A Look at Exam Scores and Factors for Academic Success

BANA.780 Problem 1
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Introduction to the Dataset

- This dataset holds information on 1000 students, and tells us their exam scores in Math, Reading, and Writing classes
- Other information we have on the students:
  - Gender
  - Parental level of education
  - Lunch type (free/subsidized or standard)
  - Prep Course (completed or none)
- With this information, we can examine how these factors may affect student's exam scores, and make decisions about how the school can attempt to improve student's grades

Explaining the Data

- Gender
  - Students are marked as male or female
- Parental Level of Education
  - Tells us the highest level of education the student's parents completed
  - Broken down into some high school, high school, some college, associate's degree, bachelor's degree, and master's degree
- Lunch
  - Students either have the standard lunch or a free/reduced lunch
  - Students are given the free/reduced lunch when their family cannot afford to pay full price for lunch
- Prep Course
  - Students can take a prep course for exams through the school
 - We will make the assumption that prep courses are an added optional expense

Summary of Student's Math Scores

- The average math exam score was 66.089%
- The median score was 66%
- The histogram here shows the range and frequency of math scores


Math Scores
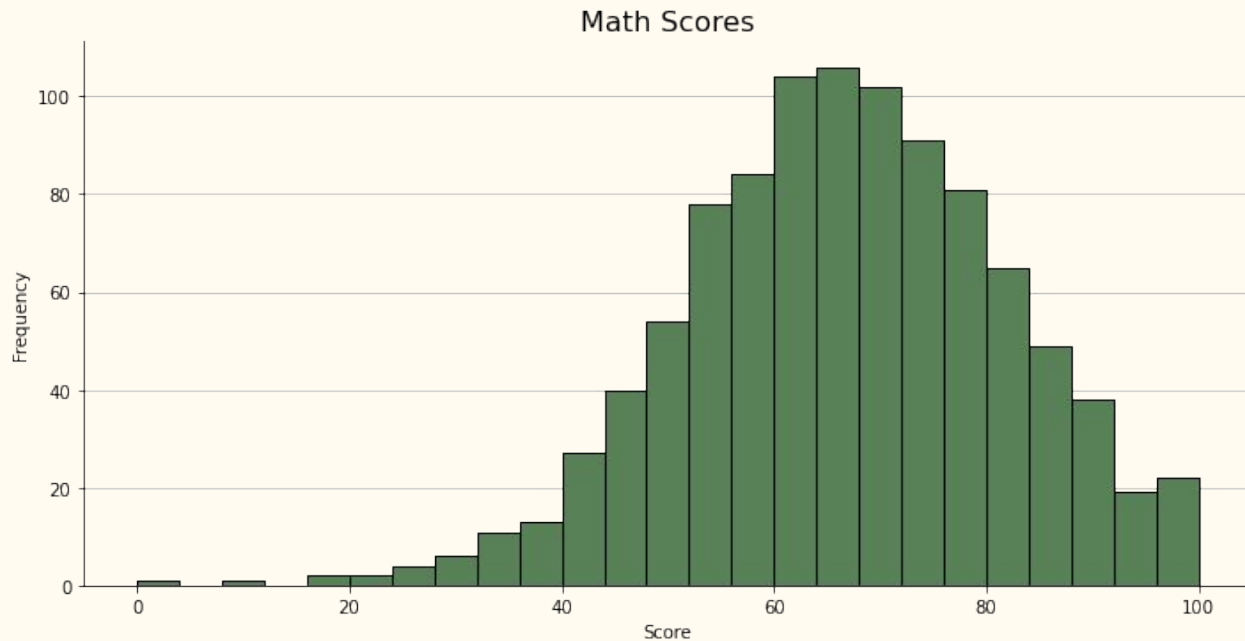
Summary of Student's Reading Scores

- The average reading exam score was 69.169%
- The median score was 70%
- The histogram here shows the range and frequency of reading scores
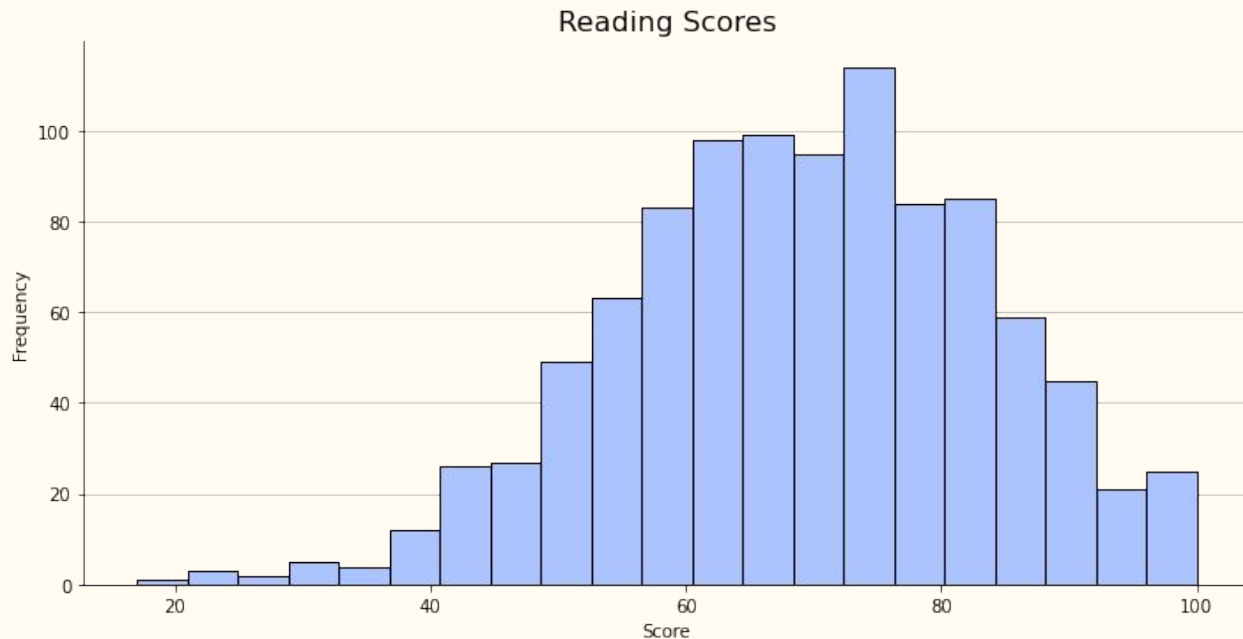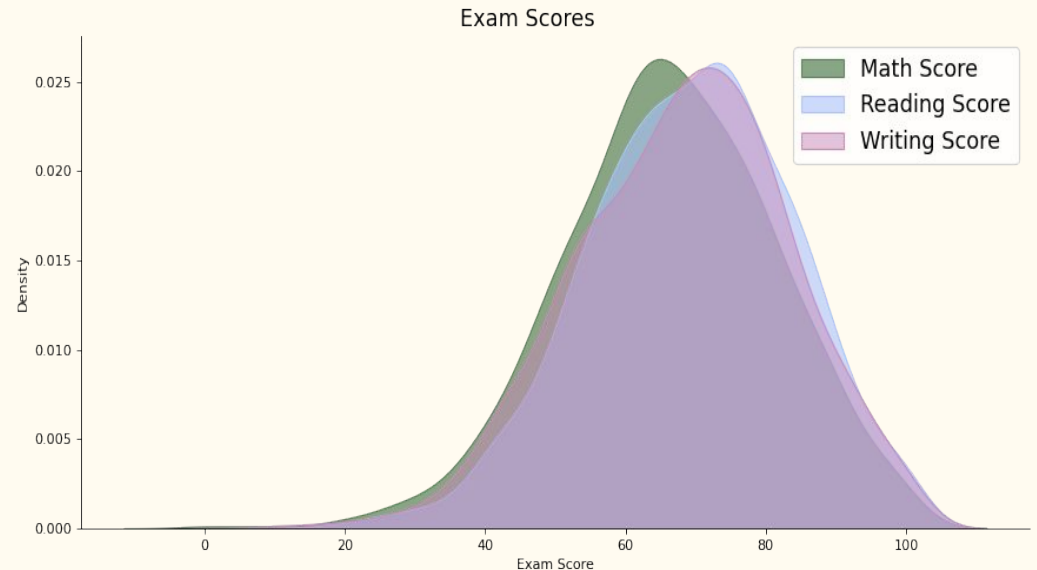

Reading Scores

Summary of Student's Writing Scores

- The average writing exam score was 68.054%
- The median score was 69%
- The histogram here shows the range and frequency of writing scores
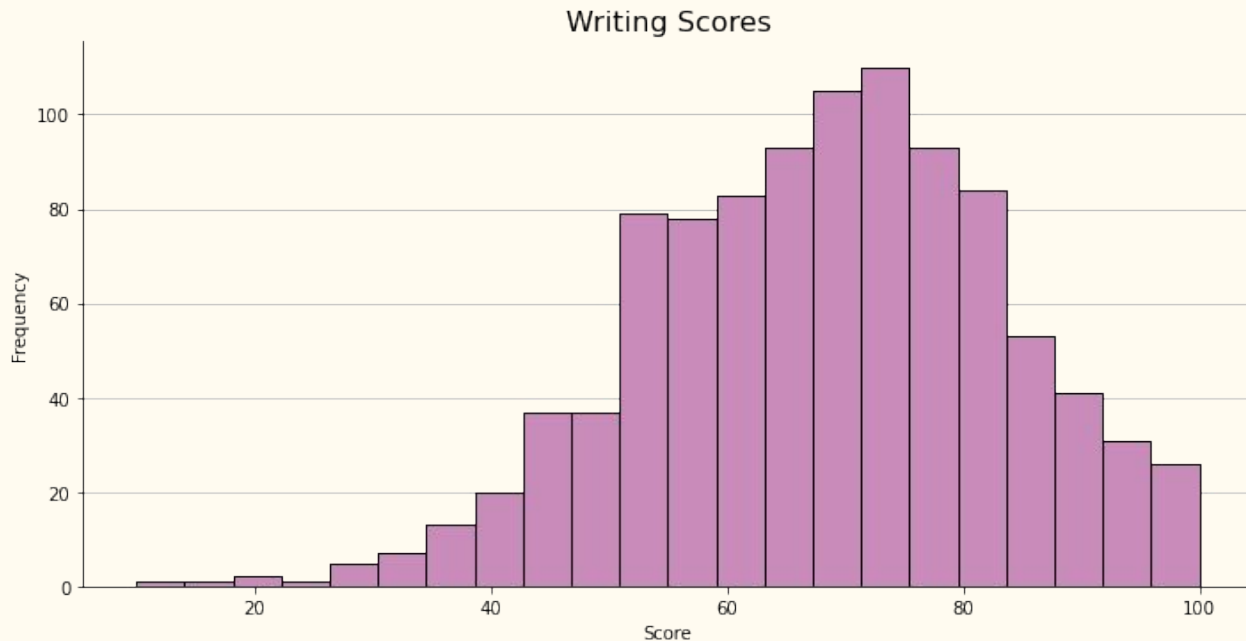

Writing Scores

- A t-test tells us that the scores on the reading and writing exams are not significantly different
- However, the scores on the math exam are significantly different from the scores on the reading exam and from the scores on the writing exam
  - This makes sense, as reading and writing are similar subjects/ require a similar skill set
  - Math is a STEM course, while reading and writing are not

	Mean	Median
Math	66.089%	66%
Reading	69.169%	70%
Writing	68.054%	69%

Exam Scores

Average Exam Score

- An average exam score was found for each student based on their math, reading, and writing exams
- The average exam score was 67.77%
- The median score was 68.3%
- The histogram here shows the range and frequency of the average scores
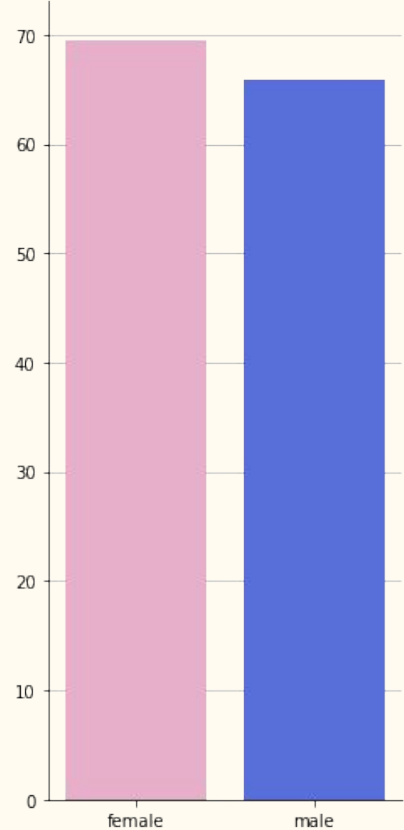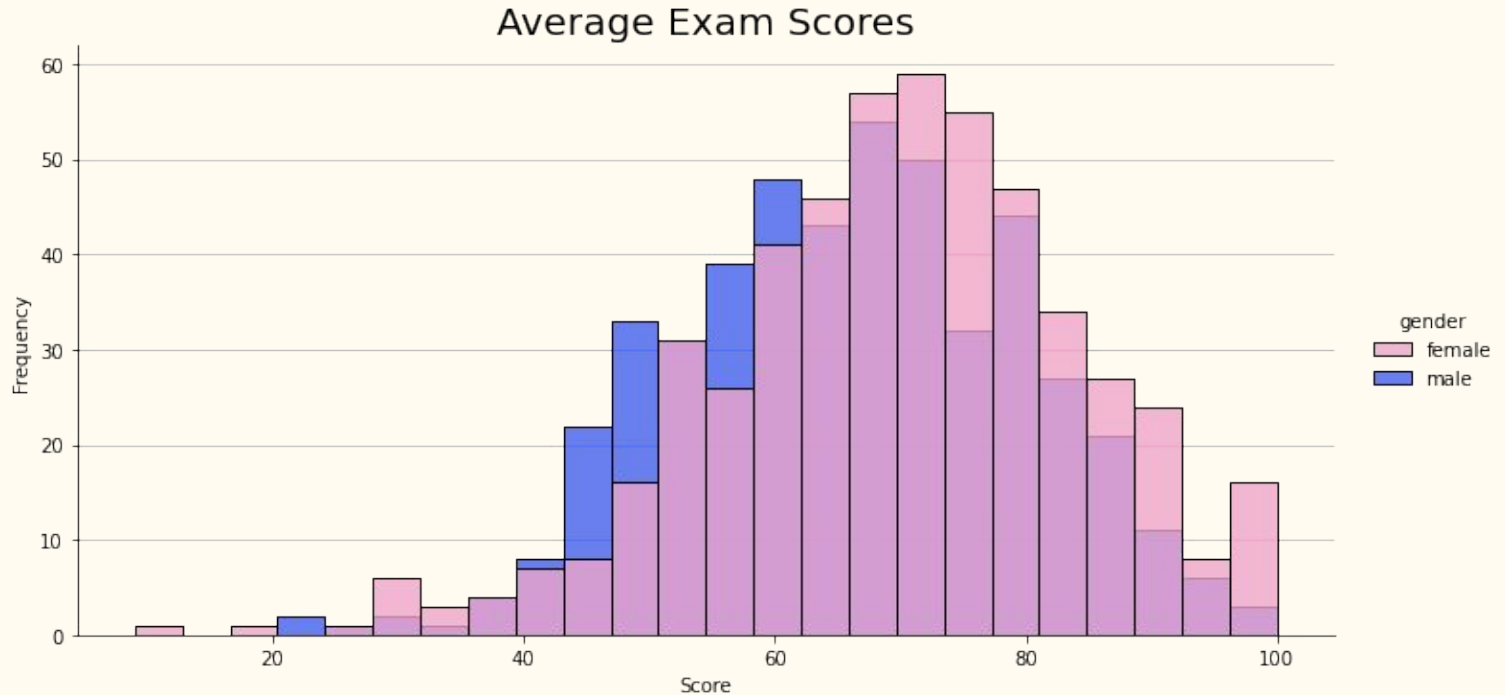

Average Exam Scores
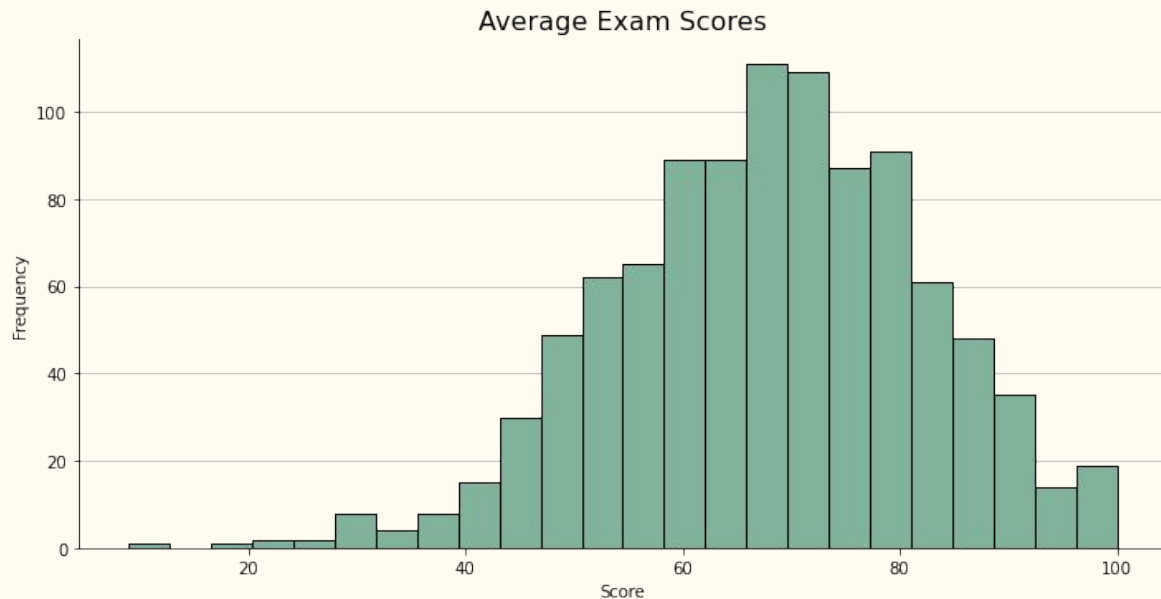
Breakdown of Exam Scores by Gender

- This bar chart shows us the average exam score of each gender
  - We can see that females have a higher average exam score compared to males


Average Exam Scores by Gender

- This histogram shows us the frequency of the average exam scores by gender
  - This also shows us that the female average is higher than the males
  - The range of grades for females and males is similar, with females having a slightly wider range

Average Exam Scores

- The scatter plot compares the math exam score of a student to the average score of their reading and writing exams
- We can see that females perform better on reading and writing exams, while males perform better on math exams.

Average Exam Scores
Reading and Writing Average vs Math Average
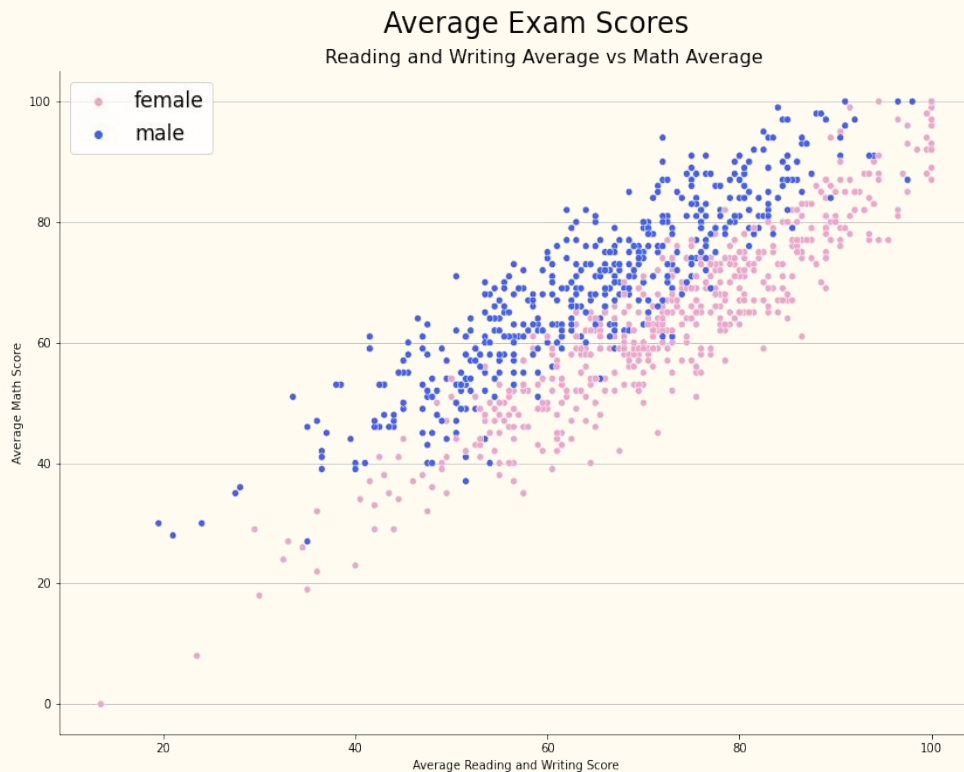
- The pie charts on the following slide show the the breakdown of all students, of the top 10% performing students, and of the bottom 10% performing students, by gender
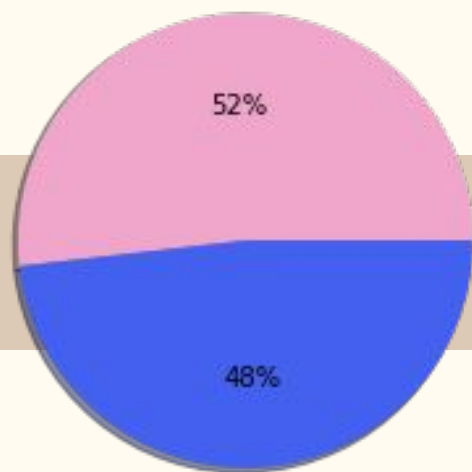- The table below shows this as well

	All Students	Top 10%	Bottom 10%
Female	52%	**67%**	**38%**
Male	48%	**33%**	**62%**

● % Increase

● % Decrease
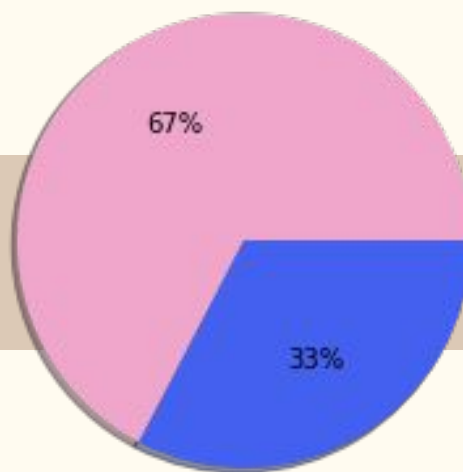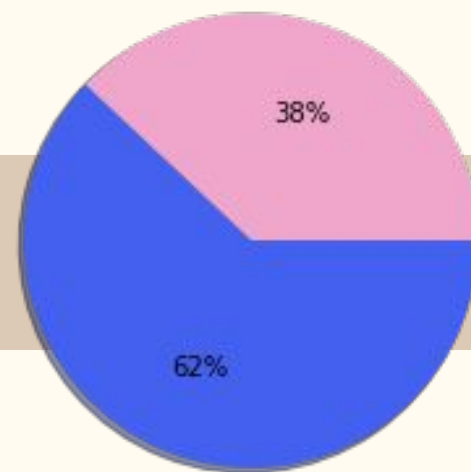
- Females have a higher overall average than males
- Females make up about ⅔ of the top 10% of students, and only around ⅓ of the bottom 10% of students
  - According to a study of 1.6 million elementary, high school, and university students, published in the Journal Nature Communications, females get higher grades than males at all ages
  - The data in our dataset reflects what was found in this study
- However, males in our dataset performed better on math exams compared to females
  - The same study found that females receive better grades than males, even in STEM subjects like math
  - However, there are some hypothesized reasons why men are often believed to be better in STEM subjects
    - Teachers tend to gauge girls' math abilities lower than those of male students, even when the grades are comparable
    - Women may steer clear of STEM subjects due to a "boys culture"
    - Women have a bigger performance advantage over men in non-STEM subjects, so they may gravitate towards those
  - The results from our dataset goes against what was found in the study, which may imply that the girls at this school do not have quality STEM resources

Parental Level of Education

- The bar chart shows us the average exam score of students broken down by their parental levels of education
  - We can see, with the exception of "some high school" vs "high school," students grades increase as their parental level of education increases

Average Exam Scores by Parental Level of Education
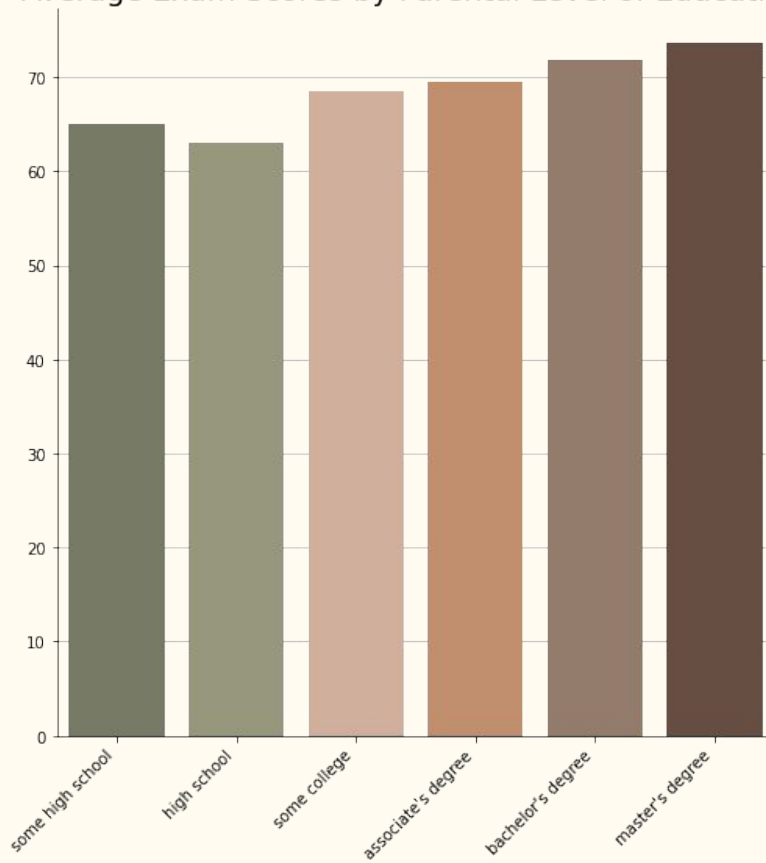
- The pie charts on the next slide show the the breakdown of all students, of the top 10% performing students, and of the bottom 10% performing students, by parental level of education
- The table below shows this as well

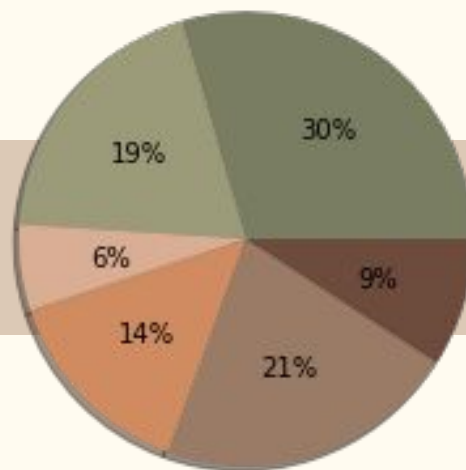|	All Students	Top 10%	Bottom 10%
Some High School	18%	9%	28%
High School	20%	6%	32%
Some College	23%	21%	14%
Bachelor's Degree	12%	19%	8%
Associate's Degree	22%	30%	17%
Master's Degree	6%	14%	1%

● % Increase

● % Decrease

Legend:
- Some High School
- High School
- Some College
- Associate's Degree
- Bachelor's Degree
- Master's Degree

Parental Level of Education for All Students
- 22% (Some High School)
- 12% (High School)
- 20% (Some College)
- 6% (Associate's Degree)
- 23% (Bachelor's Degree)
- 18% (Master's Degree)

Parental Levels of Education for Top 10% Performing Students
- 30% (Some High School)
- 19% (High School)
- 6% (Some College)
- 14% (Associate's Degree)
- 21% (Bachelor's Degree)
- 9% (Master's Degree)

Parental Levels of Education for Bottom 10% Performing Students
- 17% (Some High School)
- 8% (High School)
- 32% (Some College)
- 1% (Associate's Degree)
- 14% (Bachelor's Degree)
- 28% (Master's Degree)
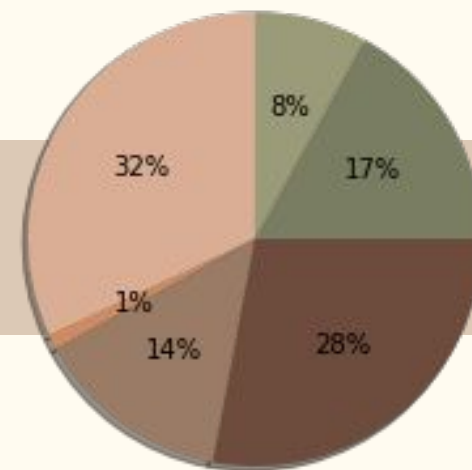
- Although the trend is not completely linear, the dataset shows that as a student's parental level of education increases, their grades increase
  - "High school" did not correlate to a higher average grade than "some high school"
- "Some high school" and "high school" both have a smaller proportion in the top 10% of students, and a larger proportion in the bottom 10% of students, compared to the entire sample population
  - This means the students in these groups were clustered more towards the bottom of the grades range
- "Some college" had a smaller proportion in both the top and bottom 10% of students, compared to the entire sample population
  - This means the students in this group fell more in the middle of the grades range, and did not have particularly high frequencies in the top or bottom 10%
- "Associate's Degree," "Bachelor's degree," and "Master's Degree" all have a larger proportion in the top 10% of students, and a smaller proportion in the bottom 10% of students, compared to the entire sample population
  - This means that the students in these groups were clustered more towards the top of the grades range

- What is causing these differences?
  - A 2001 study looked at college freshmen to analyze the relationship between parental education level and academic success
  - The study found that "students whose parents had higher educational levels performed higher on standardized tests than parents with lower educational levels"
  - The study deposits that parents with increased education levels may put a higher value on education for their child(ren), which leads to improved grades
- We had the same result with our dataset
- Socioeconomic factors also have an effect
  - The results from this research also showed that socioeconomic factors weigh heavily on the academic achievement of students
    - Students from wealthier families are more likely to have better grades
  - Parental education levels have a strong positive relationship to family income levels
    - Therefore, having an increased parental level of education can lead to increased family wealth, which can further the performance gap between students even more
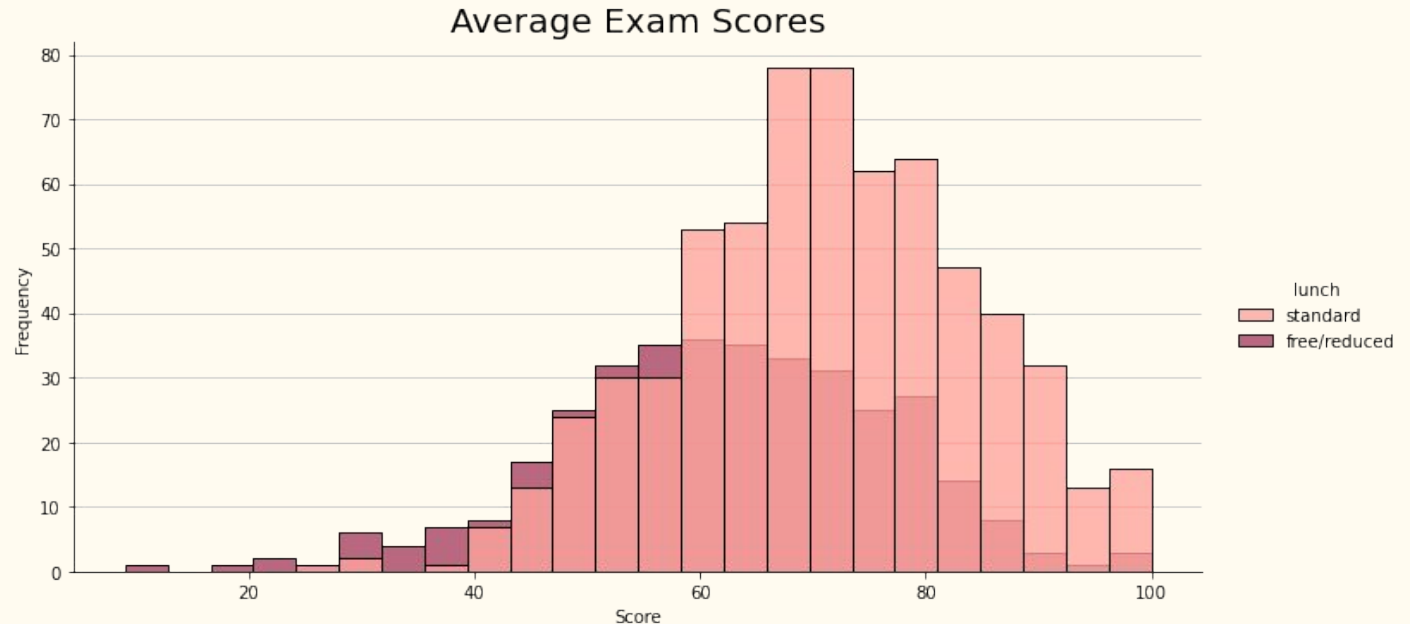
Lunch

- The bar chart shows us the average exam score for students based on their lunch type
  - We can see that students who can afford to pay for the standard lunch have a higher average than those who are given the free/reduced lunch


Average Exam Scores by Lunch Type
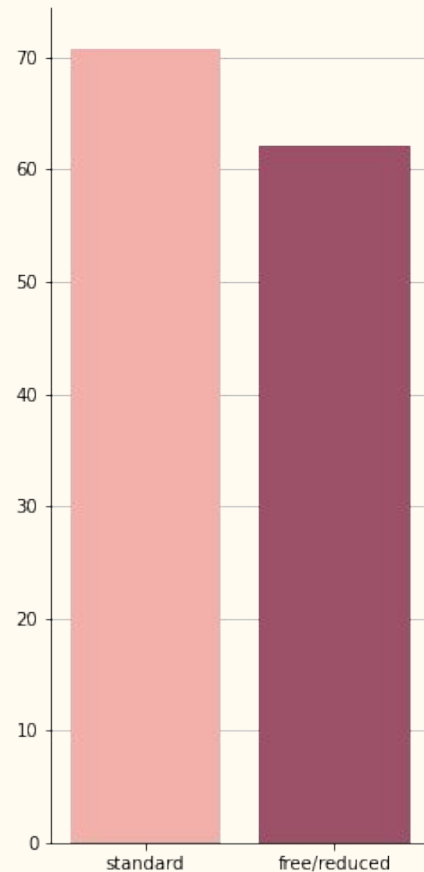
- The histogram shows us the frequency of the average exam scores by lunch type
  - This also shows us that the standard lunch type average is higher than the free/reduced type
  - We can see that the grades of the free/reduced lunch students are much more spread out, while those with the standard lunch are clustered more towards the higher end
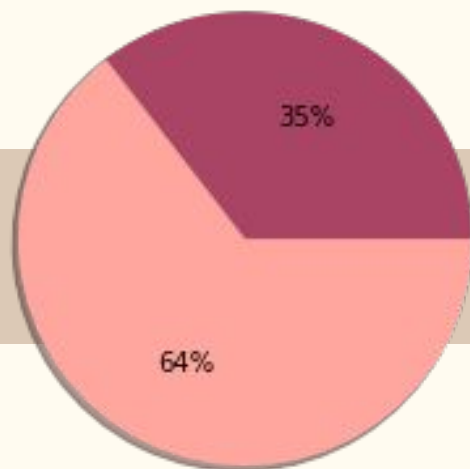

Average Exam Scores

- The pie charts on the next slide show the the breakdown of all students, of the top 10% performing students, and of the bottom 10% performing students, by lunch type
- The table below shows this as well

	All Students	Top 10%	Bottom 10%
Standard	64%	**88%**	**40%**
Free/Reduced	35%	**12%**	**60%**

● % Increase

● % Decrease

Standard
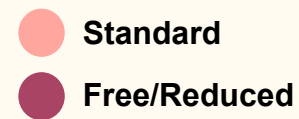
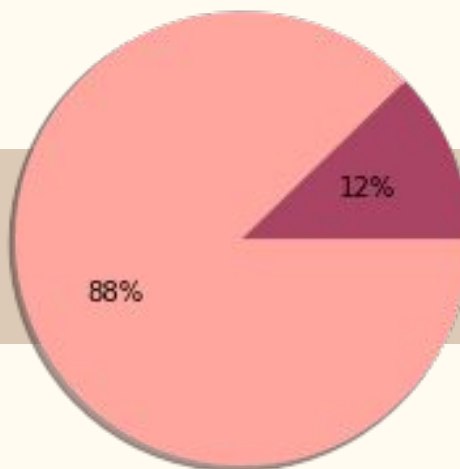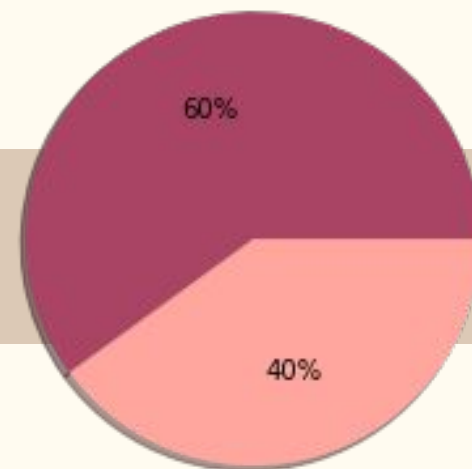**Free/Reduced**

Lunch Type for
All Students

Lunch Type for Top 10%
Performing Students

Lunch Type for Bottom
10% Performing Students

35%

64%

12%

88%

60%

40%

- The dataset shows that students who cannot afford the standard lunch and are given the free/reduced lunch perform worse on average
  - This follows what was said in the parental level of education slides
  - Socioeconomic status has been found to be heavily linked to academic performance
  - Therefore, it makes sense that students in poorer families who cannot afford the standard lunch have lower scores in our dataset
- The students who received a free/reduced lunch make up a significantly smaller proportion of the top 10% group, only about ⅓ as much as their proportion for the entire dataset
  - Therefore, it is much less likely that a student in this group will excel academically
- Students who received a free/reduced lunch make up a significantly larger proportion of the bottom 10% group, almost double their proportion for the entire dataset
  - Therefore, students who cannot afford the standard lunch are much more likely to perform extremely poorly compared to the entire dataset
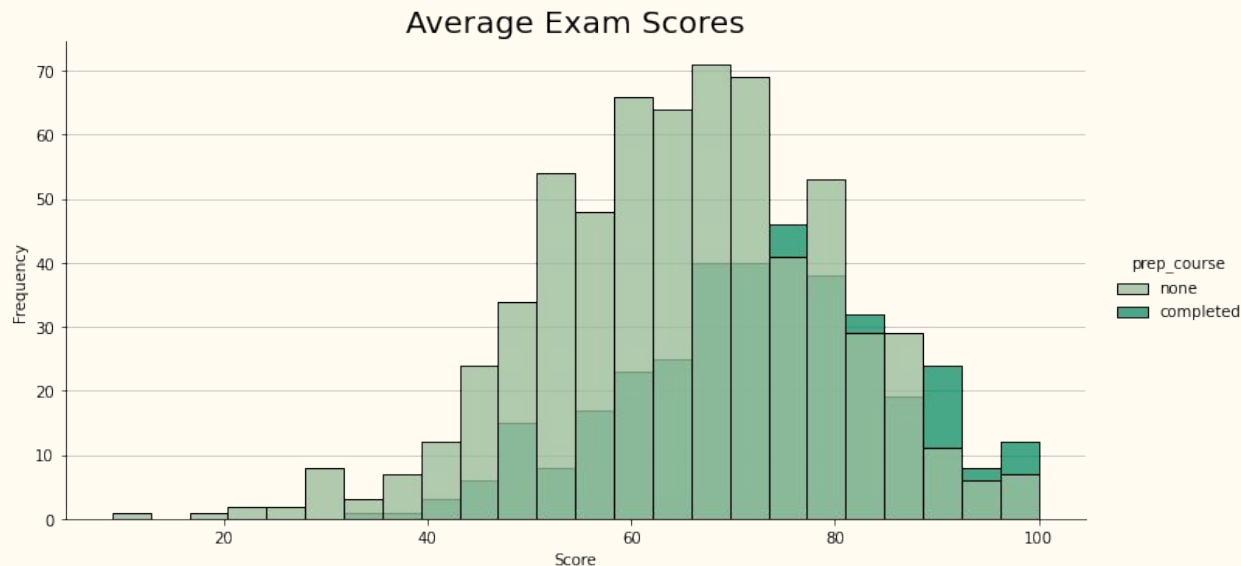
Prep Course

- The bar chart shows us the average exam score for students based on whether or not they took a prep course
  - We can see that students completed the prep course have a higher average than those who did not

Average Exam Scores by Prep Course
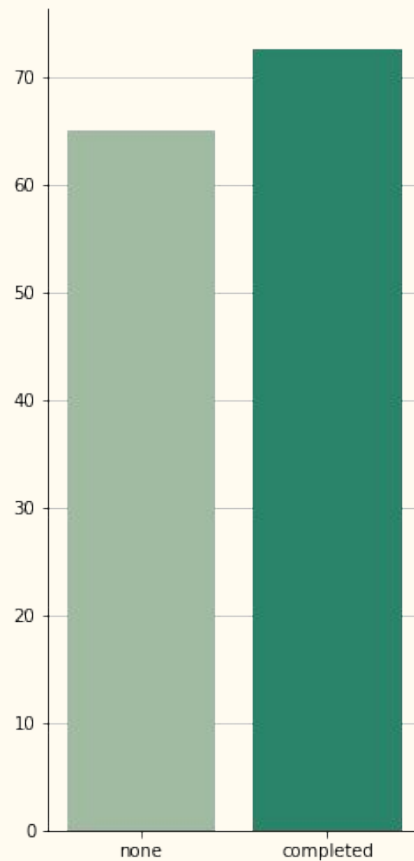
- The histogram shows us the frequency of the average exam scores by prep course completion
  - This also shows us that students completed the prep course have a higher average than those who did not
  - We can see that the grades of the students students who did not complete the prep course are more spread out, while those who did complete the prep course have grades that are clustered more towards the higher end

- The pie charts on the next slide show the the breakdown of all students, of the top 10% performing students, and of the bottom 10% performing students, by prep course
- The table below shows this as well

	All Students	Top 10%	Bottom 10%
No Prep Course	64%	**43%**	**82%**
Prep Course Completed	36%	**57%**	**18%**

🟢 % Increase

🔴 % Decrease

None
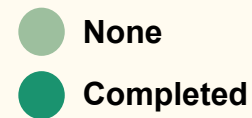
Completed

Prep Course Breakdown for All Students

36%

64%
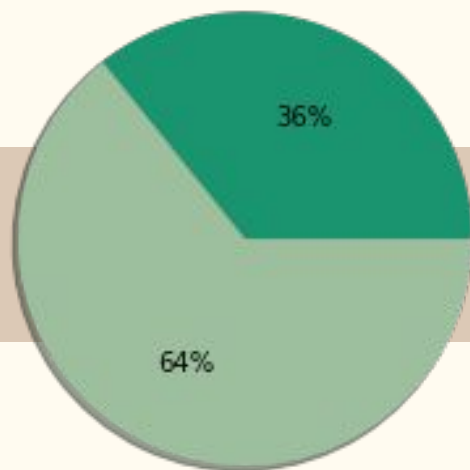
Prep Course Breakdown for Top 10% Performing Students

57%

43%

Prep Course Breakdown for Bottom 10% Performing Students

18%

82%

- This dataset shows that students who can both afford to and choose to complete a prep course perform better academically on average
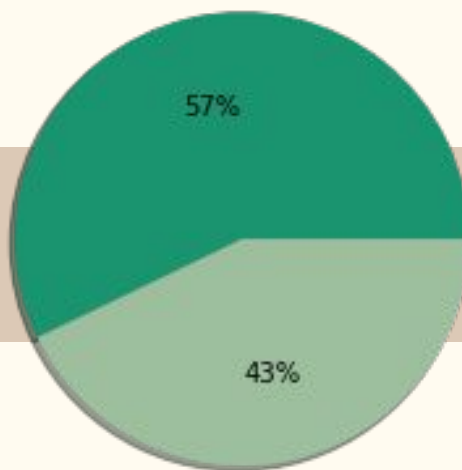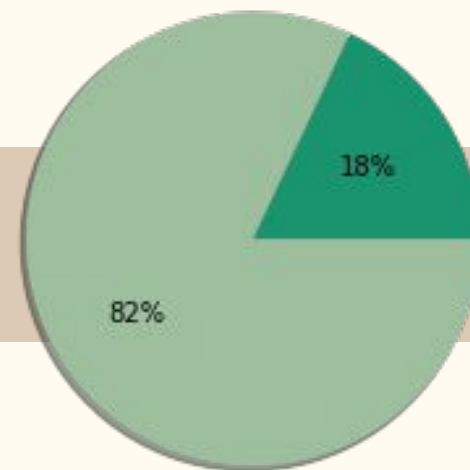 - This result makes sense, since higher family income levels are linked to higher academic performance, as was previously discussed
  - The decision to complete a prep course may come from the student, but may also be influenced by parents who value education
- Students in this dataset who complete a prep course make up a significantly smaller proportion of the bottom 10% group, only about ½ as much as their proportion for the entire dataset
  - Therefore, a prep course would likely be an effective way for a low performing student to raise their grades enough to leave the bottom 10% group

Summary of Findings

Positive Factors for Exam Scores:

- Being female (compared to being male)
- Having parent(s) who completed an associate's, bachelor's, or master's degree
- Being able to afford the standard lunch
- Completing a prep course

Negative Factors for Exam Scores:

- Being male (compared to being female)
- Having parent(s) who completed some high school or high school
- Having the free/reduced lunch
- Not completing a prep course

Analysis and Recommendations

Gender

- Obviously, gender is not something that could be changed by the school
- However, we have seen that the females in this dataset are underperforming in math, even though studies have shown that girls outperform boys in all subjects, including STEM
- I would recommend for the school to start looking for ways to promote a "Women in STEM" environment
  - This could be with clubs, in class activities, electives that could promote STEM confidence such as science or coding classes - especially geared towards women
- Males in this dataset are performing lower on average in reading and writing classes
  - I would recommend for the school to start looking into ways to encourage more male participation and enjoyment in non-STEM classes
    - Could pick more books/class topics that are more geared towards school aged boys
    - Could create clubs that involve reading or writing about common schoolboy interests - video games, TV shows, movies, sports, etc.

Parental Level of Education:

- This is not something that can be changed by the school
- However, this has been shown to have a huge impact on students, and is likely due in part to the links between education and family income
  - Therefore, there is a lot of overlap between the effects of this category and the effects of the lunch and prep course categories, as they are also heavily linked to income

Lunch Type:

- The school is already helping students out by providing those who cannot afford lunch with a free/reduced option
- However, the school needs to be aware that students who do need the free/reduced lunch are at greater risk for poor academic performance
- I would recommend that the school also provide a free/reduced breakfast option to these students
  - If they cannot afford lunch, it is probable that they cannot afford breakfast either
  - Research has shown that children from families with food insecurity are more likely to have lower math scores and repeat a grade

Prep Course

- Taking a prep course has shown to increase a students academic scores
- However, these prep courses cost money, and some students may not be able to afford it
  - It is likely that if a student cannot afford lunch, they will not be able to pay for a prep course
    - This shows how students from well-off families have many advantages over poorer classmates
  - Students are also unlikely to take a prep course if their family places little importance on education
    - Parents with lower levels of education may not put as much emphasis on education as parents with higher levels of education
- I would recommend that the school offer the prep courses at a free/reduced price to students who qualify for the free/reduced lunch
  - This would help to decrease the disadvantages that poorer students face compared to well-off students

Works Cited

Gooding, Yasan, "The relationship between parental educational level and academic success of college freshmen " (2001). Retrospective Theses and Dissertations. 429.

O'Dea, R.E., Lagisz, M., Jennions, M.D. *et al.* Gender differences in individual variation in academic grades fail to fit expected patterns for STEM. *Nat Commun* 9, 3777 (2018). https://doi.org/10.1038/s41467-018-06292-0

Weber, Allison. "Help Kids Facing Hunger This School Year." *Feeding America*, 8 Aug. 2019, www.feedingamerica.org/hunger-blog/help-kids-facing-hunger-this#:~:text=How%20does%20hunger%20affect%20a,a%20grade%2C%20among%20other%20challenges.

Dataset: https://www.kaggle.com/spscientist/students-performance-in-exams