Improvement of Average GPA At Purdue University

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Define

Project Charter

Problem Statement

Currently, student's GPAs are not as ideal as what they expect. GPA could impact a start of a student's social life profoundly. There are many factors which can influence their GPAs. Students may get low GPAs due to their laziness, lack of academic motivation or learning methods, low level of university equipment, and poor teaching from professors. Every detail may have a consequence in the final GPA calculation. To help students to find the main factors that affect their GPAs and to improve their GPAs to a more ideal level, we decided to design the project based on the problem of how to efficiently improve GPAs.

Business Case

We focus on this topic because we hope students can get higher GPAs and a better education. Consequently, they are able to acquire higher confidence and study with higher motivations. With a high GPA, a student can be more qualified to find a job with a higher wage or be more successful in graduate or PHD education.

Objective

We want to increase student's ability to learn. The measure we have chosen for this is Purdue's average GPA and our goal is to find steps Purdue can take to increase this by 10%.

Scope

This focus of the project is on University-wide or College-wide programs which can impact GPA. Examples of this might include student-faculty ratios, office hours requirements, or class size. In the end we hope to focus primarily on Purdue, but do plan on using other Universities as points of reference for the efficacy of some programs.

Resources

We plan on using both Purdue and other universities' databases containing statistics on graduation rates, GPA, etc…

Deliverables

Since the objective is easily measurable, the deliverable will match the objective meaning the primary deliverable is a 10% increase in GPA.

Voice of Customer

Overall Needs: higher GPAs

Stakeholder needs:

Students:

- No additional homework assigned

Professors:

- Similar workload per course
- No increased teaching requirements (credit hours per professor)

Administration:

- No additional funding requirements

Process Map

S	I	P	O	C
Suppliers	Inputs	Process	Outputs	Customers
1. Professors 2. Tutors 3. Learning Resources 4. Purdue University	1. OWL 2. Course Knowledge 3. Classrooms	1. Lectures 2. Assignments 3. Exams 4. Projects	1. GPA 2. Knowledge 3. Research Opportunities 4. Graduation	Students

Measure

Data Collection

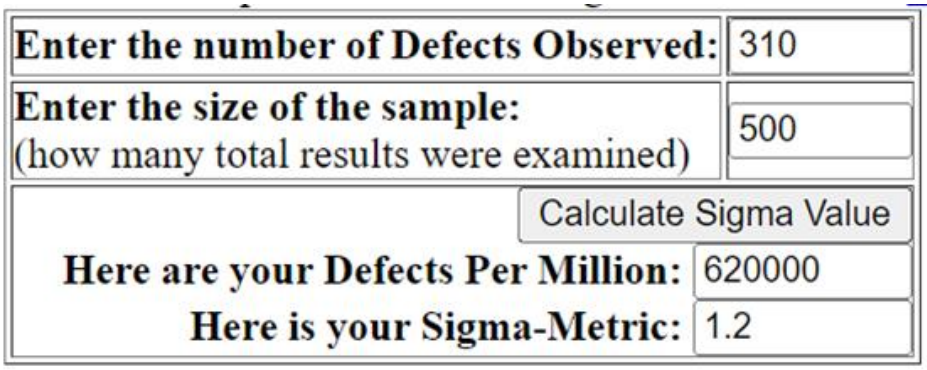
Professor, Class size

When it comes to data collection, studies on the impact of class size and professor quality on student GPA typically involve analyzing large datasets of student records, including information on class size, instructor ratings, and student grades. In order to measure the impact different factors have on GPA, we collect Purdue student GPA data to see how the professor and the class size can influence the average GPA of students. When it comes to data collection, studies on the impact of class size and professor quality on student GPA typically involve analyzing large datasets of student records, including information on class size, instructor ratings, and student grades[1]. We randomly selected 500 samples from the population with average GPA, student size, and teaching experience, while the teaching experience is 0 when the Professor doesn't have teaching experience in current courses.

KPIV: Student Size, Teaching Experience
KPOV: Average GPA

Baseline Performance

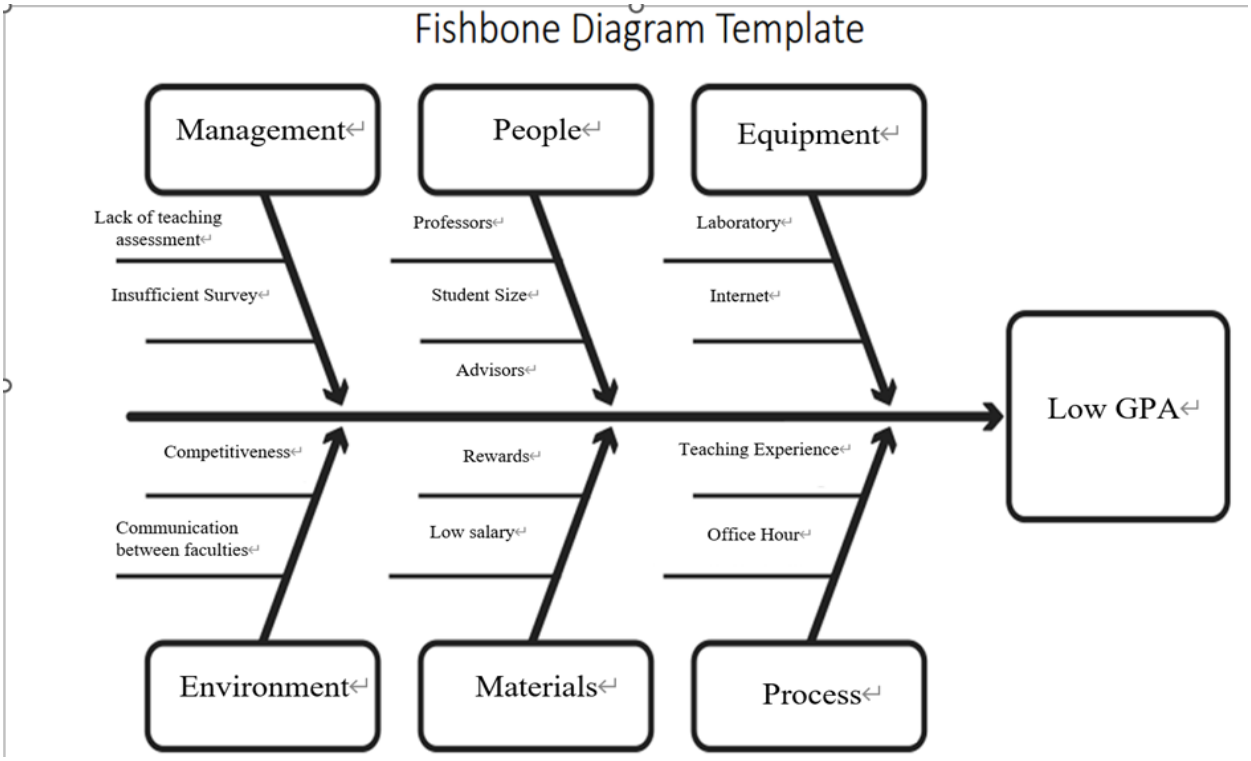
Given the target GPA is 3.6, the result shows we have 1.2 sigma level, which means GPA needs improvement to meet our target.



[1] Data from boilergrades.com, a website aggregating grade distributions of all Purdue courses over the last several years. The data was cleaned and average GPA along with teaching experience was calculated in Python.

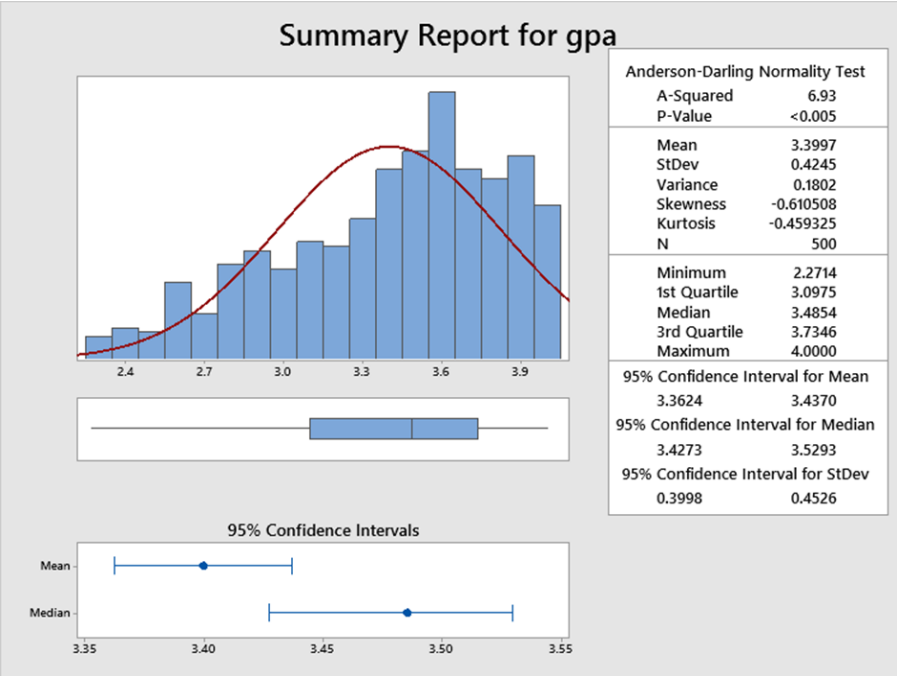
Analyze Phase

Fish-Bone Diagram:



By using a fish-bone diagram, we can identify potential root causes of low GPA, which are separated into 6 groups-Management, People, Equipment, Environment, Materials, and Process. Combining our data, we focus on two potential root causes: teaching experience and student size, and test if they are the significant root causes of low GPA.

The Original Dataset



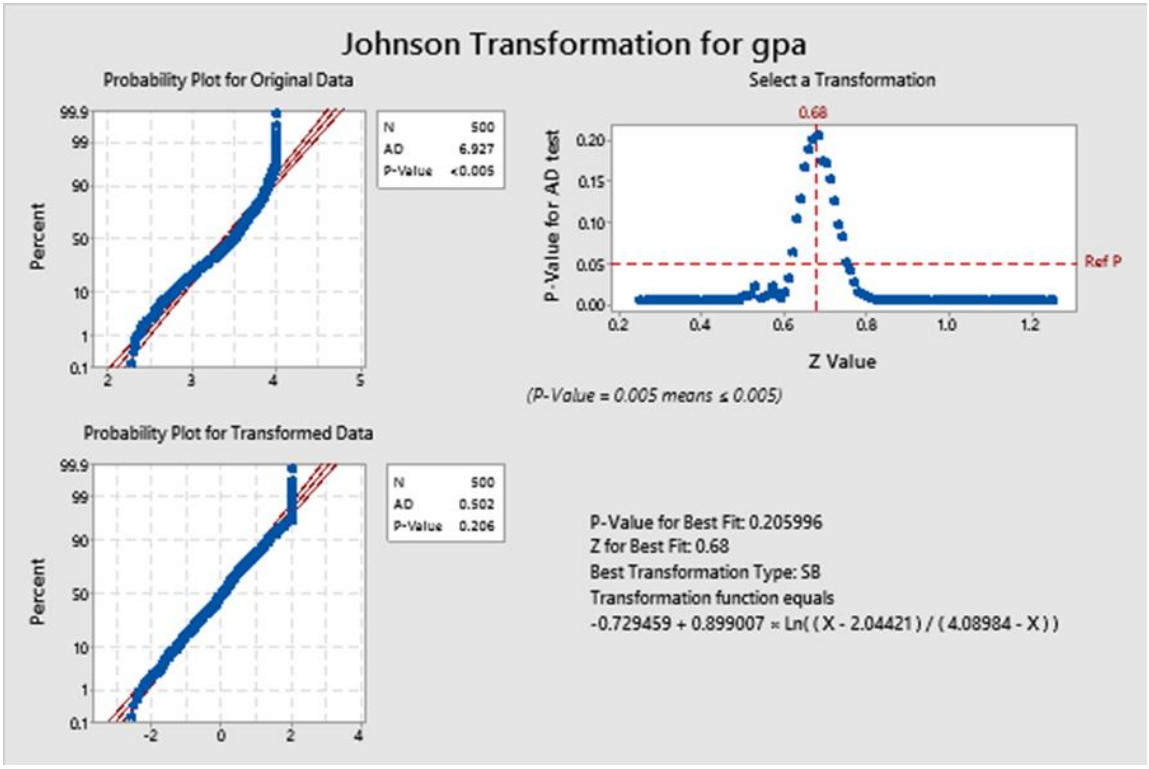
The target GPA is desired to be 3.6. The Anderson-Darling Normality test indicates that the mean GPA is 3.3997. The distribution is slightly left-skewed with a 3rd quartile value of 3.73, indicating more than 60% is lower than 3.6. This corresponds to a six sigma level of 1.2.

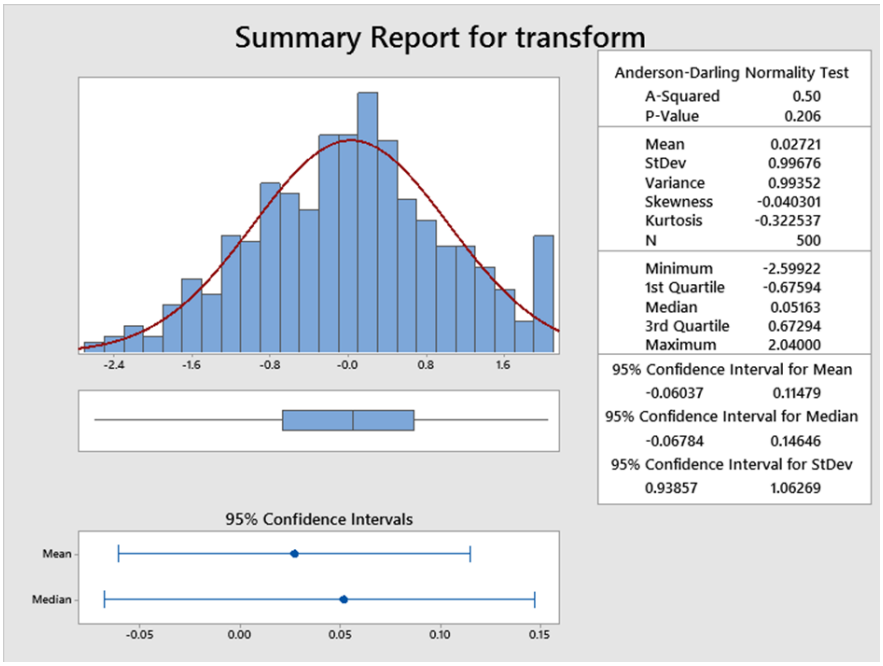
Goodness of Fit Test

Distribution	AD	P	LRT P
Normal	6.927	<0.005	
Box-Cox Transformation	3.248	<0.005	
Lognormal	10.564	<0.005	
3-Parameter Lognormal	6.952	*	0.000
Exponential	176.385	<0.003	
2-Parameter Exponential	84.771	<0.010	0.000
Weibull	3.283	<0.010	
3-Parameter Weibull	2.430	<0.005	0.016
Smallest Extreme Value	2.385	<0.010	
Largest Extreme Value	16.485	<0.010	
Gamma	9.246	<0.005	
3-Parameter Gamma	8.563	*	0.000
Logistic	6.186	<0.005	
Loglogistic	8.575	<0.005	
3-Parameter Loglogistic	6.192	*	0.000
Johnson Transformation	0.502	0.206	

None of the typical statistical distributions fit the corresponding strength data, and therefore no long range six sigma quality level can be determined.

After Transformation:





Transformation: -0.729459 + 0.899007 × Ln((X - 2.04421) / (4.08984 - X))

Transformed target: 0.309497

After we transform our data by Johnson Transformation, the distribution becomes normal as the p-value is greater than 0.05.The transformation makes it harder to interpret the meaning of mean value and standard deviation. However, we can still transform the target and compare it with the sample mean.

One sample t test

Test

Null hypothesis	H_0: μ = 0.309497
Alternative hypothesis	H_1: μ < 0.309497

T-Value	P-Value
-6.33	0.000

From 1 sample t-test, it clearly shows that the sample mean is 100 percent smaller than the target value. It means we should find out the root causes and improve the GPA of Purdue students.

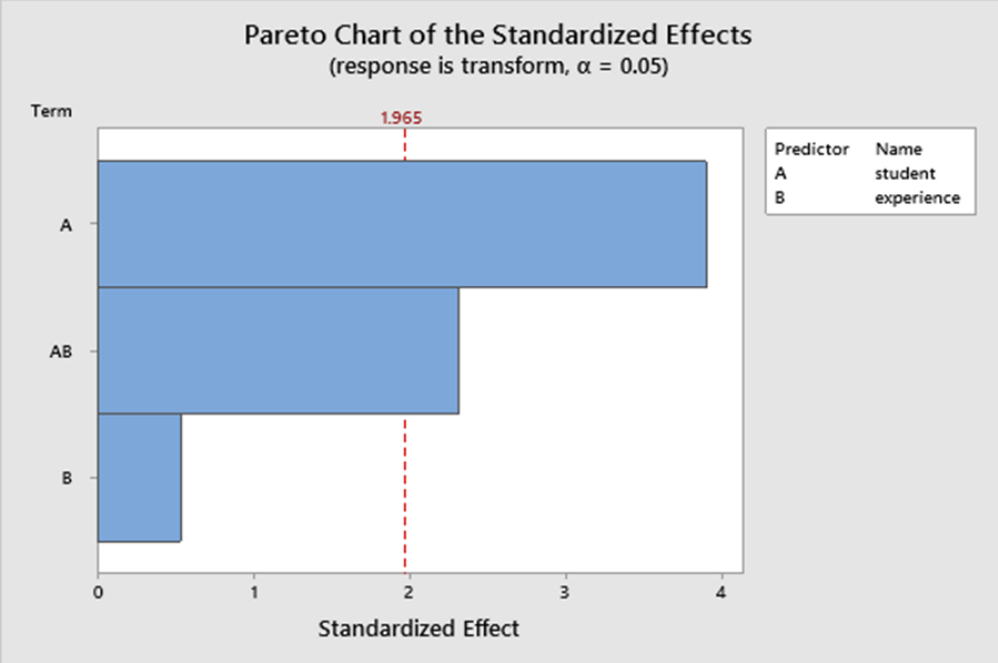
Regression

Regression Equation

experience	
0	transform = 0.1505 - 0.002801 student
1	transform = 0.0926 - 0.000752 student

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.1505	0.0876	1.72	0.087	
student	-0.002801	0.000718	-3.90	0.000	2.91
experience					
1	-0.058	0.108	-0.54	0.591	1.32
student*experience					
1	0.002049	0.000887	2.31	0.021	3.27



In the MLR function, we have student size, teaching experience, and the interaction effect between student size and teaching experience as x variables. The GPA is the response variable. By looking at the summary table and Pareto Chart, it is obvious that student size and the interaction effect between student size and teaching experience have significant linear impacts on GPA. The coefficient table tells us that student size negatively affects GPA and interaction effect positively affects GPA. Therefore, student size and experience are two root causes. We will focus on those two factors in the improvement phase and see how to improve the GPA by controlling student size and teaching experience.

Improve

During the define phase, we have established a goal to increase GPA by 10%. In the analysis phase, we found out that the current average mean GPA is 3.3997. We will use hypothesis tests to assess whether our improved data can support the hypothesis that GPA has increased by 10%. We have already identified two root causes for the current GPA: class size and teaching experience. For the purposes of this analysis, we will consider a class size to be small if it is less than 20 but greater than 5. We will also group teaching experience into two categories: not having or not having enough experience before (0-2 semesters), and having enough experience before (3 semesters and above). We will conduct hypothesis tests for both of these variables individually, and then compare which factor has a more significant impact on increasing average GPA.
Target GPA: 3.3997*110%=3.73967

Testing of Solutions

Class size: We consider class size to be small when the student number is greater than 5 and less than 20. That's because some tiny classes with a few students may have special situations on GPA, such as all students with a final 4.0 GPA. Therefore, we have to eliminate them from our data.

H_0: The average GPA is increased by 10%
H_a: The average GPA is not increased 10%

One-Sample T: Fall2022avgGpa

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Upper Bound for μ
778	3.5837	0.3748	0.0134	3.6059

μ: population mean of Fall2022avgGpa

Test

Null hypothesis	H_0: μ = 3.73967
Alternative hypothesis	H_1: μ < 3.73967

T-Value	P-Value
-11.60	0.000

From the One-Sample T test, we reject the null hypothesis because p-value=0 is obviously smaller than the significant alpha level of 0.05. To conclude, the average GPA will not be increased by 10% in a class size of 5-20. Although the target increase has not been completed, we could still find a higher average GPA has been shown after limiting the class size. So we would like to discover how much the GPA was improved by doing a few more tests and starting with an increase of 4%.

H_0: The average GPA is increased by 4%
H_a: The average GPA is increased more than 4%

One-Sample T: Fall2022avgGpa (4% increase)

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Lower Bound for μ
778	3.5837	0.3748	0.0134	3.5616

μ: population mean of Fall2022avgGpa

Test

Null hypothesis	H_0: μ = 3.53569
Alternative hypothesis	H_1: μ > 3.53569

T-Value	P-Value
3.58	0.000

From our One-Sample T test, we reject the null hypothesis because p-value=0, which is smaller than the significant alpha level of 0.05. Even if we were not able to meet the 10% target, we can conclude that the average GPA has increased more than only by 4%.

Then, we tried to find if the teaching experience would have an influence on the average GPA.

Teaching experience:We have categorized teaching experience into two groups: professors without enough experience (0-2 semesters) and professors with sufficient experience (3 semesters and above), which is the group of professors who have taught more than semesters.

H_0: The average GPA is increased by 10% with professors who have 3 semester experience and above
H_a: The average GPA is not increased by 10% with professors who have 3 semester experience and above

One-Sample T: Fall2022avgGpa

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Upper Bound for μ
1303	3.4131	0.4151	0.0115	3.4320

μ: population mean of Fall2022avgGpa

Test

Null hypothesis	H_0: μ = 3.73967
Alternative hypothesis	H_1: μ < 3.73967

T-Value	P-Value
-28.40	0.000

From the One-Sample T test, we reject the null hypothesis because p-value=0 is obviously smaller than the significant alpha level of 0.05. To conclude, the average GPA will not be increased by 10% when professors have 3 semester experience and above.

H_0: The average GPA is the same as before.
H_a: The average GPA has increased with professors who have 3 semester experience and above

One-Sample T: Fall2022avgGpa

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Lower Bound for μ
1303	3.4131	0.4151	0.0115	3.3942

μ: population mean of Fall2022avgGpa

Test

Null hypothesis	H_0: μ = 3.3997
Alternative hypothesis	H_1: μ > 3.3997

T-Value	P-Value
1.16	0.122

From the One-Sample T test, we fail to reject the null hypothesis because p-value=0.122 is larger than the significant alpha level of 0.05. To conclude, the average GPA will not be increased when professors have 3 semester experience and above.

Optimal Solution

Pugh Matrix

Options / Critica	Weight	Limiting Class Size	Requiring Teaching Experience	Providing Student Tutoring	Offering More Office Hours
How much will it cost	5	3	1	1	3
How many supports will it get from University	4	2	1	2	1
How many long term benefits it can bring	4	3	3	3	2
How easy to implement	3	2	1	1	2
Score		41	24	28	33

* The baseline: 10; Good (Positive): 3; Average: 2; Bad (Negative): 1.

Based on the tests we have completed, we found that the increase of average GPA can achieve 4% if students were assigned in classes with 5-20 people. Although it did not meet the expectation of an increment of 10%, it was an obvious improvement and could be helpful. However, when we did the test of teaching experience, we found that the teaching experience of professors was not as influential as the class size to the average GPA.

We also created a pugh matrix to get the optimal solution. By setting the critica in four aspects that we need to consider about, we get the highest score for limiting class size since it will offer the most long-term benefits while costing the least budget.

Control

Main Cause and Control

In the previous analysis and the improvement phase, we identified some of the main factors that can affect the average GPA of students. In the implementation phase, we tested the effect of different class sizes on students' GPAs and found that a class size of less than 20 and more than five students could increase students' GPAs by approximately 4% compared to a class size of more than 20 students. However, the previous analysis did not find a significant effect of the two different teaching experience models on GPA. And we have doubly verified that controlling for class size is an effective way to improve GPA through cost and feasibility analyses.

We know that many objective factors influence a student's GPA. For example, the different teachers teaching, the tutor set-up of the course, and the number of office hours the teacher has will also impact the students' average GPA. To accurately monitor the impact of class size on students' GPAs, we need to keep the teachers, the availability of tutors, and the length of teachers' office hours as consistent as possible for different class sizes.

Monitoring and Problem Solutions

Since reducing class size helps improve GPA, we can consider further refinement of class size, such as 5-10 class size, 10-20 class size, 20-40 class size, etc. On this basis, we can keep track of the GPA of each class size over time. We can then analyze whether there is a better class size that will increase the student's GPA to a greater extent.

We need to keep records and track GPA over time for different class sizes because there is a lag effect on GPA changes, so we need to keep a continuous record of changes in student GPA over a long period. This is because the effect of class size may take at least one semester before it has an impact. We can also build a dynamic dashboard to analyze changes in student GPAs for different class sizes in real time. We can also use the X Bar-R Chart to analyze and compare the average GPA across class sizes, identify anomalies, and optimize our controls.