

# **The Epsilon School Problem**

**Presented by Section R Jacks**

**Hiring New Teachers Conundrum**

**Abhinav, Anush, Jonah, Mateo**

### The Problem:

A new wing is being added to the Epsilon School of Mathematics and Science, so that the student population can be increased from 490 to 630 for the 2022-2023 school year. Historically, the size of the sophomore class has been that of the senior class, plus any students that dropped out. To accommodate the influx of new students, the school will be hiring seven additional teachers. Given the number of teachers in each department, which subjects should receive new teachers, and how many new teachers should they receive? Note that foreign language instructors can teach two different languages, all courses are year-long, and 5% of the incoming class drops out prior to graduation.

#### Givens:

- Teachers in each discipline:  
6 Mathematics      5 English  
3 Chemistry        3 Foreign Language  
3 Physics            1 Music  
4 Biology            1 Art  
5 Social Studies
- Department Enrollment Totals in September 2021 (See Table Below)
- 140 new Sophomores
- Foreign Language Instructors can teach 2 languages
- 5% of students will drop out by senior year

#### Assumptions:

- The dropout rate is constant
  - o / year
- Every student takes exactly 1 English course (every year)
  - o Number of English Enrollments = Number of Students
  - o This tells us how many students are in each grade, and that can be used to find the number of courses a student takes each year (on average).
- The percentage of course enrollments for a specific subject stays constant regardless of the class size
  - o Ex: 17.45% of sophomore enrollments will always be for English
- The average number of courses a student in a given grade takes stays constant regardless of the class size
  - o Ex: On average, sophomores will always take about 5.7 classes

#### Hypotheses:

1. We will need to hire at least 1 Math, English, Biology, and Social Studies Teachers, since those are the most popular classes among sophomores
2. Art and Music will not require any new hires

#### Analysis of the Problem:

- The final goal is to decide how to most effectively distribute the seven new teachers based on demand from new students in each discipline
- Using our assumption of grade sizes based on English class sizes, we know the number of students in each grade for the starting year (2021)
- We also know the number of new sophomores that will be added in the 2022-2023 year
- The drop-out rate is also used to get an accurate result for the class sizes
- With this information, we can calculate the grade sizes for the 2022-2023 school year

- Knowing the sizes of the grades, we can find the average number of courses each student takes
- Using the average number of courses taken, we can find the number of students in each discipline (math, chem, physics, etc.)
- This shows the demand in each discipline, and based on that we can determine how the seven new faculty should be distributed among the disciplines

**Design of the Model:**

In order to find the number of teachers we need to hire, our model needs to be able to find the total number of teachers required for the 2022-2023 school year. Based on these results, the administration can assess what staffing gaps need to be addressed, given the current teaching staff. Our model found the total number of required teachers by taking the projected number of course enrollments for the 2022-2023 school year and dividing it by the enrollment-to-teacher ratio.

**Calculating the projected number of course enrollments:**

1. Find the percentage of course enrollments in a given grade for each subject
  - a.  $\text{Course Enrollments for a Subject} / \text{Total Course Enrollments of the Class}$
2. Find the projected number of students for the 2022-2023 school year
  - a. Use the previous sophomore and junior class sizes to find the new junior and senior classes (adjusted for dropout rate), and find the remaining number of sophomores required for a 630-student class size
3. Find the average number of courses a student in a given grade takes
  - a.  $(\text{Total Course Enrollments of the Class}) / (\text{Class Size for 2021-2022 year})$
4. Use the average number of course enrollments per student to find the total number of course enrollments for a given class size.
  - a.  $(\text{Average Course Enrollments of the Class}) * (\text{Class Size for 2022-2023 year})$

Once you find the projected number of course enrollments, the model can use the described methodology to find the number of teachers the Epsilon School needs to hire.

Department Enrollment Totals: September 2021				
Department	10th	11th	12th	Total
Art	31	33	35	99
Biology	198	95	26	319
Chemistry	59	126	109	294
English	183	155	152	490
Mathematics	184	201	262	647
Music	50	56	49	155
Physics	50	58	183	291
Social Studies	183	131	59	373
<b>Total</b>	<b>938</b>	<b>855</b>	<b>875</b>	<b>2668</b>
<b>Total (Including Language)</b>	<b>1049</b>	<b>935</b>	<b>967</b>	<b>2973</b>

  

Department Enrollment Totals: September 2021 (Foreign Language)				
Language	10th	11th	12th	Total
French	41	32	49	122
German	19	22	10	73
Spanish	51	26	33	110
<b>Total</b>	<b>111</b>	<b>80</b>	<b>92</b>	<b>305</b>

Department Enrollment Percentages: September 2021				
Department	10th	11th	12th	Total
Art	2.96%	3.53%	3.62%	3.33%
Biology	18.88%	10.16%	2.69%	10.73%
Chemistry	5.62%	13.48%	11.27%	9.89%
English	17.45%	16.58%	15.72%	16.48%
Mathematics	17.54%	21.50%	27.09%	21.76%
Music	4.77%	5.99%	5.07%	5.21%
Physics	4.77%	6.20%	18.92%	9.79%
Social Studies	17.45%	14.01%	6.10%	12.55%
Total	89.42%	91.44%	90.49%	89.74%
Total (Including Language)	100.00%	100.00%	100.00%	100.00%

Department Enrollment Percentages: September 2021 (Foreign Language)				
Language	10th	11th	12th	Total
French	3.91%	3.42%	5.07%	4.10%
German	1.81%	2.35%	1.03%	2.46%
Spanish	4.86%	2.78%	3.41%	3.70%
Total	10.58%	8.56%	9.51%	10.26%

Class Sizes for 2022-2023	
10th	301
11th	178
12th	151

Projected Department Enrollment: September 2022				
Department	10th	11th	12th	Total
Art	51	38	35	124
Biology	325	109	26	460
Chemistry	97	145	108	350
English	301	178	151	630
Mathematics	302	231	260	794
Music	82	64	49	195
Physics	82	67	182	331
Social Studies	301	151	59	510
Total	1,541	984	870	3,394
Total (Including Language)	1,723	1,076	961	3,760

Projected Department Enrollment: September 2022 (Foreign Language)				
Language	10th	11th	12th	Total
French	67	37	49	153
German	31	25	10	66
Spanish	84	30	33	146
Total	182	92	91	366

Department Enrollment Ratios: September 2021					
Department	10th	11th	12th	Faculty	Ratio (Students:Faculty)
Art	31	33	35	1	99
Biology	198	95	26	4	79.75
Chemistry	59	126	109	3	98
English	183	155	152	5	98
Mathematics	184	201	262	6	107.8333333
Music	50	56	49	1	155
Physics	50	58	183	3	97
Social Studies	183	131	59	5	74.6

Projected Teachers Required for the 2021-2022 School Year						
Department	Ratio	Total Students	Required Staff	Existing Staff	Hiring Requirements	Round(HR)
Art	99	124	1.25	1	0.25	0
Biology	79.75	460	5.77	4	1.77	2
Chemistry	98	350	3.57	3	0.57	1
English	98	630	6.43	5	1.43	1
Mathematics	107.8333333	794	7.36	6	1.36	1
Music	155	195	1.26	1	0.26	0
Physics	97	331	3.41	3	0.41	0
Social Studies	74.6	510	6.84	5	1.84	2
Language	152.5	366	3.60	3	0.60	1
Total New Staff Required:					8.49	9

### Justification of the Model:

The model can be tested by calculating the required number of teachers for different class sizes, such as if you were to add 300 new sophomores. Additionally, the model should be tested for changes in class size to other grades, such as the junior or senior class. In order to validate this model, the values found for percentage of class enrollments per subject, and the average number of course enrollments per student should be tested for accuracy.

**Solutions:**

Our final answers are as follows. The new staff that should be hired consist of:

**2 Biology Teachers**

**2 Social Studies Teachers**

**1 English Teacher**

**1 Math Teacher**

**1 French/Spanish Teacher**

**Potential Strengths and Weaknesses to Solution:****Strengths:**

- Our solution considers all the grades
- The solution predicts how students will enroll in classes by using data from the previous class
- Our solution follows a very strong and robust model, meaning that assuming our foundation and assumptions to be true, the model and its intermediate methods prove to be extremely stable and succeed with little error

**Weakness:**

- There could be differing dropout rates amongst the individual grades
- Errors could have been made in intermediate estimation
- In the final steps before the solutions, certain subjects projecting to need additional staff were overlooked due to there being a limited number of hire-able staff and differing demands levels. For example, chemistry was not given additional staff although needing some because the demand for additional chemistry teachers did not surpass that of the other subjects
- It assumes many averages, such as the fact that there are an equal number of people in each language class (this specific assumption was decided to be negligible) and assumes that patterns will remain consistent, such as the enrollment in different classes based on class and grade.