

Math Scores for Different Teaching Styles

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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 student performance for each teacher, based on student demographics, that would justify such grouping.

Another proposal was that students should be grouped according to ability within each classroom. The teacher making this suggestion referenced an article, "Math and Reading Instruction in Tracked First-Grade Classes" (Stephen M Ross, et.al). The third task is to review this study to determine if ability grouping is supported by the findings.

The data includes math scores for students in grades 7-8. More information about this data project can be found at [Kaggle.com](https://www.kaggle.com).

It should be noted that this data includes only one score for each student. A more effective method for measuring the quality of instruction would be a collection of multiple scores that could be used to demonstrate student growth.

Clean the Data

Preview Data Frame

##	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

Tidy Columns

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

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

Omit Missing Values

Analysis

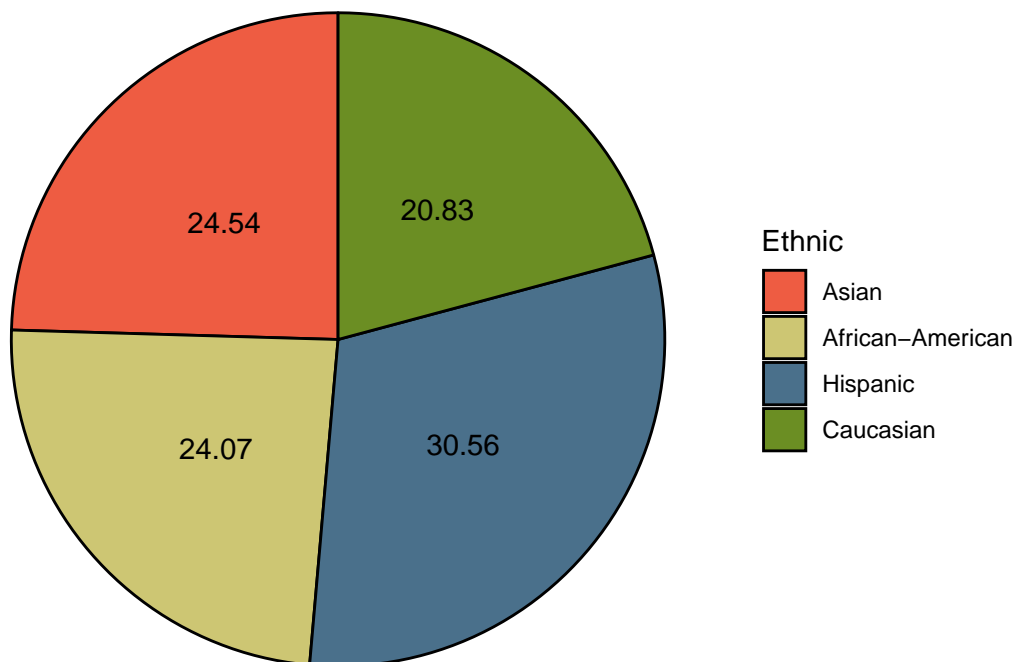
Inspect Population

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

Student Demographics - 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
```

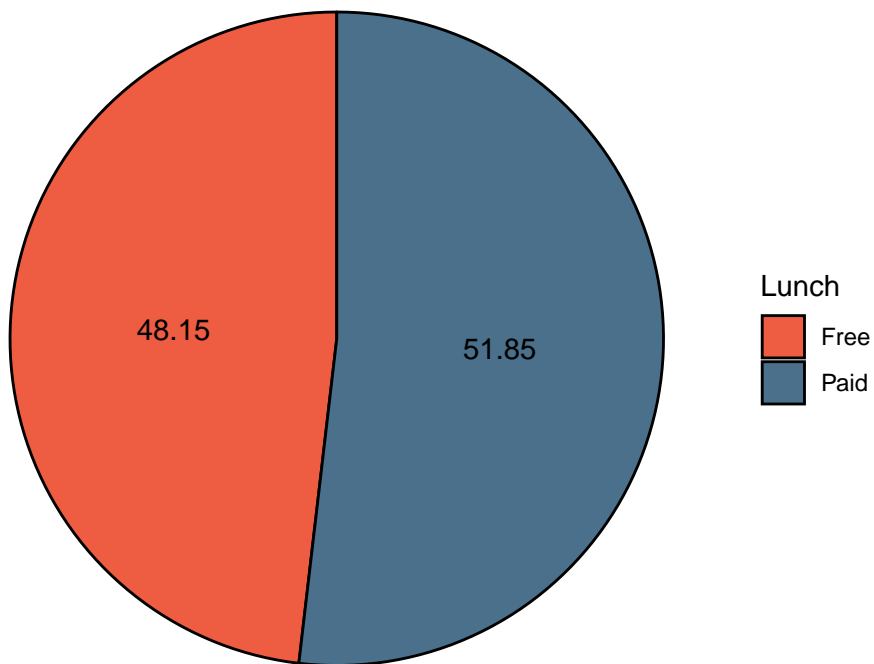
Percentages of Students By Ethnicity



Student Demographics - Lunch Status

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

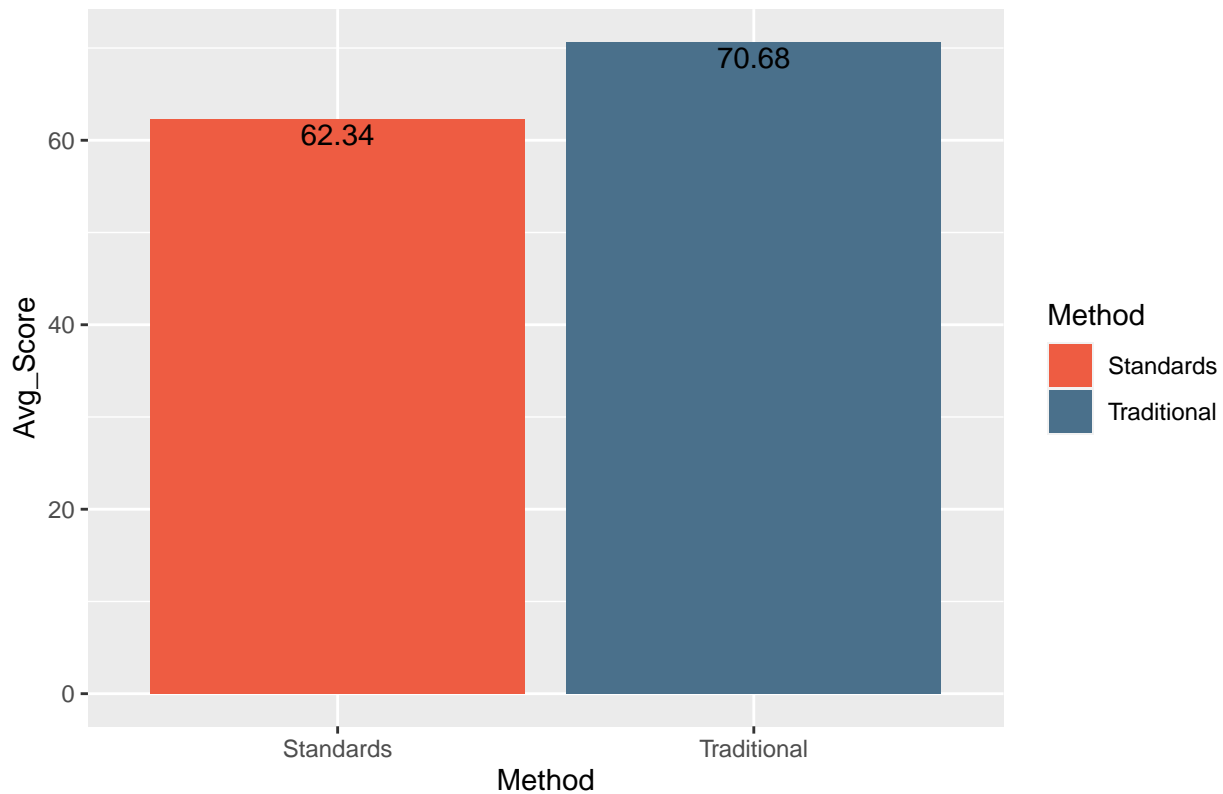
Percentages of Students By Lunch Status



Compare Methods

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

Average Math Score by Method



Initial comparison of average test scores for each method shows higher scores for the traditional method (70.7), compared to the standards-based method (62.3).

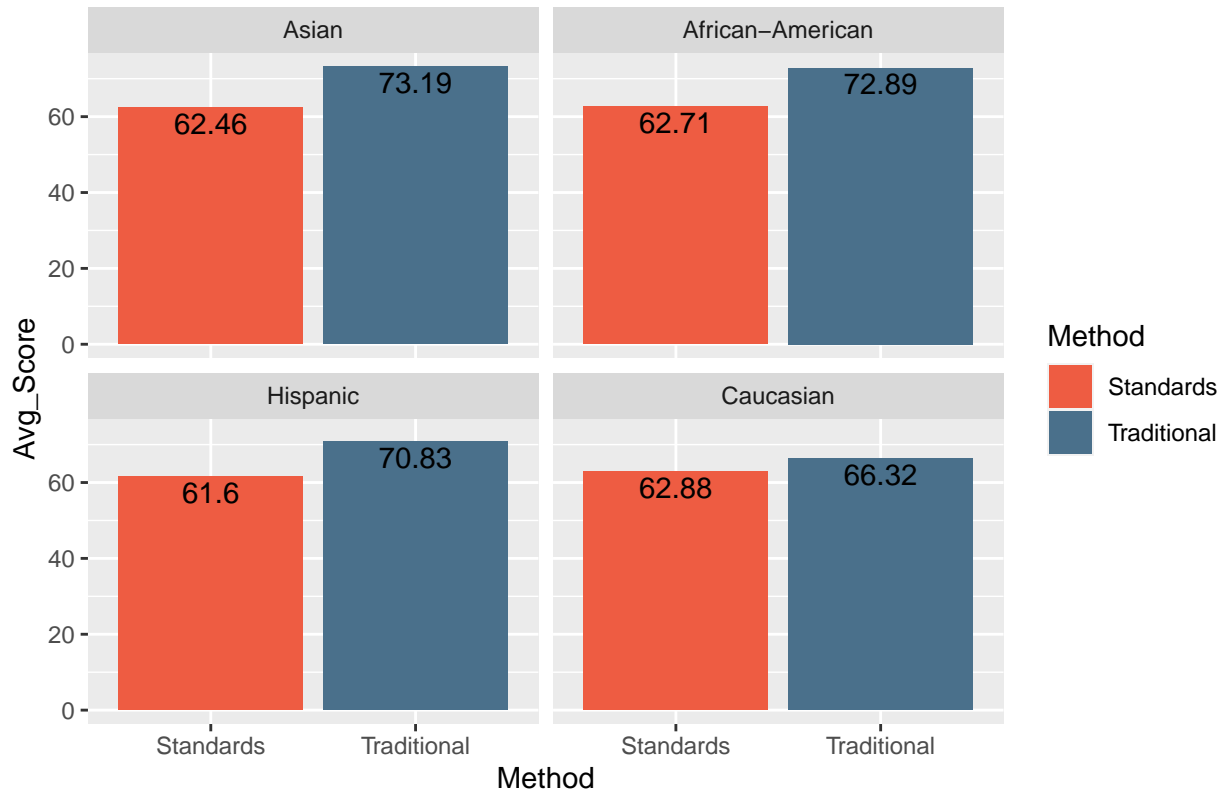
Compare Methods Within Ethnicity and Lunch Status Groups

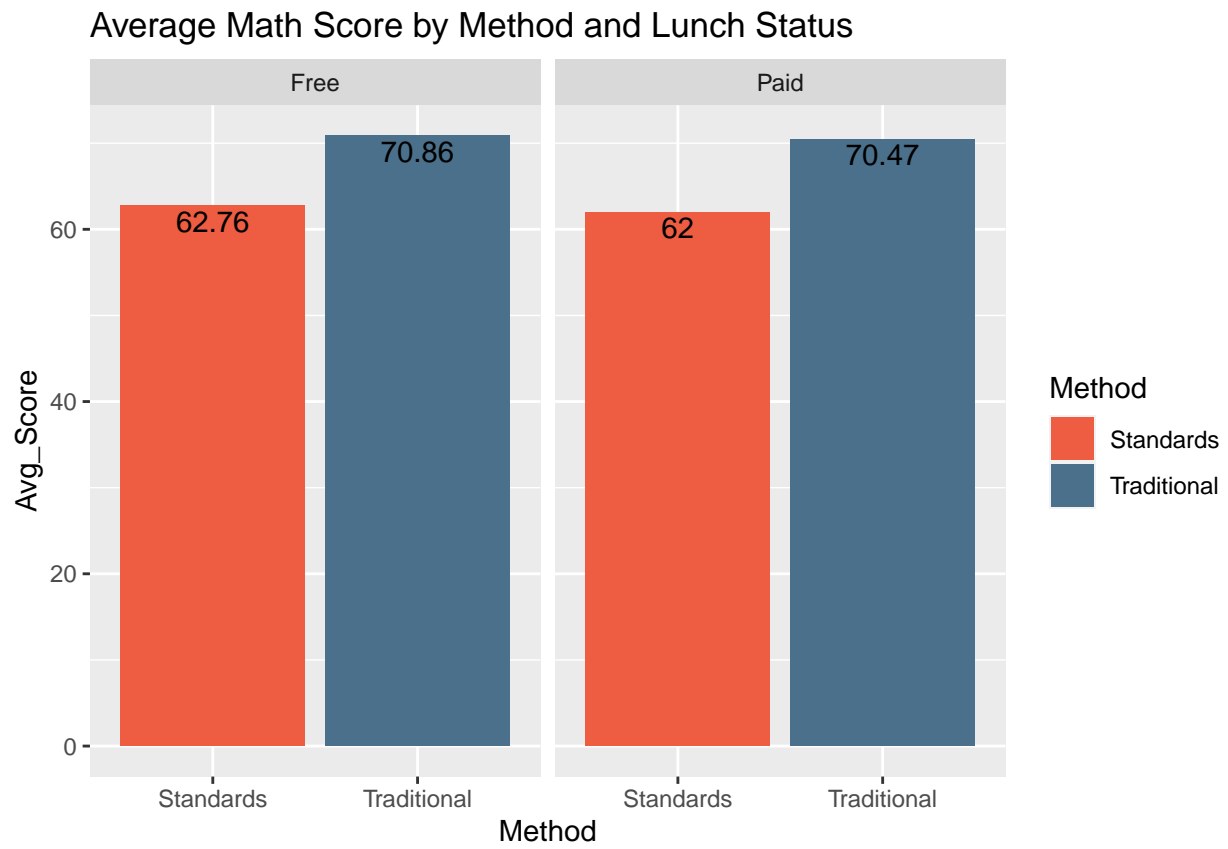
When comparing averages of students from different groups based on ethnicity or lunch status, the traditional method continues to show a higher average score for all student groups.

```
## # 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
## # 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
```

Average Math Score by Method and Ethnicity



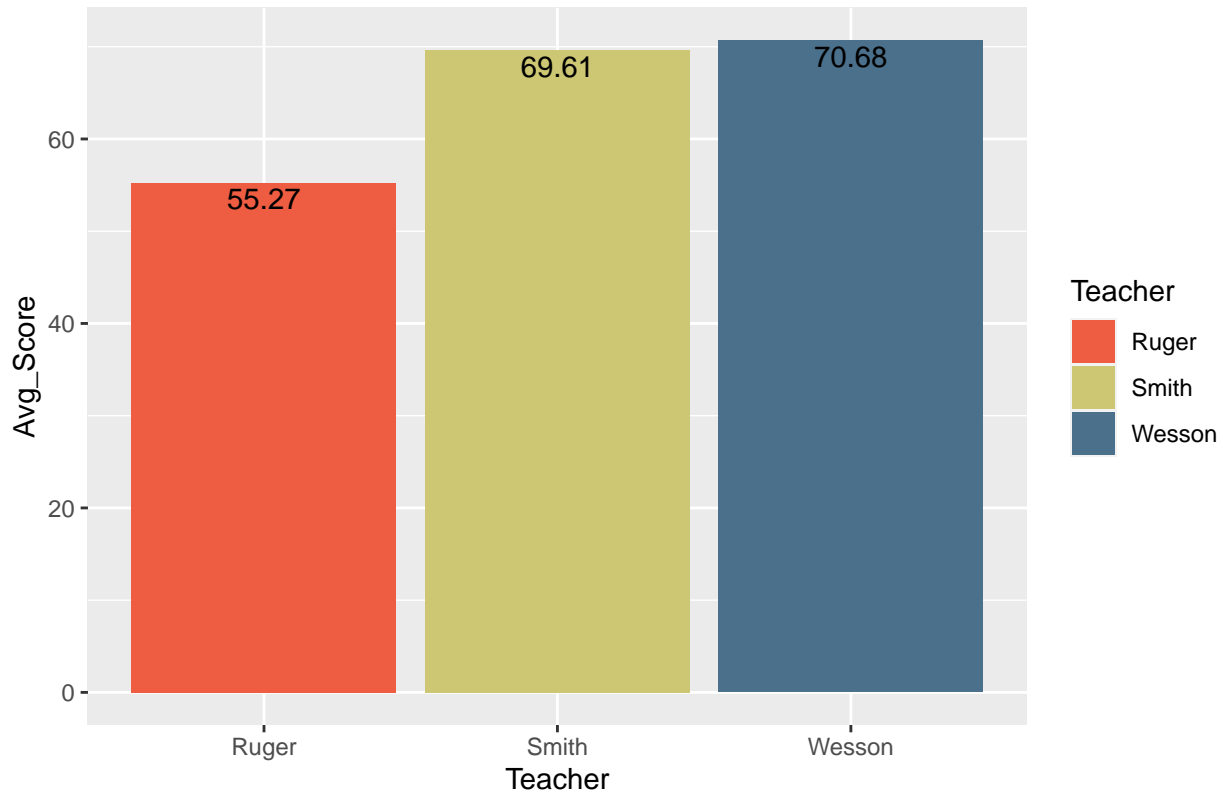


Compare Teachers

Compare Student Scores Based on Their Math Teacher.

```
## # A tibble: 3 x 2
##   Teacher Avg_Score
##   <fct>     <dbl>
## 1 Ruger      55.3
## 2 Smith      69.6
## 3 Wesson     70.7
```

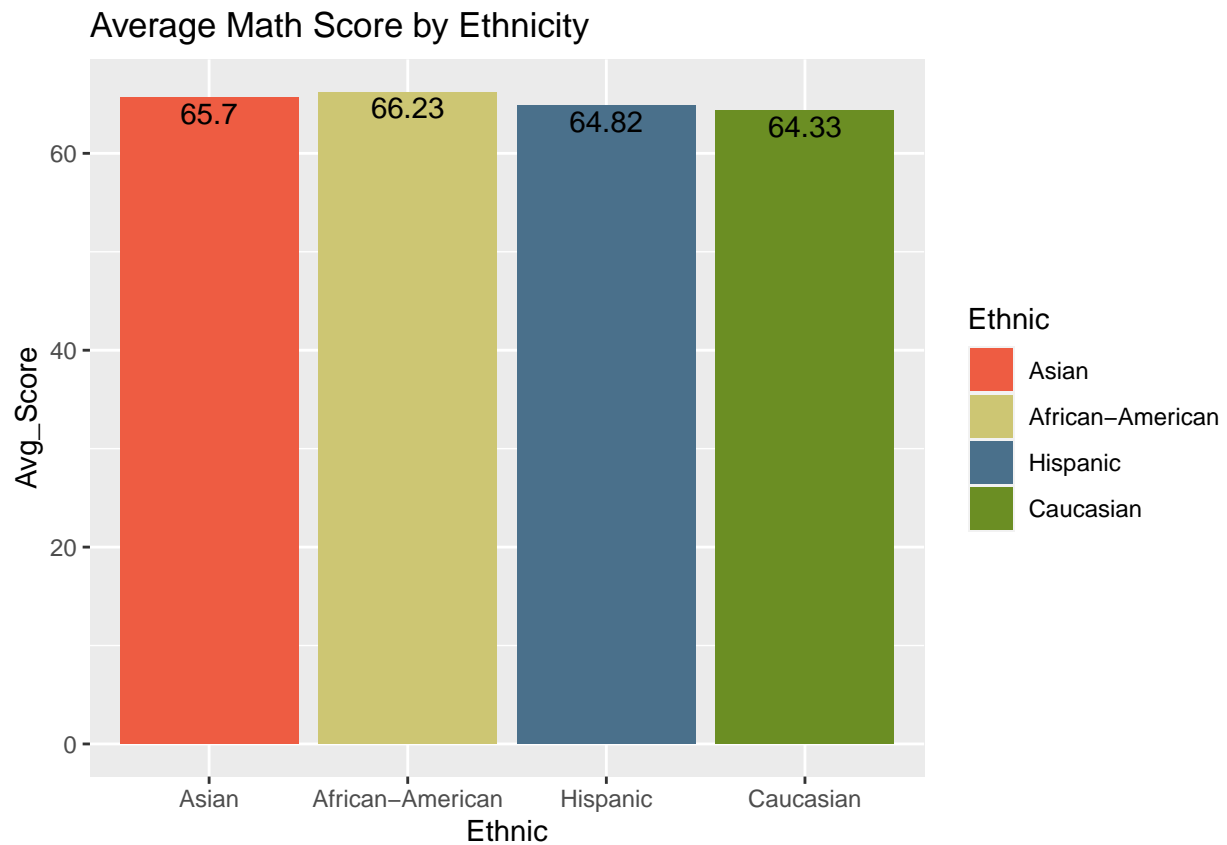
Average Math Score by Teacher



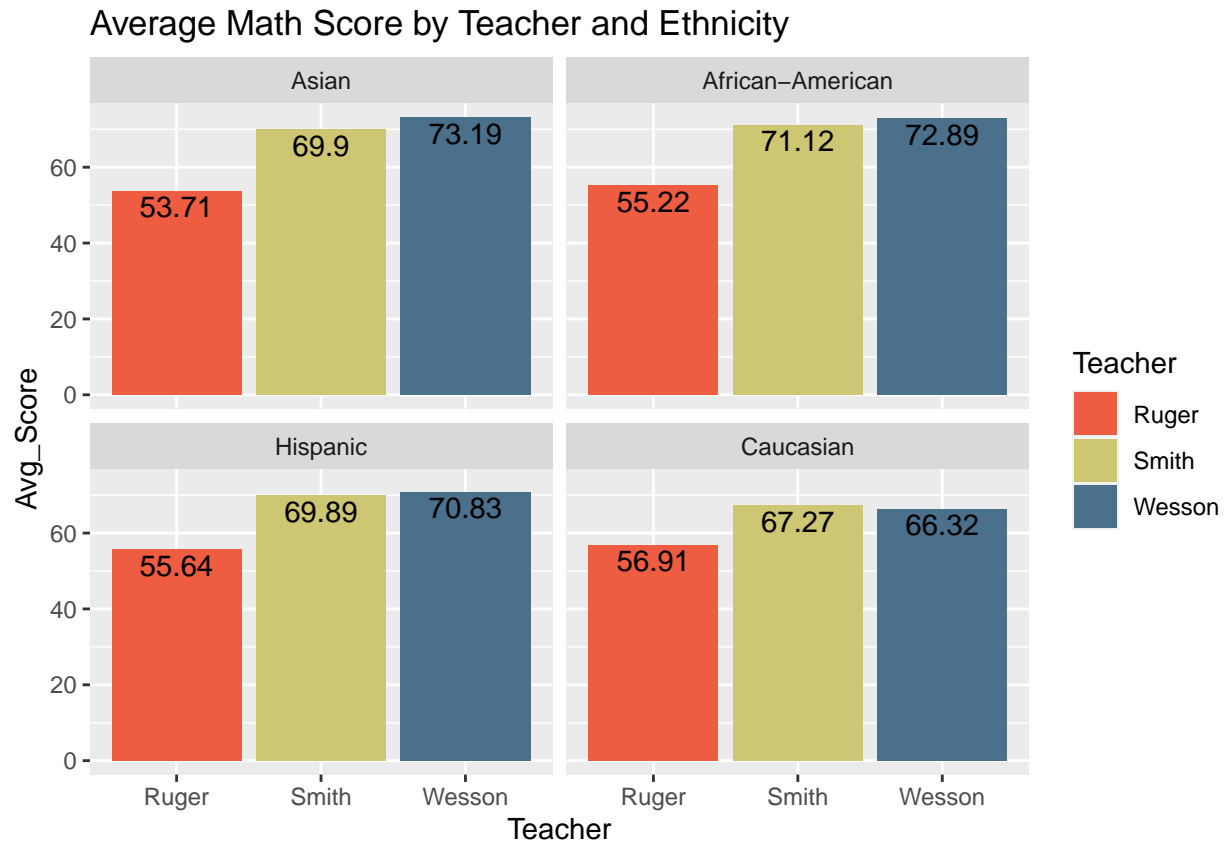
Ms. Wesson and Ms. Smith have students with average scores that are very similar (70.7 and 69.6, respectively). Ms. Ruger's students average score is 55.26.

Compare Student Scores Based on Math Teacher and Ethnicity. Next, look at average scores in each ethnicity group, and examine how each teacher's students perform when grouped by ethnicity and lunch status.

```
## # 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
```



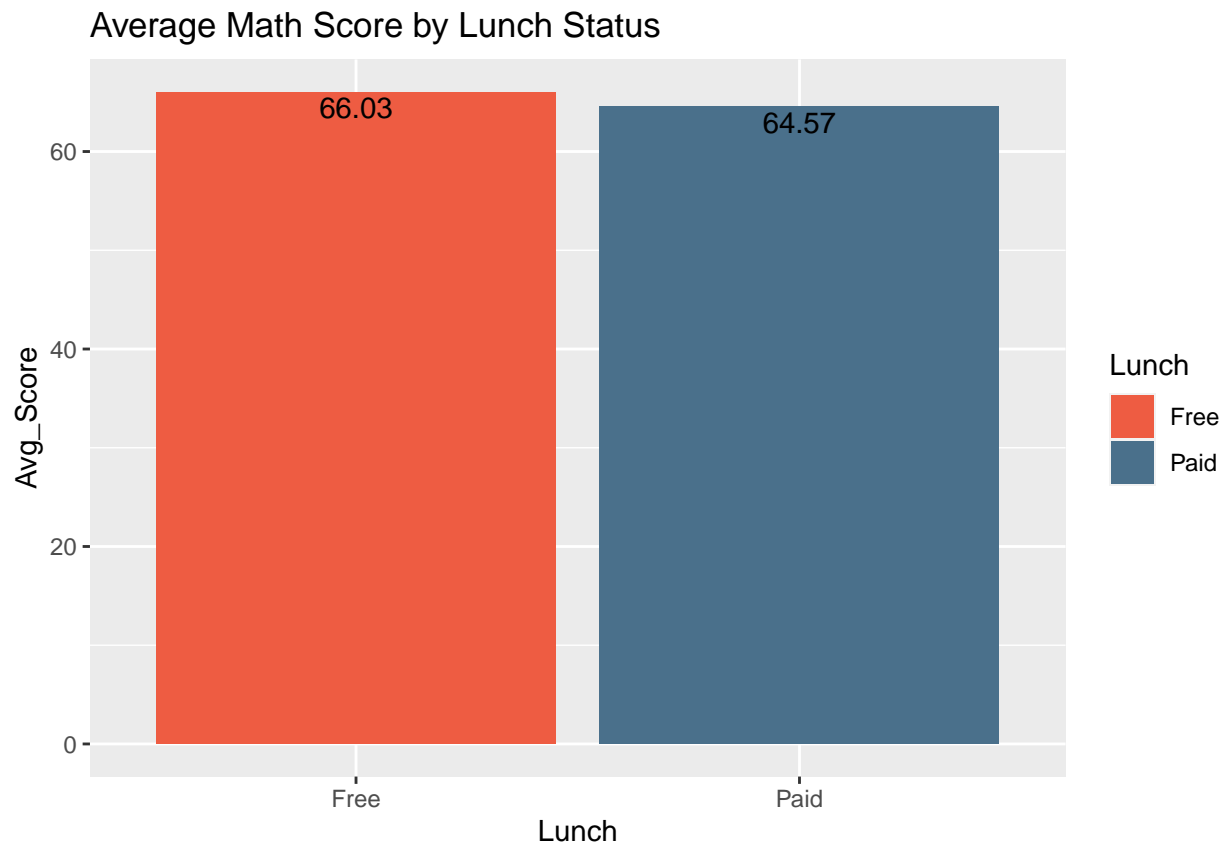
```
## # A tibble: 12 x 3
## # Groups:   Ethnic [4]
##   Ethnic      Teacher Avg_Score
##   <fct>      <fct>      <dbl>
## 1 Asian      Ruger        53.7
## 2 Asian      Smith        69.9
## 3 Asian      Wesson       73.2
## 4 African-American Ruger        55.2
## 5 African-American Smith        71.1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

There is little differences 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, average student scores in Ms. Ruger's class were over 10-16 points lower than the other two student groups for all ethnic groups.

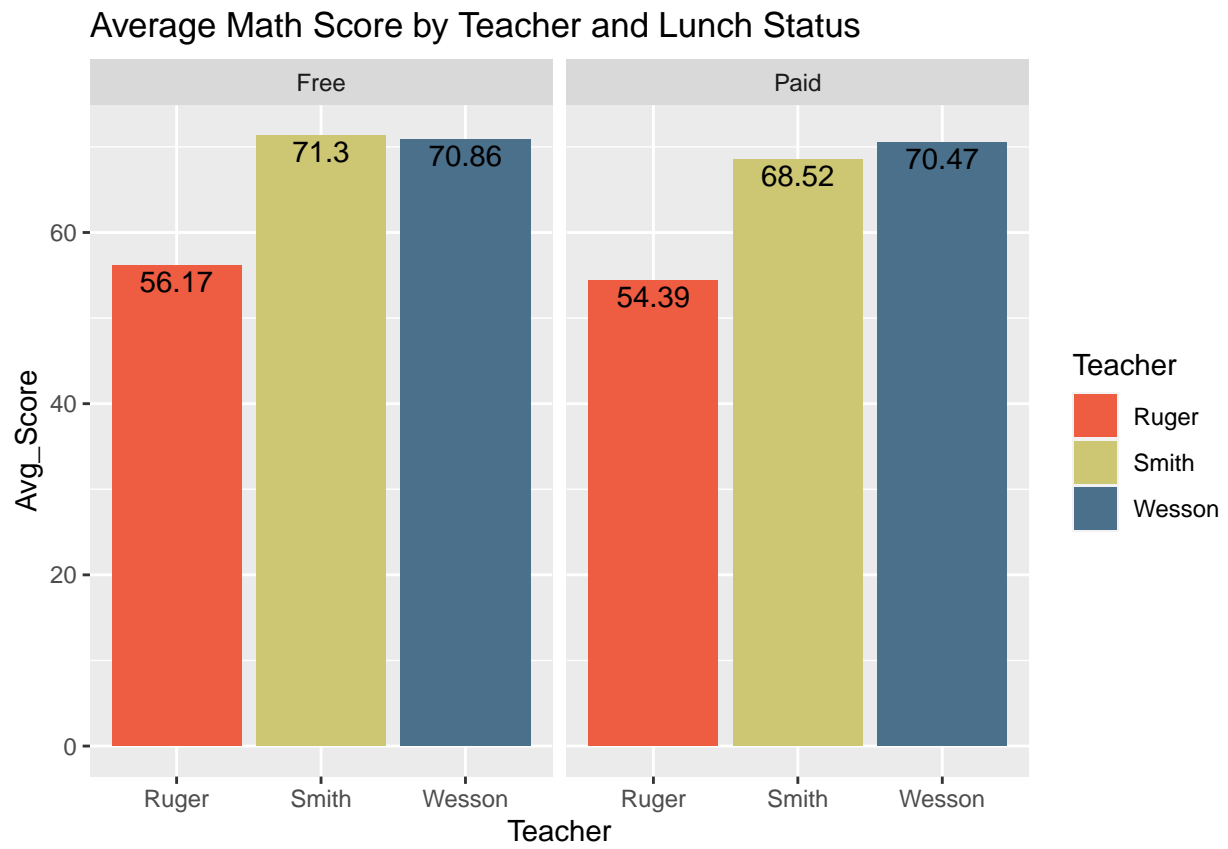
Compare Student Scores Based on Math Teacher and Lunch Status.

```
## # A tibble: 2 x 2
##   Lunch Avg_Score
##   <chr>     <dbl>
## 1 Free      66.0
## 2 Paid      64.6
```



Findings show 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.

```
## # 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
```



Summary

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 uses the traditional method. When ranking the performance of students in each class, the standards-based method ranks first and last, while the traditional method is a close second place. Considering the discrepancy between the two standards-based classrooms, we cannot definitively 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 that would outweigh the ethical issues that such groupings could create. 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.

The largest difference in student performance was found when comparing teachers. The differences between student scores in each class can be seen on a graph, but may not be statistically significant. There could be other factors causing an appearance of low performance. Hypothesis testing needs to be done to determine the level of significance for these results.

The final task was to evaluate the suggestion to group students by ability within the classroom. While the data set provided does not address this question, a careful read of the article cited by the teacher reveals that the data does not support the teacher's suggestion. The study observed the impact of grouping whole classes by ability, but did not address student grouping within a classroom. The paper showed no significant difference in teacher behavior or student performance between classes that were ability-tracked. However, there were negative differences in teacher attitude towards students in low-ability classrooms.

To find answers, it is necessary to look at other data. In his paper, "Ability Grouping in Mathematics Classrooms: A Bourdieuan Analysis," Robyn Zevenbergen found that ability grouping within the classroom can have a negative impact on how students perceive themselves and the subject of mathematics in general.

Further, "Within-Class Grouping: A Meta-Analysis" (Yiping Lou, et.al) found that, while small-group instruction within a classroom is preferable to whole-class instruction, the effect was largest if the teacher received training to adapt instructional delivery to each group. When comparing homogeneous or heterogeneous ability grouping within the classroom, the analysis found homogeneous groups benefit students with medium ability, but not low- or high-ability students. Additionally, a significant benefit of ability grouping was found in reading, but not in mathematics.

In summary, "Larger effects occurred when the group formation was based on mixed sources and involved more considerations than ability alone." These findings do support the use of small-group instruction with teacher training in adaptive methods for each group. They do not, however, support using ability as the exclusive criteria for forming small groups.

Recommendations

1. Allow teachers to continue using their preferred method. Collect more data that includes pre- and post-instruction scores to demonstrate growth, then reevaluate this issue based on future data.
2. Do not group classes according to ability, ethnicity, or socioeconomic status.
3. Encourage small-group instruction, and provide training to teachers on how to adapt instruction for each group. Small group criteria can include, but should not be limited to, mathematical ability.
4. If the difference between student scores proves to be statistically significant, the school administration should consider evaluating and offering professional development support for Ms. Ruger.