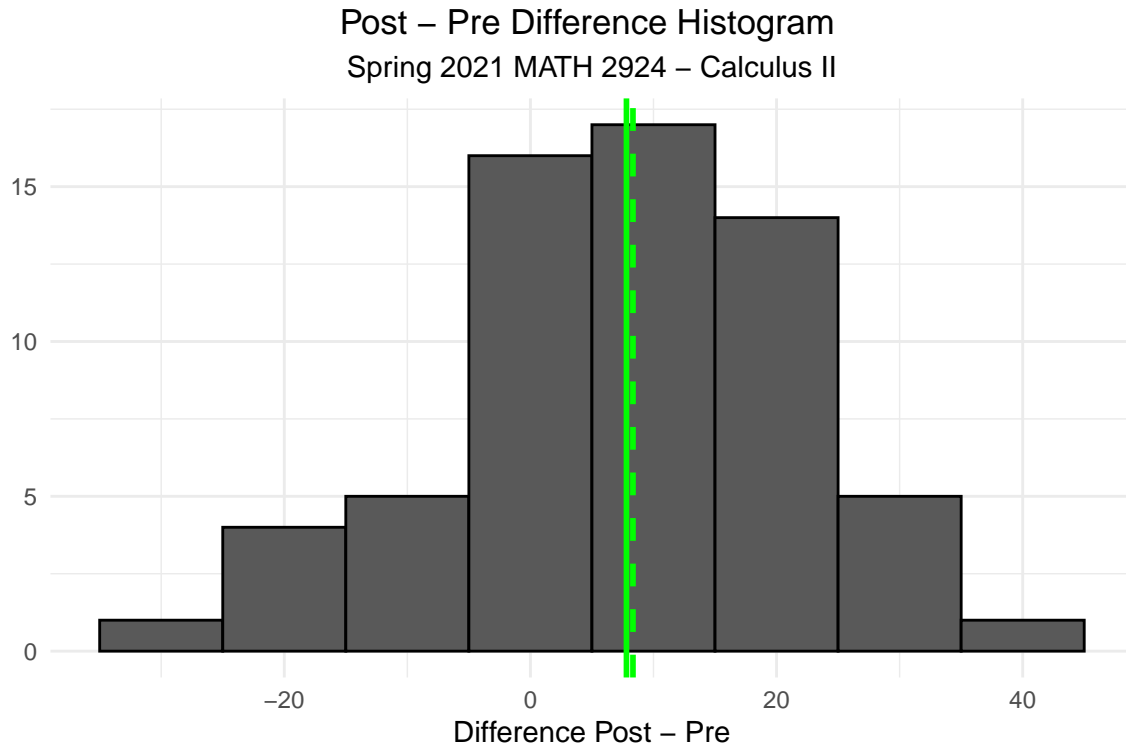
Paired T confidence interval (Spring 2021 - MATH 2924 - Calculus II)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	7.804	1.837	62.00	4.133	11.48

The following histogram represents the distribution in Post - Pre. We could see that while a few scores went down, the majority of scores increased on average of about 8%.

- The green Solid line represents the mean of Post - Pre.
- The green Dashed line represents the median of Post - Pre.



Spring 2021 - MATH 2934 - Calculus III

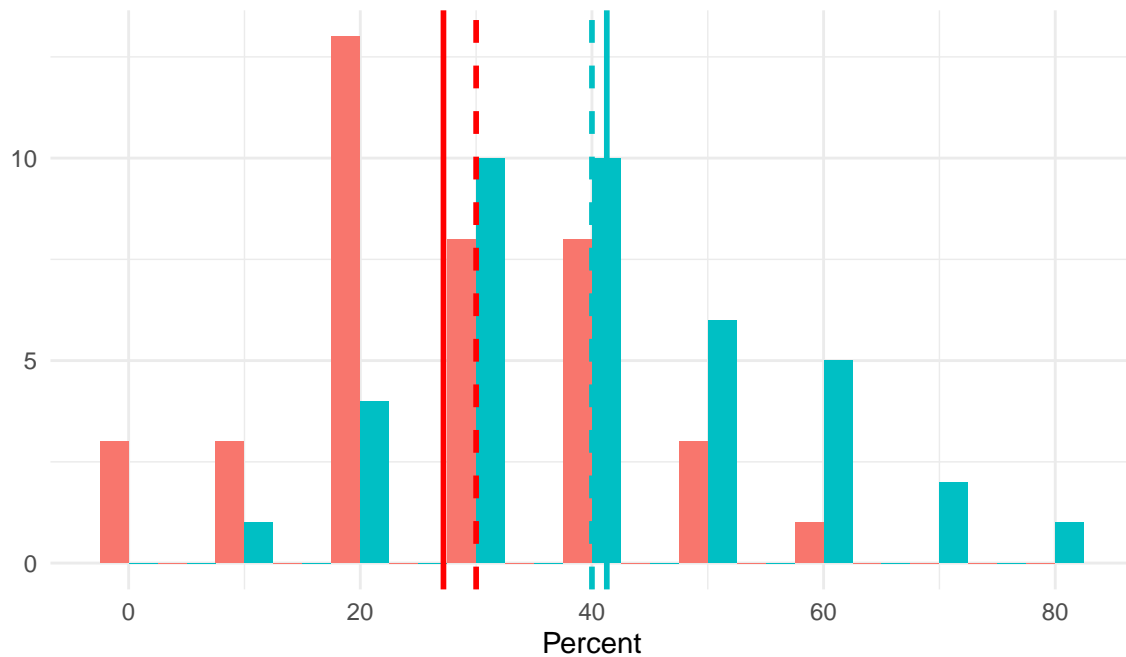
During the Spring semester, there are totally 39 students finished both Pre and Post tests for the course.

Histogram (Spring 2021 - MATH 2934 - Calculus III)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

Histogram – Spring 2021 MATH 2934 – Calculus III

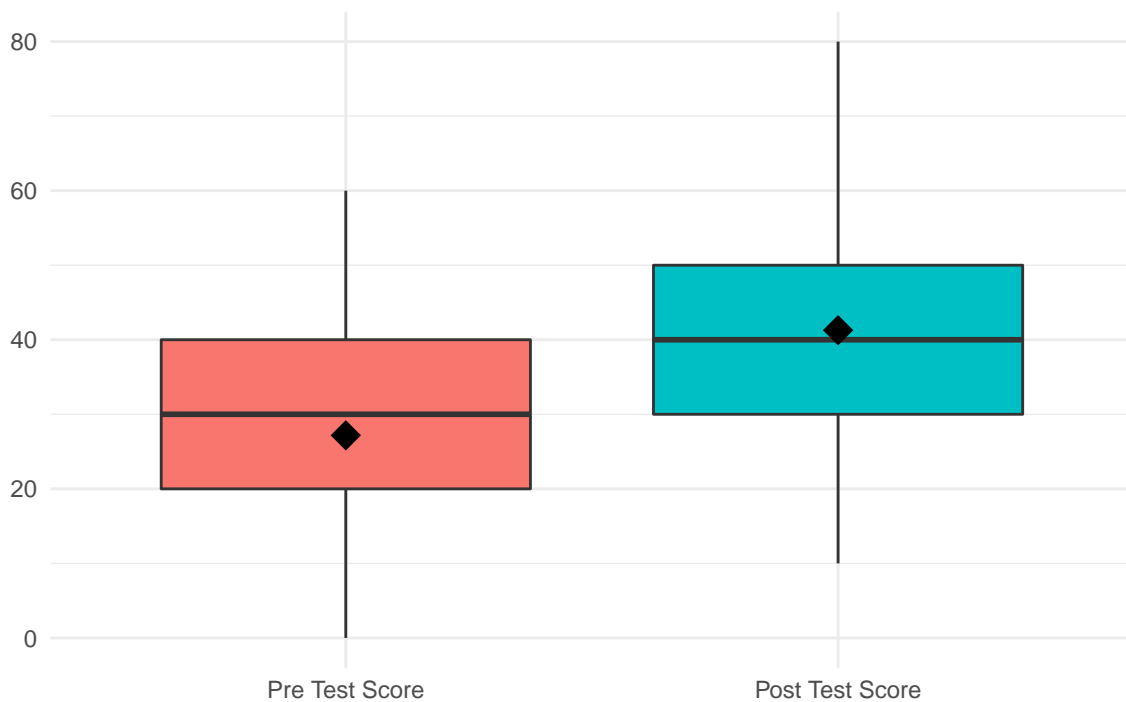


Boxplot (Spring 2021 - MATH 2934 - Calculus III)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.

Box Plot – Spring 2021 MATH 2934 – Calculus III



Summary Statistics (Spring 2021 - MATH 2934 - Calculus III)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	39	27.18	14.32	0	20.00	30.00	40.00	60.00
pst	39	41.28	15.76	10.00	30.00	40.00	50.00	80.00

Matched Pair T-Test Statistics (Spring 2021 - MATH 2934 - Calculus III)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	14.10	3.197	38.00	4.412	81.77×10^{-6}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

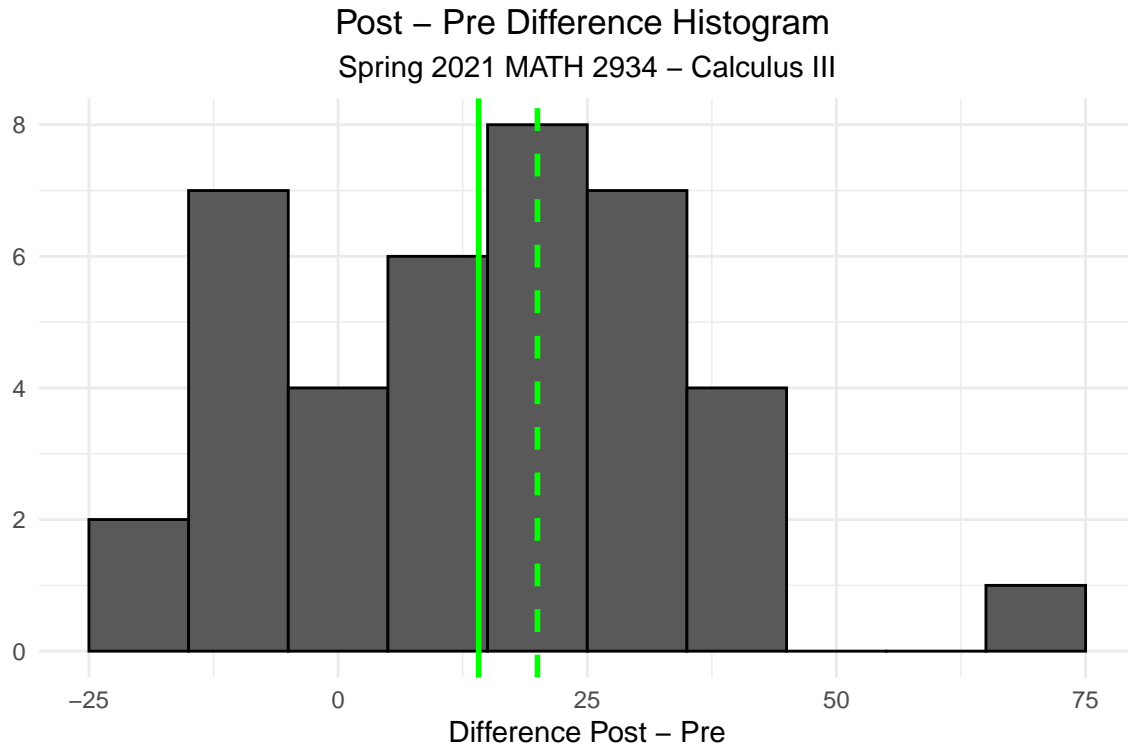
Paired T confidence interval (Spring 2021 - MATH 2934 - Calculus III)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	14.10	3.197	38.00	7.631	20.57

The following histogram represents the distribution in **Post - Pre**. We could see that while a few scores went down, the majority of scores increased on average of about 14%.

- The green Solid line represents the mean of **Post - Pre**.
- The green Dashed line represents the median of **Post - Pre**.



Spring 2021 - MATH 3243 - Differential equations

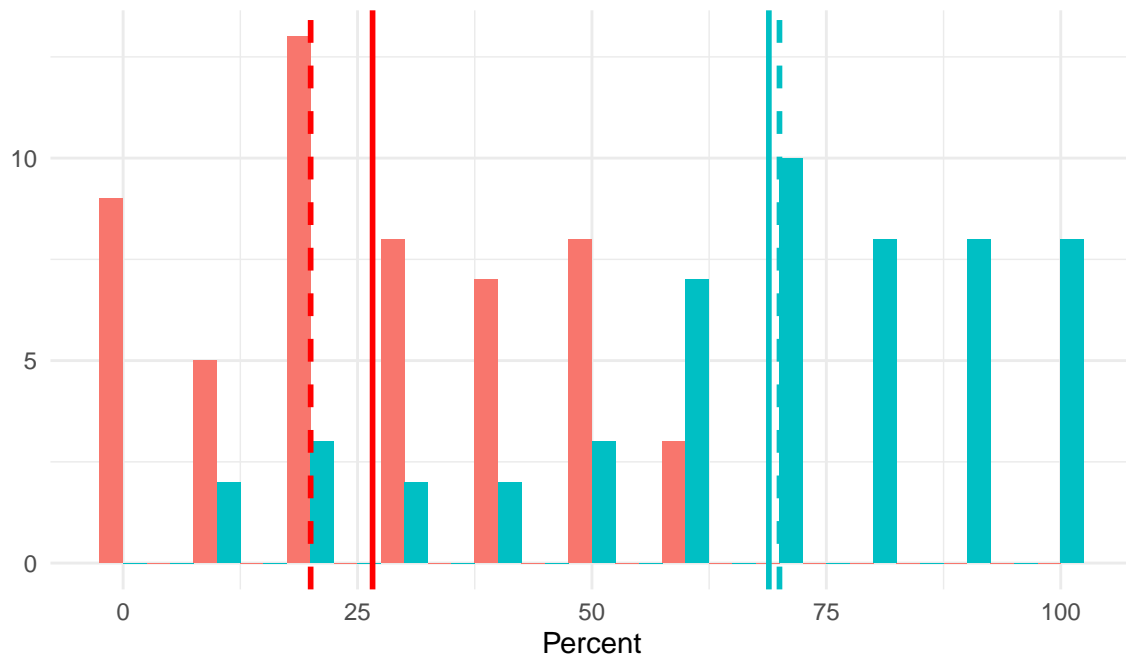
During the Spring semester, there are totally 53 students finished both Pre and Post tests for the course.

Histogram (Spring 2021 - MATH 3243 - Differential equations)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

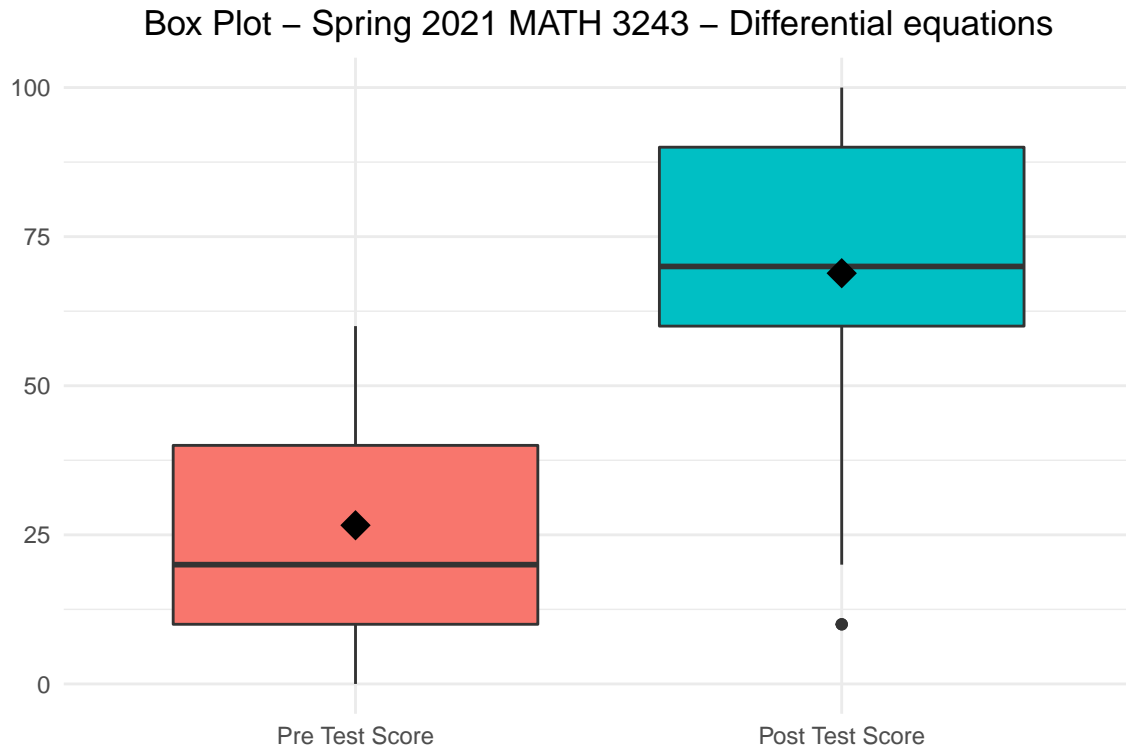
Histogram – Spring 2021 MATH 3243 – Differential equations



Boxplot (Spring 2021 - MATH 3243 - Differential equations)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.



Summary Statistics (Spring 2021 - MATH 3243 - Differential equations)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	53	26.60	18.29	0	10.00	20.00	40.00	60.00
pst	53	68.87	25.09	10.00	60.00	70.00	90.00	100.0

Matched Pair T-Test Statistics (Spring 2021 - MATH 3243 - Differential equations)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	42.26	3.835	52.00	11.02	3.252×10^{-15}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

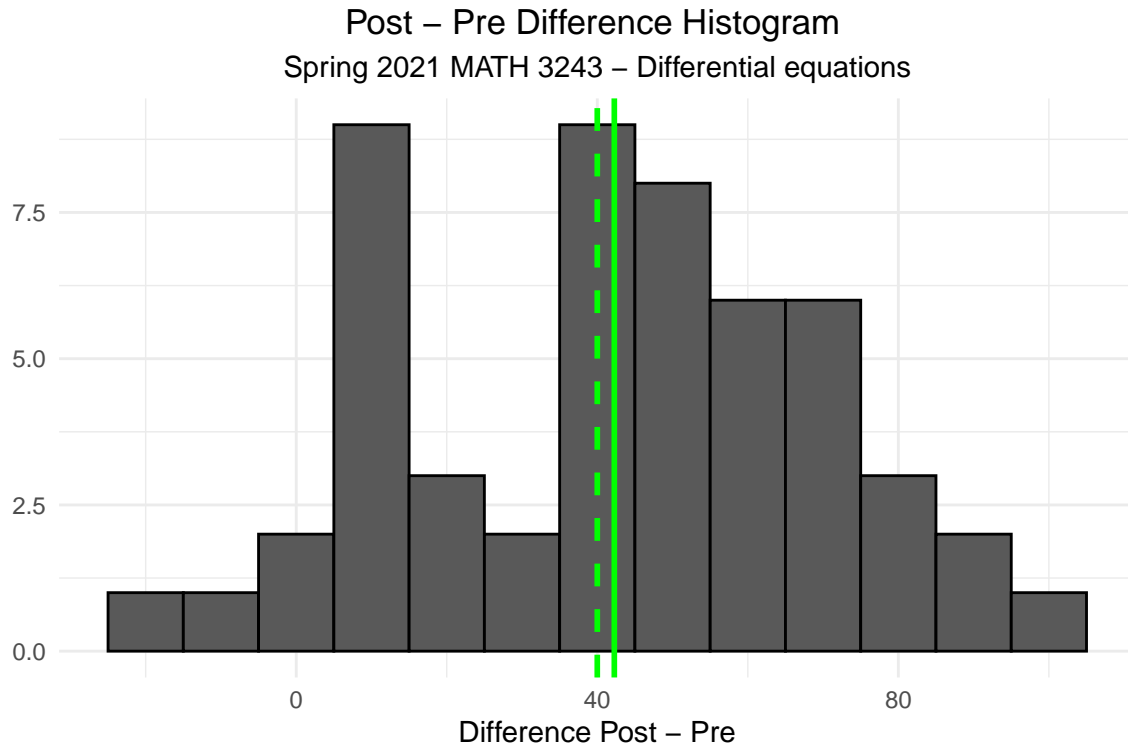
Paired T confidence interval (Spring 2021 - MATH 3243 - Differential equations)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	42.26	3.835	52.00	34.57	49.96

The following histogram represents the distribution in Post - Pre. We could see that while a few scores went down, the majority of scores increased on average of about 42%.

- The green Solid line represents the mean of Post - Pre.
- The green Dashed line represents the median of Post - Pre.



Fall 2021 - MATH 2914 - Calculus I

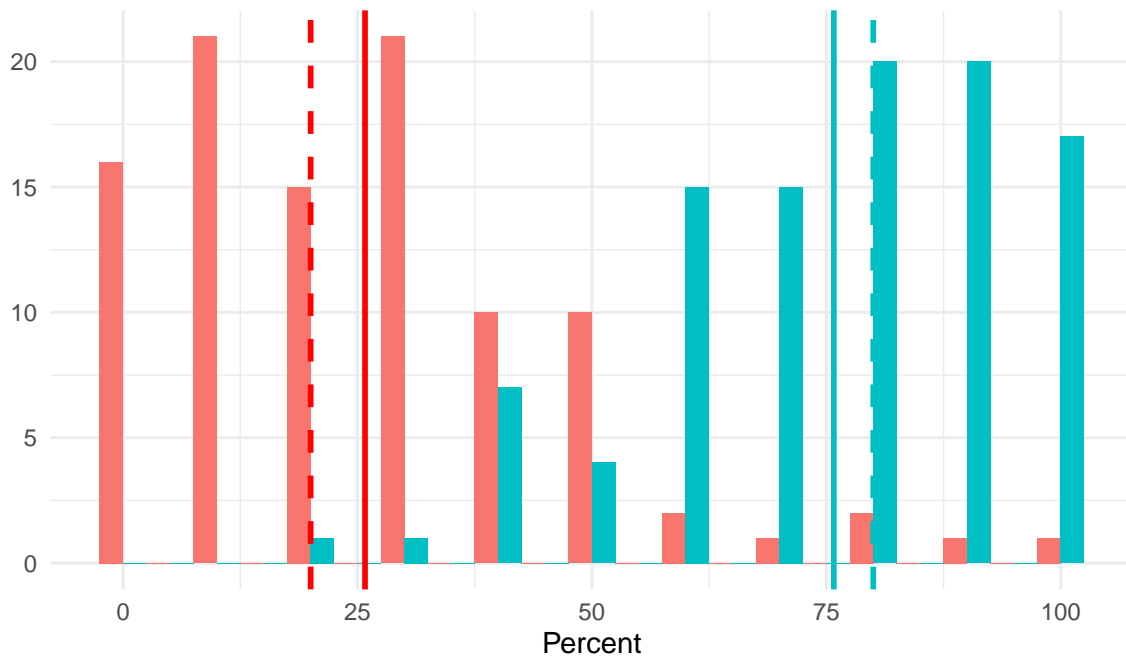
During the Spring semester, there are totally 100 students finished both Pre and Post tests for the course.

Histogram (Fall 2021 - MATH 2914 - Calculus I)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

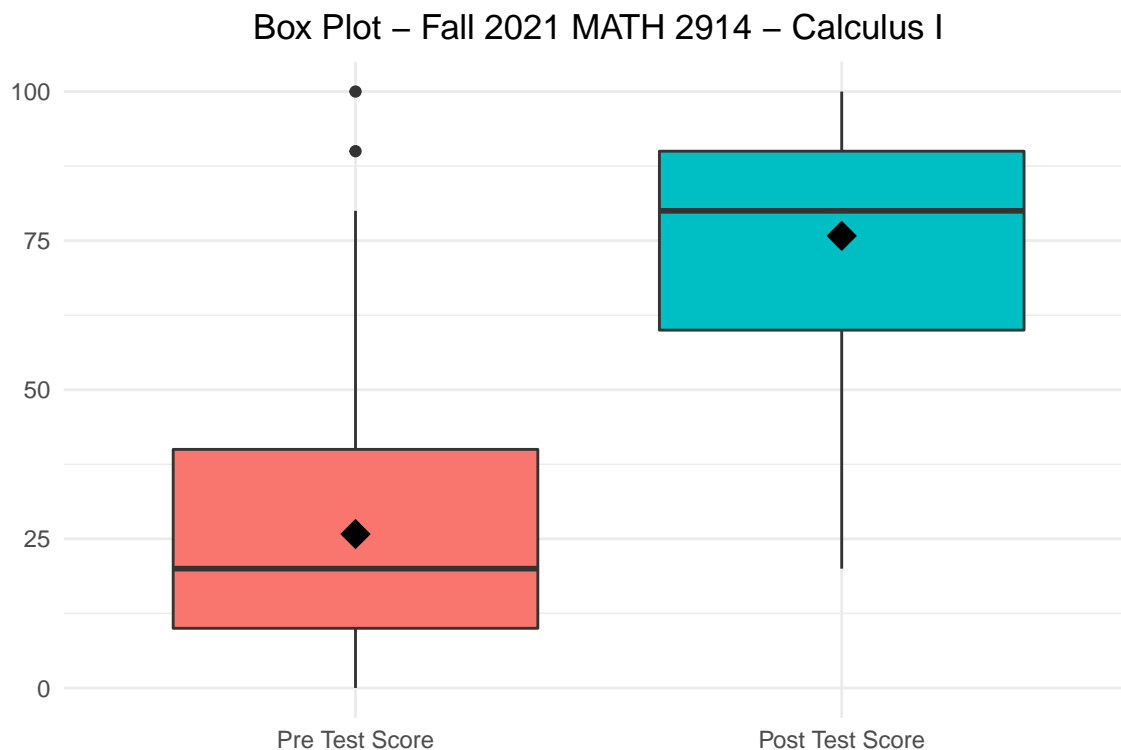
Histogram – Fall 2021 MATH 2914 – Calculus I



Boxplot (Fall 2021 - MATH 2914 - Calculus I)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.



Summary Statistics (Fall 2021 - MATH 2914 - Calculus I)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	100	25.80	21.19	0	10.00	20.00	40.00	100.0
pst	100	75.80	18.92	20.00	60.00	80.00	90.00	100.0

Matched Pair T-Test Statistics (Fall 2021 - MATH 2914 - Calculus I)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	50.00	2.511	99.00	19.92	2.108×10^{-36}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

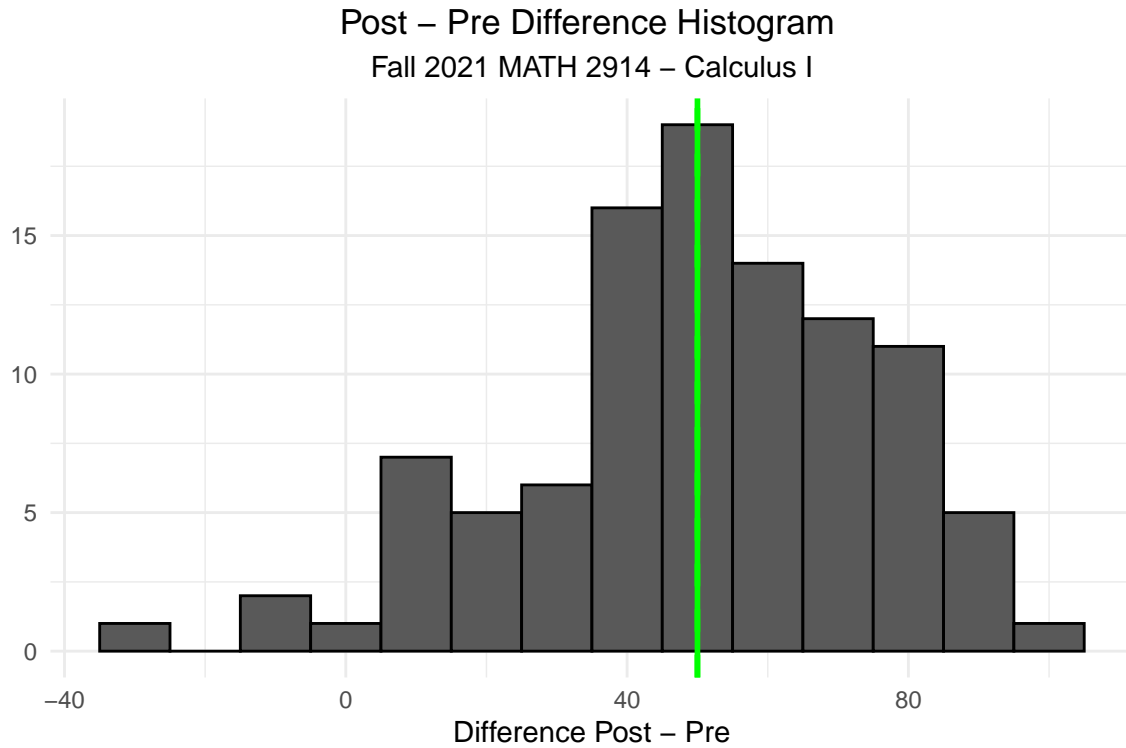
Paired T confidence interval (Fall 2021 - MATH 2914 - Calculus I)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	50.00	2.511	99.00	45.02	54.98

The following histogram represents the distribution in Post - Pre. We could see that while a few scores went down, the majority of scores increased on average of about 50%.

- The green Solid line represents the mean of Post - Pre.
- The green Dashed line represents the median of Post - Pre.



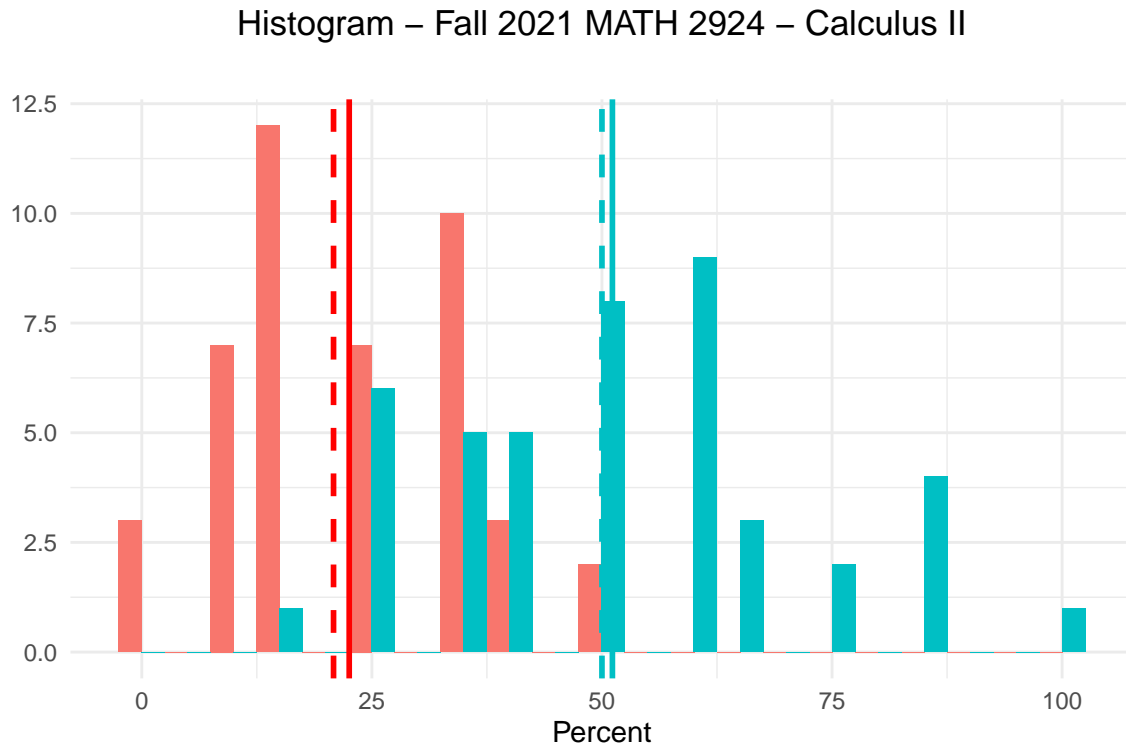
Fall 2021 - MATH 2924 - Calculus II

During the Spring semester, there are totally 44 students finished both Pre and Post tests for the course.

Histogram (Fall 2021 - MATH 2924 - Calculus II)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

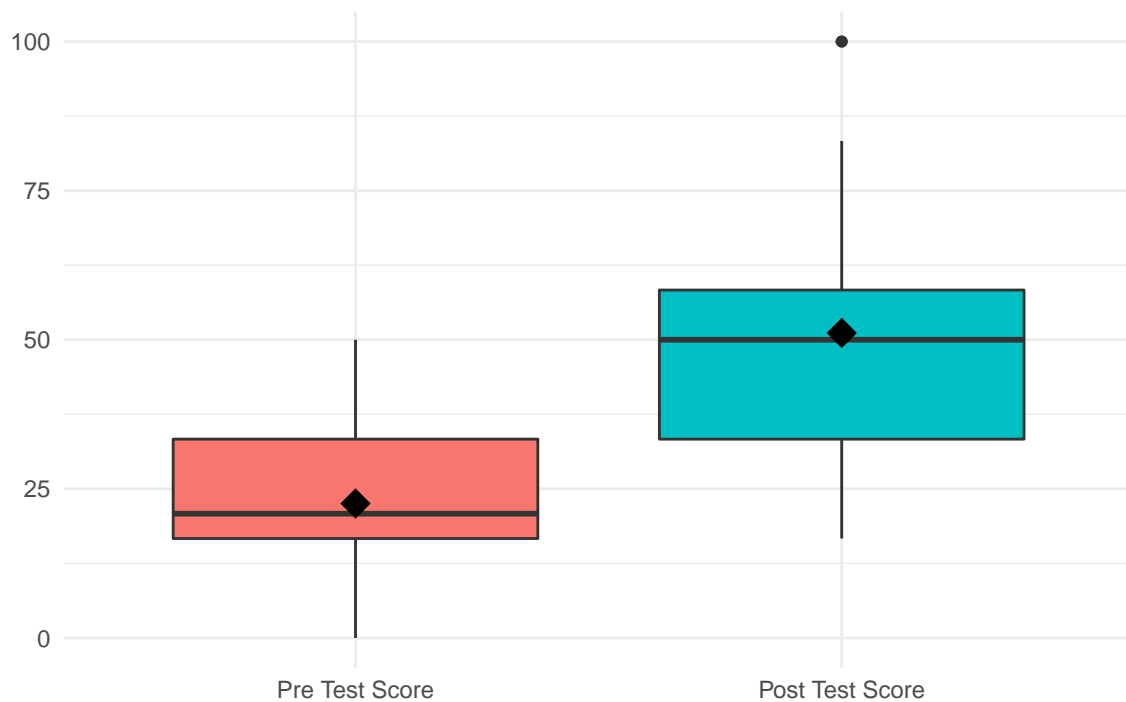


Boxplot (Fall 2021 - MATH 2924 - Calculus II)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.

Box Plot – Fall 2021 MATH 2924 – Calculus II



Summary Statistics (Fall 2021 - MATH 2924 - Calculus II)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	44	22.54	12.91	0	16.67	20.83	33.33	50.00
pst	44	51.14	19.41	16.67	33.33	50.00	58.33	100.0

Matched Pair T-Test Statistics (Fall 2021 - MATH 2924 - Calculus II)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	28.60	3.578	43.00	7.993	485.3×10^{-12}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

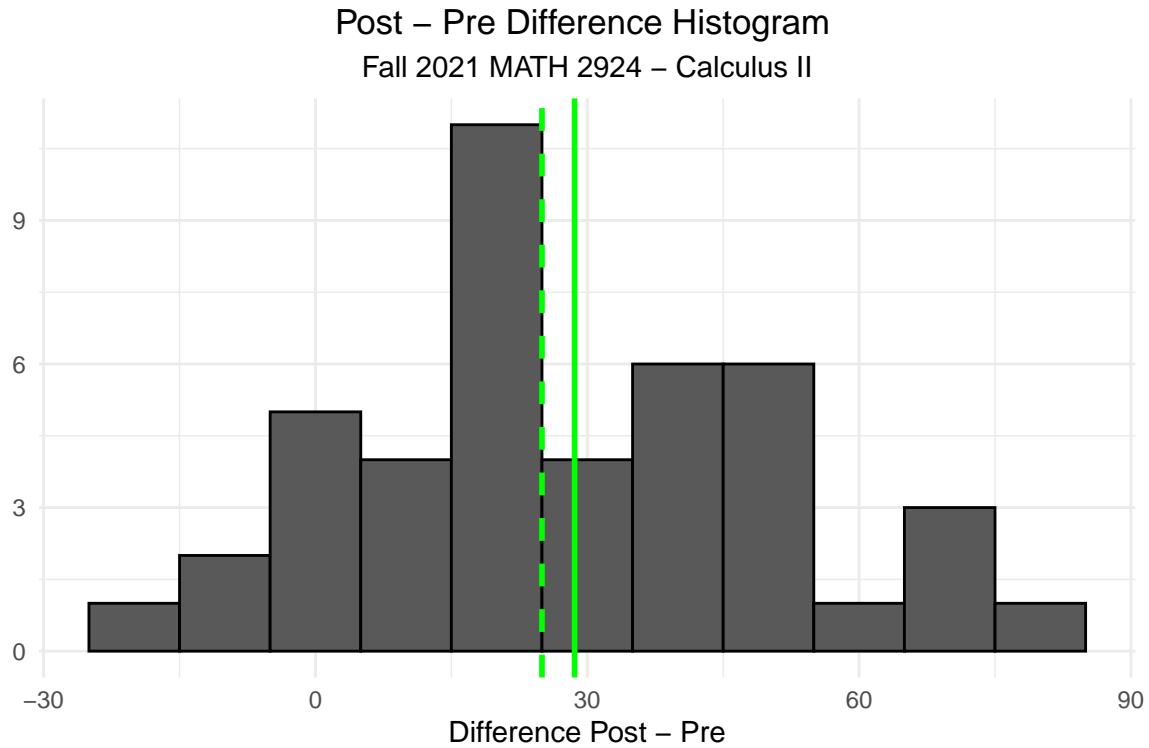
Paired T confidence interval (Fall 2021 - MATH 2924 - Calculus II)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	28.60	3.578	43.00	21.38	35.81

The following histogram represents the distribution in Post - Pre. We could see that while a few scores went down, the majority of scores increased on average of about 29%.

- The green Solid line represents the mean of Post - Pre.
- The green Dashed line represents the median of Post - Pre.



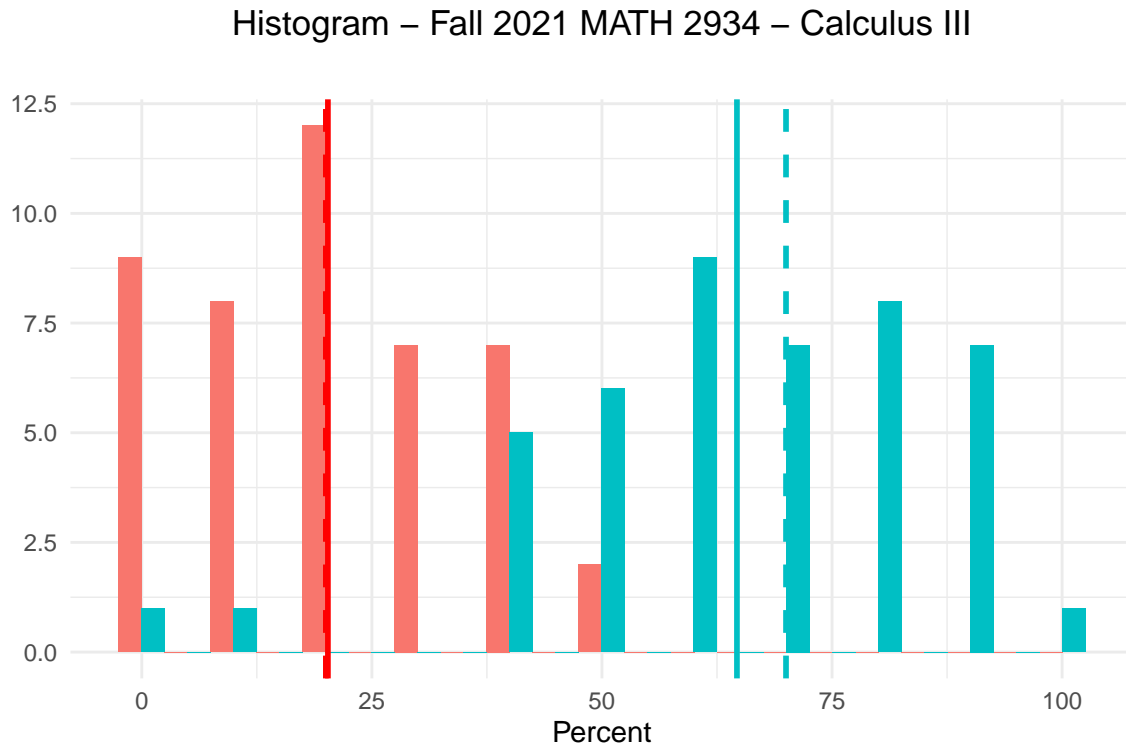
Fall 2021 - MATH 2934 - Calculus III

During the Spring semester, there are totally 45 students finished both Pre and Post tests for the course.

Histogram (Fall 2021 - MATH 2934 - Calculus III)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

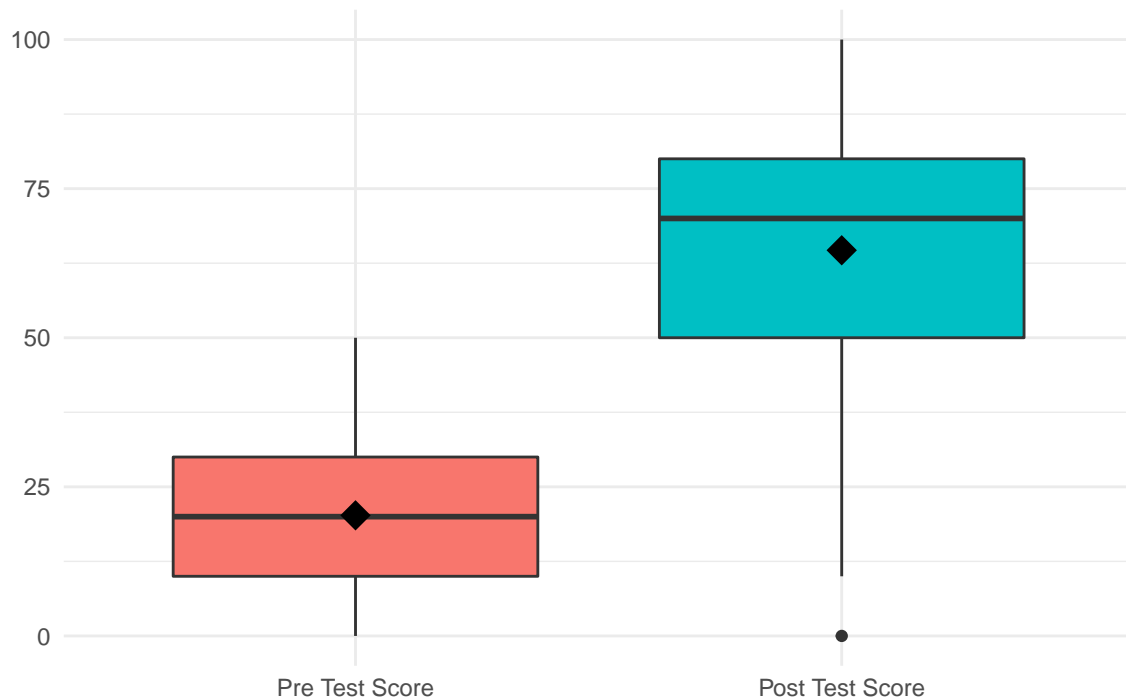


Boxplot (Fall 2021 - MATH 2934 - Calculus III)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.

Box Plot – Fall 2021 MATH 2934 – Calculus III



Summary Statistics (Fall 2021 - MATH 2934 - Calculus III)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	45	20.22	14.85	0	10.00	20.00	30.00	50.00
pst	45	64.67	21.06	0	50.00	70.00	80.00	100.0

Matched Pair T-Test Statistics (Fall 2021 - MATH 2934 - Calculus III)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	44.44	3.821	44.00	11.63	5.177×10^{-15}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

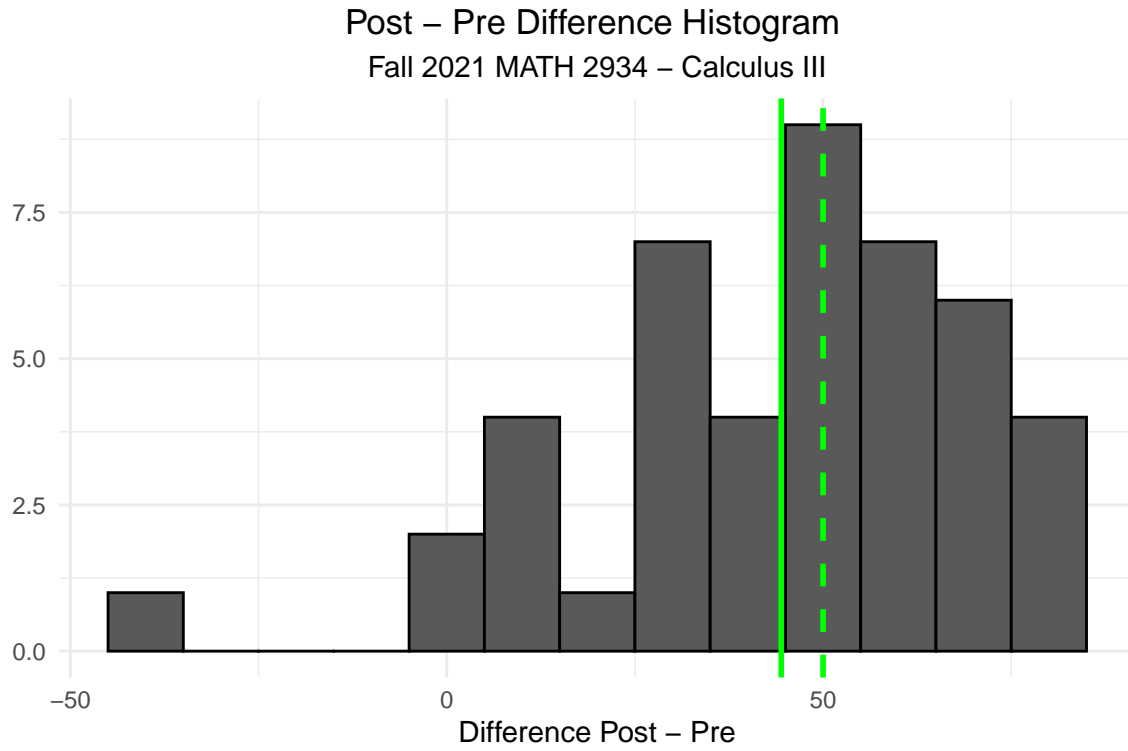
Paired T confidence interval (Fall 2021 - MATH 2934 - Calculus III)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	44.44	3.821	44.00	36.74	52.15

The following histogram represents the distribution in **Post - Pre**. We could see that while a few scores went down, the majority of scores increased on average of about 44%.

- The green Solid line represents the mean of **Post - Pre**.
- The green Dashed line represents the median of **Post - Pre**.



Fall 2021 - MATH 3243 - Differential equations

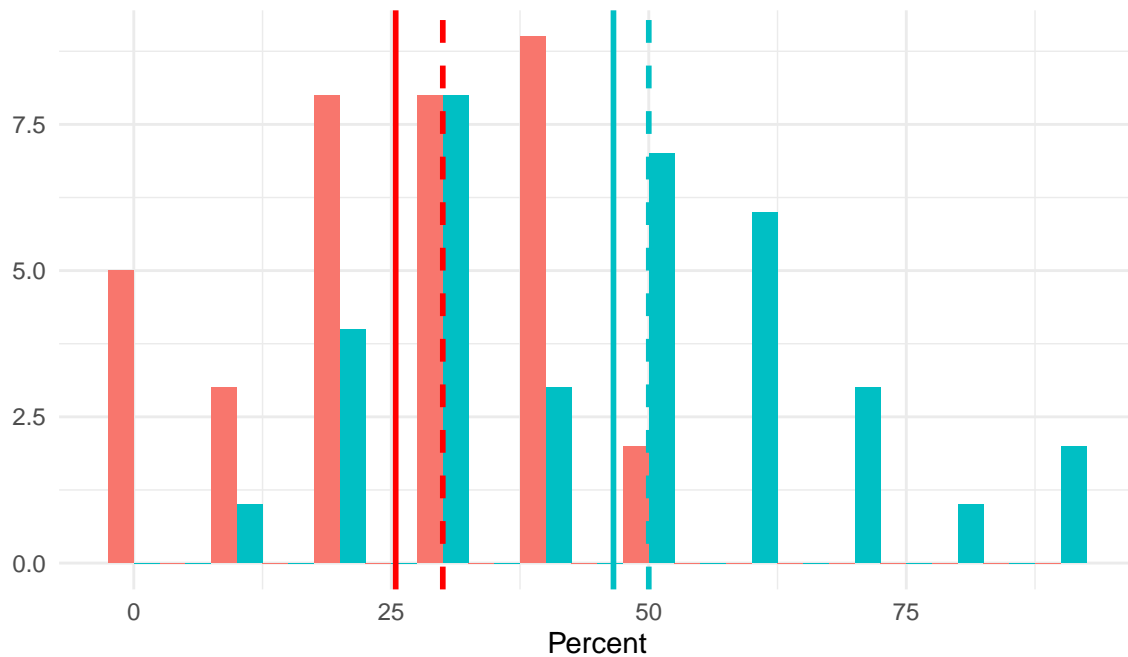
During the Spring semester, there are totally 35 students finished both Pre and Post tests for the course.

Histogram (Fall 2021 - MATH 3243 - Differential equations)

The histogram below shows the distribution of the Pre & Post test scores.

- The blue represent Post test scores, while the red represents Pre test scores.
- The **solid** vertical line represents the mean of the test scores.
- The **dashed** vertical line represents the median of the test scores.

Histogram – Fall 2021 MATH 3243 – Differential equations



Boxplot (Fall 2021 - MATH 3243 - Differential equations)

Now we turn to the box plot. This is another visual of the data values for the Pre & Post test scores.

- The black *horizontal line* in the middle of the boxplot represents the median.
- The black **diamond point** represents the mean.

Box Plot – Fall 2021 MATH 3243 – Differential equations



Summary Statistics (Fall 2021 - MATH 3243 - Differential equations)

The above plots can be summarized into the following table.

Variable	n	Mean	Std.dev.	Min	Q1	Median	Q3	Max
pre	35	25.43	14.82	0	20.00	30.00	40.00	50.00
pst	35	46.57	20.43	10.00	30.00	50.00	60.00	90.00

Matched Pair T-Test Statistics (Fall 2021 - MATH 3243 - Differential equations)

We look at the statistics of the difference of Pre and Post test scores.

Difference	Mean	Std.Err	DF	T.Stat	P.value
Post - Pre	21.14	3.592	34.00	5.886	1.211×10^{-6}

Since the P-value < 0.05 , it shows that the increase of the scores from Pre test to Post test is significant.

Paired T confidence interval (Fall 2021 - MATH 3243 - Differential equations)

The 95% confidence interval to characterize the difference between Post percent and Pre percent is shown below.

Difference	Mean	Std.Err	DF	L.Limit	U.Limit
Post - Pre	21.14	3.592	34.00	13.84	28.44

The following histogram represents the distribution in Post - Pre. We could see that while a few scores went down, the majority of scores increased on average of about 21%.

- The green Solid line represents the mean of Post - Pre.
- The green Dashed line represents the median of Post - Pre.

