

Epsilon School



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Section: S

Clarification/Problem Restatement, Work Summary

This problem is asking us what types of teachers we should hire to be as fair and judicial as possible.

In order to do this, we first figured out how many students there would be in each grade in the 2024 year. We then used enrollment percentages to calculate the number of students in each class, through which we got the Student:Teacher ratio. Finally, we added teachers to the classes with the highest Student:Teacher ratios.

Class Number and Schedule

2023 School Year									
Department	Enrollment %	10th	Enrollment %	11th	Enrollment %	12th	Total	Teachers	
Art		31		33		35	99	1	
Biology		198		95		26	319	4	
Chemistry		59		126		109	294	3	
English		183		155		152	490	5	
French		41		32		49	122	1	
German		19		22		10	51	1	
Spanish		51		26		33	110	1	
Mathematics		184		201		262	647	6	
Music		50		56		49	155	1	
Physics		50		58		183	291	3	
Social Studies		183		131		59	373	5	

Class Number and Schedule

2023 School Year										
Department	Enrollment %	10th		Enrollment %	11th		Enrollment %	12th	Total	Teachers
Art			31		33			35	99	1
Biology			+ 198		95			26	319	4
Chemistry			+ 59		126			109	294	3
English			+ 183		155			152	490	5
French			+ 41		32			49	122	1
German			+ 19		22			10	51	1
Spanish			+ 51		26			33	110	1
Mathematics			+ 184		201			262	647	6
Music			+ 50		56			49	155	1
Physics			+ 50		58			183	291	3
Social Studies			+ 183		131			59	373	5
			= 1049		935			967	2951	

1049 = Total number of enrolled courses

Class Number and Schedule

2023 School Year									
Department	Enrollment %	10th		Enrollment %	11th	Enrollment %	12th	Total	Teachers
Art			31		33		35	99	1
Biology			+ 198		95		26	319	4
Chemistry			+ 59		126		109	294	3
English			+ 183		155		152	490	5
French			+ 41		32		49	122	1
German			+ 19		22		10	51	1
Spanish			+ 51		26		33	110	1
Mathematics			+ 184		201		262	647	6
Music			+ 50		56		49	155	1
Physics			+ 50		58		183	291	3
Social Studies			+ 183		131		59	373	5
			= 1049	/6	935		967	2951	
Total Per Grade			= 174		155		161	490	

1049 = Total number of enrolled courses

174 = Number of students in the 10th grade class

$$174 + 155 + 161 = 490$$

Assumptions:

Schedule: Every student takes six classes; one Science, one Math, one English, one Social Studies, one Foreign Language, and one elective.

The sophomore, junior, and senior classes from 2023 have 174, 155, and 161 students respectively; this came from floor dividing the total number of classes taken by each grade by 6, the number of courses each student takes.

Dropout

Department	Enrollment % 10th	Enrollment % 11th	Enrollment % 12th	Total	Teachers
Art	0.1823529	0.21724819	0.219360095	99	1
Biology	1.1647059	0.625411455	0.162953214	319	4
Chemistry	0.3470588	0.829493088	0.683150011	294	3
English	1.0764706	1.020408163	0.952649557	490	5
French	0.2411765	0.210664911	0.307104133	122	1
German	0.1117647	0.144832126	0.062674313	51	1
Spanish	0.3000000	0.17116524	0.206825233	110	1
Mathematics	1.0823529	1.323238973	1.642066999	647	6
Music	0.2941176	0.368663594	0.307104133	155	1
Physics	0.2941176	0.381830151	1.146939927	291	3
Social Studies	1.0764706	0.86240948	0.369778446	373	5
		1049	935	2951	
Total Per Grade		174	155	490	
With Dropout		170	152	481	

We assumed that 2% of the 2023 sophomore class, 2% of the 2023 junior class, and 1% of the 2023 senior class dropped out.

2024 School Year

Department	Enrollment % 10th	Enrollment % 11th	Enrollment % 12th	Total	Teachers
Art	0.1823529	0.21724819	0.219360095	101	1
Biology	1.1647059	0.625411455	0.162953214	490	4
Chemistry	0.3470588	0.829493088	0.683150011	352	3
English	1.0764706	1.020408163	0.952649557	650	5
French	0.2411765	0.210664911	0.307104133	157	1
German	0.1117647	0.144832126	0.062674313	69	1
Spanish	0.3000000	0.171165240	0.206825233	153	1
Mathematics	1.0823529	1.323238973	1.642066999	808	6
Music	0.2941176	0.368663594	0.307104133	200	1
Physics	0.2941176	0.381830151	1.146939927	330	3
Social Studies	1.0764706	0.86240948	0.369778446	534	5
Total Per Grade		308	170		152

$$161 + 0.02 * 174 + 0.02 * 155 + 140$$

$$0.98 * 174$$

$$0.98 * 155$$

We multiplied the enrollment percentage of the 2023 school year in each class for each grade with the predicted grade sizes for 2024 to obtain the predicted number of classes being taken by students in each department.

Teacher:Student Ratio

2023 School Year										
Department	Enrollment % 10th	Enrollment % 11th	Enrollment % 12th	Total	Teachers	Student:Teacher Ratio				
Art	0.1823529	31	0.21724819	33	0.219360095	35	99	1		99
Biology	1.1647059	198	0.625411455	95	0.162953214	26	319	4		80
Chemistry	0.3470588	59	0.829493088	126	0.683150011	109	294	3		98
English	1.0764706	183	1.020408163	155	0.952649557	152	490	5		98
French	0.2411765	41	0.210664911	32	0.307104133	49	122	1		122
German	0.1117647	19	0.144832126	22	0.062674313	10	51	1		51
Spanish	0.3000000	51	0.17116524	26	0.206825233	33	110	1		110
Mathematics	1.0823529	184	1.323238973	201	1.642066999	262	647	6		108
Music	0.2941176	50	0.368663594	56	0.307104133	49	155	1		155
Physics	0.2941176	50	0.381830151	58	1.146939927	183	291	3		97
Social Studies	1.0764706	183	0.86240948	131	0.369778446	59	373	5		75
		1049		935		967	2951			
Total Per Grade		174		155		161	490			
With Dropout		170		152		160	481			

Next School Year									
Department	Enrollment % 10th	Enrollment % 11th	Enrollment % 12th	Total	Teachers	2024 S:T Ratio		Increase in Ratio	Rank
Art	0.1823529	56	0.21724819	37	0.219360095	33	126	1	1.28
Biology	1.1647059	359	0.625411455	106	0.162953214	25	490	4	1.54
Chemistry	0.3470588	107	0.829493088	141	0.683150011	104	352	3	1.20
English	1.0764706	332	1.020408163	173	0.952649557	145	650	5	1.33
French	0.2411765	74	0.210664911	36	0.307104133	47	157	1	1.29
German	0.1117647	34	0.144832126	25	0.062674313	10	69	1	1.34
Spanish	0.3000000	92	0.171165240	29	0.206825233	31	153	1	1.39
Mathematics	1.0823529	333	1.323238973	225	1.642066999	250	808	6	1.25
Music	0.2941176	91	0.368663594	63	0.307104133	47	200	1	1.29
Physics	0.2941176	91	0.381830151	65	1.146939927	174	330	3	1.13
Social Studies	1.0764706	332	0.86240948	147	0.369778446	56	534	5	1.43
Total Per Grade		308		170		152			

We assumed that 2% of the 2023 sophomore class, 2% of the 2023 junior class, and 1% of the 2023 senior class dropped out.

2023 vs. 2024 Student:Teacher Ratio

Modified New Year (2024)													
Department	Enrollment % 10th	Enrollment % 11th	Enrollment % 12th	Total	Teachers			2024 S:T Ratio		2023 S:T Ratio		Increase in Ratio	
Art	0.1823529	55	0.21724819	38	0.219360095	34	127	1	127	99		1.28	
Biology	1.1647059	351	0.625411455	109	0.162953214	25	485	5	97	80		1.22	
Chemistry	0.3470588	104	0.829493088	144	0.683150011	106	355	3	118	98		1.21	
English	1.0764706	324	1.020408163	178	0.952649557	148	649	6	108	98		1.10	
French	0.2411765	73	0.210664911	37	0.307104133	48	157	2	78	122		0.64	
German	0.1117647	34	0.144832126	25	0.062674313	10	69	2	34	51		0.67	
Spanish	0.3000000	90	0.171165240	30	0.206825233	32	152	2	76	110		0.69	
Mathematics	1.0823529	326	1.323238973	230	1.642066999	255	811	6	135	108		1.25	
Music	0.2941176	89	0.368663594	64	0.307104133	48	200	2	100	155		0.65	
Physics	0.2941176	89	0.381830151	66	1.146939927	178	333	3	111	97		1.14	
Social Studies	1.0764706	324	0.86240948	150	0.369778446	57	531	6	89	75		1.19	

We then compared the S:T ratios (with division) from 2023 to 2024 to calculate the increase in ratios. This is to be in accordance with our definition of “fair”.

Error Analysis

Some calculation errors that occurred in our model include the rounding of the totals for each grade in the 2023 school year so that we could obtain 490 students total.

Problem Analysis

This is a problem about the distribution of newly hired teachers in the upcoming 2024-2025 school year at Epsilon School. The 24-25 school year is going to have 190 more students than the 2023-2024 year, and the school has decided that an additional seven teachers will be hired to compensate for this. Our job is to decide the ideal “fair” distribution of the seven teachers.

Our model is designed in a way that lessens the load on the teachers with the highest number of students before adding any new teachers.

Definitions

Fair Distribution

Teachers should be distributed to those classes with the highest Student to Teacher Ratio.

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Enrollment Percent

The number of enrolled students in a given class divided by the total number of students in the class. An enrollment % greater than 1 indicates that some students are doubling up on subjects.

Assumptions

Schedule: Every student takes six classes; one Science, one Math, one English, one Social Studies, one Foreign Language, and one elective.

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2% of the dropouts will be during sophomore year, 2% will be during junior year, and 1% will be during senior year. This number is added to the number of incoming sophomores.

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The added Spanish teacher also teaches German.

Strengths and Weaknesses

Strengths:

- Versatile language.
- Can use model for any number of students with the same constraints.
- Accounts for the 5% dropout rate

Weaknesses:

- Some classes still have a higher S:T ratio than others, and this model was not able to keep them all super similar.
- Teachers are placed based on the 2023-2024 school year, doesn't take the student distribution of future years into account.

Our Solution

Our Solution is to add teachers to...

Biology

Our Solution

Our Solution is to add teachers to...

Biology

English

Our Solution

Our Solution is to add teachers to...

Biology

English

French

Our Solution

Our Solution is to add teachers to...

Biology English French

German

Our Solution

Our Solution is to add teachers to...

Biology English French

German

Spanish

Our Solution

Our Solution is to add teachers to...

Biology

English

French

German

Spanish

Music

Our Solution

Our Solution is to add teachers to...

Biology English French

German

Spanish

Music

Social Studies

Recap: Our Final Model

Modified New Year (2024)								
Department	Enrollment % 10th	Enrollment % 11th	Enrollment % 12th	Total	Teachers			
Art	0.1823529	55	0.21724819	38	0.219360095	34	127	1
Biology	1.1647059	351	0.625411455	109	0.162953214	25	485	5
Chemistry	0.3470588	104	0.829493088	144	0.683150011	106	355	3
English	1.0764706	324	1.020408163	178	0.952649557	148	649	6
French	0.2411765	73	0.210664911	37	0.307104133	48	157	2
German	0.1117647	34	0.144832126	25	0.062674313	10	69	2
Spanish	0.3000000	90	0.171165240	30	0.206825233	32	152	2
Mathematics	1.0823529	326	1.323238973	230	1.642066999	255	811	6
Music	0.2941176	89	0.368663594	64	0.307104133	48	200	2
Physics	0.2941176	89	0.381830151	66	1.146939927	178	333	3
Social Studies	1.0764706	324	0.86240948	150	0.369778446	57	531	6

2024 S:T Ratio	Increase in Ratio
126	1.28
122	1.54
117	1.20
130	1.33
157	1.29
69	1.34
153	1.39
135	1.25
200	1.29
110	1.13
107	1.43



2024 S:T Ratio	2023 S:T Ratio	Increase in Ratio
127	99	1.28
97	80	1.22
118	98	1.21
108	98	1.10
78	122	0.64
34	51	0.67
76	110	0.69
135	108	1.25
100	155	0.65
111	97	1.14
89	75	1.19