Epsilon School

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Background:

A new wing is being added to the Epsilon School of Mathematics and Science (a small change?), so that the student population can be increased from 490 to 630 for the 2022.2023 school year. Historically, the size of the incoming sophomore class has been equal to that of the graduating senior class (plus any students who dropped out during the year). Next year, the new sophomore class will have 140 more students than the graduating senior class. To accommodate this increase, seven additional faculty will be hired. There is a great deal of discussion on campus about which departments should get the extra teachers.

Departmental Enrollment Totals: September 2021

Subject	10th	11th	12th	Total
Art	31	33	35	99
Biology	198	95	26	319
Chemistry	59	126	109	294
English	183	155	152	490
French	41	32	49	122
German	19	22	10	51
Spanish	51	26	33	110
Mathematics	184	201	262	647
Music	50	56	49	155
Physics	50	58	183	291
Social Studies	183	131	59	373

Problem

How would you hire the new faculty?
Explain why your decision is fair.

1.

Strategy

How we approached the problem

Assumptions

- Each of the language teachers teaches a separate language
- Ignoring grade sizes - focusing on student:teacher ratio
- All s-to-t ratios will increase at the same proportion for each subject
- The 2021-2022 s-to-t ratios are good
- Ratio of the # of students taking a subject to the total # of students is the same for each subject for both 2021-2022 and 2022-2023
- Each class is taught by one teacher

Goal

- Want to maintain similar student to teacher ratios for each subject

General Approach

- Only focusing on overall student count for each subject
  - Ignoring drop outs
  - Ignoring individual grade sizes

Strategy

- Found students per teacher in each subject for 2021-2022 school year
  - (total # of students per subject)/teachers per subject
- Found students per teacher in each subject for 2022-2023 school year WITHOUT new hires
  - (# students/490) * 630, divide by # teachers w/o new hires
- Found difference between student per teacher ratios for each subject between both years without new hires
  - Added new teachers to the subjects with highest differences

Justification

- At the beginning of the year, no students have dropped out yet so the entire grade w/o dropouts needs to be planned for
- Some classes may or may not include students from multiple grades
  - grade of each student doesn’t matter
- The main problem with an increasing student body is that class sizes will increase and each subject has a different average class size
- Goal of our model is to keep the new average class size of each subject as close to the original as possible

Justification (Cont.)

- How our model can be tested:
  - The new student-to-teacher ratios for 2022-2023 with new hires can be compared to the 2021-2022 student-to-teacher ratios
  - Goal of the model is to minimize the change in s-to-t ratio for each subject
  - Calculate and average the difference in ratios between the 2 years
    - Gives an indication of how well the model worked
    - Goal is for average to be closest to 0

2.

Solution

How to hire

Subject	2021-2022 S-to-T Ratios	2022-2023 (w/o new hires) S-to-T Ratios	Differences
Art	99	127	28
Bio	80	103	23
Chem	98	126	28
Eng	98	126	28
French	122	157	35
German	51	66	15
Spanish	110	141	31
Math	108	139	31
Music	155	199	44
Physics	97	125	28
Social studies	75	96	21

New Hires

- 1 for Math
- 1 for English
- 1 for Chemistry
- 1 for Physics
- 1 for Art
- 1 for Music
- 1 for French/Spanish (teaches both languages)

3.

Verification

Strengths and Weaknesses of Model

Subject	2022-2023 New Student-to-Teacher Ratios With New Hires
Art	64
Bio	103
Chem	95
Eng	105
French	105
German	66
Spanish	94
Math	119
Music	100
Physics	94
Social Studies	96

Subject	2021-2022 student to teacher ratio	2022-2023 student to teacher ratio WITH new hires	Differences
Art	99	64	-35
Bio	80	103	23
Chem	98	95	-3
Eng	98	105	7
French	122	105	-17
German	51	66	15
Spanish	110	94	-6
Math	108	119	11
Music	155	100	-55
Physics	97	94	-3
Social Studies	75	96	21

Averages of Differences

Without Hires	With Hires
28.4	**-3.81**

Strengths and Weaknesses

Strengths

- Simple model
- Minimal assumptions
- Easily able to see which departments may need more staff

Weaknesses

- Didn’t account for 5% dropout rate
- Does not account for class sizes of grade-specific classes
- Does not account for special class sizes (ex: music ensembles)
- Average difference is not weighted based on the enrollment per course

Thank you!

Any questions?