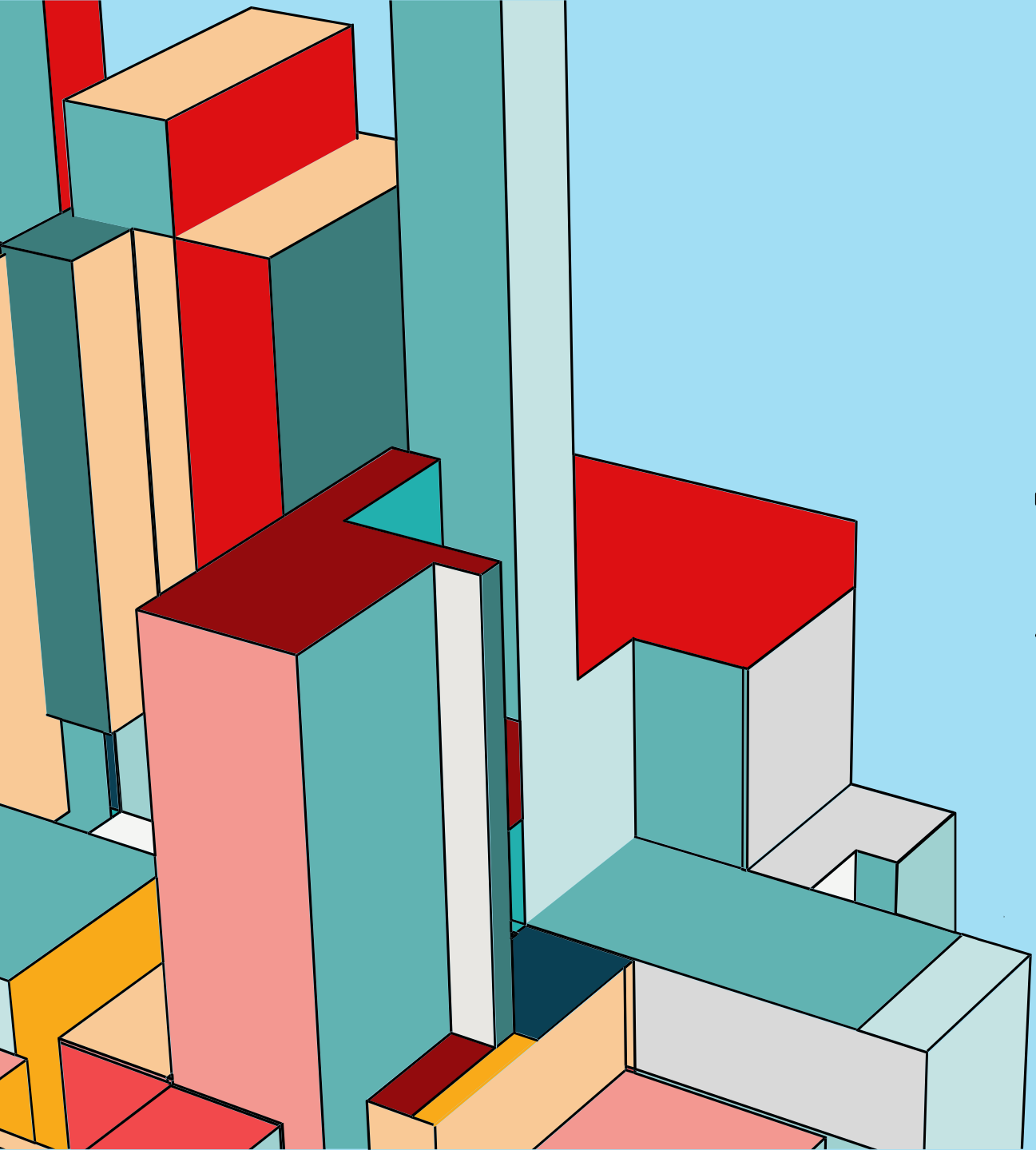

THE EPSILON SCHOOL

Aansh, Jianna, Lydia
Aces

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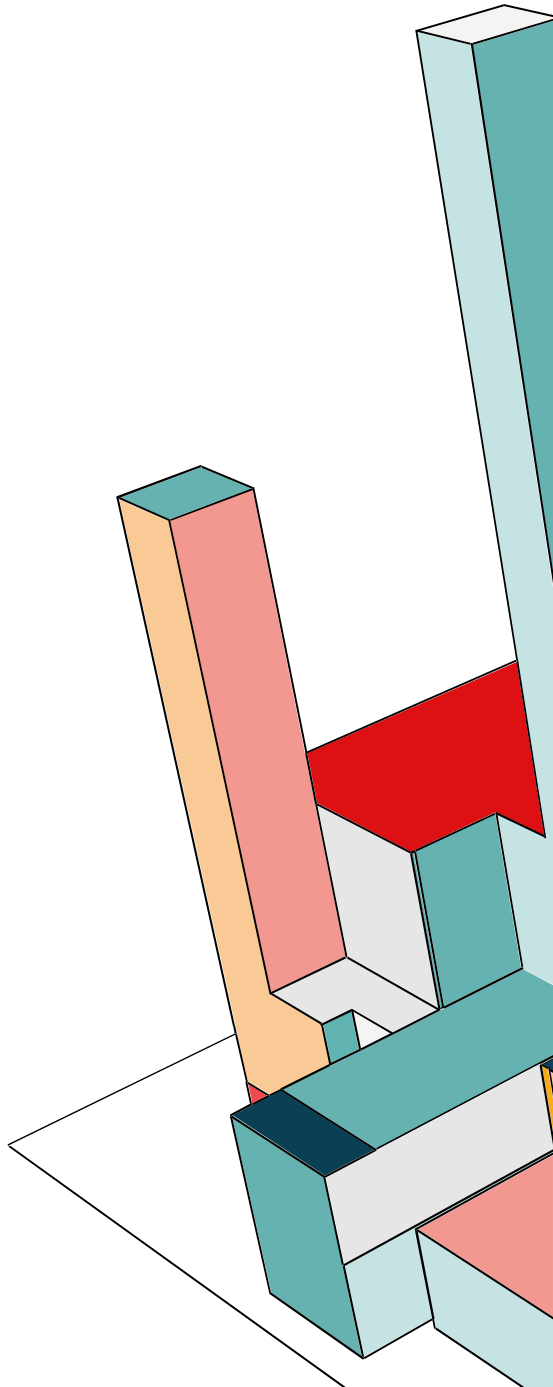
THE PROBLEM

PROBLEM RESTATEMENT

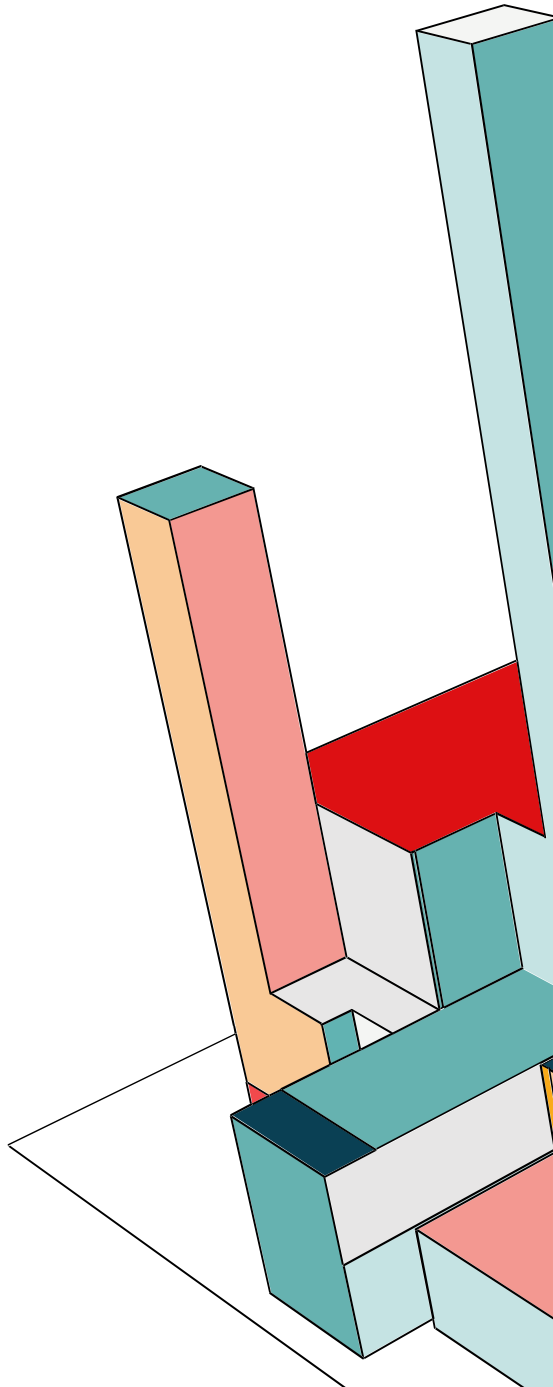
- The Epsilon School for Math and Science is being expanded for the new school year. The student population will increase to 630 students, from the previous total of 490. The 140 new students will be coming in as part of the incoming sophomore class. There is currently a 5% dropout rate at the Epsilon School.
- To distribute the workload, seven new teachers are being hired for the new school year. Taking into consideration the differences in enrollment and number of current teachers in each subject area, how can the seven new teachers be distributed across disciplines fairly?



ASSUMPTIONS

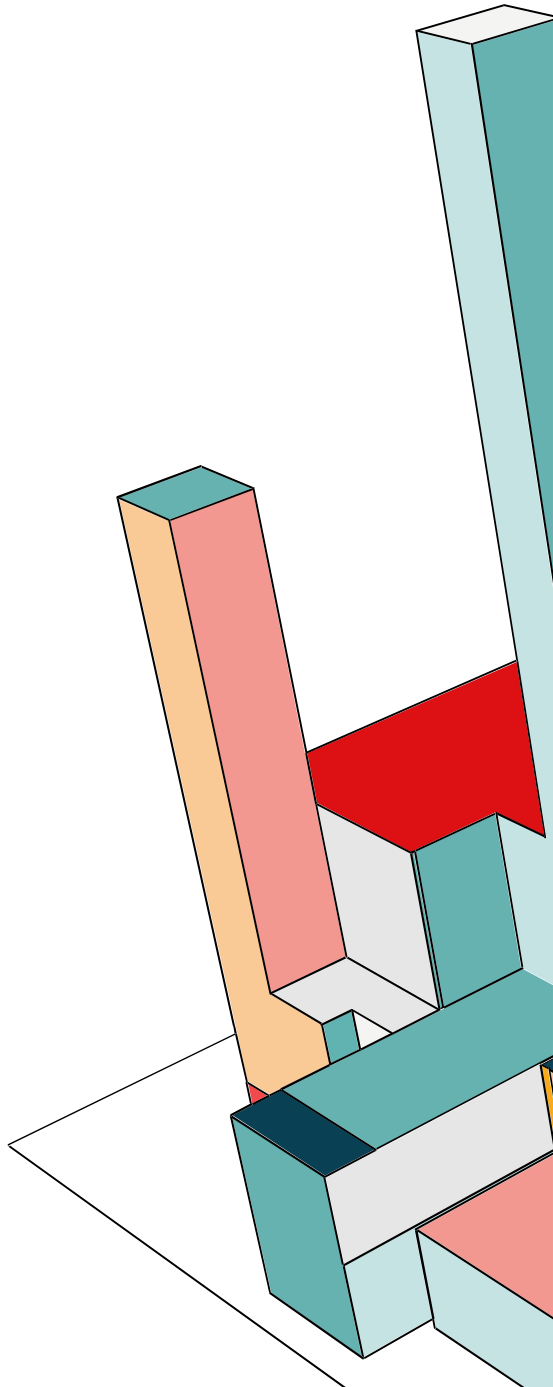
WE ASSUMED THAT...

- The 5% drop rate is from students dropping out between junior and senior year, and no students drop out at other times.
- Each existing language teacher teaches one of the languages.
- It is more difficult for teachers to have larger class sizes.
- The percentage of students in each grade who enroll in each course stays relatively consistent over time.
- “Fairness” depends on the percent increase in students per teacher. That is, if a teacher is used to large class sizes, they can most likely handle a larger number of additional students with less difficulty.
- A student taking two classes from a teacher adds the same workload as two students taking one class each.
- The given capacity of the student body accounts for dropouts.



WE ASSUMED THAT...

- The current class sizes are close to every teacher's capacity. That is, increasing the number of students per teacher would be equally undesirable for all teachers.
- The new language teachers will all teach two languages.



VARIABLES

-Number of students per grade in each class for last school year

-Number of existing students

-Number of incoming students

-Drop rate

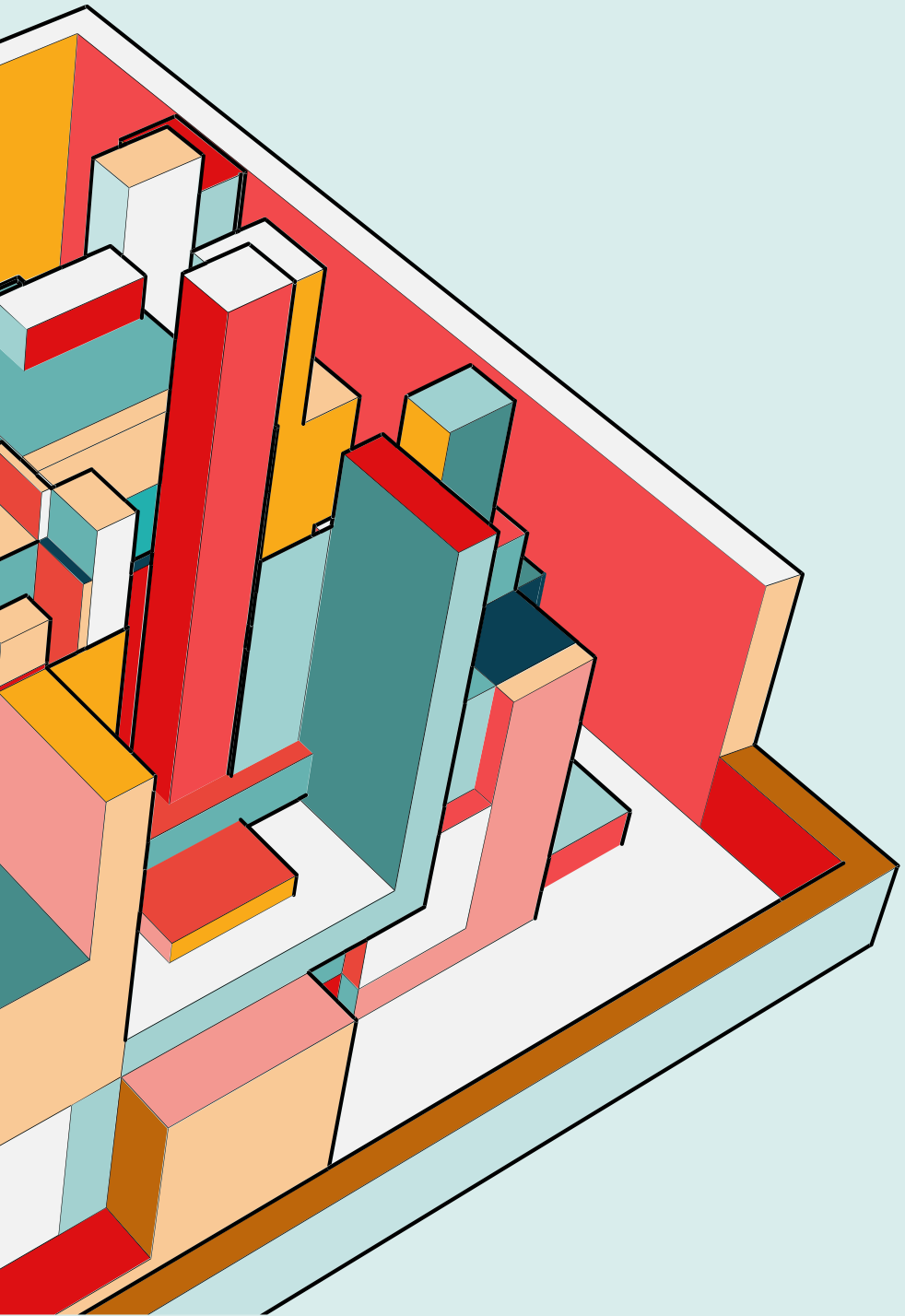
-Number of existing teachers

-Number of incoming teachers

HYPOTHESES

-Biology will need a new teacher, while Chemistry and Physics will not.

-At least one new foreign language teacher will be hired.

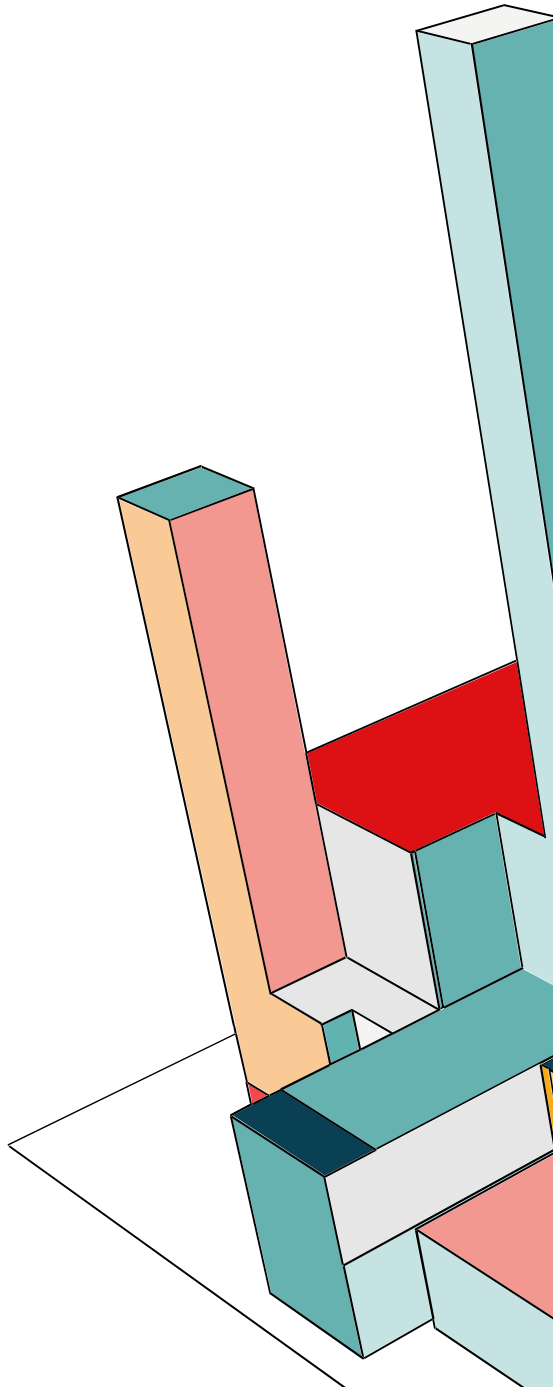


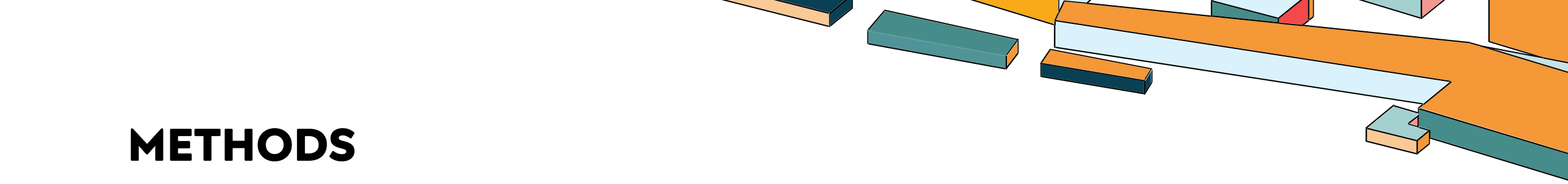
ANALYSIS & PROCESS

-What are we looking for?
-How can we use math to help?
-What was our process?

ANALYZING THE PROBLEM

- We knew we would need to calculate the number of students in each department somehow, to determine which department was most deserving of new hires.
- We also knew we had to take into account the difference between sophomores and upperclassmen in the classes they tend to take when considering the next year's enrollments, since the increase would come largely from sophomores.
- An earlier approach we tried relied on the number of students who would join each class. However, we realized we were missing one key piece of the puzzle, which was the teachers. Since the number of teachers and students in each department was variable, we realized we needed to instead look at the student-teacher ratios.





METHODS

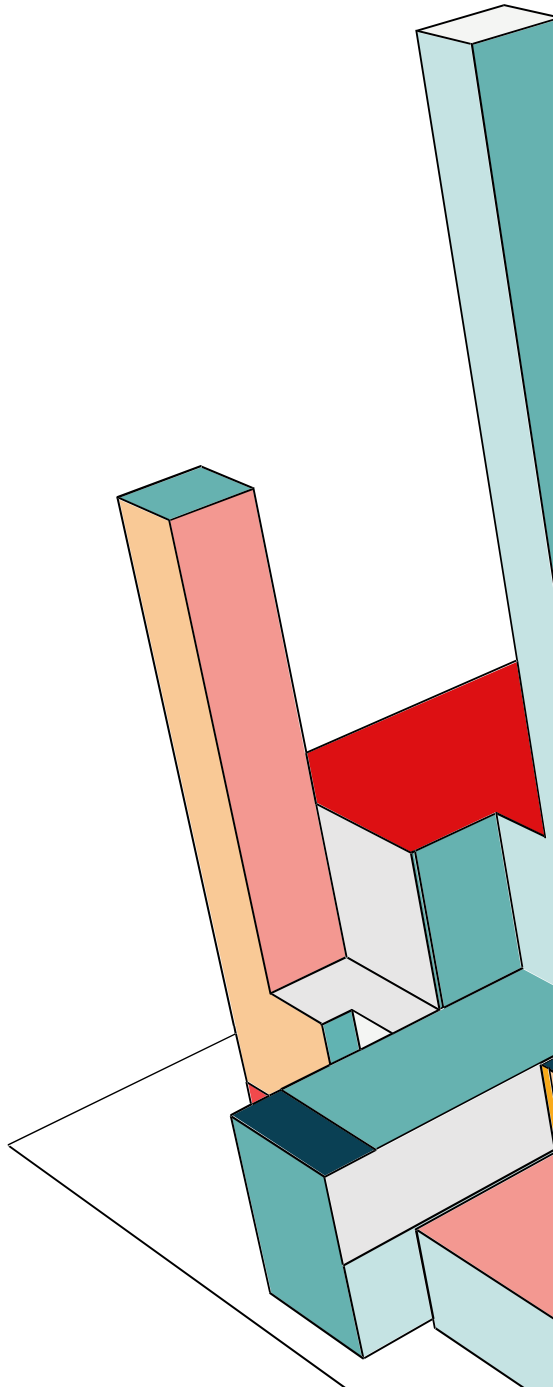
We first calculated the number of sophomores for the current school year. We call the number of students in 10th grade x. Then, the total number of students would be equal to 295% of x, since the junior class is the same size as the sophomore class and 5% of the senior class was assumed to have dropped out over the summer. Given that 490 is 295% of x, we see that $x \approx 166$. So, the size of the old sophomore class was 166 students.

Adding the 140 new students to this class size, we also find that the number of students in the incoming sophomore class is 306 students.

METHODS

	A	B	C	D	E	F	G	H	I
1	Class	10	11	12	Total		Percent of 10th grade taking class in 2024	Number of 10th grade enrollments in 2025 (predicted)	How many extra students teachers have to teach
2	Art	31	33	35	99		18.6746988	57.14457831	26.14457831
3	Biology	198	95	26	319		119.2771084	364.9879518	166.9879518
4	Chemistry	59	126	109	294		35.54216867	108.7590361	49.75903614
5	English	183	155	152	490		110.2409639	337.3373494	154.3373494
6	French	41	32	49	122		24.69879518	75.57831325	34.57831325
7	German	19	22	10	51		11.44578313	35.02409639	16.02409639
8	Spanish	51	26	33	110		30.72289157	94.01204819	43.01204819
9	Math	184	201	262	647		110.8433735	339.1807229	155.1807229
10	Music	50	56	49	155		30.12048193	92.1686747	42.1686747
11	Physics	50	58	183	291		30.12048193	92.1686747	42.1686747
12	Social Studies	183	131	59	373		110.2409639	337.3373494	154.3373494
13	total	1108	1061	1076	3245				

- First, we used the previously calculated number of sophomores and the given data to determine the percentage of the 10th grade students who took each class in 2024.
- We then applied those percentages to the number of students in the new sophomore class to find the predicted number of 10th grade enrollments per class in 2025.



METHODS

	A	J	K	L	M
1	Class	Amount of teachers	students per teacher in 2024	extra sophmores per teacher	students per teacher without new hires (2025)
2	Art	1	99	26.14457831	125.1445783
3	Biology	4	79.75	41.74698795	121.496988
4	Chemistry	3	98	16.58634538	114.5863454
5	English	5	98	30.86746988	128.8674699
6	French	1	122	34.57831325	156.5783133
7	German	1	51	16.02409639	67.02409639
8	Spanish	1	110	43.01204819	153.0120482
9	Math	6	107.8333333	25.86345382	133.6967871
10	Music	1	155	42.1686747	197.1686747
11	Physics	3	97	14.0562249	111.0562249
12	Social Studies	5	74.6	30.86746988	105.4674699
13	total				the boxes are blue dabadidabadie

We next calculated the number of students per teacher in each class in 2024. Then, we calculated the number of extra sophomores per teacher that would be added in 2025 and added it to that to get the number of students per teacher in 2025 without any new hires.

METHODS

O	P
percent increase in students per teacher	Z scores
26.40866496	-0.372988275
52.34732032	2.124852516
16.92484223	-1.286261494
31.49741824	0.11704852
28.34287972	-0.186727251
31.41979683	0.109573733
39.10186199	0.84934129
23.98465578	-0.606415526
27.20559658	-0.296245349
14.4909535	-1.520640125
41.37730547	1.06846196

(This data was taken before any teachers were added.)

Finally, we calculated the percent increase in students per teacher from 2024 to 2025 using the previous calculations.

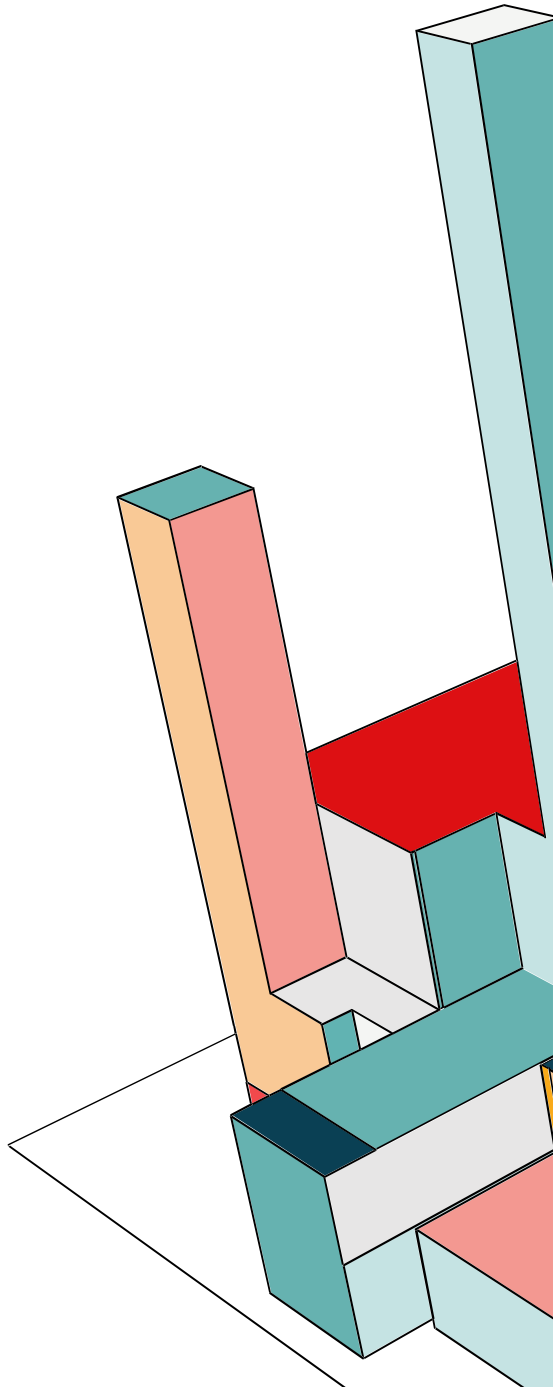
In addition to the existing teachers, we created a column for new teachers added and changed the row logic to reflect the new teachers in the students per teacher ratio when calculating percent increase.

OUR MODEL

Designed by Freepik (www.freepik.com)

THE MODEL ITSELF

- We calculated a mean for the percent increase and the standard deviation from the mean. We used this information to find the Z-score for each department. Our model then was to take the department with the highest Z-score, add a teacher to that department, recalculate the values, and rinse and repeat until we had added seven teachers.
- For the special case in which the next-highest Z-score belonged to a foreign language, we took the two languages with the highest Z-scores and added half a teacher to each of them (hiring one teacher who could teach both). This maximized the number of subject areas which benefited.



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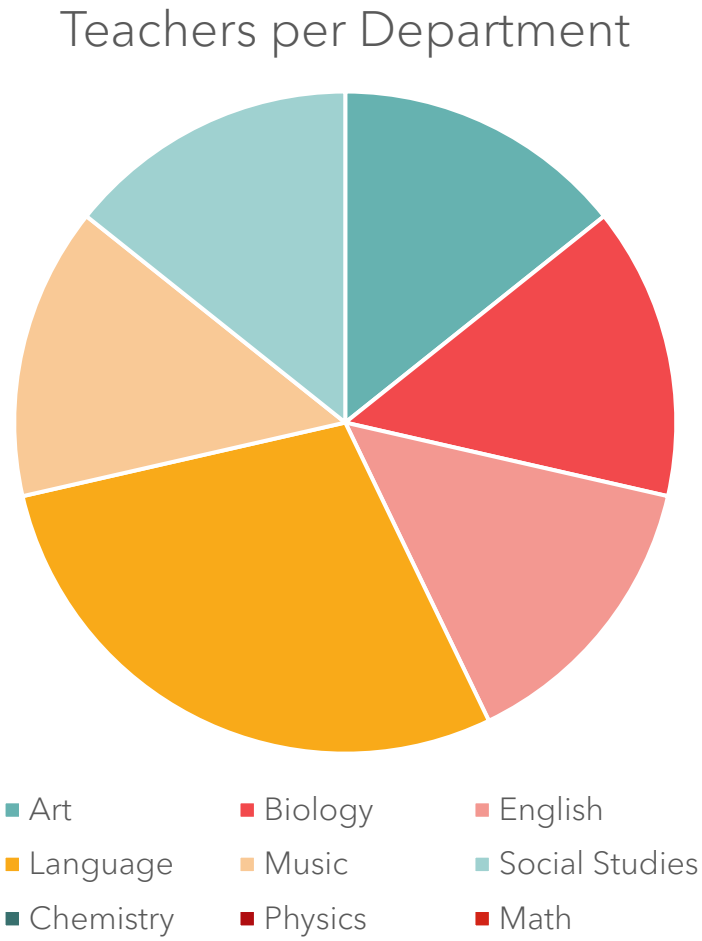
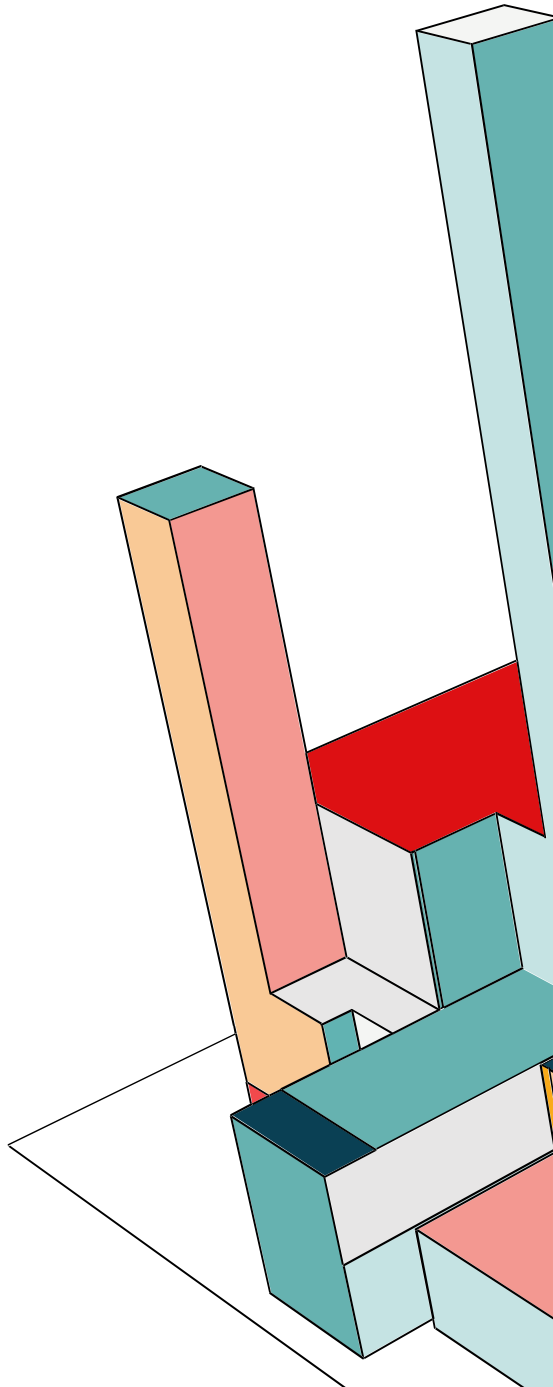
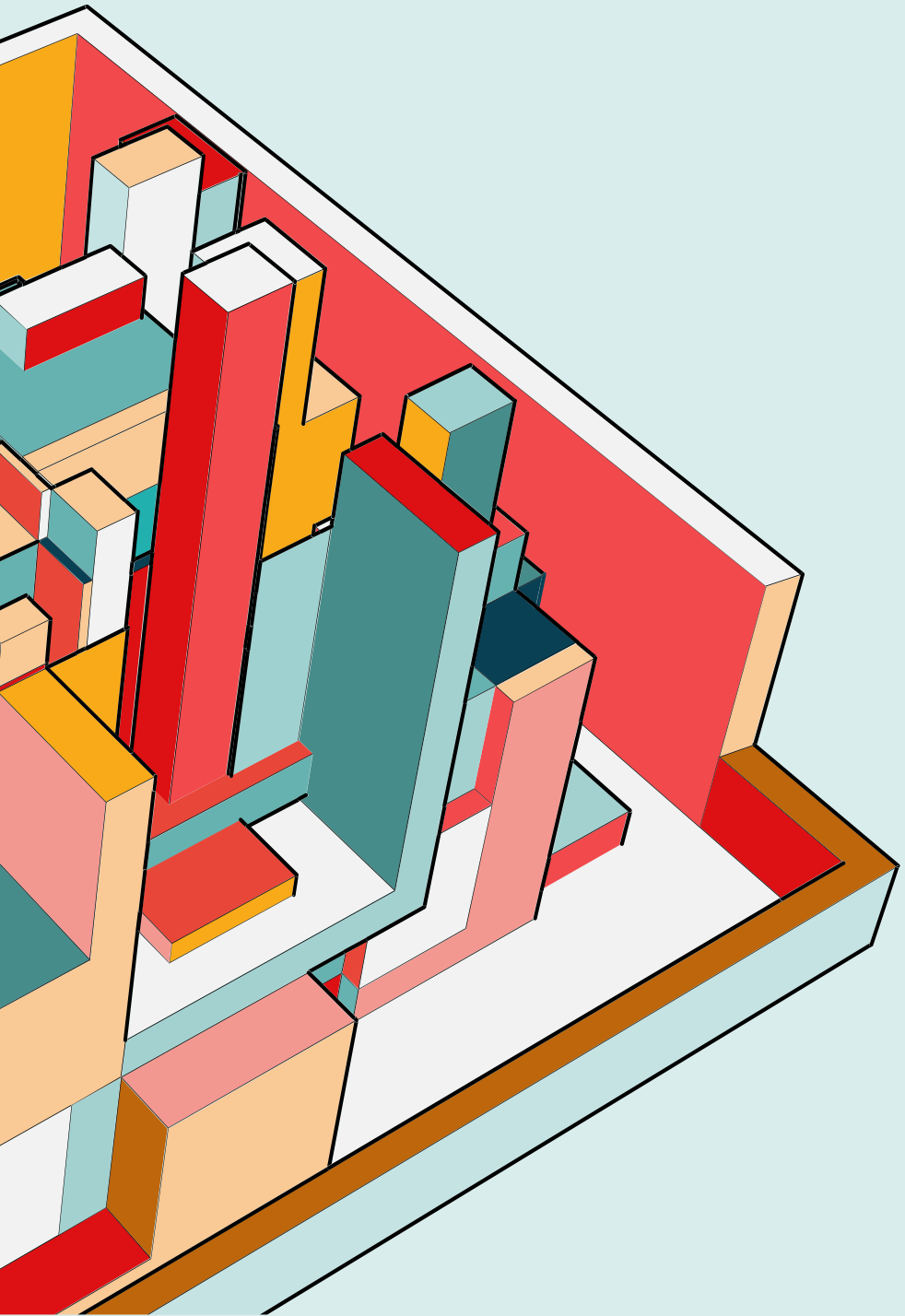
OUR SOLUTION

HOW TO DISTRIBUTE NEW TEACHERS

- 1 Art teacher
- 1 Biology teacher
- 1 English teacher
- 1 French and Spanish teacher
- 1 German and Spanish teacher
- 1 Music teacher
- 1 Social Studies teacher





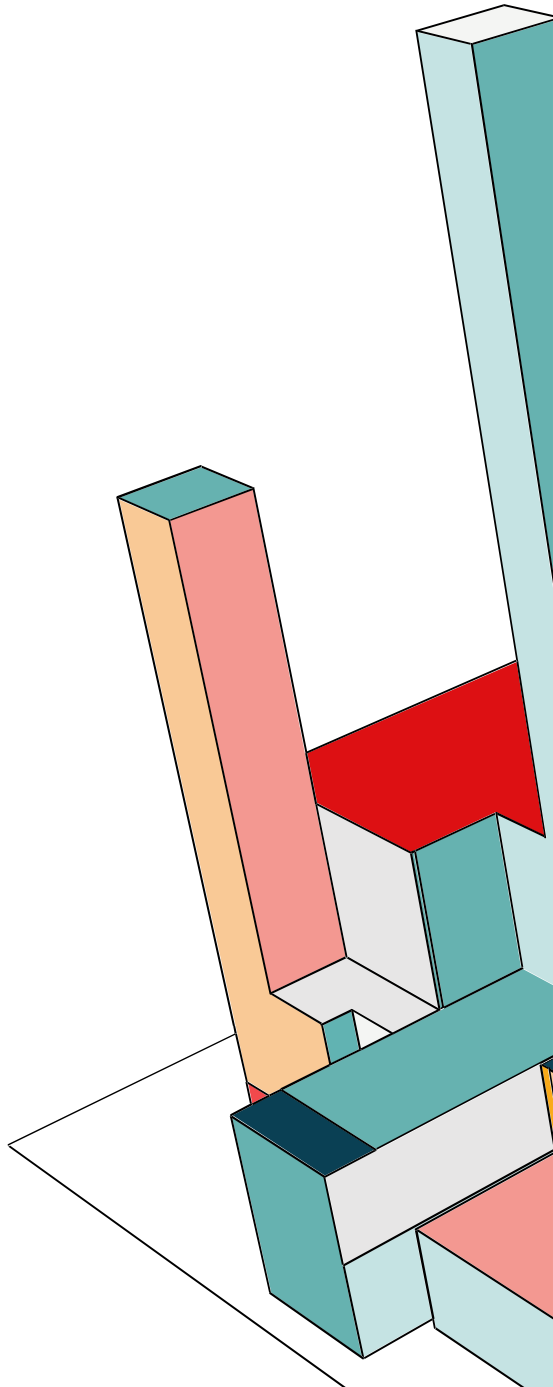


JUSTIFICATION

-Why you should trust this model
-Evidence

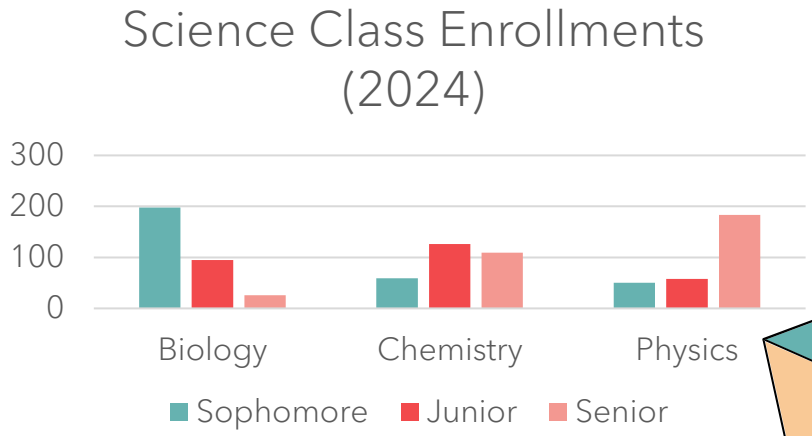
WHY THIS WORKS

- We consider all the possible data in our model and use appropriate statistical methods to find the solution.
- This model considers both teacher and student perspectives, and the math is backed up by solid reasoning.
- Our decision is fair because it tries to minimize the percent increase in students per teacher, therefore adding more teachers to the departments who would be most negatively affected.



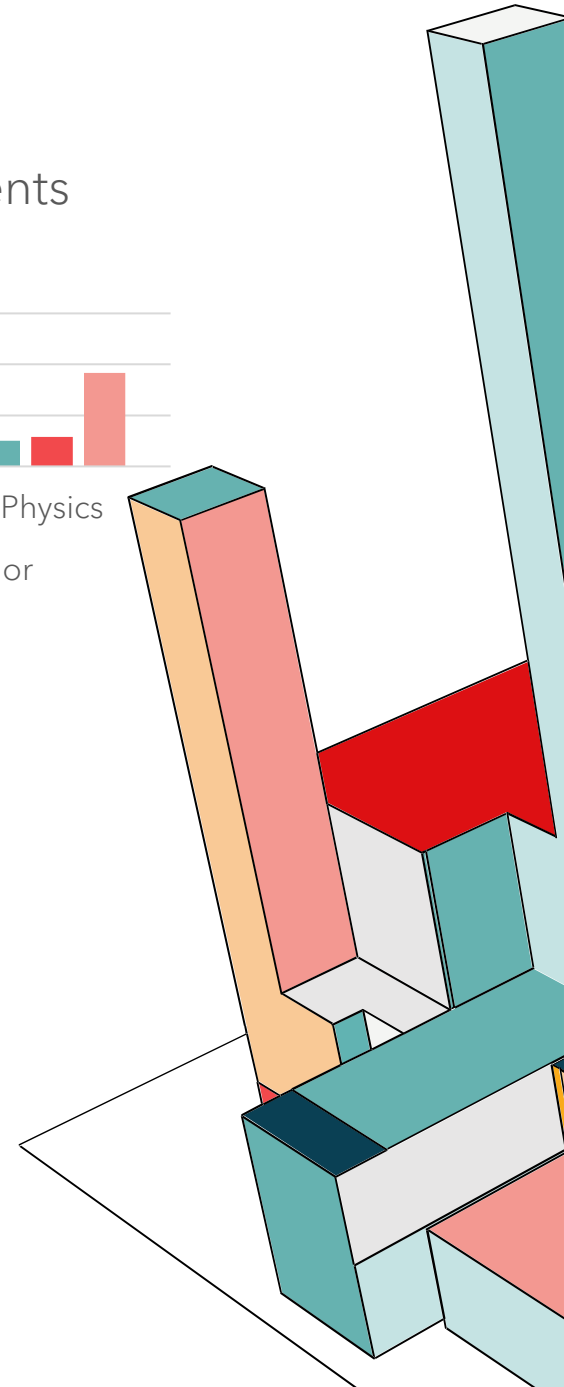
THE SUBJECTS WITHOUT NEW TEACHERS MAKE SENSE

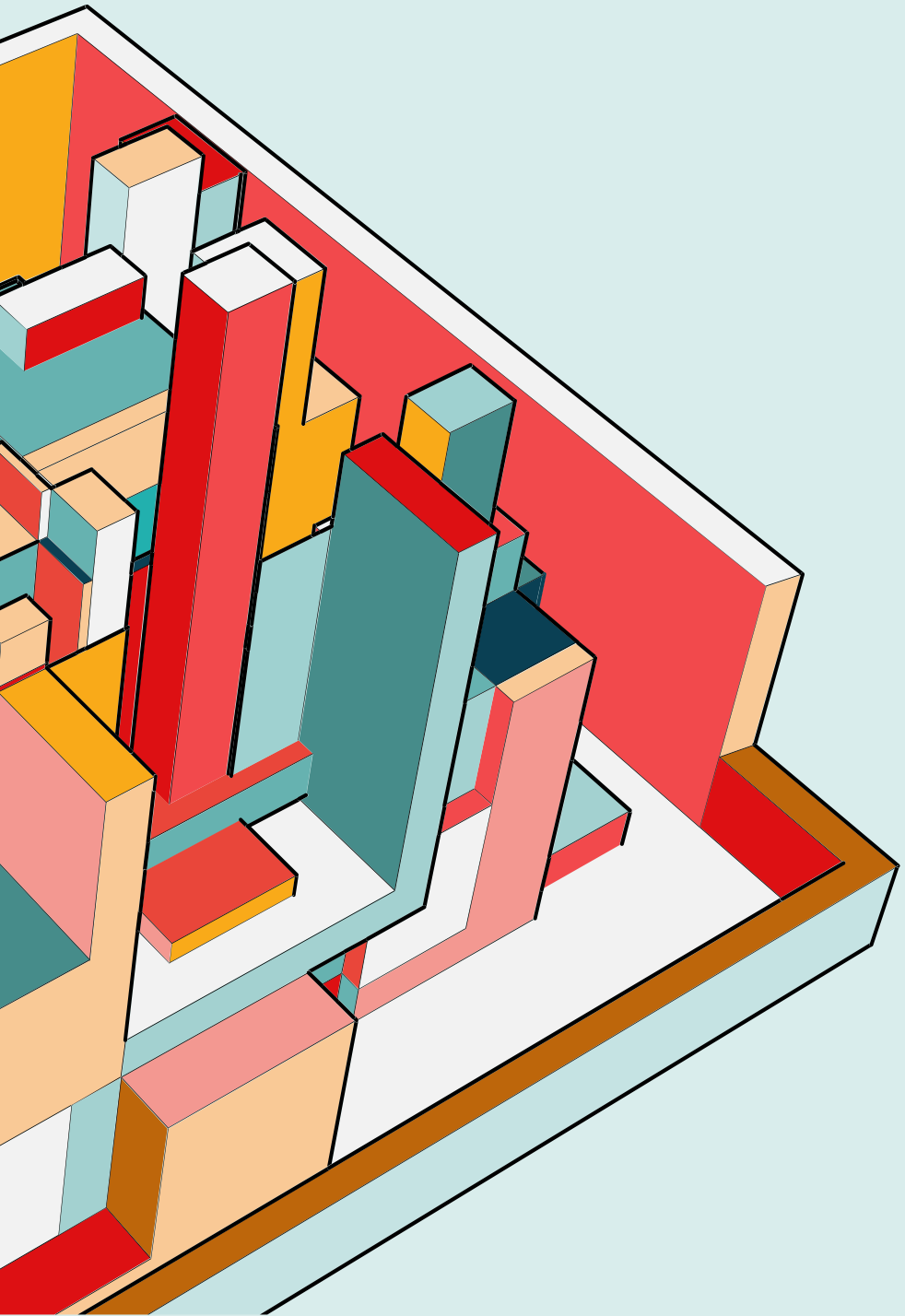
- Chemistry and Physics both don't need new teachers. This makes sense because sophomores don't tend to take these classes, as shown by the graph to the right.



- Math doesn't need a new teacher. At first, this seemed confusing to us. However, we noticed that the student-teacher ratio was really high in previous years as well. Additionally, the Math department was the next department our model predicted would need a new teacher.

P
Z scores
-1.491757868
1.048866574
0.834395929
0.516407818
-0.523651145
-0.434828676
-1.216943569
1.140093179
-1.474503885
0.729006022
0.872915622

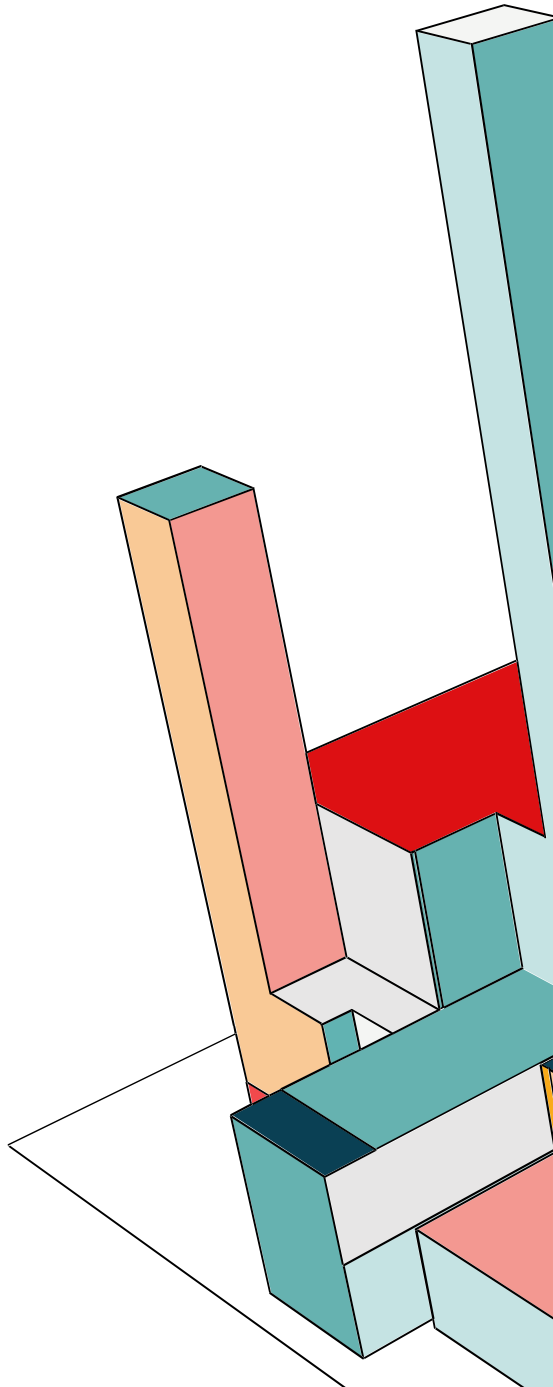




HOW CAN WE IMPROVE?

LIMITATIONS

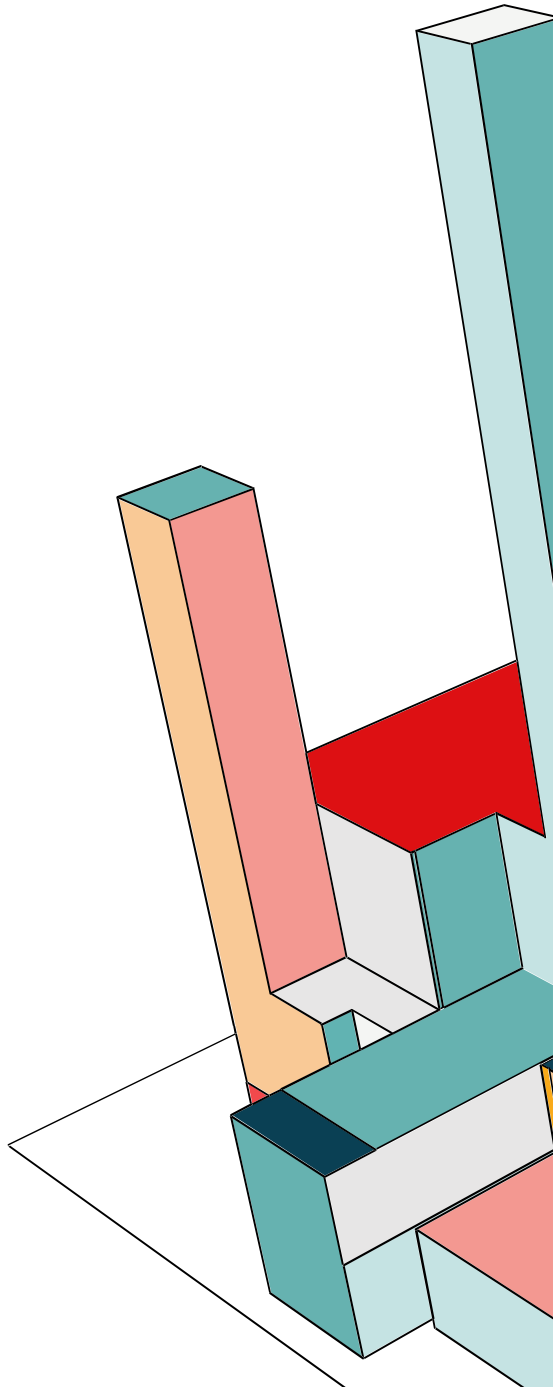
- The drop rate was assumed to be exclusively between 11th and 12th grade, so this model doesn't account for dropouts at other times.
- The existing language teachers were assumed to teach one language each, so the model doesn't account for cases where existing language teachers teach classes in multiple languages.
- It was assumed that the current class sizes were close to the capacity of each teacher, but some teachers may be able to handle many more students than their class sizes reflect, such as specialized teachers like the art instructor. Therefore, the model doesn't account for the fact that some classes may be able to handle a larger percent increase in the student-teacher ratio than others.



EXPANSION

In addition to compensating for the previously mentioned flaws, this solution could be made more realistic by adding constraints.

- The model could consider required classes.
- The model could consider requirements on the number of classes each student may take.
- The model could track the individual students across grades.
- The model could consider requirements that must be completed prior to graduation.



THANK YOU!

Acknowledgements:

Thanks to Mrs. Burns for helping us with our process!