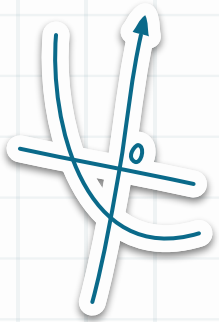
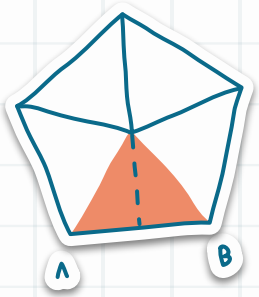
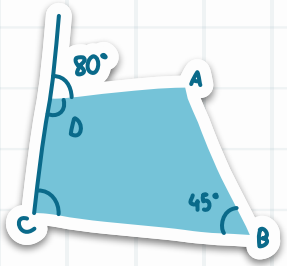


Epsilon School

Claire Newcom, Dylan Whiting, Palak Yadav





Background

The Epsilon School of Mathematics and Science incoming sophomore class is larger than previous years, causing the student population to grow from. from 490 to 630. Because of this, seven new teachers will be hired.

Method

In this presentation we will show how we mathematically found out which departments should receive new teachers by using class data from previous years and and attempting to keep the new and old student to teacher ratio similar.

Assumptions and Variables:

Assumptions:

- Students take 6 classes
- Class enrollment followed historical trends
- Consistently rounded down
- The dropout rate was consistent and no dropouts occur during senior year
- Teachers can teach students of any grade

Variables:

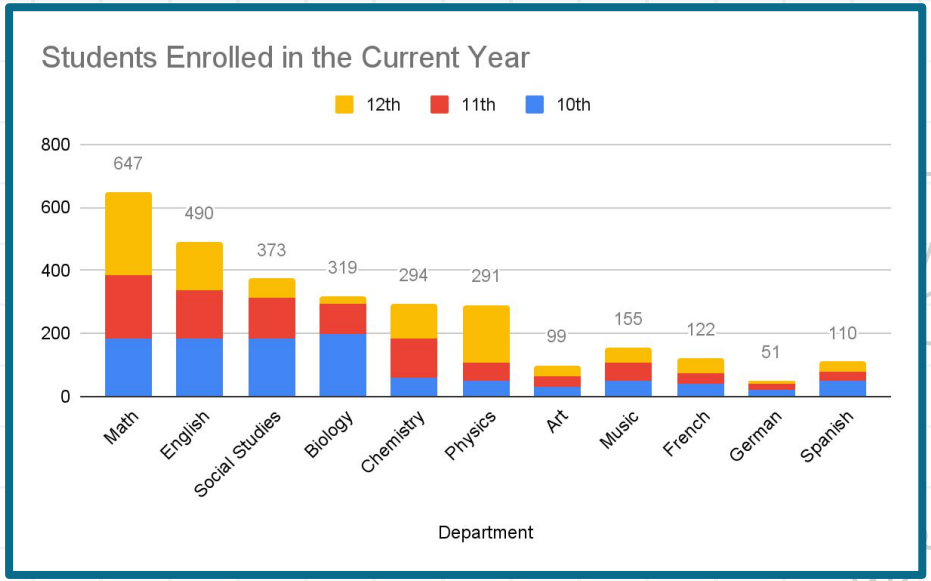
- Number of students in next year's 10th grade
- Number of students in next year's 11th grade
- Number of students in next year's 12th grade
- Number of students in each department next year
- Current class size

Conditions

Criteria	Current Year	Next Year
Student Number	490	630 Sophomores: 140 more than the graduating seniors
Faculty Number	31	38
Conditions	Size of the graduating class = graduating seniors + anyone who dropped out during the year	Incoming sophomore class is the size of the original size of the graduating class plus 140

Current Numbers

Department	Total	Faculty	Ratio(Student:faculty)
Math	647	6	108
English	490	5	98
Social Studies	373	5	75
Biology	319	4	80
Chemistry	294	3	98
Physics	291	3	97
Art	99	1	99
Music	155	1	155
French	122	1	122
German	51	1	51
Spanish	110	1	110



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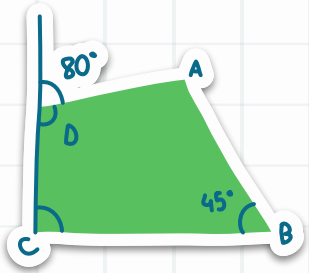
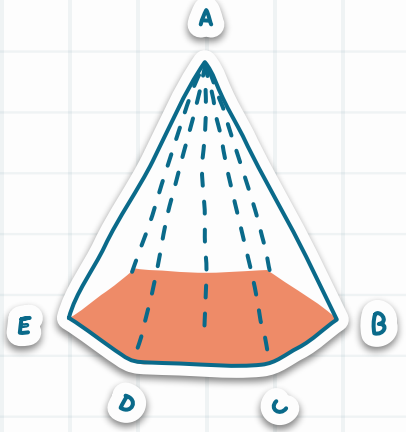


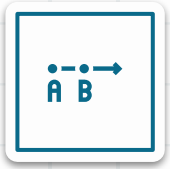
Problem

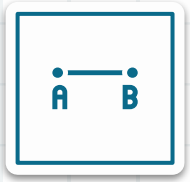
7 teachers are hired for next year to meet the increased enrolment.

How many teachers should each department receive?



1. Finding Current Class Size





Process

- Sum number of enrollments in each grade
- Assumed that each students takes 6 classes in a day
- Divide by 6 to identify the number of students in each grade

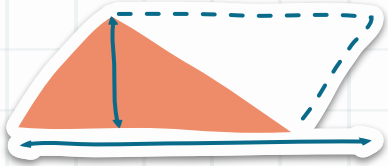
Reasoning

- Because each student takes six classes per day, if we add all of the classes taken up, and divide by six, that should give us the total number of students

1. Finding Current Class Size

Department	10th	11th	12th
Math	184	201	262
English	183	155	152
Social Studies	183	131	59
Biology	198	95	26
Chemistry	59	126	109
Physics	50	58	183
Art	31	33	35
Music	50	56	49
French	41	32	49
German	19	22	10
Spanish	51	26	33
Sum	**1049**	**935**	**967**
Class Size	**174.8**	**155.8**	**161.2**
Rounded	**174**	**155**	**161**

2. Using Drop Out Rates to Predict Class Size



Condition:

- [ ] 5% of the incoming class drop out prior to graduation

  Size of the incoming class = graduating senior class (+ any students who dropped out during the year

Current year:

- Seniors: 161

Assumed no dropouts occur during senior year

- The senior year class originally started off with **169** students
(161 is 5% loss from 169)

- The incoming sophomore class is projected to have **169 students + 140 additional = 309** students

2. Using Drop Out Rates to Predict Class Size

Current Senior Year Class:

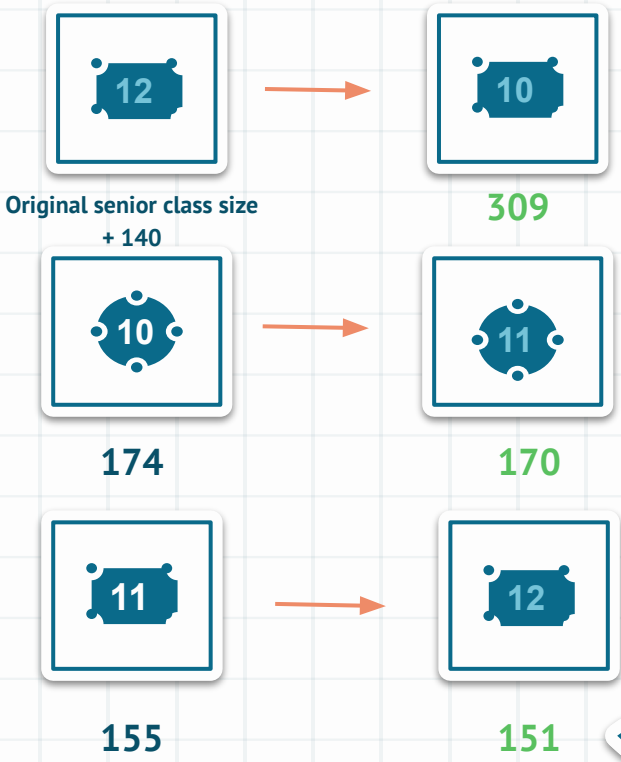
-Initial: 169 students

-Lose 8 students over 2 years

-Assumed even distribution of drop out → 4 students dropped out each year

-2.367 % drop out rate each year

Grades Move Up → Lose 2.367% each year



Total Students Next Year: **630**

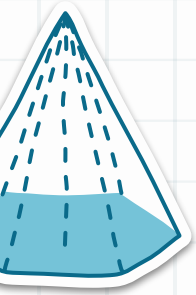
3. Finding a Ratio of Students to Predict Department Sizes

To find out the new number of students enrolled in classes in each of the departments, we used ratios.

- Assumed that the same ratios of students would take classes in each of the departments over the years.
- For example, the ratio of students taking math in 10th grade in the current year is assumed to be equal to the ratio of students taking math in 10th grade next year.

Equation:

$$\frac{\text{students in department in current grade}}{\text{total number of current students in a grade}} = \frac{x \text{ students in department in new grade}}{\text{total number of new students in a grade}}$$



$$\frac{184\ current\ 10th\ grade\ students\ enrolled\ in\ math}{174\ total\ 10th\ grade\ students} = \frac{x\ 10th\ grade\ students\ enrolled\ in\ math\ next\ year}{309\ new\ 10th\ grade\ students}$$

Example:

Solving for new 10th grade math:

$$x = \frac{(309\ new\ students)(184\ current\ 10th\ grade\ students\ enrolled\ in\ math)}{174\ total\ 10th\ grade\ students}$$

$$x = 326\ 10th\ grade\ students\ enrolled\ in\ math\ next\ year$$

Enrollment Numbers

Department	10th	New 10th	%Change	11th	New 11th	%Change	12th	New 12th	%Change
Math	184	326	77.2	201	220	9.7	262	246	-6.2
English	183	324	77.0	155	170	9.7	152	**143**	-6.2
Social Studies	183	324	77.0	131	144	9.7	59	55	-6.2
Biology	198	351	77.3	95	104	9.7	26	24	-6.2
Chemistry	59	104	76.3	126	138	9.7	109	102	-6.2
Physics	50	88	76.0	58	64	9.7	183	172	-6.2
Art	31	55	77.4	33	36	9.7	35	33	-6.2
Music	50	88	76.0	56	61	9.7	49	46	-6.2
French	41	72	75.6	32	35	9.7	49	46	-6.2
German	19	33	73.7	22	24	9.7	10	9	-6.2
Spanish	51	90	76.5	26	29	9.7	33	31	-6.2
Class Size	174	309		155	170		161	151	

4. Student to Teacher Ratio

Current Year

- Using the date from the previous school year, we found the current student teacher ratio by dividing total number of students in a department by the amount of teachers for that department

Next Year

- Using the new department sizes found by assuming a constant ratio of subject size to class size, we found the new student teacher ratio by dividing the new total amount of students in the department by the amount of teachers before adding the new 7

Department	*Current* S:T Ratio	*New* S:T Ratio
Math	108	132
English	98	127
Social Studies	75	105
Biology	80	120
Chemistry	98	115
Physics	97	108
Art	99	124
Music	155	195
French	122	153
German	51	67
Spanish	110	149

5. Distributing the Teachers

Finding the Difference

- We then found the percent difference between the two ratios for each subject using the percent increase formula

Distributing the Teachers

- Teachers were added to the departments in order of highest difference until all percent difference was ⩽ 30%

= subject with a teacher added

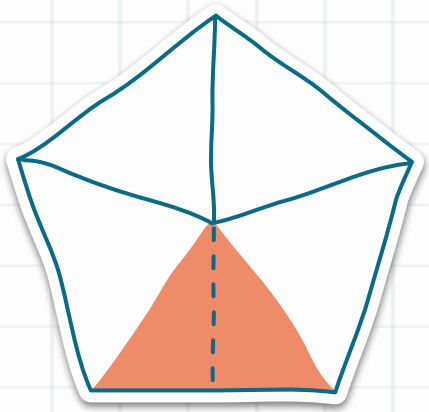
Department	% Increase w/o Added Teachers	% Increase w/ Added Teachers
Math	22	5
English	30	8
Social Studies	40	17
Biology	50	20
Chemistry	17	17
Physics	11	11
Art	25	-37
Music	26	-37
French	25	-16
German	30	30
Spanish	36	-9

5. Distributing the Teachers

The departments that received teachers are as follows:

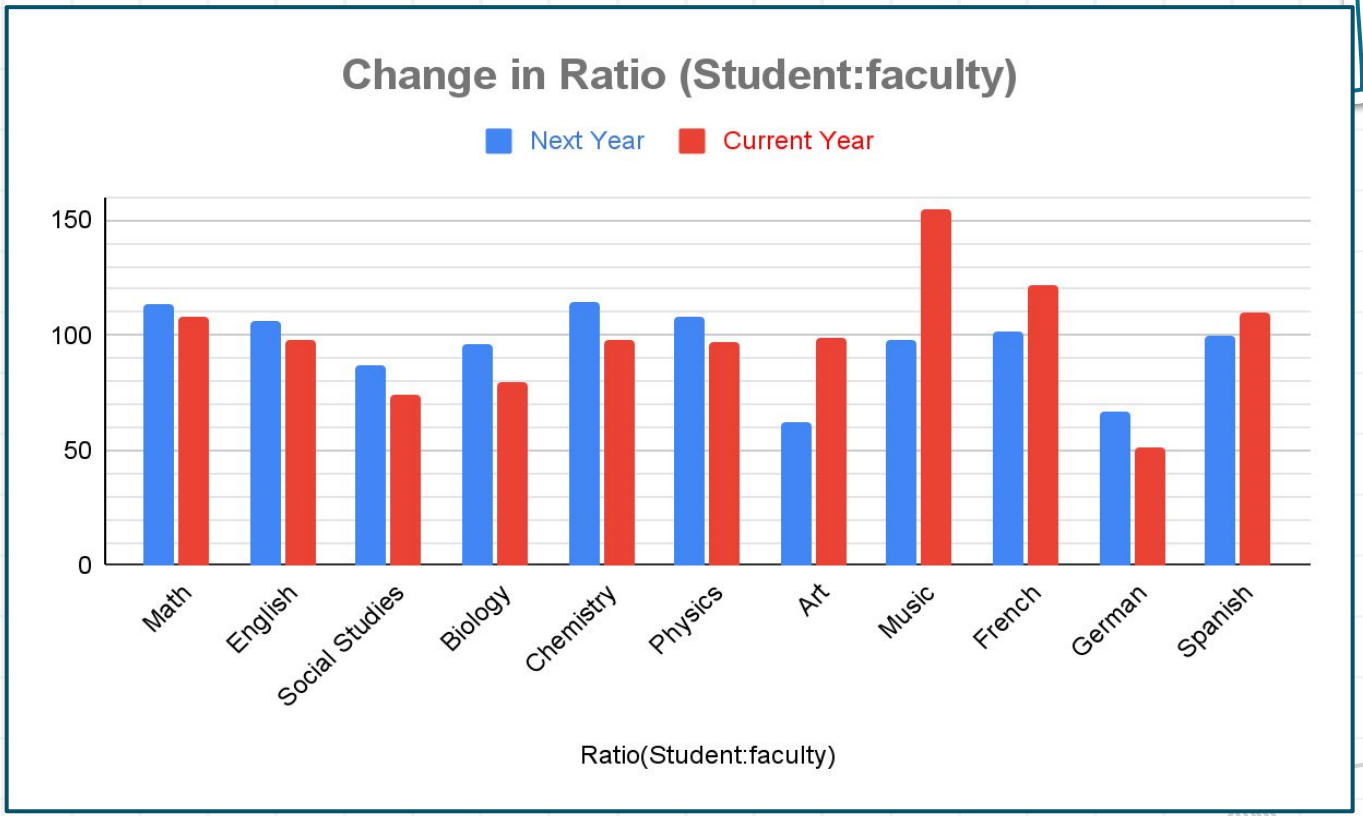
Department	Teachers allocated
Math	1 teacher
English	1 teacher
Social Studies	1 teacher
Biology	1 teacher
Art	1 teacher
Music	1 teacher
French/Spanish	1 teacher

A+B+C+D=360°



Analysis

Student:Faculty ratio was maintained close to original or reduced and we consider that a positive



Checking Work

- We reinforced our answer by using a different method of finding class size
- By assuming each student took exactly one English class per year, we used department enrollment in english for class sizes
- % increase in classe sizes all stayed below 30% with our answer

Department	% Increase w/ Added Teachers
Math	2%
English	4%
Social Studies	11%
Biology	13%
Chemistry	14%
Physics	9%
Art	-40%
Music	-39%
French	-19%
German	26%
Spanish	-14%

A+B+C+D=360°

Validating Answer

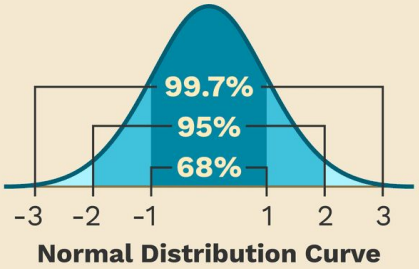
Calculating Standard Deviation

$$s_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

n = The number of data points

x_i = Each of the values of the data

$\bar{x}$ = The mean of x_i



Normal Distribution Curve

ThoughtCo.

	Current Year	Next Year
Math	108	113
English	98	106
Social Studies	75	87
Biology	80	96
Chemistry	98	115
Physics	97	108
Art	99	62
Music	155	98
French	122	102
German	51	67
Spanish	110	100
Mean	99	96
Standard Deviation	27	17

$A+B+C+D=360°$

$g(x)=\sqrt{x(x-a)(x-6)}$

Analysis

- The average student:teacher ratio remained about the same
- The standard deviation improved
- Infer that class sizes will remain relatively the same or better

	Current Year	Next Year
Math	108	113
English	98	106
Social Studies	75	87
Biology	80	96
Chemistry	98	115
Physics	97	108
Art	99	62
Music	155	98
French	122	102
German	51	67
Spanish	110	100
Mean	99	96
Standard Deviation	27	17

Strengths and Weaknesses

Strengths

- Few assumptions needed to be made
- Checked that model worked with different class size assumptions

Weaknesses

- Assuming no dropouts can occur during senior year can be inaccurate
- Does not take into account how the school will accommodate students in future years
- Class enrollment may not always follow historical trends

Error Analysis

- Each grade has different interests and therefore may not have the same ratio of department to class size, which was not accounted for in our model
- In reality, students drop out throughout each year. In our model, we assume that no students drop out during senior year which would most likely not be the case
- Our class size assumed all students took exactly 6 classes every day which may not be the case as some may have study blocks
    - This error was corrected by trying out model with different assumptions made for class sizes

Thank you!

Extra gratitude to Mrs. Burns and the XYZ group!