PHEW! THAT'S A RELIEF:

ASSESSING DRINKING WATER QUALITY AND TREATMENT OF WATER SUPPLY

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CLASS: MAT-309: DESIGN & ANALYSIS OF EXPERIMENTS

INTRODUCTION

INTRODUCTION

- **Access to safe drinking water is a human right, however …**
  - An Iowan town found that the level of lead in their water supply is 3x higher than what is recommended by the EPA (Des Moines Register, 2016)
  - Long-term health risks that will be consequential to population health
- **Point-of-use devices are solutions for improving water quality**
  - Quick, affordable, and convenient cost
  - Can vary in what contaminants will be filtered out (ie. copper, chlorine, etc.)

INTRODUCTION

- **The student body has a wide variety of remarks about drinking water quality throughout Grinnell College.**
  - From strange tastes to skepticism about water quality in Grinnell
- **Objectives**
  - To evaluate the quality of drinking water from different Grinnell College locations (ie. academic buildings, residence halls, off-campus residences)
  - To determine the effectiveness of water filters in improving water quality

METHODOLOGY

METHODOLOGY

Measurement

Used pH level as our measure for water quality

- Signifies presence of chemicals and heavy metals in water (U.S. Geological Survey
- Safe drinking water should be within pH range of 6.5 to 8.5 (World Health Organization

METHODOLOGY

Data Collection

1. Randomly chose order to visit all three locations in one day
2. For each location, randomly selected a building
3. At each building, found the nearest kitchen sink from the front entrance on the first floor.
4. Collected one sample using a Brita pitcher with Standard Filter and one sample using a Brita pitcher without any device from each building
5. Repeated for 6 consecutive days
6. Transported samples to laboratory to measure and record pH level

Photos retrieved from Grinnell College (www.grinnell.edu)

METHODOLOGY

Experimental Design & Analysis

- Design – Factorial Experiment
  - Location, Filtration Treatment
    - 6 treatment combinations x 6 replicates = 36 observations
- Analysis – Two-Way Analysis of Variance (ANOVA)
  - Tukey's test for multiple comparisons

RESULTS

RESULTS

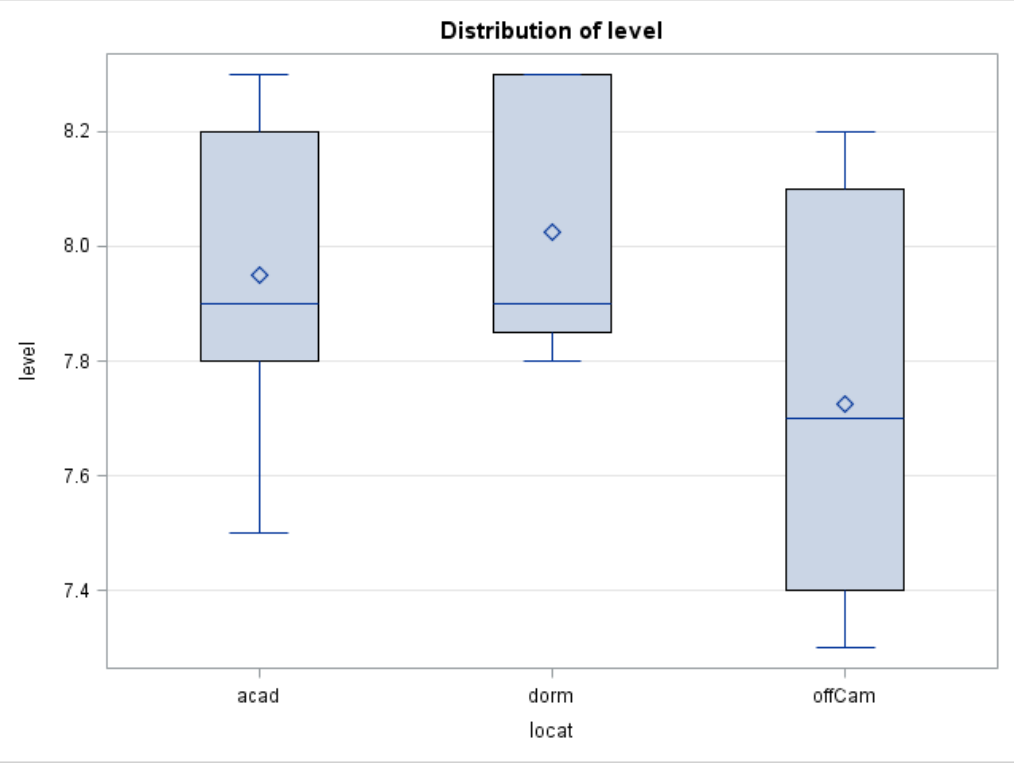


Figure 1:

- Boxplot of pH Levels of Drinking Water Around Grinnell College
- Two-Way ANOVA
  - F-val. = 18.80 | p-val. < 0.0001
- Tukey's Multiple Comparisons
  - acad = Group A; $\overline{X}$ = 7.950
  - dorm = Group A; $\overline{X}$ = 8.025
  - offCam = Group B; $\overline{X}$ = 7.725

RESULTS

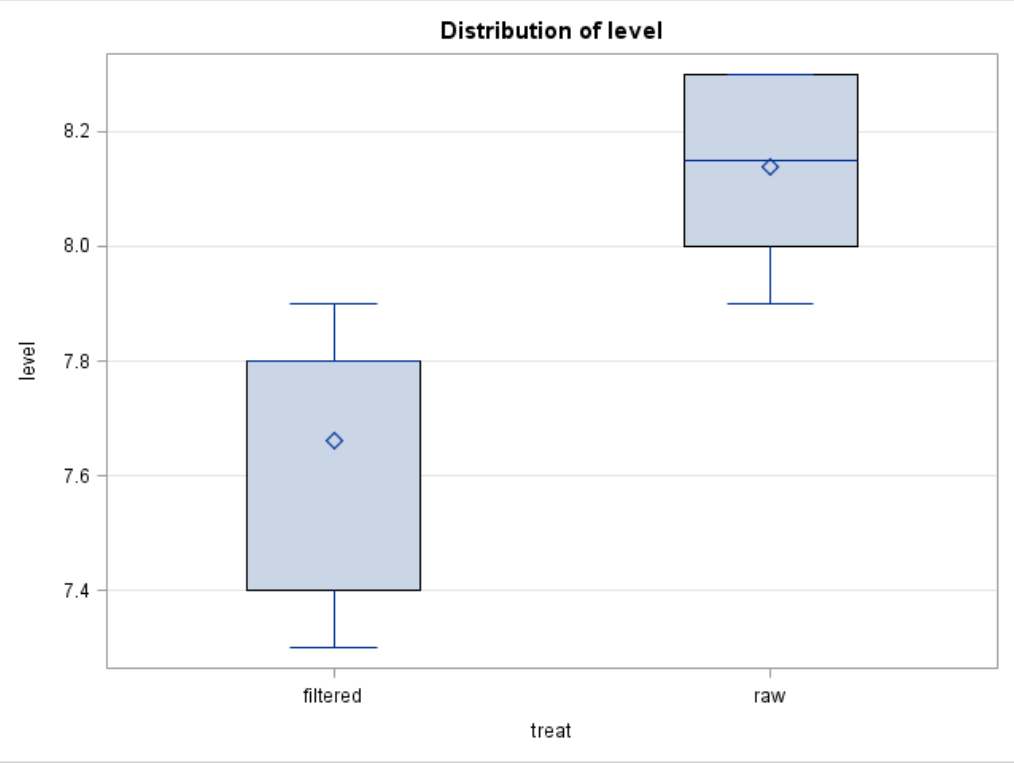


Figure 2:

- Boxplot of pH Levels of Treated and Untreated Drinking Water
- Two-Way ANOVA
  - F-val. = 132.07 | p-val. < 0.0001
- Tukey's Multiple Comparisons
  - raw = Group A; $\overline{X}$ = 8.139
  - filtered = Group B; $\overline{X}$ = 7.661

RESULTS

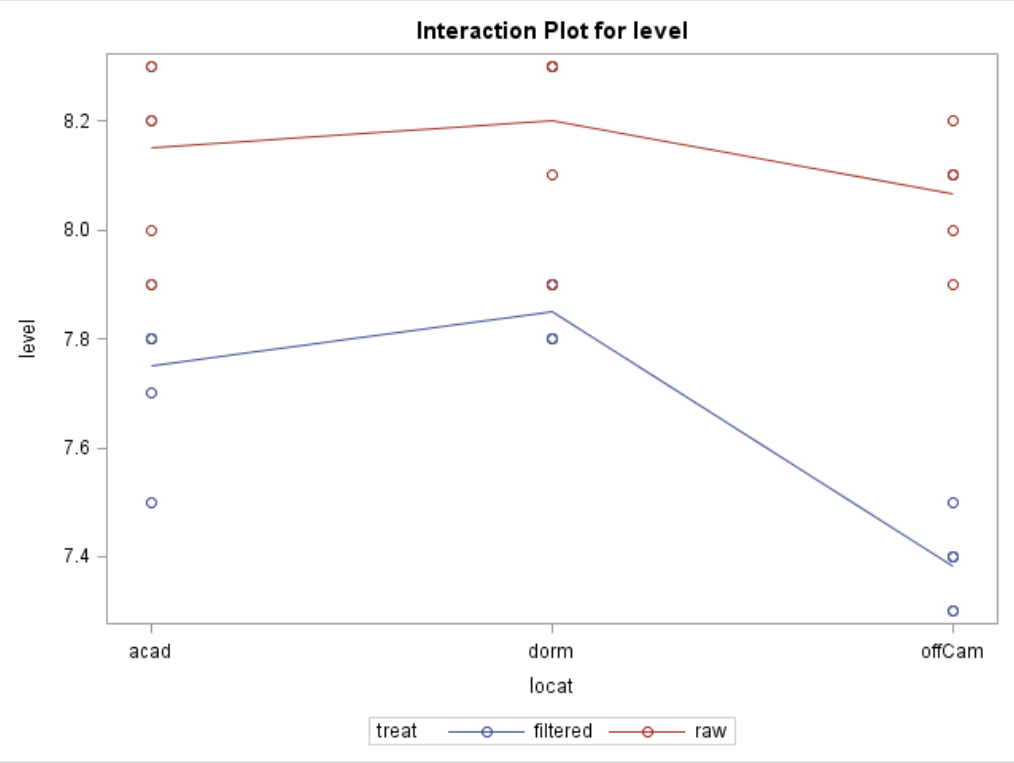
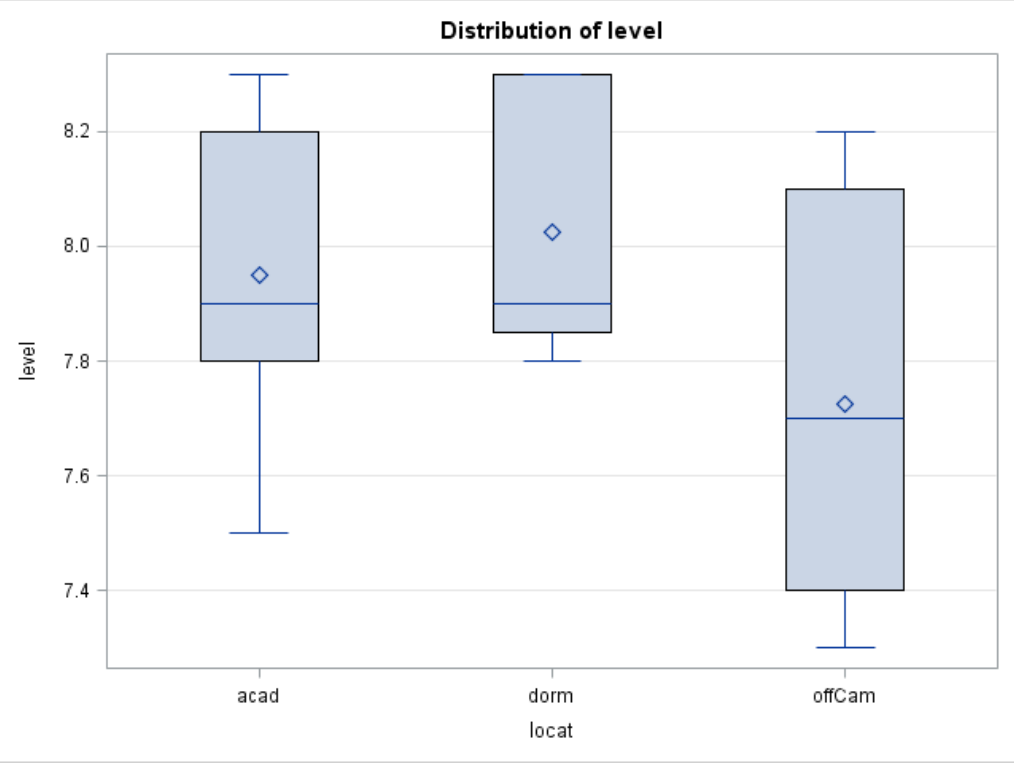


Figure 3:

- Interaction Plot of pH Levels for Location and Treatment Variables.
- Two-Way ANOVA
  - F-val. = 6.23 | p-val. = 0.0055

DISCUSSION

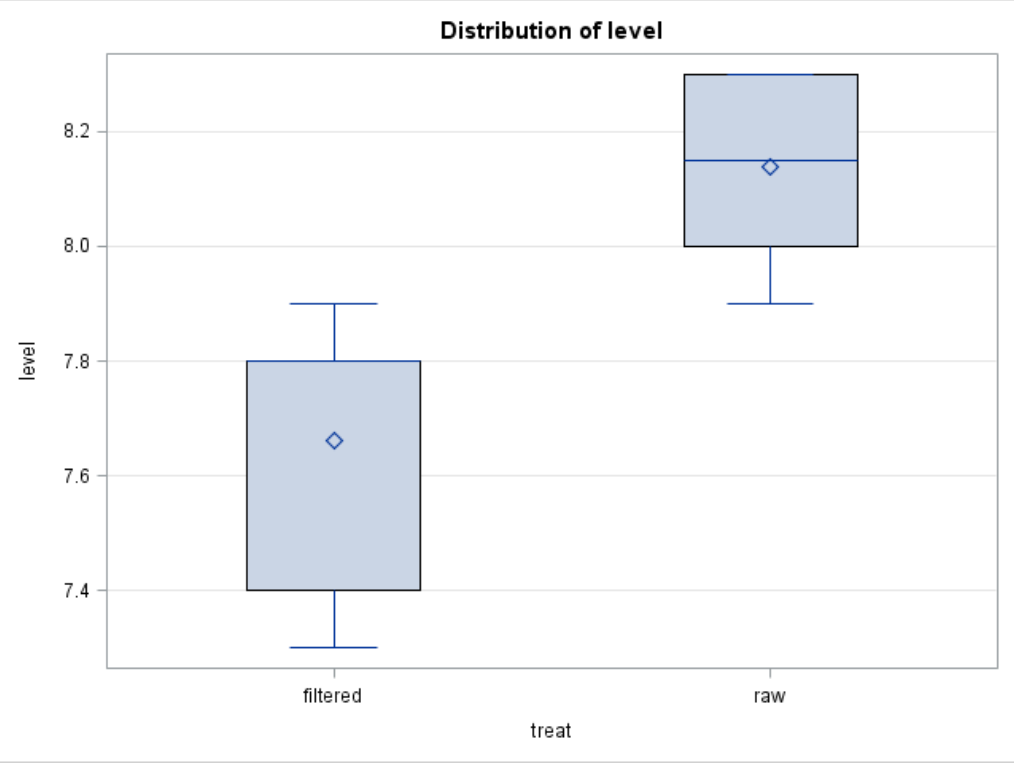
DISCUSSION



Effect of Location on Water Quality

- Off-campus locations have a significantly lower pH level than that of academic buildings and residence halls at Grinnell College

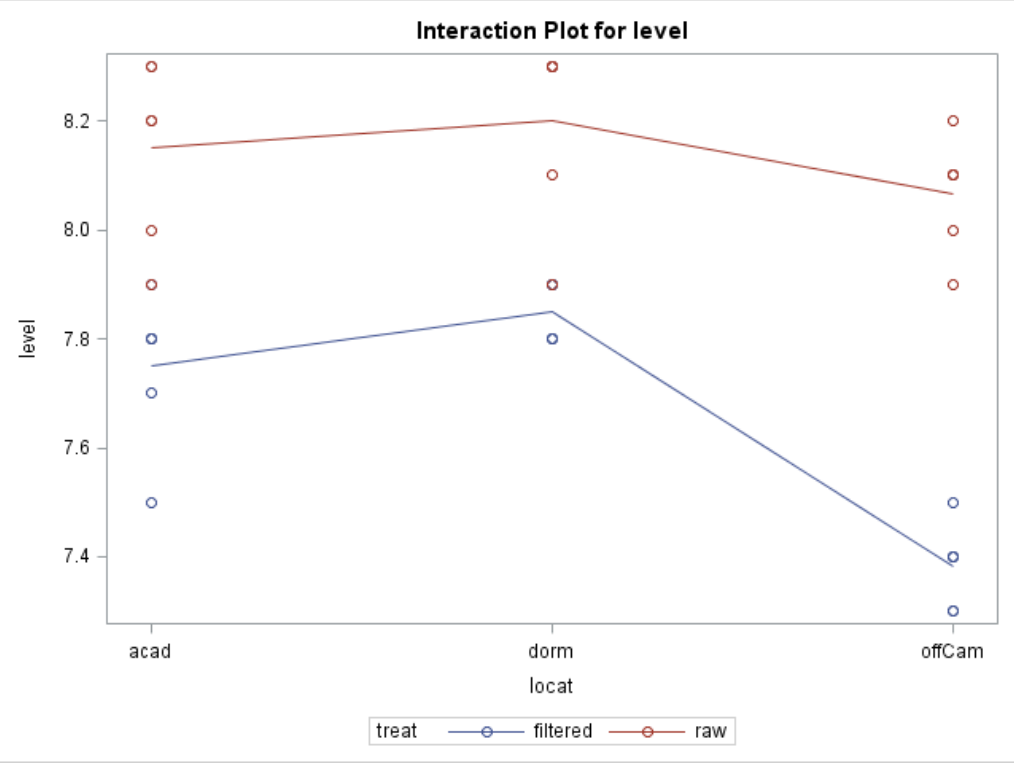
DISCUSSION



Effect of Location on Water Quality

- BRITA Standard Filter removes chlorine, copper, cadmium, mercury, and zinc (Brita, LP, 2017)
- The removal of specific compounds may interact differently depending on filter treatment technology (Anumo et al., 2015; Brophy, 2016)

DISCUSSION



Interaction Effect Between Location and Treatment

- Significant drop in pH level for off-campus samples that are treated than for academic building and residence hall samples
- Difference in water treatment and source

DISCUSSION

Limitations in Experimental Design & Implementation

- Minor issues with nonconstant variance and deviation from normality
  - Increase sample size
- Future iterations of this study may conduct collection across several weeks
- Other studies have recorded measures, such as amount of a specific organic compound, that may better indicate the quality of drinking water

DISCUSSION

Conclusion

1. Off-campus drinking water has a significantly lower pH level than other places
2. Using a BRITA Standard Filter significantly reduces pH level
3. **All of our samples are within the recommended range for safe drinking water**

RESOURCES

APPENDIX

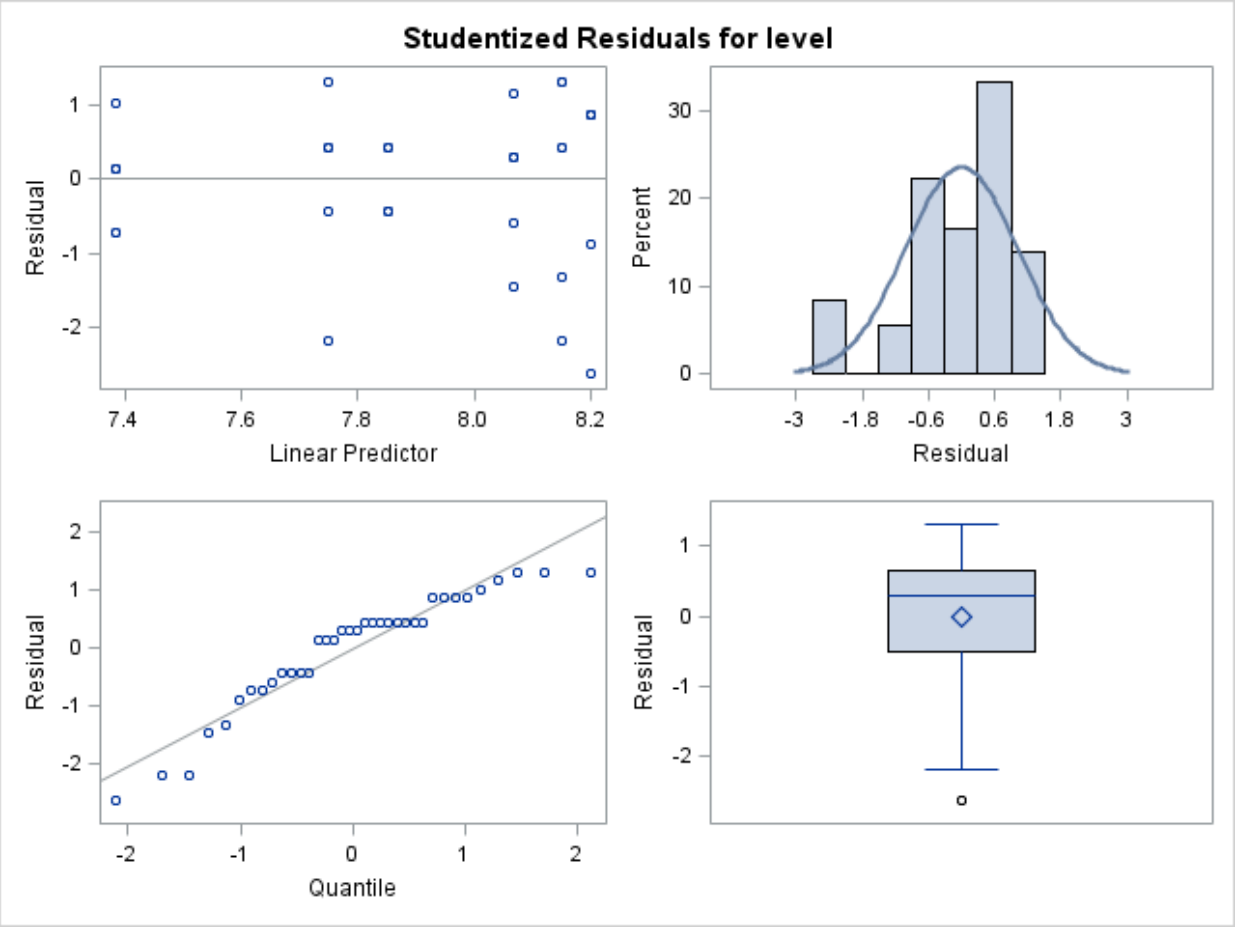
VariableName	Description
date	Date; the day when the water sample was collected; formatted as mm/dd/yyyy; date ranges from 04/04/2017 to 04/09/2017
locat	Location; the general category of location where water was collected; acad = Academic, buildings on the campus of the midwestern liberal arts institution where classes or events can take place; dorm = Dorm, student residence halls; offCam = Off-Campus, houses and/or apartments that are not directly on-campus but are within its vicinity
locatSpec	Specific location; the name of the street/building where the structure was located
treat	Treatment; the filtration treatment the sample of water was given; raw = water was left untouched after collection; filtered = water was filtered once through a Brita filter
level	pH; the pH level of the water when recorded using PASCO Scientific software; note that the range of pH for safe drinking water is between 6.5 to 8.5

APPENDIX

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	2.83333333	0.56666667	36.43	<.0001
Error	30	0.46666667	0.01555556		
Corrected Total	35	3.30000000			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
locat	2	0.58500000	0.29250000	18.80	<.0001
treat	1	2.05444444	2.05444444	132.07	<.0001
locat*treat	2	0.19388889	0.09694444	6.23	0.0055

APPENDIX


Studentized Residuals for level
Residual
Linear Predictor
7.4
7.6
7.8
8.0
8.2
1
0
-1
-2
Percent
Residual
30
20
10
0
-3
-1.8
-0.6
0.6
1.8
3
Residual
Quantile
2
1
0
-1
-2
Residual
1
0
-1
-2

ACKNOWLEDGEMENTS

- Undergraduate Class Project Competition (USCLAP)
- Jeffrey N. Jonkman, Mathematics & Statistics Department
- Corasi Ortiz, Chemistry Department
- Grinnell College

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QUESTIONS?

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