Math Scores for Different Teaching Styles

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Load Necessary Packages and Data

```
knitr::opts_chunk$set(warning = FALSE, message = FALSE)
knitr::opts_chunk$set(echo = TRUE)
```

```
library("tidyr")
library("dplyr")
library("foreign")
library("ggplot2")
#load data
math <- read.spss("1ResearchProjectData.sav", to.data.frame = TRUE)
```

Three teachers at a junior high school have different opinions about which teaching method is most effective for 8th grade math students. Ms. Wesson uses a traditional approach, while Ms. Ruger and Ms. Smith use a standards-based method. The first task is to determine which approach is more effective, based on the math scores of their current students.

In addition, it has been suggested that each teacher has strengths that will make them more effective with students in certain ethnic groups. One teacher believes that students should be divided into classes based on ethnicity. The second task is to determine if there is a difference between performance for each teacher based on student demographics.

The data includes math scores for students in grades 7-8. More information about this data project can be found here.

Cleaning the Data

Tidy Columns

```
head(math)
```

```
##   Student Teacher Gender           Ethnic  Freeredu Score      wesson
## 1       1   Ruger Female            Asian Free lunch    76 Ruger_Smith
## 2       2   Ruger Female         Hispanic Paid lunch    56 Ruger_Smith
## 3       3   Ruger Female African-American Free lunch    34 Ruger_Smith
## 4       4   Ruger Female            Asian Paid lunch    59 Ruger_Smith
## 5       5   Ruger   Male         Hispanic Free lunch    73 Ruger_Smith
## 6       6   Ruger   Male        Caucasian Paid lunch    58 Ruger_Smith
```

```
#rename columns
math <- math %>%
  rename(Method="wesson")
```

```
#change "Freeredu" column to "Lunch"
math <- math %>%
  rename(Lunch="Freeredu")
colnames(math)
```

```
## [1] "Student" "Teacher" "Gender"  "Ethnic"  "Lunch"   "Score"   "Method"
```

```
#drop word "lunch" from lunch status descriptions
math <- math %>%
  mutate(Lunch=gsub(' lunch','',Lunch))

 # change Method factors Ruger_Smith = standards, Wesson = traditional
math$Method <- sub("Ruger_Smith","Standards",math$Method)
math$Method <- sub("Wesson","Traditional",math$Method)

head(math)
```

```
##   Student Teacher Gender            Ethnic Lunch Score    Method
## 1       1   Ruger Female             Asian  Free    76 Standards
## 2       2   Ruger Female          Hispanic  Paid    56 Standards
## 3       3   Ruger Female African-American  Free    34 Standards
## 4       4   Ruger Female             Asian  Paid    59 Standards
## 5       5   Ruger   Male          Hispanic  Free    73 Standards
## 6       6   Ruger   Male          Caucasian  Paid    58 Standards
```

Check for Duplicates and Omit Missing Values

```
#check for duplicates
math %>%
  duplicated() %>%
  table()
```

```
## .
## FALSE
##   217
```

```
#none found


#check for NA
math <- na.omit(math)
```

Analysis

Inspect Population

```
#total students
pop_total <- math %>%
  summarize(count=n())
pop_total
```

```
##   count
## 1   216
```

```
#student ethnicity
pop_ethnicity <- math %>%
```

```
  group_by(Ethnic) %>%
  summarize(count=n()) %>%
  mutate(Perc=(count/216)*100)
pop_ethnicity
```

```
## # A tibble: 4 x 3
##   Ethnic           count  Perc
##   <fct>            <int> <dbl>
## 1 Asian               53  24.5
## 2 African-American    52  24.1
## 3 Hispanic            66  30.6
## 4 Caucasian           45  20.8
```

```
#plot
pop_ethnicity_viz <- ggplot(pop_ethnicity,aes(x="",y = Perc, fill = Ethnic,)) +
  geom_col(color="black")+
  scale_fill_manual(values =c("tomato2","khaki3","skyblue4","olivedrab"))+
  geom_text(aes(label = round(Perc,2)),
            position = position_stack(vjust = 0.5)) +
  coord_polar(theta = "y")+
  labs(title="Percentages of Students By Ethnicity")+
  theme_void()

pop_ethnicity_viz
```

Percentages of Students By Ethnicity
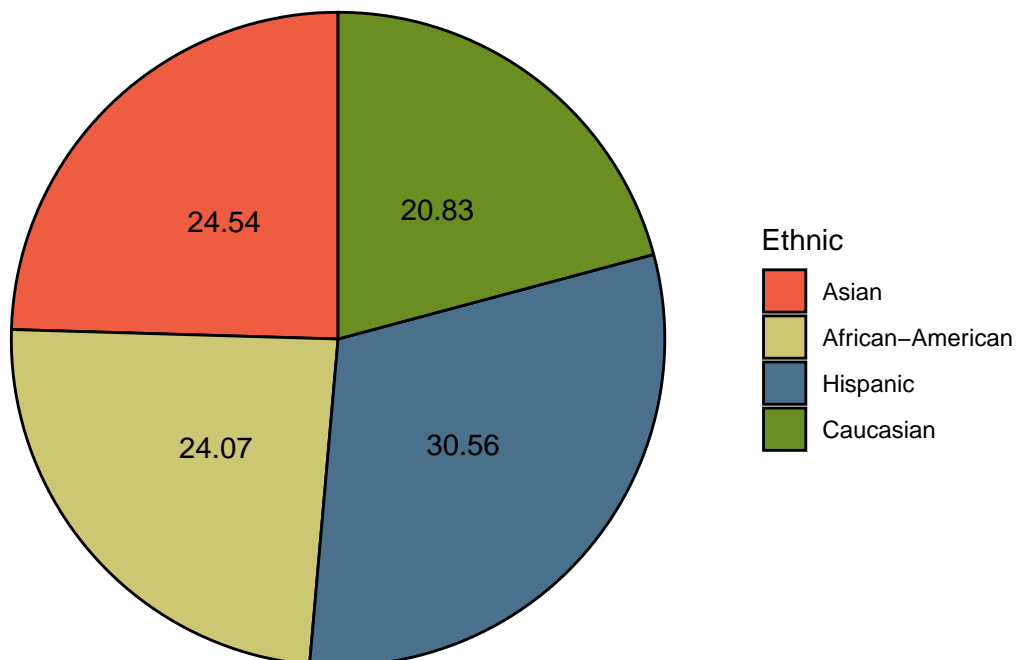

```
#Lunch Status
pop_lunch_status <- math %>%
  group_by(Lunch)%>%
  summarize(count=n())%>%
  mutate(Perc=(count/216)*100)
```

```
pop_lunch_status
```

```
## # A tibble: 2 x 3
##   Lunch count  Perc
##   <chr> <int> <dbl>
## 1 Free    104  48.1
## 2 Paid    112  51.9
```

```r
#plot
pop_lunch_viz <- ggplot(pop_lunch_status,aes(x="",y = Perc, fill = Lunch,)) +
  geom_col(color="black")+
  scale_fill_manual(values =c("tomato2","skyblue4"))+
  geom_text(aes(label = round(Perc,2)),
            position = position_stack(vjust = 0.5)) +
  coord_polar(theta = "y")+
  labs(title="Percentages of Students By Lunch Status")+
  theme_void()
pop_lunch_viz
```

## Percentages of Students By Lunch Status
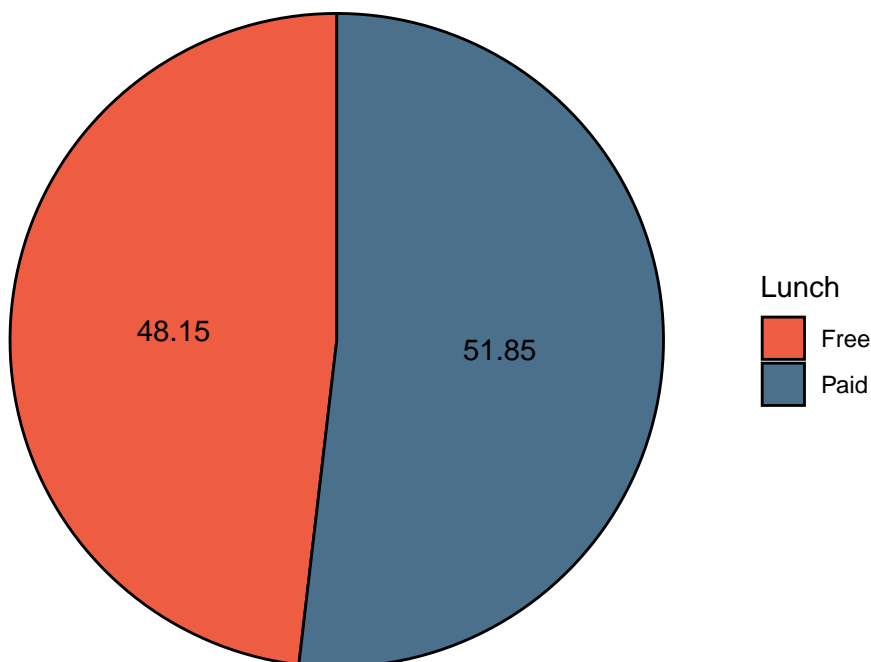
Comparing Methods

Initial comparison of average test scores for each method show higher scores for the traditional method (70.7), compared to the standards-based method (62.3). While the traditional method seems to outperform the standards-based method, the differences between these two samples are not statistically significant.

```r
#avg score by Method
avg_score_method <- math %>%
  group_by(Method) %>%
  summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_score_method
```

```
## # A tibble: 2 x 2
##   Method      Avg_Score
##   <chr>           <dbl>
## 1 Standards        62.3
## 2 Traditional      70.7
```

```r
#plot
avg_method_viz <- ggplot(data=avg_score_method,aes(x=Method,y=Avg_Score,fill=Method))+
  geom_bar(stat="identity")+
  geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  scale_fill_manual(values=c("tomato2","skyblue4"))+
  labs(title="Average Math Score by Method")
avg_method_viz
```

Average Math Score by Method
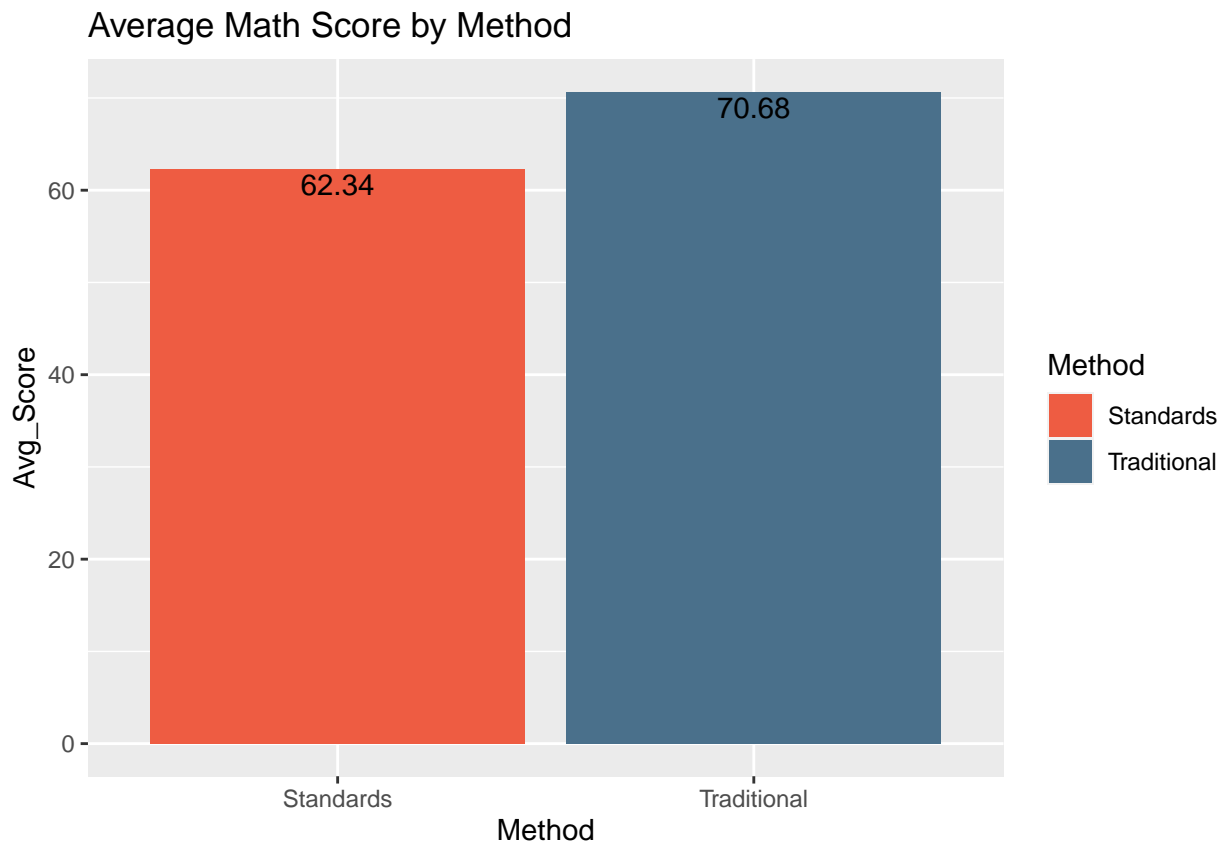
Evaluating the scores by method shows higher scores, with little difference between groups of students based on ethnicity or lunch status.

```r
#avg score by Method and ethnicity
avg_score_method_ethnicity <- math %>%
  group_by(Method,Ethnic) %>%
  summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_score_method_ethnicity
```

```
## # A tibble: 8 x 3
## # Groups:   Method [2]
##   Method      Ethnic            Avg_Score
##   <chr>       <fct>                 <dbl>
## 1 Standards   Asian                  62.5
## 2 Standards   African-American       62.7
```

```
## 3 Standards   Hispanic              61.6
## 4 Standards   Caucasian             62.9
## 5 Traditional Asian                 73.2
## 6 Traditional African-American      72.9
## 7 Traditional Hispanic              70.8
## 8 Traditional Caucasian             66.3
```

```r
#plot
avg_method_ethnicity_viz <- ggplot(data=avg_score_method_ethnicity,aes(x=Method,y=Avg_Score,fill=Method
  geom_bar(stat="identity")+
  geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  facet_wrap(~Ethnic)+
  scale_fill_manual(values=c("tomato2","skyblue4"))+
  labs(title="Average Math Score by Method and Ethnicity")
avg_method_ethnicity_viz
```


Average Math Score by Method and Ethnicity
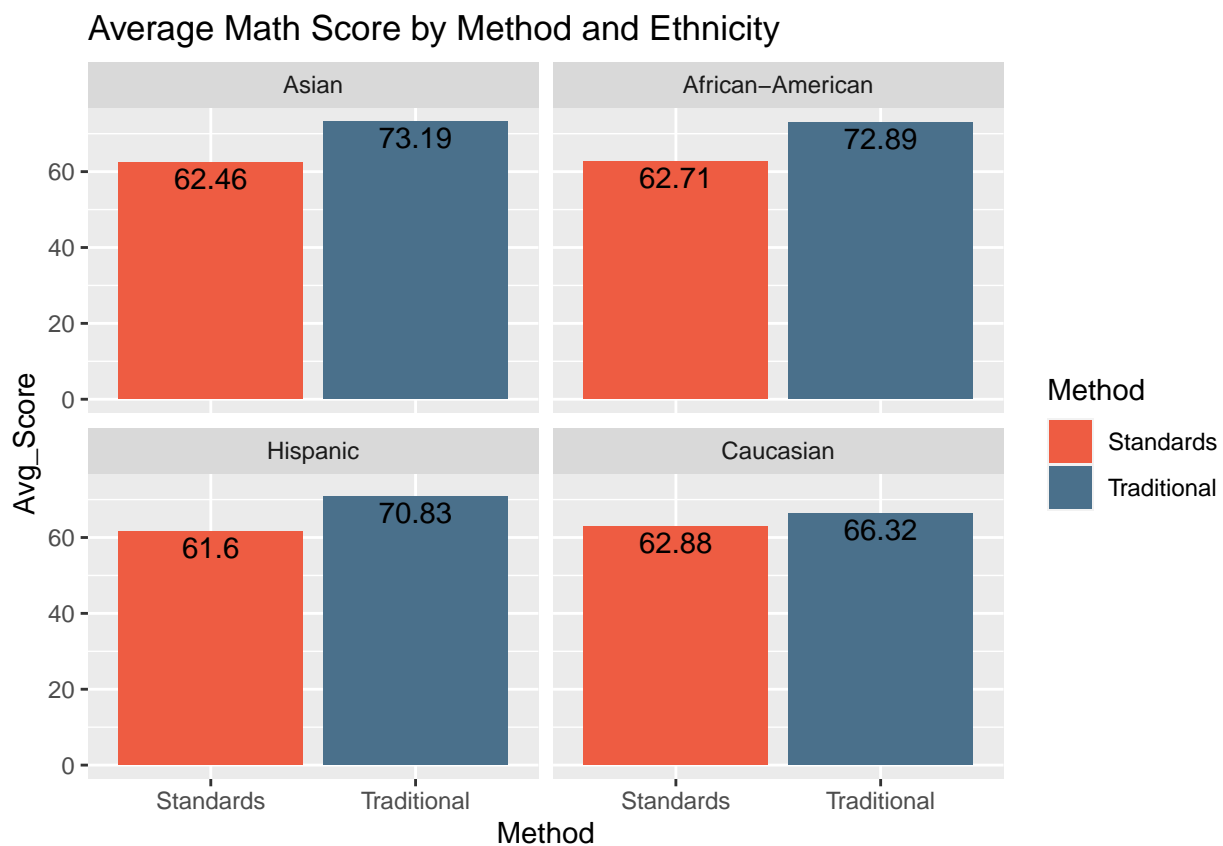
```r
#avg score by Method and lunch status
avg_score_method_lunch <- math %>%
  group_by(Method,Lunch) %>%
  summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_score_method_lunch
```

```
## # A tibble: 4 x 3
## # Groups:   Method [2]
##   Method      Lunch Avg_Score
##   <chr>       <chr>     <dbl>
## 1 Standards   Free       62.8
## 2 Standards   Paid       62
```

```
## 3 Traditional Free       70.9
## 4 Traditional Paid       70.5
```

```
#plot
avg_method_lunch_viz <- ggplot(data=avg_score_method_lunch,aes(x=Method,y=Avg_Score,fill=Method))+
  geom_bar(stat="identity")+
  geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  facet_wrap(~Lunch)+
  scale_fill_manual(values=c("tomato2","skyblue4"))+
  labs(title="Average Math Score by Method and Lunch Status")
avg_method_lunch_viz
```
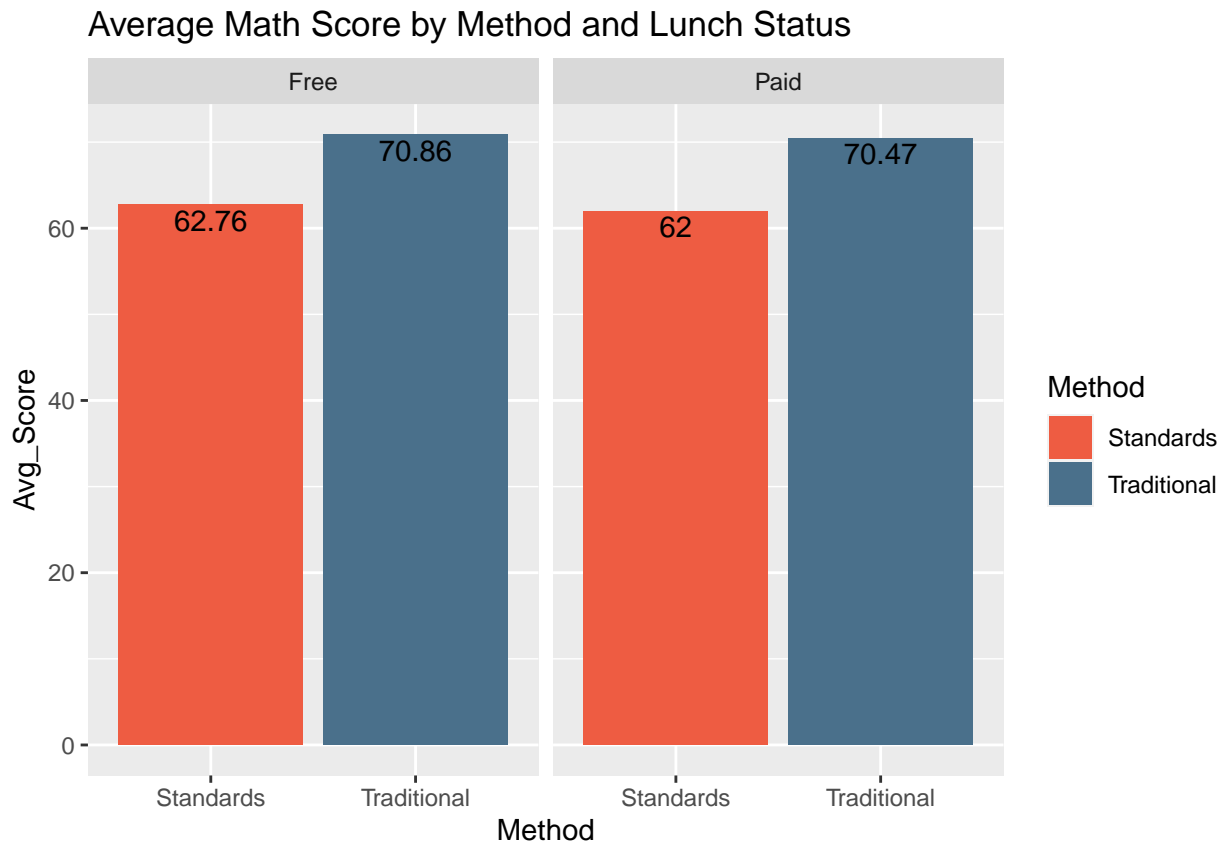

Comparing Teachers

We should also compare student scores based on their math teacher.

Ms. Wesson and Ms. Smith have students with average scores that are very similar (70.7 and 69.6, respectively). Ms. Ruger's students average score is 55.26. The differences are measurable, but they are not statistically significant.

```
#avg score by teacher
avg_teacher_score <- math %>%
    group_by(Teacher) %>%
    summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_teacher_score
```

```
## # A tibble: 3 x 2
##   Teacher Avg_Score
##   <fct>       <dbl>
```

```
## 1 Ruger        55.3
## 2 Smith        69.6
## 3 Wesson       70.7
```

```
#plot
avg_teacher_viz <- ggplot(data=avg_teacher_score,aes(x=Teacher,y=Avg_Score,fill=Teacher))+
  geom_bar(stat="identity")+
  geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  scale_fill_manual(values=c("tomato2","khaki3","skyblue4"))+
  labs(title="Average Math Score by Teacher")
avg_teacher_viz
```

Average Math Score by Teacher
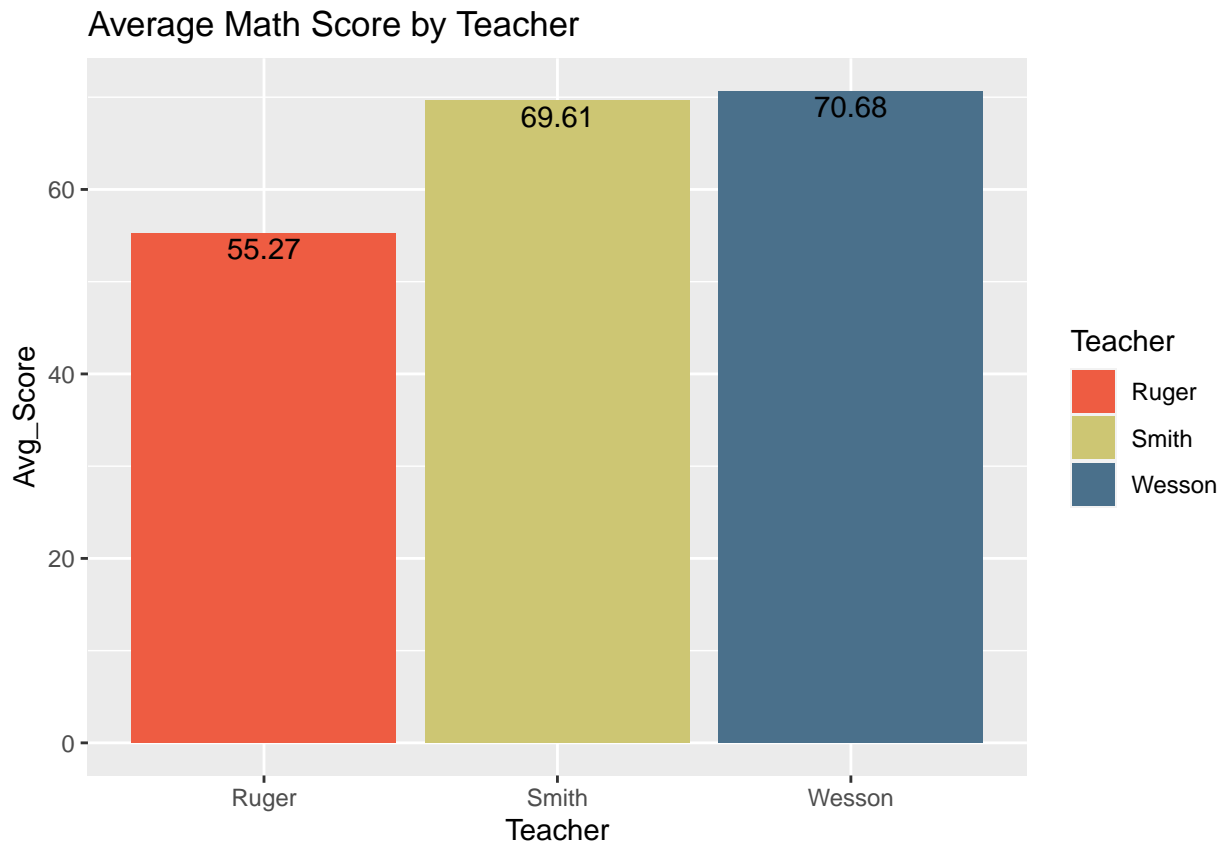
Next, we will examine how each teacher's students perform when grouped by ethnicity and lunch status.

There is no significant difference in overall performance between ethnic groups. While there are minor differences between average student scores of Ms. Smith and Ms. Wesson when grouped according to ethnicity, the differences are not statistically significant. Average student scores in Ms. Ruger's class were lower, regardless of ethnicity, but the difference is also not statistically significant.
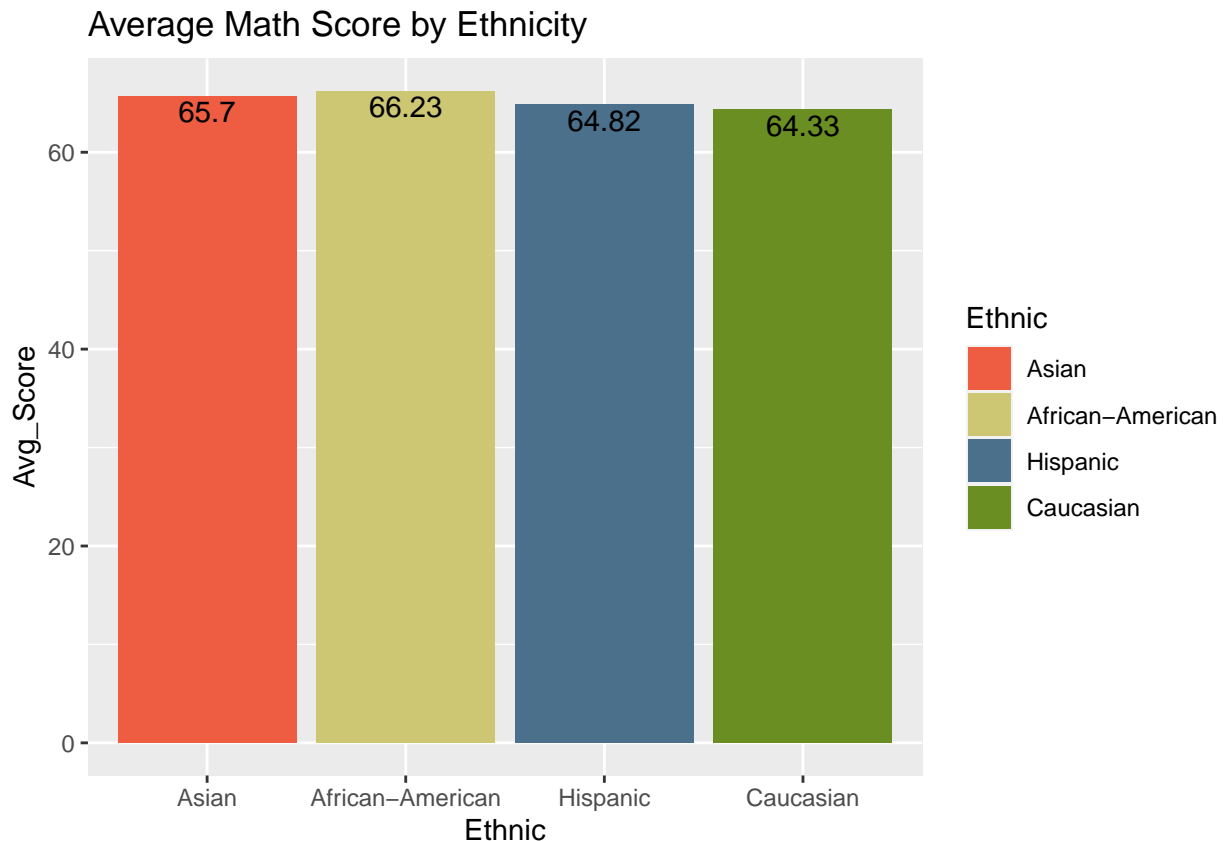
```
#avg score by ethnicity
avg_score_ethnicity <- math %>%
    group_by(Ethnic) %>%
    summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_score_ethnicity
```

```
## # A tibble: 4 x 2
##   Ethnic         Avg_Score
##   <fct>              <dbl>
## 1 Asian               65.7
```

```
## 2 African-American       66.2
## 3 Hispanic               64.8
## 4 Caucasian              64.3
```

```r
#plot
avg_ethnicity_viz <- ggplot(data=avg_score_ethnicity,aes(x=Ethnic,y=Avg_Score,fill=Ethnic))+
  geom_bar(stat="identity")+
  geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  scale_fill_manual(values=c("tomato2","khaki3","skyblue4","olivedrab"))+
  labs(title="Average Math Score by Ethnicity")
avg_ethnicity_viz
```

Average Math Score by Ethnicity


```r
#avg score by teacher for each ethnicity
avg_teacher_score_ethnicity <- math %>%
  group_by(Ethnic,Teacher) %>%
  summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_teacher_score_ethnicity
```

```
## # A tibble: 12 x 3
## # Groups:   Ethnic [4]
##    Ethnic           Teacher Avg_Score
##    <fct>            <fct>       <dbl>
##  1 Asian            Ruger        53.7
##  2 Asian            Smith        69.9
##  3 Asian            Wesson       73.2
##  4 African-American Ruger        55.2
##  5 African-American Smith        71.1
##  6 African-American Wesson       72.9
```

```
##  7 Hispanic           Ruger          55.6
##  8 Hispanic           Smith          69.9
##  9 Hispanic           Wesson         70.8
## 10 Caucasian          Ruger          56.9
## 11 Caucasian          Smith          67.3
## 12 Caucasian          Wesson         66.3
```

```
#plot
avg_teacher_ethnic_viz <- ggplot(data=avg_teacher_score_ethnicity,aes(x=Teacher,y=Avg_Score,fill=Teacher
  geom_bar(stat="identity")+
   geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  facet_wrap(~Ethnic)+
  scale_fill_manual(values=c("tomato2","khaki3","skyblue4"))+
  labs(title="Average Math Score by Teacher and Ethnicity")
avg_teacher_ethnic_viz
```

Average Math Score by Teacher and Ethnicity
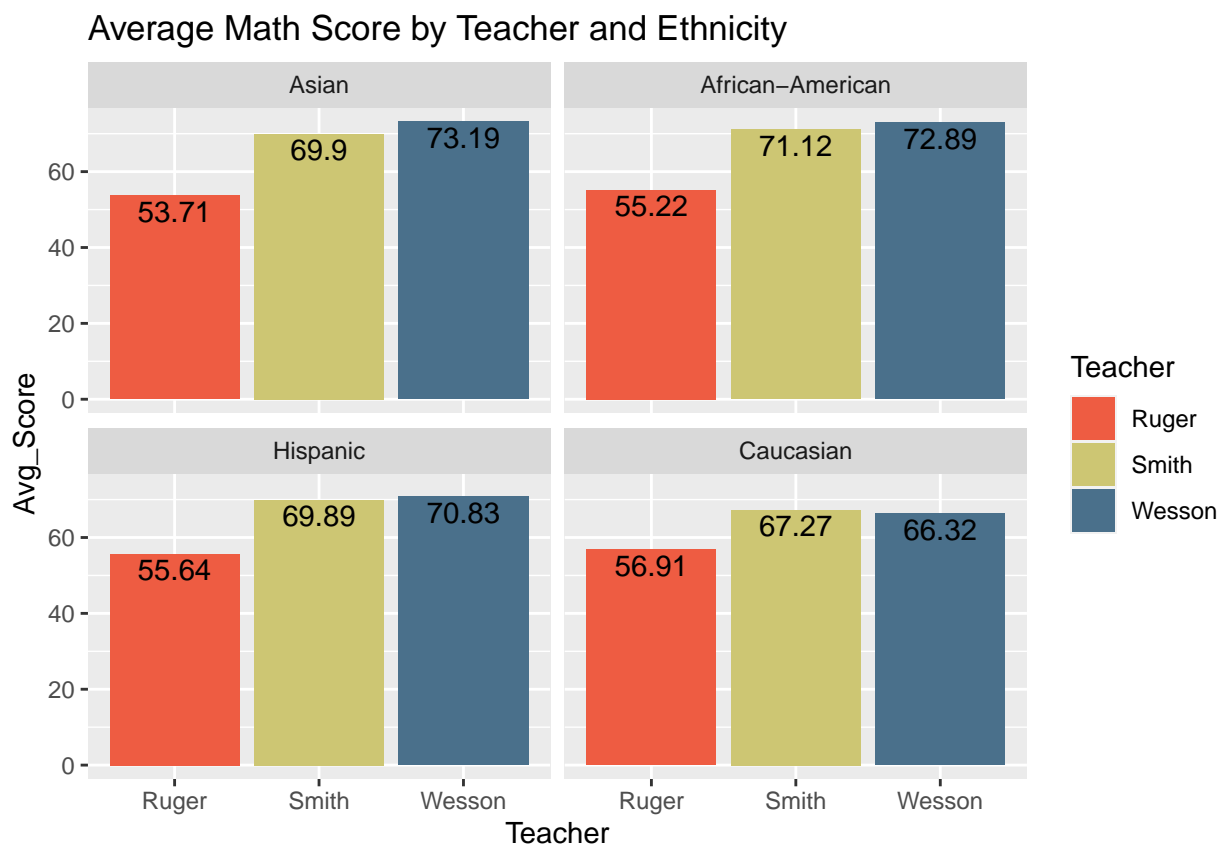
Again we find there is no large difference in performance between all students grouped by lunch status, but there remains a visible gap between the performance of students in both groups when comparing teachers.

```
#avg score by lunch status
avg_score_lunch <- math %>%
  group_by(Lunch)%>%
  summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_score_lunch
```

```
## # A tibble: 2 x 2
##   Lunch Avg_Score
##   <chr>     <dbl>
## 1 Free       66.0
```

```
## 2 Paid        64.6
```
```
#plot
avg_lunch_viz <- ggplot(data=avg_score_lunch, aes(x=Lunch,y=Avg_Score,fill=Lunch))+
      geom_bar(stat="identity")+
      geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
      scale_fill_manual(values=c("tomato2","skyblue4"))+
      labs(title="Average Math Score by Lunch Status")
avg_lunch_viz
```

## Average Math Score by Lunch Status
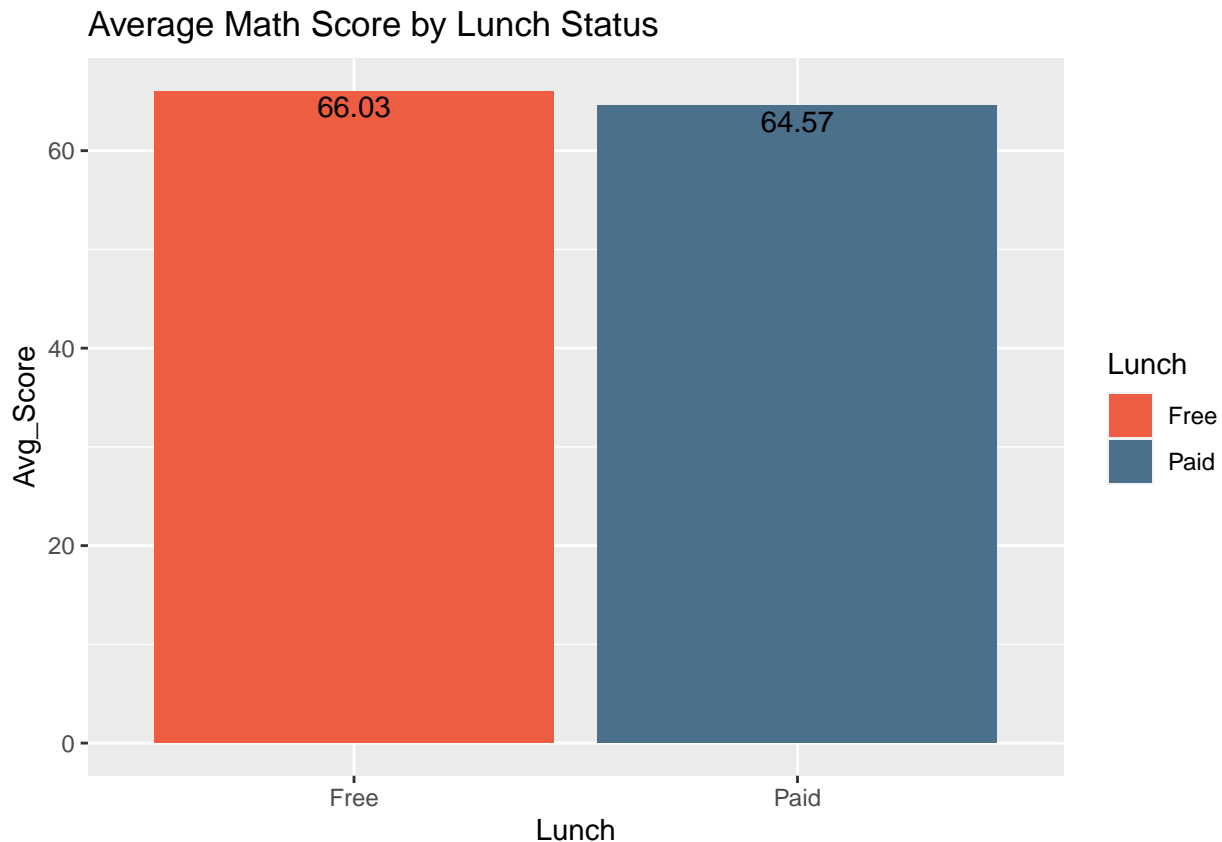

```
#avg score by teacher for lunch status
avg_teacher_score_lunch <- math %>%
  group_by(Teacher,Lunch) %>%
  summarize(Avg_Score=mean(Score,na.rm=TRUE))
avg_teacher_score_lunch
```
```
## # A tibble: 6 x 3
## # Groups:   Teacher [3]
##   Teacher Lunch Avg_Score
##   <fct>   <chr>     <dbl>
## 1 Ruger   Free       56.2
## 2 Ruger   Paid       54.4
## 3 Smith   Free       71.3
## 4 Smith   Paid       68.5
## 5 Wesson  Free       70.9
## 6 Wesson  Paid       70.5
```
```
#plot
avg_teacher_lunch_viz <- ggplot(data=avg_teacher_score_lunch,aes(x=Teacher,y=Avg_Score,fill=Teacher))+
```

```
  geom_bar(stat="identity")+
   geom_text(aes(label=round(Avg_Score,2)), vjust=1.25)+
  facet_wrap(~Lunch)+
  scale_fill_manual(values=c("tomato2","khaki3","skyblue4"))+
  labs(title="Average Math Score by Teacher and Lunch Status")
avg_teacher_lunch_viz
```
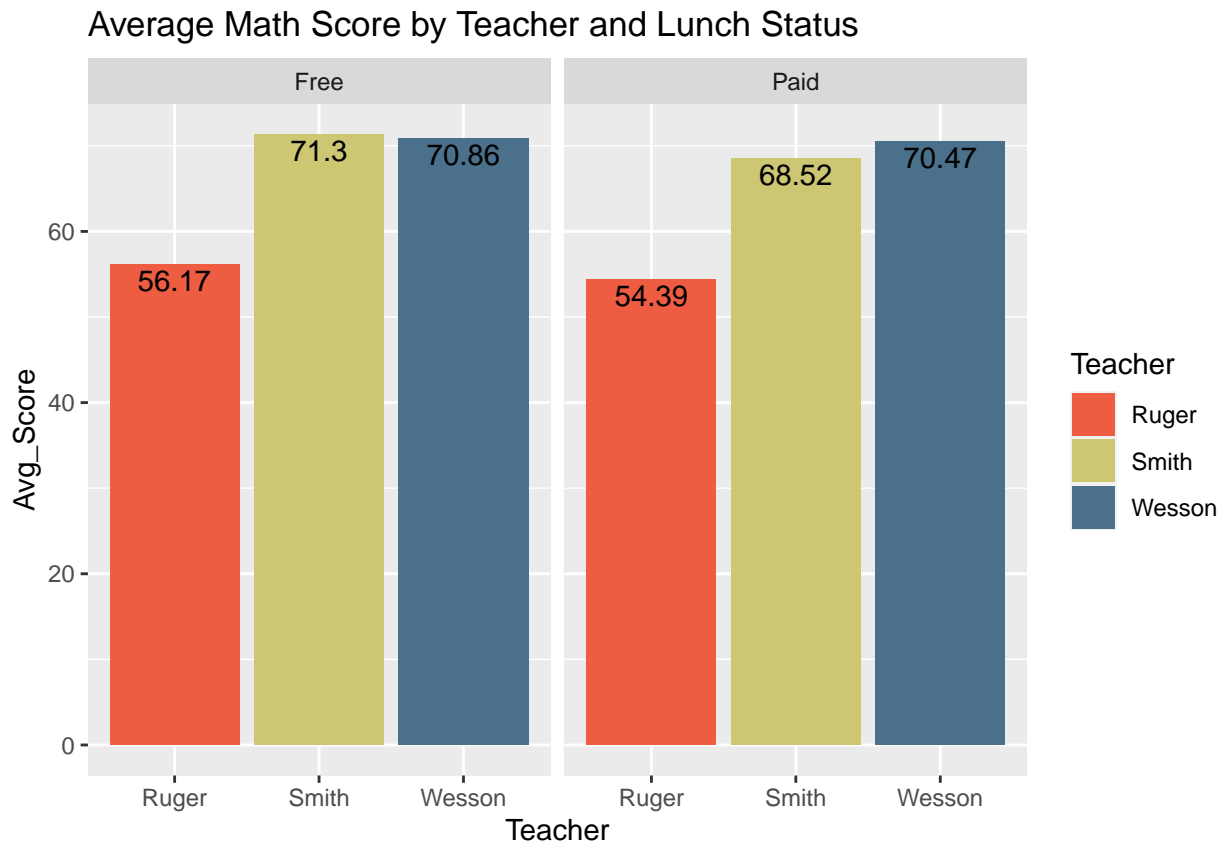

Conclusions

When comparing traditional and standards-based methods among all students, the traditional method seems to result in higher scores. However, the difference between the scores of students taught by Ms. Wesson and Ms.Smith is less than the difference between those two classes and Ms. Ruger's students.

Ms. Wesson and Ms. Ruger both use the standards-based method, and Ms. Smith use the traditional method. When ranking the performance of students in each class, the traditional method ranks first and last. Considering these results, we cannot conclude that the teaching method is the determining factor affecting student performance.

The data does not show any benefit for students being assigned to a specific teacher according to their ethnicity or lunch status. It does show that Ms. Ruger's students do not perform as well as those taught by Ms. Smith or Ms. Wesson, even when taking ethnicity and lunch status into account. However, none of these differences are statistically significant.

Based on this analysis, the data does not support grouping students by ethnicity or mandating one teaching method over another. The school administration could evaluate and offer support for Ms. Ruger, but this should be approached with care. The differences between student scores in each class can be seen on a graph, but are not statistically significant. There could be other factors causing an appearance of low performance.