Introduction

This is my version of the Google Data Analytics Capstone - Case Study 1. The full document of the case study can be found in the Google Data Analytics Capstone: Complete a Case Study course.

Getting context from the cyclistic document (Copy):

> Assume you are the new superintendent of School District which has a Junior High School that consists of approximately 500 students in grades 7-8. Students are randomly assigned to grade-level, subject-specific classroom teachers. The school is diverse socioeconomically with several students qualifying for free or reduced-price meals. The ethnic composition of the school is relatively diverse consisting primarily of African-American, Hispanic, Asian, and Caucasian students.

> There are three teachers who teach 8th-grade math at the school, each doing their own thing when it comes to teaching math. Ms. Ruger, a young African-American lady who is certified to teach science and math, has been teaching for a total of 5 years and has taught math for the past 3 years. Ms. Smith, a Caucasian lady in her 40s who is certified to teach Spanish and math, has taught Spanish for 12 years but has taught math for the past 3 years. Ms. Wesson, an older Caucasian lady and the sister of the school board president, has been teaching PE for 24 years and has been assigned to teach math for the past 3 years. Each teacher was allowed to use their preferred teaching method and to select their own textbook three years ago. All three use different textbooks.

> Ms. Wesson’s approach to teaching math would be broadly defined as the traditional method. The traditional math teacher adheres to a top-down approach in which knowledge originates from the teacher and is disseminated to the students. The teacher is recognized by the students (and often by the teacher herself) as the authority on the subject matter. Traditional math teachers tend to thrive on structure and order, resulting in quiet, calm learning environments. There is research that indicates certain behavioral issues are minimized in a traditional classroom resulting in effective, direct instruction.

> Ms. Ruger and Ms. Smith’s approach to teaching math would be more broadly defined as the standards-based method. The standards-based math teacher adheres to a literal interpretation of well-written standards. The teacher facilitates the learning in a constructivist environment in which students develop, explore, conjecture and test their conjectures within the confines of the standard. The teacher believes there is research that a majority of children learn more and deeper mathematics and are better problem solvers when in the standards-based classroom.

> During a meeting with the math department it was suggested that the three 8th-grade math teachers should be using the same teaching method and the same textbook. Ms. Wesson, being quite vocal, feels strongly that her approach is the better of the two because of the ethnic composition and sociological background of the students. She further believes and proposes that the students should be grouped among the three teachers according to the students' ethnicity. She suggests that Ms. Ruger who is African-American teach the majority of the African-American students and that she, Ms. Wesson, would primarily teach the Caucasian and Asian students. Ms. Smith, who speaks fluent Spanish, would teach the majority of the Hispanic students. She also proposes that students be grouped within each teacher's class by their ability with the high-ability students in a group by themselves and the lower-ability students in a group by themselves because she believes, based on a "gut" feeling, that the students will perform better if they are segregated into groups within the classroom. To support her argument she provides a copy of an article she located in the ATU library (see the Ross article entitled "Math and Reading Instruction in Tracked First-Grade Classes") to each member of the department. She mentions that she has discussed this with her brother, the school board president, and that it will probably be discussed at the next board meeting. She further states that math is math and teachers should be allowed to teach using the style in which they are most comfortable.

> Ms. Smith does not agree with Ms. Wesson's proposal and shares an article that she has read (see the Thompson article about standards-based math). She states that research indicates students in traditional programs may have better procedural skills, but definitely lack in problem-solving creativity. She proposes that all three teachers should be using the standards-based approach to teaching.

> Knowing that you have less than 30 days before the next board meeting you know that you need to have a proposal prepared based on school performance data. You have access to the

The problem to be solved is determining which teaching method is best suited for the 8th year students and whether and how students should be grouped in the future.

The insight will help teachers in having a better teaching approach, resulting in better student performances.

Task is to find key differences in these teaching methods and how/whether these methods affect students with different backgrounds differently.

Where is your data located?

> The data is located in a Kaggle dataset.

Format of the data?

> The data is primary, internal, discrete, quantitative, qualitative, nominal and structured.

Are there issues with bias or credibility in this data? Does your data ROCCC?

> It doesn't contain questions that would be misleading but the results are just from one test which is a problem. In regard to being ROCCC, the data is reliable, original, current and cited but I wouldn't say it's comprehensive as the column names (freeredu and wesson) didn't describe the data clearly.

How are you addressing licensing, privacy, security, and accessibility?

> In order to protect confidentially, student names have been replaced by numbers.

How did you verify the data's integrity?

> All the files have consistent columns and each column has the correct type of data.

How does it help you answer your question?

> It may have some key insights about the students and their learning styles.

Are there any problems with the data?

Getting Started

1. Check the data for duplicates, missing data and clean it.
2. What I'm interested in is:
    - How are students distributed by teaching style?
    - How are students distributed by ethnicity for each teacher group and in general in the 8th grade?
    - What are the average scores in the teaching method group, teacher group, ethnic group, gender group and free/paid lunch group?
3. Check different hypotheses with appropriate tests.
4. Write final insights, conclusions, limitations, recommendations, and improvements.

In [1]:

```
library(tidyverse)
```

```
── Attaching packages ─────────────────────────────────────── tidyvers
e 1.3.1 ──

✔ ggplot2 3.3.6     ✔ purrr   0.3.4
✔ tibble  3.1.7     ✔ dplyr   1.0.9
✔ tidyr   1.2.0     ✔ stringr 1.4.0
✔ readr   2.1.2     ✔ forcats 0.5.1

── Conflicts ────────────────────────────────────────── tidyverse_conf
licts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
```

In [2]:

```
library(haven)
library(readr)
library(dplyr)
df <- read_sav("../input/students-math-score-for-different-teaching-style/1ResearchI

head(df)
```

A tibble: 6 × 7

Student	Teacher	Gender	Ethnic	Freeredu	Score	wesson
<dbl>	<dbl+lbl>	<dbl+lbl>	<dbl+lbl>	<dbl+lbl>	<dbl>	<dbl+lbl>
1	1	1	1	1	76	0
2	1	1	3	2	56	0
3	1	1	2	1	34	0
4	1	1	1	2	59	0
5	1	2	3	1	73	0
6	1	2	4	2	58	0

In [3]:

```
# A quick summary.
summary(df)
```

```
    Student          Teacher          Gender          Ethnic      
 Min.   :  1.00   Min.   :1.000   Min.   :1.000   Min.   :1.000  
 1st Qu.: 54.75   1st Qu.:1.000   1st Qu.:1.000   1st Qu.:2.000  
 Median :108.50   Median :2.000   Median :2.000   Median :3.000  
 Mean   :108.50   Mean   :2.023   Mean   :1.556   Mean   :2.477  
 3rd Qu.:162.25   3rd Qu.:3.000   3rd Qu.:2.000   3rd Qu.:3.000  
 Max.   :216.00   Max.   :3.000   Max.   :2.000   Max.   :4.000  
 NA's   :1        NA's   :1       NA's   :1       NA's   :1      
    Freeredu         Score           wesson      
 Min.   :1.000   Min.   :30.00   Min.   :0.0000  
 1st Qu.:1.000   1st Qu.:53.00   1st Qu.:0.0000  
 Median :2.000   Median :65.00   Median :0.0000  
 Mean   :1.519   Mean   :65.27   Mean   :0.3502  
 3rd Qu.:2.000   3rd Qu.:79.00   3rd Qu.:1.0000  
 Max.   :2.000   Max.   :95.00   Max.   :1.0000  
 NA's   :1       NA's   :1                       
```

Data Cleaning and Preparation

In [4]:

```
#Checking if there are any duplicates. If there were, we would have to remove them.
anyDuplicated(df)
```

0

There are no duplicated in the dataset

In [5]:

```
# From the summary() we see there are NA values so they had to be removed from the d
df_noNa <- na.omit(df)
```

In [6]:

```
# The imported data is sav format and it converted the string values in number, maki
# I tried to convert it to csv format, but it didn't help. Don't know if this is the
# The "wesson" column was replaces with teaching methods of the teacher

df_noNa$Teacher <- as.character(df_noNa$Teacher)
df_noNa$Gender <- as.character(df_noNa$Gender)
df_noNa$Ethnic <- as.character(df_noNa$Ethnic)
df_noNa$Freeredu <- as.character(df_noNa$Freeredu)
df_noNa$wesson <- as.character(df_noNa$wesson)

df_noNa$Teacher[df_noNa$Teacher == "1"] <- "Ruger"
df_noNa$Teacher[df_noNa$Teacher == "2"] <- "Smith"
df_noNa$Teacher[df_noNa$Teacher == "3"] <- "Wesson"
df_noNa$Gender[df_noNa$Gender == "1"] <- "Female"
df_noNa$Gender[df_noNa$Gender == "2"] <- "Male"
df_noNa$Ethnic[df_noNa$Ethnic == "1"] <- "Asian"
df_noNa$Ethnic[df_noNa$Ethnic == "2"] <- "African-American"
df_noNa$Ethnic[df_noNa$Ethnic == "3"] <- "Hispanic"
df_noNa$Ethnic[df_noNa$Ethnic == "4"] <- "Caucasian"
df_noNa$Freeredu[df_noNa$Freeredu == "1"] <- "Free lunch"
df_noNa$Freeredu[df_noNa$Freeredu == "2"] <- "Paid lunch"
df_noNa$wesson[df_noNa$wesson == "0"] <- "Standard"
df_noNa$wesson[df_noNa$wesson == "1"] <- "Traditional"

df_noNa
```

A tibble: 216 × 7

Student	Teacher	Gender	Ethnic	Freeredu	Score	wesson
<dbl>	<chr>	<chr>	<chr>	<chr>	<dbl>	<chr>
1	Ruger	Female	Asian	Free lunch	76	Standard
2	Ruger	Female	Hispanic	Paid lunch	56	Standard
3	Ruger	Female	African-American	Free lunch	34	Standard
4	Ruger	Female	Asian	Paid lunch	59	Standard
5	Ruger	Male	Hispanic	Free lunch	73	Standard
6	Ruger	Male	Caucasian	Paid lunch	58	Standard
7	Ruger	Female	African-American	Paid lunch	62	Standard
8	Ruger	Male	Hispanic	Free lunch	40	Standard
9	Ruger	Female	African-American	Free lunch	82	Standard
10	Ruger	Male	African-American	Paid lunch	78	Standard
11	Ruger	Male	African-American	Paid lunch	64	Standard
12	Ruger	Female	Asian	Paid lunch	68	Standard
13	Ruger	Male	Hispanic	Free lunch	39	Standard
14	Ruger	Male	Caucasian	Free lunch	48	Standard
15	Ruger	Female	Caucasian	Free lunch	66	Standard
16	Ruger	Male	Asian	Free lunch	68	Standard
17	Ruger	Female	Hispanic	Paid lunch	72	Standard
18	Ruger	Female	African-American	Free lunch	60	Standard
19	Ruger	Male	Caucasian	Free lunch	54	Standard
20	Ruger	Male	Asian	Paid lunch	34	Standard
21	Ruger	Female	Hispanic	Paid lunch	30	Standard
22	Ruger	Male	Asian	Free lunch	43	Standard
23	Ruger	Female	Hispanic	Paid lunch	73	Standard
24	Ruger	Male	African-American	Free lunch	44	Standard
25	Ruger	Male	Asian	Free lunch	39	Standard
26	Ruger	Male	African-American	Free lunch	67	Standard
27	Ruger	Female	Hispanic	Paid lunch	37	Standard
28	Ruger	Male	Caucasian	Free lunch	67	Standard
29	Ruger	Male	Hispanic	Paid lunch	32	Standard
30	Ruger	Male	Caucasian	Paid lunch	64	Standard
⋮	⋮	⋮	⋮	⋮	⋮	⋮
187	Wesson	Male	Caucasian	Free lunch	45	Traditional
188	Wesson	Male	Hispanic	Paid lunch	81	Traditional
189	Wesson	Female	African-American	Paid lunch	65	Traditional
190	Wesson	Male	African-American	Free lunch	89	Traditional
191	Wesson	Female	Caucasian	Paid lunch	64	Traditional

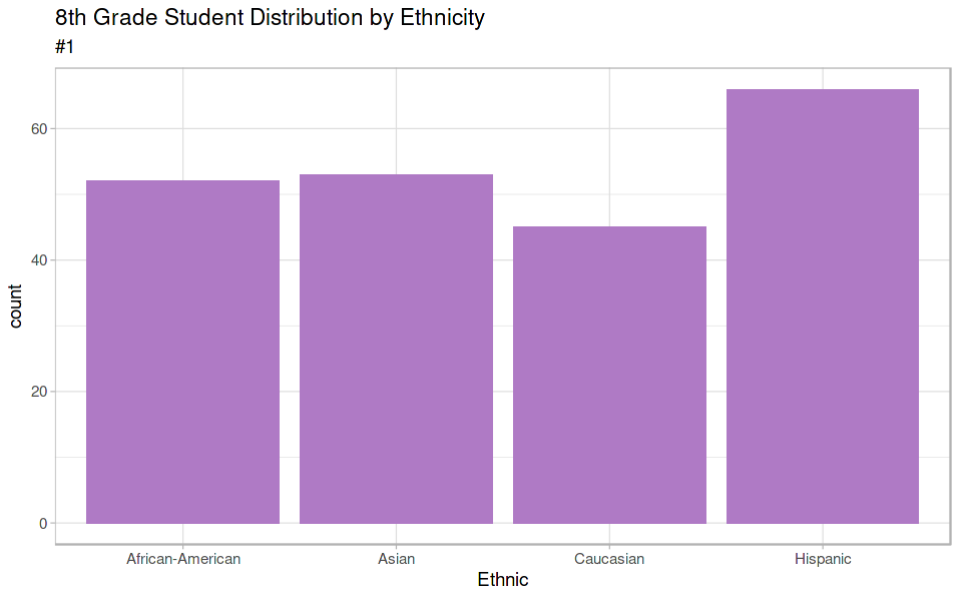
Student	Teacher	Gender	Ethnic	Freeredu	Score	wesson
<dbl>	<chr>	<chr>	<chr>	<chr>	<dbl>	<chr>
192	Wesson	Female	Asian	Paid lunch	85	Traditional
193	Wesson	Male	Caucasian	Paid lunch	90	Traditional
194	Wesson	Female	Hispanic	Free lunch	64	Traditional
195	Wesson	Female	Caucasian	Paid lunch	68	Traditional
196	Wesson	Female	Hispanic	Paid lunch	84	Traditional
197	Wesson	Female	African-American	Free lunch	83	Traditional
198	Wesson	Female	Asian	Paid lunch	93	Traditional
199	Wesson	Male	Caucasian	Paid lunch	47	Traditional
200	Wesson	Female	Hispanic	Free lunch	83	Traditional
201	Wesson	Female	Asian	Free lunch	53	Traditional
202	Wesson	Male	Caucasian	Paid lunch	79	Traditional
203	Wesson	Male	Asian	Free lunch	87	Traditional
204	Wesson	Male	African-American	Paid lunch	89	Traditional
205	Wesson	Female	Asian	Paid lunch	56	Traditional
206	Wesson	Female	Hispanic	Paid lunch	83	Traditional
207	Wesson	Male	Caucasian	Paid lunch	45	Traditional
208	Wesson	Male	Caucasian	Paid lunch	75	Traditional
209	Wesson	Female	Caucasian	Free lunch	58	Traditional
210	Wesson	Female	African-American	Free lunch	72	Traditional
211	Wesson	Male	Caucasian	Paid lunch	79	Traditional
212	Wesson	Male	African-American	Paid lunch	56	Traditional
213	Wesson	Male	Hispanic	Free lunch	94	Traditional
214	Wesson	Male	Hispanic	Paid lunch	91	Traditional
215	Wesson	Female	African-American	Paid lunch	53	Traditional
216	Wesson	Male	Hispanic	Paid lunch	57	Traditional

What does the data say?

Let's take a quick look at some visuals.

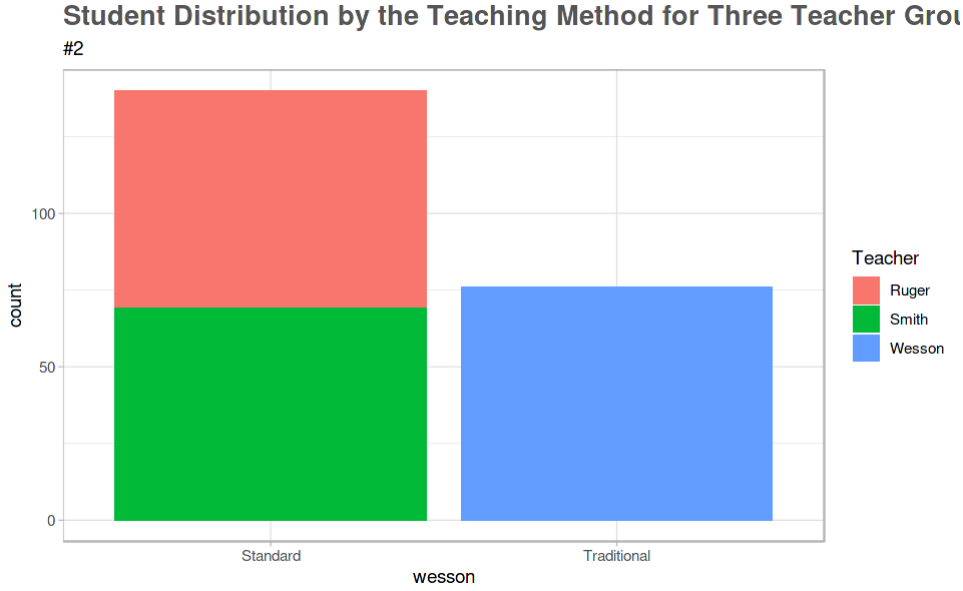
In [7]:

```
options(repr.plot.width =8, repr.plot.height = 5)

theme_set(theme_bw(base_size = 14))
theme_set(theme_light())

ggplot(data = df_noNa)+geom_bar(mapping=aes(x=Ethnic),fill="#AF7AC5") +
labs(title = "8th Grade Student Distribution by Ethnicity", subtitle="#1")+theme_upd
```



In [8]:

```
# Standard vs Traditional count
# Coloring bars based on who is the teacher


ggplot(data = df_noNa)+geom_bar(mapping=aes(x=wesson,fill=Teacher)) + labs(title = '
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



In [9]:

```
# Number of students within each teaching group.
# I will soon try to implenet the number in a chart.
df_noNa %>% group_by(wesson) %>%  summarise(n = n())
```

A tibble: 2 × 2

wesson	n
<chr>	<int>
Standard	140
Traditional	76

In [10]:

```
# Number of students per teacher
# Again, a good thing to do is to implement these numbers in the chart.
df_noNa %>% group_by(Teacher) %>%  summarise(n = n())
```

A tibble: 3 × 2

Teacher	n
<chr>	<int>
Ruger	71
Smith	69
Wesson	76

In [11]:

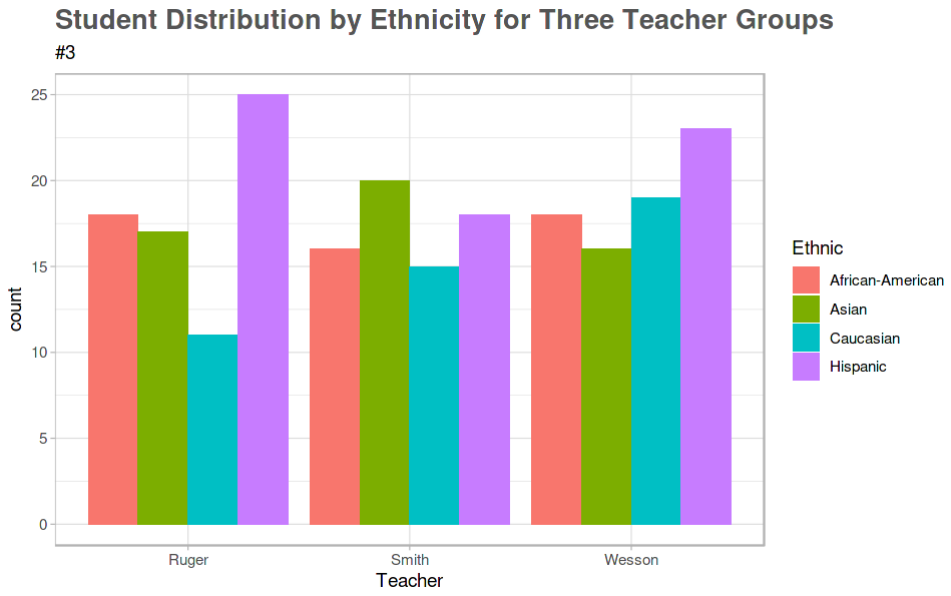
```
# Number of students per teacher
# Again, a good thing to do is to implement these numbers in the chart.
df_noNa %>% group_by(Gender) %>%  summarise(n = n())
```

A tibble: 2 × 2

Gender	n
<chr>	<int>
Female	96
Male	120

In [12]:

```
ggplot(data = df_noNa)+geom_bar(mapping=aes(x=Teacher,fill=Ethnic), position="dodge"
labs(title = "Student Distribution by Ethnicity for Three Teacher Groups ", subtitle
theme(plot.title = element_text(color='#555555', size=16, face='bold', hjust=0))
```

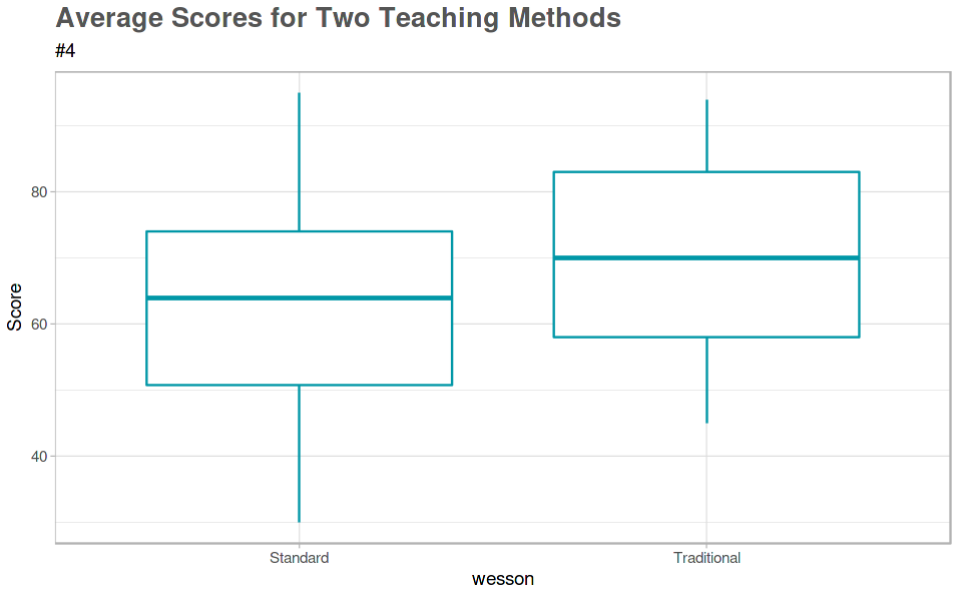


- 8th year Hispanic students make up largest ethnic group.
- 8th year Caucasian students make up smallest ethnic group.
- There are more male (120) than female (96) students.
- The Standard group is almost twice as big as the Traditional group. All teachers teach approximately the same number of students.
- Distribution of students from different ethnic backgrounds among teachers is relatively equal.
- Ms. Ruger teaches twice as much Hispanic students as Caucasian ones.

Average Students' Scores

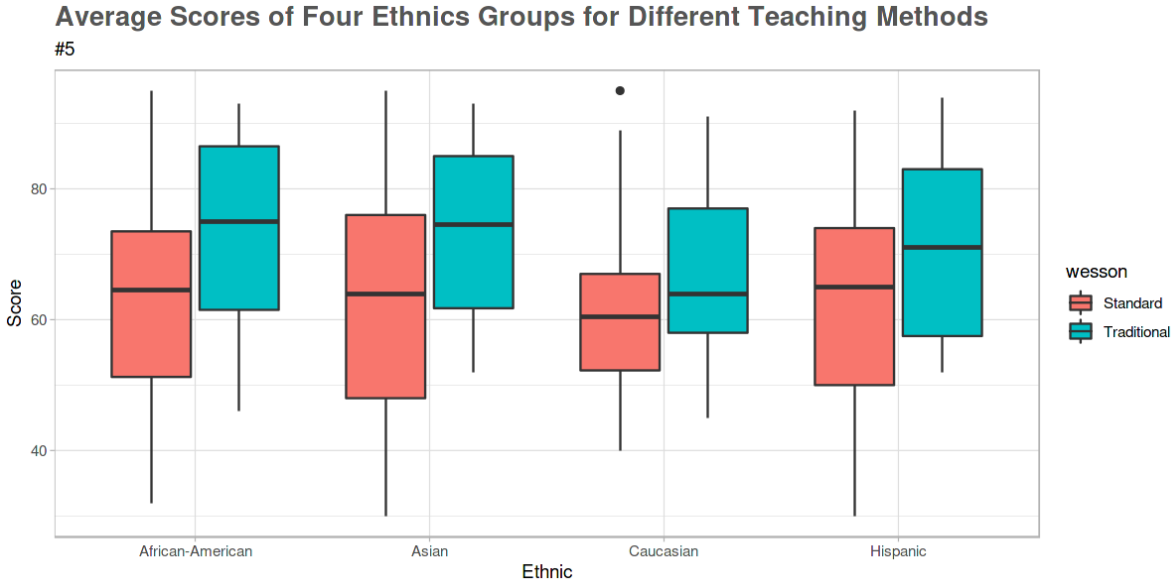
In [13]:

```
ggplot(data=df_noNa,aes(x=wesson, y=Score)) + geom_boxplot(color="#0097A7") +theme_m
labs(title = "Average Scores for Two Teaching Methods", subtitle="#4") +
theme(legend.position="False")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



In [14]:

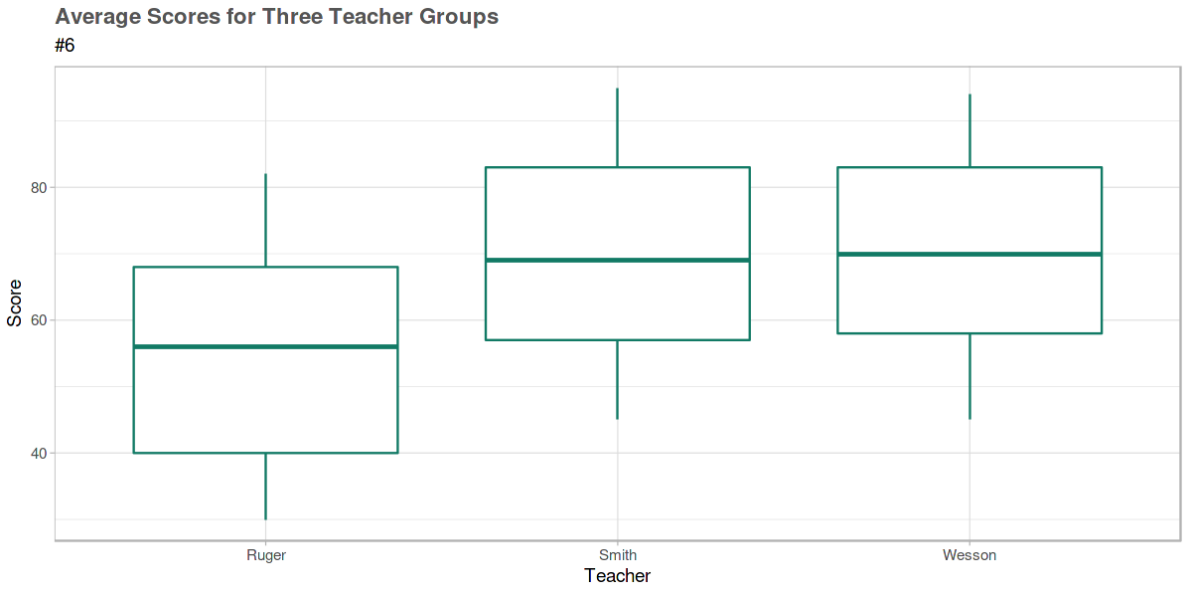
```
options(repr.plot.width = 10, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Ethnic, y=Score,fill=wesson)) + geom_boxplot() +theme_mini
labs(title = "Average Scores of Four Ethnics Groups for Different Teaching Methods",
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=13, face='bold', hjust=
```



First insight shows that the teacher with a traditional approach achieved better results in average for all four ethnic groups. Let's dig deeper into this.

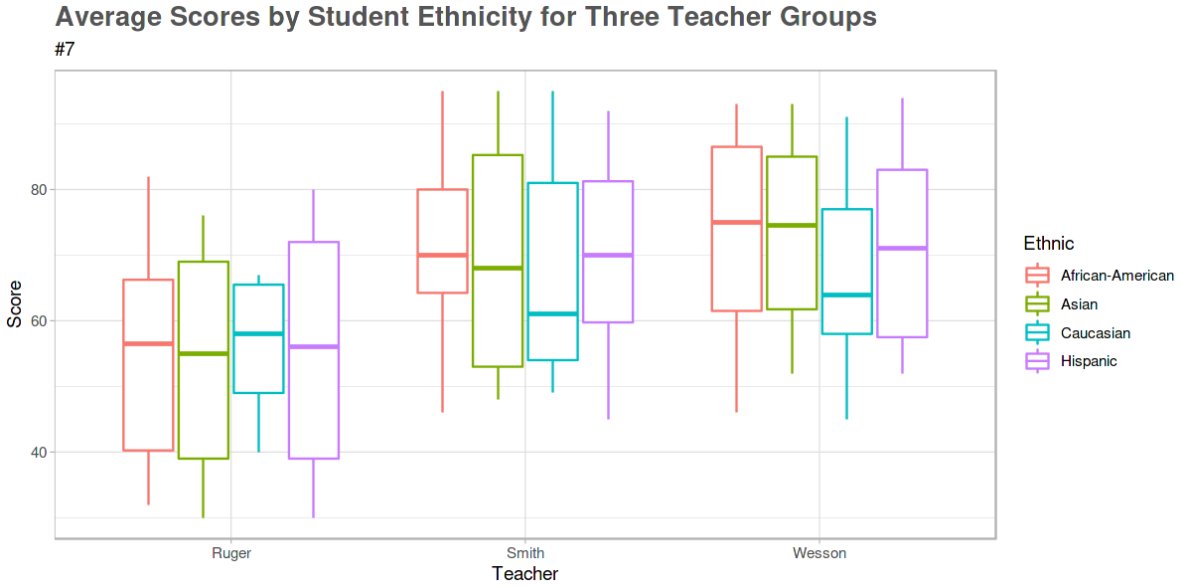
In [15]:

```
options(repr.plot.width = 10, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Teacher, y=Score)) + geom_boxplot(color="#117A65") +theme_
labs(title = "Average Scores for Three Teacher Groups", subtitle="#6") +
theme(legend.position="False")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



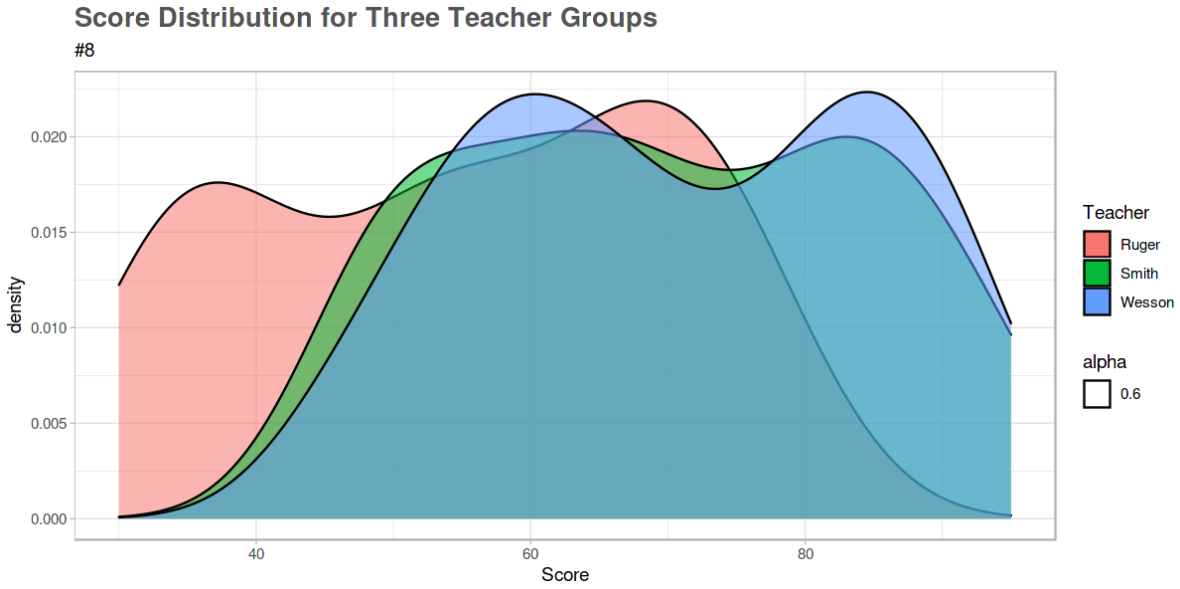
In [16]:

```
options(repr.plot.width = 10, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Teacher, y=Score,color=Ethnic)) + geom_boxplot() +theme_mi
labs(title = "Average Scores by Student Ethnicity for Three Teacher Groups", subtitl
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



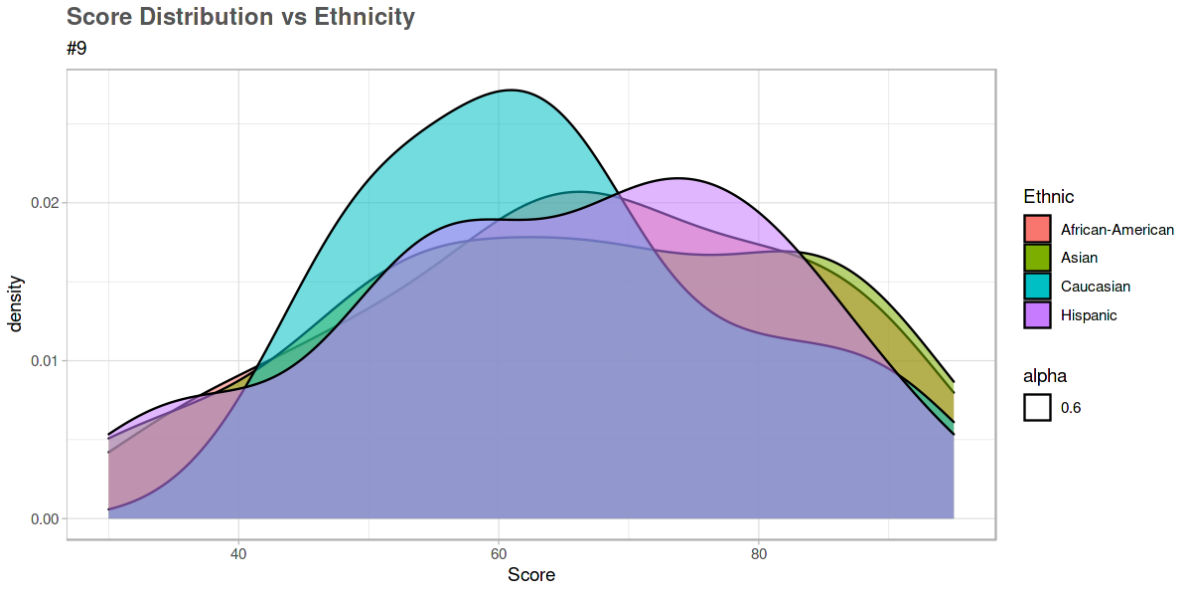
In [17]:

```
ggplot(df_noNa, aes(Score, fill=Teacher, alpha=0.6)) + geom_density()+
labs(title = "Score Distribution for Three Teacher Groups", subtitle="#8") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=14, face='bold', hjust=
```



In [18]:

```
ggplot(df_noNa, aes(Score, fill=Ethnic, alpha=0.6)) + geom_density()+
labs(title = "Score Distribution vs Ethnicity", subtitle="#9") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=14, face='bold', hjust=
```



In [19]:

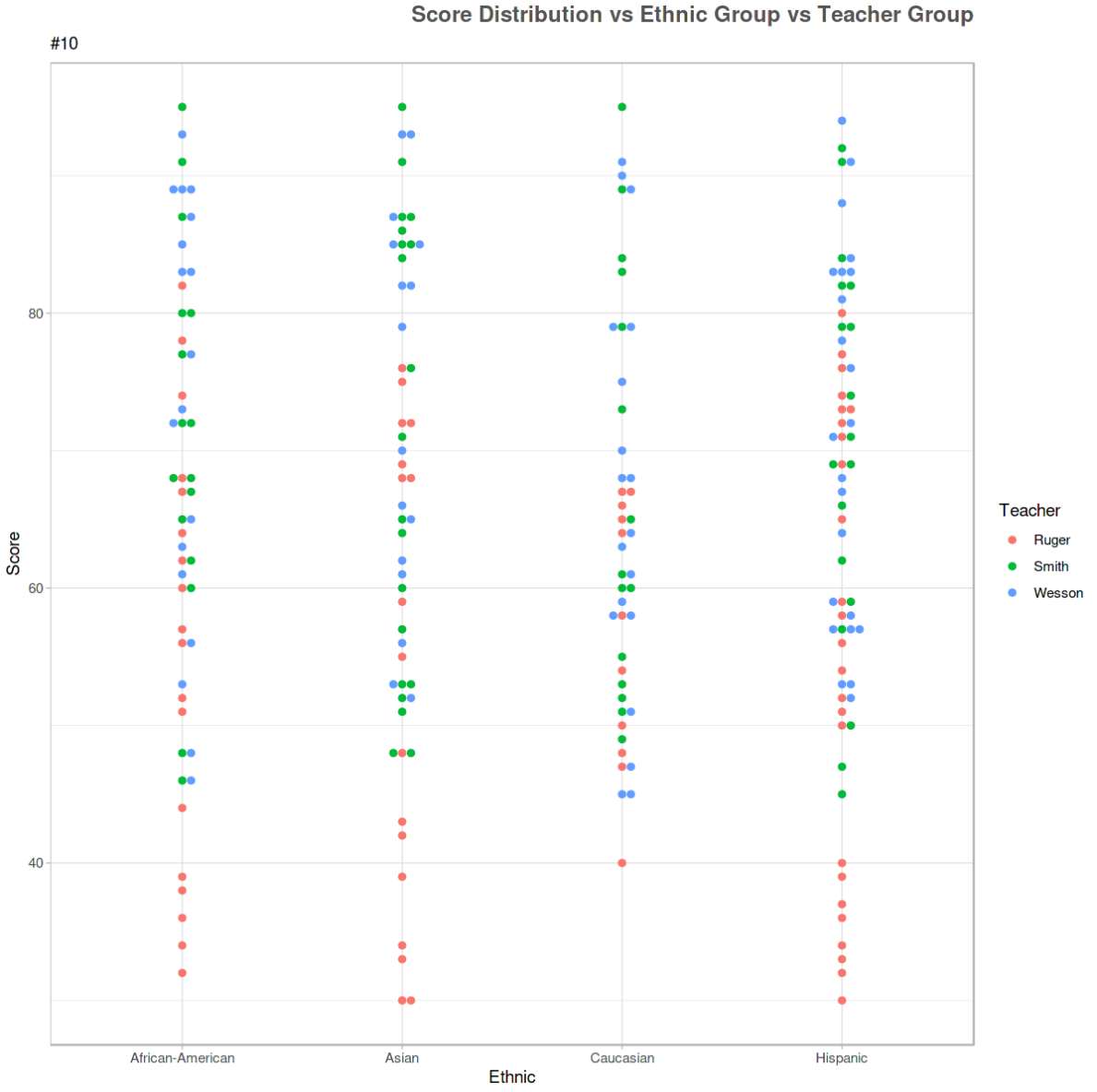
```
# Number of students per Ethnic group
# Average score by each group
df_noNa %>% group_by(Ethnic) %>%  summarise(n = n(), mean = mean(Score), sd = sd(Sco
```

A tibble: 4 × 4

Ethnic	n	mean	sd
<chr>	<int>	<dbl>	<dbl>
African-American	52	66.23077	16.80875
Asian	53	65.69811	17.85151
Caucasian	45	64.33333	14.19187
Hispanic	66	64.81818	16.45592

In [20]:

```
library(ggbeeswarm)

options(repr.plot.width = 10, repr.plot.height = 10)

ggplot(data=df_noNa,aes(x=Ethnic, y=Score)) + geom_beeswarm(aes(color = Teacher))+
labs(title = "Score Distribution vs Ethnic Group vs Teacher Group", subtitle="#10")
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



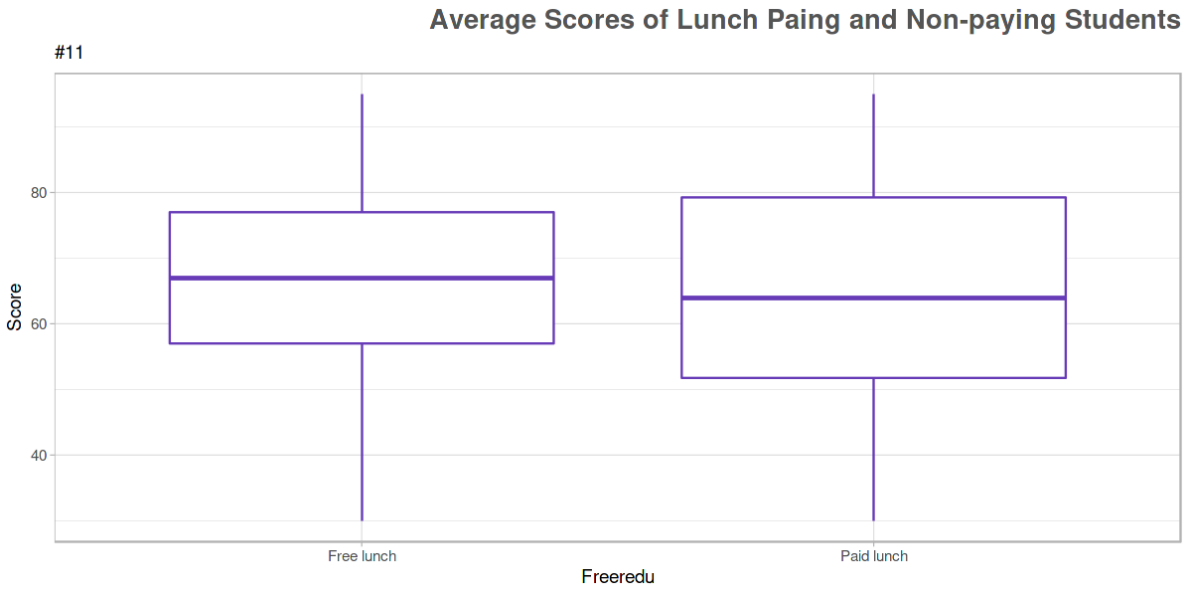
I turns out that the method of teaching isn't the main reason behind average score differeneces on the test. What we can see from here is that:

- Ms. Smith's (Standard method) and Ms. Wesson's (Traditional method) students achieved better results than Ms. Ruger's (Standard method) students.
- Ms. Ruger's students achieved similar average results in all ethnic groups.
- Caucasian students had lower average scores in the Ms. Smith's and Ms. Wesson's class group.
- Caucasian students had lower overall average scores, but at the same time, they are the only ethnic group that didn't have results under 40 on the test.

What Role does the Free/Paid Lunch Play?

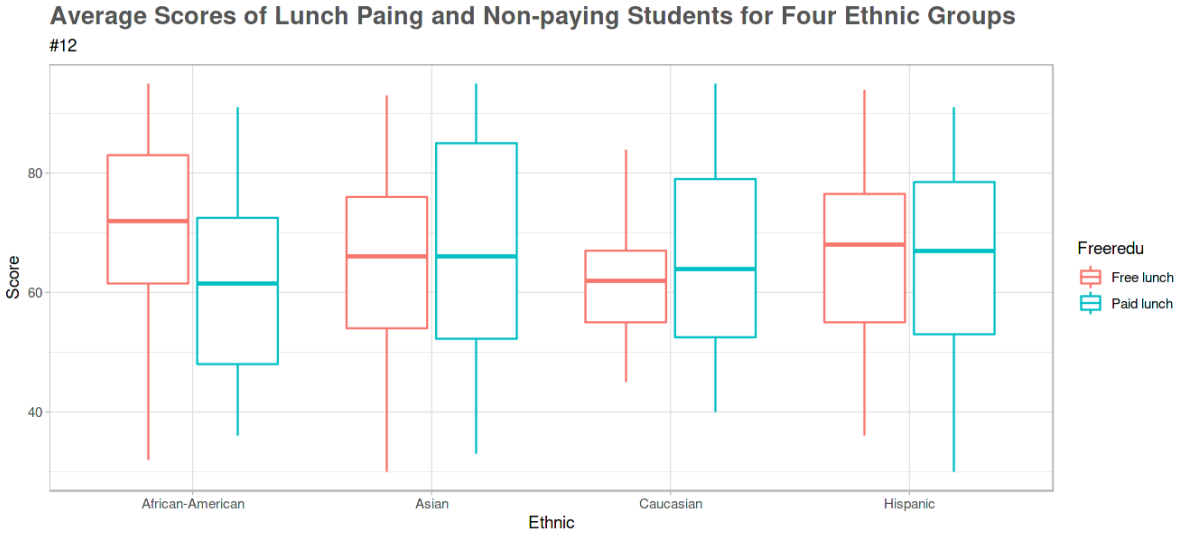
In [21]:

```
options(repr.plot.width = 10, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Freeredu, y=Score)) + geom_boxplot(color="#673AB7") +theme
labs(title = "Average Scores of Lunch Paing and Non-paying Students", subtitle="#11"
theme(legend.position="False")
```



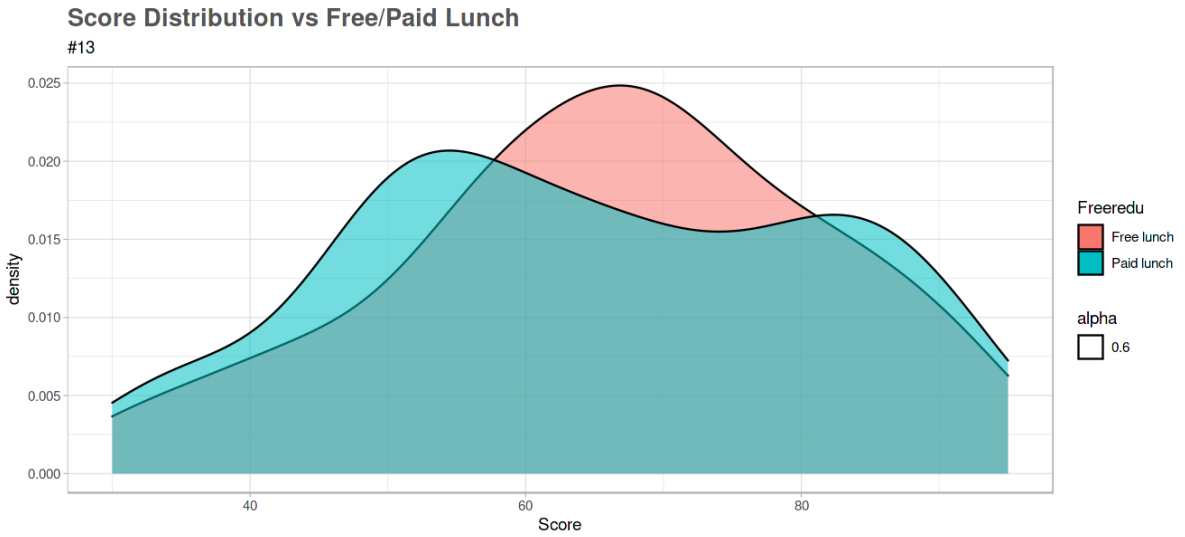
In [22]:

```
options(repr.plot.width = 11, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Ethnic, y=Score,color=Freeredu)) + geom_boxplot() +theme_m
labs(title = "Average Scores of Lunch Paing and Non-paying Students for Four Ethnic
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



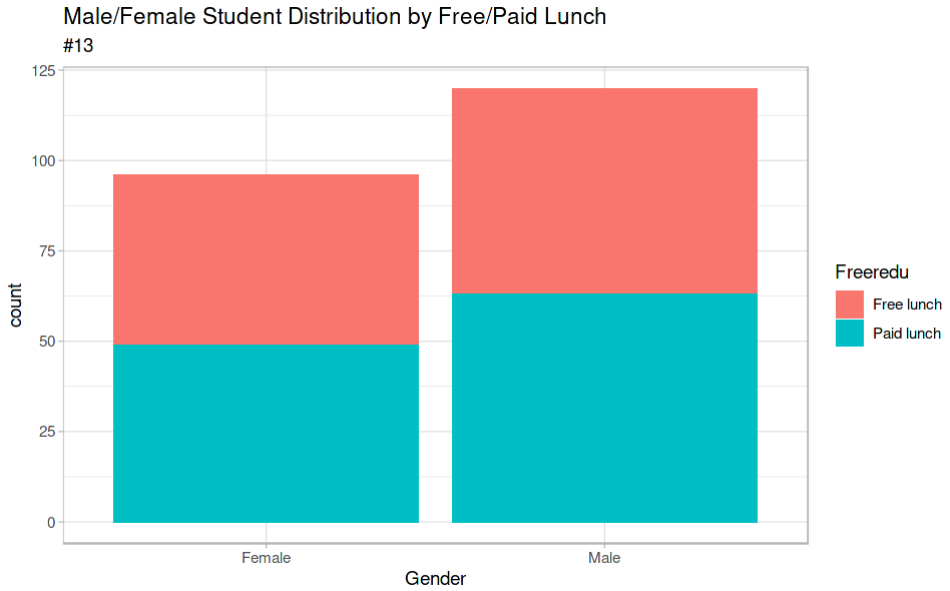
In [23]:

```
ggplot(df_noNa, aes(Score, fill=Freeredu, alpha=0.6)) + geom_density()+
labs(title = "Score Distribution vs Free/Paid Lunch",subtitle="#13") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



In [24]:

```
options(repr.plot.width =8, repr.plot.height = 5)

theme_set(theme_bw(base_size = 14))
theme_set(theme_light())
ggplot(data = df_noNa)+geom_bar(mapping=aes(x=Gender,fill=Freeredu)) + labs(title =
theme_update(plot.title = element_text(color='#555555', size=20, face='bold', hjust=
```

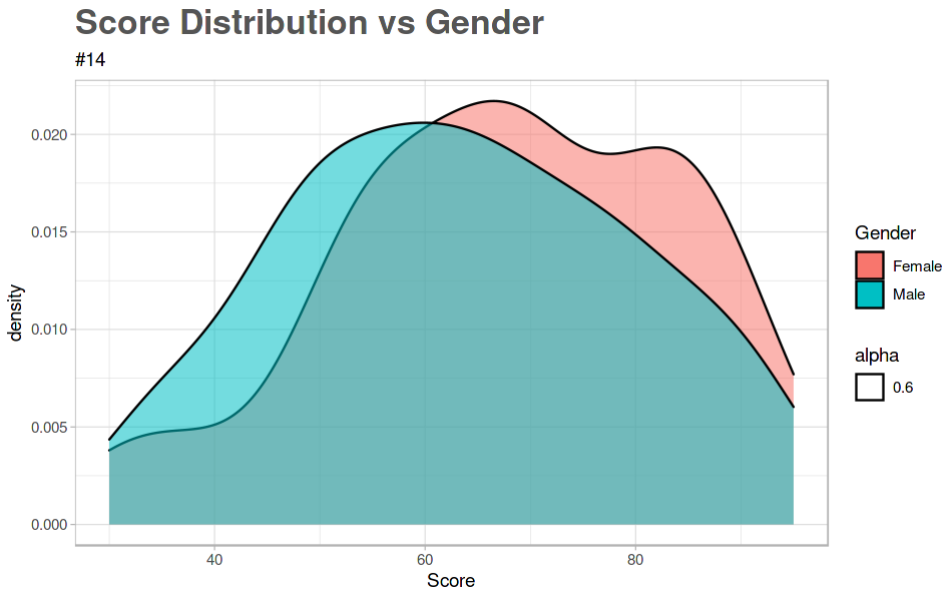


- The average score doesn't vary much for a "free" and "paid" lunch group.
- There is the same percentage of female students that have free and paid lunch.
- There is the same percentage of male students that have free and paid lunch.
- There is a higher density of students that have free lunch in the higher score part of graph #13
- The average score of the Free/Paid lunch group is only different for the African-American students. It is visible that those who had free lunch achieved a better overall score.

What Role does the Gender Play?

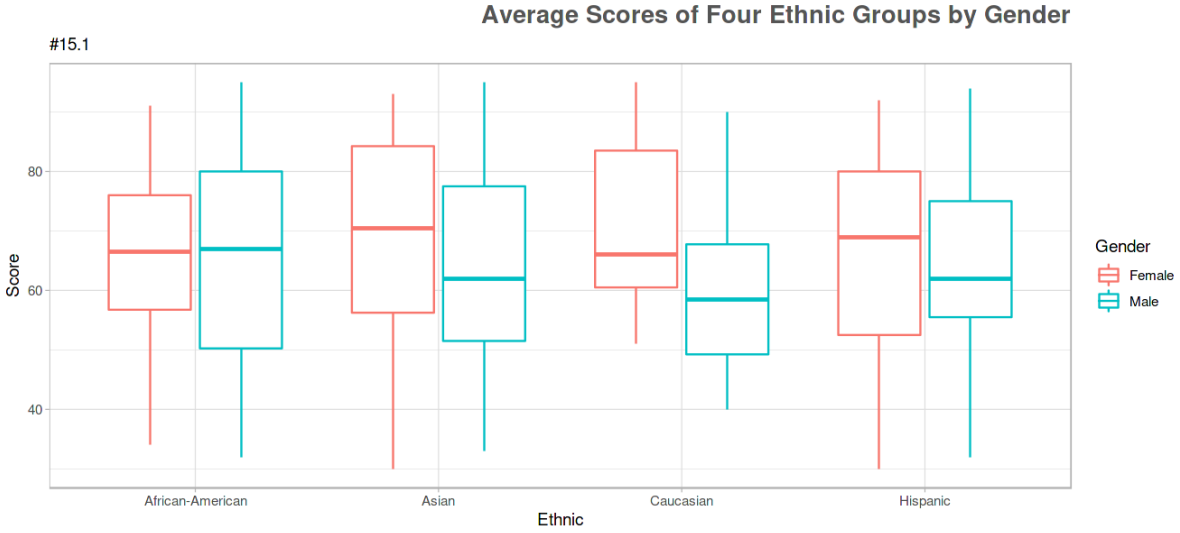
In [25]:

```
ggplot(df_noNa, aes(Score, fill=Gender, alpha=0.6)) + geom_density()+
labs(title = "Score Distribution vs Gender", subtitle="#14") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



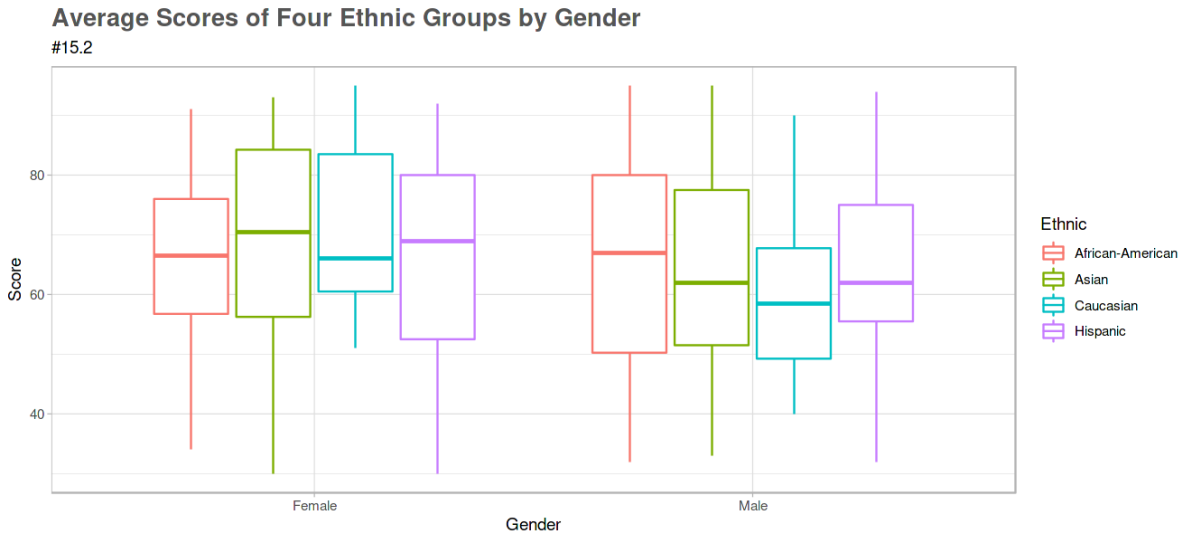
In [26]:

```
options(repr.plot.width = 11, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Ethnic, y=Score,color=Gender)) + geom_boxplot() +theme_mir
labs(title = "Average Scores of Four Ethnic Groups by Gender",subtitle="#15.1") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



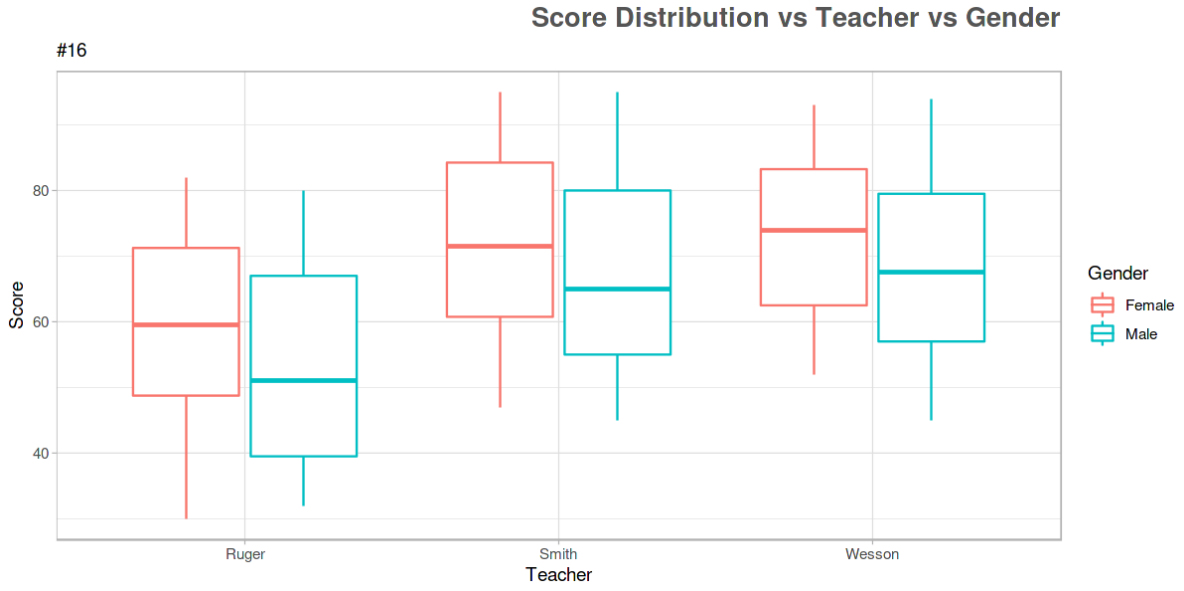
In [27]:

```
ggplot(data=df_noNa,aes(x=Gender, y=Score))+
labs(title = "Average Scores of Four Ethnic Groups by Gender", subtitle="#15.2") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



In [28]:

```
options(repr.plot.width = 10, repr.plot.height = 5)

ggplot(data=df_noNa,aes(x=Teacher, y=Score)) +
labs(title = "Score Distribution vs Teacher vs Gender", subtitle="#16") +
theme(legend.position="right")+
theme_update(plot.title = element_text(color='#555555', size=16, face='bold', hjust=
```



- Female students perform better in each teacher group.
- Female students perform better in all ethnic groups, except African-American where both genders have equal average scores.

Hypothesis Testing

In [29]:

```
# Shapiro-Wilk's test to test normality
shapiro.test(df_noNa$Score)
# Note: p>= 0.05 which is our choosen alpha, we can assume normality
```

```
	Shapiro-Wilk normality test

data:  df_noNa$Score
W = 0.9786, p-value = 0.002282
```

As we can see, this data doesn't follow a normal distribution and therefore is not suited for t-tests and ANOVA tests. I will use nonparametric Statistic.

In [30]:

```
#Mann Whitney U Test (Wilcoxon Rank Sum Test)

group_by(df_noNa, Gender) %>% summarise(median(Score, na.rm = T))

# Is there any significant difference between male and female scores?
wilcox.test(Score~Gender, data = df_noNa)
# Note: p < 0.05, We can conclude that the median score is significantly different b
```

A tibble: 2 × 2

Gender	median(Score, na.rm = T)
<chr>	<dbl>
Female	68.0
Male	62.5

```
	Wilcoxon rank sum test with continuity correction

data:  Score by Gender
W = 6689, p-value = 0.04187
alternative hypothesis: true location shift is not equal to 0
```

- Acording to the p-value score, we can say that there is a significant performance difference among these two gender groups.

In [31]:

```
#Mann Whitney U Test (Wilcoxon Rank Sum Test)

group_by(df_noNa, wesson) %>% summarise(median(Score, na.rm = T))

# Is there any significant difference between two teaching method scores?
wilcox.test(Score~wesson, data = df_noNa)
# Note: p < 0.05, We can conclude that the median score is significantly different b

# This test doesh show a significant difference, but we saw from the graphs that the
```

A tibble: 2 × 2

wesson	median(Score, na.rm = T)
<chr>	<dbl>
Standard	64
Traditional	70

```
        Wilcoxon rank sum test with continuity correction

data:  Score by wesson
W = 3859, p-value = 0.0008673
alternative hypothesis: true location shift is not equal to 0
```

In [32]:

```
# Are there any significant differences between scores of teachers' students?
kruskal.test(Score ~ Teacher, data = df_noNa)
```

```
        Kruskal-Wallis rank sum test

data:  Score by Teacher
Kruskal-Wallis chi-squared = 33.44, df = 2, p-value = 5.477e-08
```

- There are significant differences between scores of teachers' students.

In [33]:

```
#Mann Whitney U Test (Wilcoxon Rank Sum Test)

group_by(df_noNa,Freeredu ) %>% summarise(median(Score, na.rm = T))

# Is there any significant difference between scores of those who have free and paic
wilcox.test(Score~Freeredu, data = df_noNa)
# Note: p < 0.05, We can conclude that the median score is significantly different k
```

A tibble: 2 × 2

Freeredu	median(Score, na.rm = T)
<chr>	<dbl>
Free lunch	67
Paid lunch	64

```
        Wilcoxon rank sum test with continuity correction

data:  Score by Freeredu
W = 6173, p-value = 0.4475
alternative hypothesis: true location shift is not equal to 0
```

- There is no significan't differenece between average results of the Free/Paid lunch groups.

In [34]:

```
# Are there any significant differences between scores of different ethnic groups?
kruskal.test(Score ~ Ethnic, data = df_noNa)
```

```
        Kruskal-Wallis rank sum test

data:  Score by Ethnic
Kruskal-Wallis chi-squared = 0.77572, df = 3, p-value = 0.8553
```

- There are no significant differences between scores of different ethnic groups.

Conclusion

Ms. Ruger:

- African-American
- Science and math
- Teaching: 5y
- Math: 3y

Ms. Smith:

- Caucasian
- Spanish and math
- Teaching: 12y

- Math: 3y

Ms. Wesson:

- Caucasian
- Physical education and math
- Teaching: 24y
- Math: 3y

Important Observations

- Ms. Ruger teaches twice as much Hispanic students as Caucasian ones. It turns out that the method of teaching isn't the main reason behind average score differences on the test. What we can see from here is that:
- Ms. Smith's (Standard method) and Ms. Wesson's (Traditional method) students achieved equally better results than Ms. Ruger's (Standard method) students.

> I am interested in why Ms. Ruger's students had a lower average score. What I would exclude as a reason is:
> - *her ethnicity* as all ethnic groups performed the same.
> - *her number of students* as she has a few students more than the other two teachers
> - *her math teaching experience* as all teachers have been teaching math for 3 years.

> One reason could be that she has the least experience in teaching in general.

- Ms. Ruger's students achieved similar average results in all ethnic groups.
- Caucasian students had lower average scores in Ms. Smith's and Ms. Wesson's class group.

> This is also worth investigating.

- Caucasian students had lower overall average scores, but at the same time, they are the only ethnic group that didn't have results under 40 on the test.
- The average score of the Free/Paid lunch group is only different for the African-American students. It is visible that those who had free lunch achieved a better overall score.

> It would be good to investigate this in the future and see what is the correlation.

- Female students perform better in each teacher group.
- Female students perform better in all ethnic groups, except African-Americans where both genders have equal average scores.

Data limitation:

- The results provided are from just 1 test.
  - Should contain scores from previous 8th class students that have been thought by these teachers for the past 3y.
  - For comparison, it would be meaningful to see how these students performed in the 7th grade.

Math department suggestions and my suggestions/comments:

Same teaching method and textbook.

- PROS: *Teachers could collaborate, share notes and be more productive.*
- CONS: *Some teachers would need to adapt to the new teaching style that maybe doesn't suit them, which could negatively impact their presence/performance in the class. Also, students that were more comfortable and more adapted to one style of learning would have to adapt. If the changes should be made, they should be introduced to a new generation of students that are just starting to learn math.*

Students grouped by ethnicity (Ms. Ruger - African-American students, Ms. Wesson - Caucasian&Asian students, Ms. Smith- Hispanic.

- *Data visualization (#7) and hypothesis testing didn't show any significant differences in ethnic group performances so there is no need to make these suggested changes.*
  - *If there should be any grouping, my suggestion would be to conduct a survey to see student preferences regarding teaching methods.

Groupe segregation (high/low ability students), "Math and Reading Instruction in Tracking First-Grade Classes".

- *Caucasian students did have lower overall average scores, but at the same time, they are the only ethnic group that didn't have results under 40 on the test. As the sample is small, and the hypothesis testing didn't show that the difference is significant this kind of segregation isn't recommended. The article also is based on the 1st-grade classes and what may apply there, doesn't have to apply to the 8th-grade classes. Ms. Smith's article about standard-based math applies to K-12 classes so it is more relevant.*

Type *Markdown* and LaTeX: α^2

I would definitely write to the school board president as soon as possible and ask for more time to collect additional data needed in order to give my final opinion. The data, as it is, doesn't give any evidence that one method of teaching is better than the other.

*Note: This is the first version and I will try to make the graphs better for version two. What I mean by that is look to scale the title and subtitle size, place them in the same place... :)