

Team-Based Learning for Experimental Design and Statistical Inference

Cheyne Seleski

Math instructor at Royal Palm Beach Community High School

Cheyne.Seleski@PalmBeachSchools.org

Abstract: In this action research, I will try to implement team-based learning for my experimental design and Statistical inference units for my AP Statistics course. In my own self-assessment, experimental design is my worst-taught unit. I can use team-based learning to improve the learning of all students, which will also help them pass the AP Statistics exam at the end of the year. I think this learning strategy is also viable with statistical inference, so I will include this unit as well, as it will help with quantifying results. I will spend some time researching team-based learning, and then implement team-based learning with my experimental design and statistical inference units. Depending on the number of AP Statistics sections, I plan to use one or more sections as the treatment (team-based learning) and all the others as the control (my usual instruction). I will convert class averages into Z-scores and conduct a two sample z-test to prove significance between the treatment and control.

Rationale: During the Catalysis program, the workshop that I found the most useful was the team-based instruction. In this workshop, we modeled team-based learning, so teachers had a first-hand experience on why this teaching strategy works so well. I personally (and many other teachers had similar feelings) that this workshop was the best professional development I have ever experienced. There may be some difficulties applying this learning strategy in math as it lends better to content that is more open-ended, so I want to try using it for the Statistics content that is less math-related (experimental design and statistical inference). I personally feel that experimental design is my worst unit that I teach, so I think team-based learning has a big opportunity to significantly improve student growth in this unit.

Intervention: Team-based learning is made up of four parts: (1) Groups should be properly formed, (2) Students are accountable for their pre-learning and for working in teams, (3) Team assignments must promote both learning and team development, (4) Students must receive frequent and immediate feedback. I will be providing packets of information about experimental design and their homework will be to read and understand the provided concepts and terms. The next class, I will form groups (1) by having all students form a line. Women who have taken psychology first will be at the front of the line. Men who have taken psychology first will be next in line. Women who are currently taking psychology will be next. Men who are currently taking psychology will be next. Women who have taken/currently taking Calculus will be next. Men who have taken/currently taken Calculus will be next. Women who have taken/currently taken AICE math will be next. Men who have taken/currently taken AICE math will be next. Any remaining women will be next. Any remaining men will be next.

Once groups are formed and seated, students will be taking the iRAT (2). The iRAT will include lower level questions that are necessary in order to have success in the team application activity later in the lesson. iRAT is supposed to be completed individually, without using any notes. Once this is completed, students will now complete the tRAT. The tRAT has the same questions as the iRAT, but it is completed by students working together in their groups. Both the iRAT and tRAT count toward the students' grade, holding them accountable to do the necessary learning. It shouldn't be necessary to go over any of the iRAT questions, as most of them should have been figured out by the end of the iRAT.

Next follows the team application (3). These are made up of higher-level questions, where it is normal to have more than one correct answer. Enough time needs to be given so the team can have enough time to discuss the problems and decide on answers. Once all teams are ready, then we have an inter-team

discussion of all of the questions. This is where most of the significant learning occurs. Teams will each show which answer is picked, and will then defend their answers.

Once the lesson is complete, students will then anonymously give feedback to their partners (4). The following class period, I will compile all results given to each individual student, and distribute it to them. I will repeat this process for each lesson, and then take a test on the entire unit.

My usual instruction would include the gradual release model. I give them notes on key definitions and examples. I will do an example, and then I will have them try an example in class. Finally, the students will try relevant examples on their own at home. The team-based learning would still do the same homework as the usual instruction. See appendix for lesson/unit plan.

Data collection and Analysis: This component will largely depend on the number of AP Statistics sections given to me for the coming school year. Only one section will drastically change the data collection and analysis. If I am given two or more sections then the following idea will work. For each of the experimental design and statistical inference units, there will be one control section, and the rest of the sections will be treatments. The data collected will be from the unit assessments at the end of each unit. For each section, the mean test score and standard deviation will be calculated. The overall mean and standard deviation will also be calculated. I will convert both mean section scores into z-scores, relative to the overall mean and standard deviation. I can then run a 2 sample z-test for each section testing to see if there is a significant difference between the z-scores between the treatment and control.

Connections to the Catalyses science institute: Team-based learning was one of the workshops presented to the teachers this year. Once this workshop was presented to us, I knew right away this is what I wanted to implement with my students.

Literature cited: Getting Started with Team based learning by Sibley and Ostafichuk

Permissions: This proposal will be submitted for approval to the principal of Royal Palm Beach Community High School, Dr. Jesus Armas. Parent permissions are not needed because student data is being reported anonymously.

Unit Plan for experimental design: The experimental design unit is made up of 3 lessons: Simulations, sampling methods, experiments. There will be a quiz after the first two lessons (Simulations and sampling methods), and then a quiz after the last lesson (experiments). Team-based learning will be implemented in all 3 lessons. We will spend a class block (approximately 1 hr and 30 mins) going over quiz problems and practicing previously used free response questions (FRQ) relevant to this unit. Finally, there will be a unit assessment encompassing all 3 lessons.

LESSON PLAN

TITLE:

The science behind data collection.

KEY QUESTION(S):

How do we collect data?

How do we know if the data collected is representative of the population?

SCIENCE SUBJECT:

Statistics

GRADE AND ABILITY LEVEL:

AP level grades 10-12.

SCIENCE CONCEPTS:

Identifying sampling methods, understanding the types of bias in data collection, designing and executing a data collection method.

OVERALL TIME ESTIMATE:

1 hour and 45 minutes

LEARNING STYLES:

Visual and auditory

VOCABULARY:

Random sample, simple random sample, stratified sample, cluster sample, systematic sample, voluntary response sample, convenience sample, sampling bias, representativeness of a sample

LESSON SUMMARY:

This lesson will cover sampling methods (both good and bad), problems with data collection, and how to design and execute your own data collection. I will achieve this by using team-based learning.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

The students will be able to:

- 1) Identify and understand the different types of sampling methods.
- 2) Identify and understand sampling bias.

MATERIALS:

Graphing calculator (per student), tRAT cards (per 3-4 students), iRAT/tRAT question papers (per student), team application assignment papers (per student), mini whiteboards (per 3-4 students), whiteboard markers (per 3-4 students).

BACKGROUND INFORMATION:

There are various ways to collect data. Some ways are good, some ways are bad. In this lesson we will cover the primary ways data is collected.

Sampling frame: The population of subjects that you wish to collect data from.

Random sample: Every individual has an equal chance of being selected.

Simple random sample: Not only does every individual have an equal chance of being selected, but every combinations of samples have an equal chance of occurring.

Stratified sample: The sampling frame is organized into groups, and an amount is randomly selected from each group.

Cluster sample: The sampling frame is organized into groups. One or more groups are randomly selected. All the subjects in those groups are then sampled.

Systematic sample: The sampling frame is placed in a list. Every 'nth' subject is selected.

Convenience sample: The person who collects the data selects subjects in a way that is most convenient for them.

Voluntary sample: The subjects decide whether they want to participate in the data collection or not.

Sampling bias: When data is collected in a way that is not representative of the population of interest.

Certain sampling methods may be better to use than others depending on the situation. Voluntary and convenience samples are bad in all cases, as they are not representative of the population.

ADVANCE PREPARATION:

The desks need to be organized in a way that is convenient for team activities. Materials need to be organized.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

As students enter the classroom, they will be completing a bellringer. They will be given 6 minutes total for two multiple choice problems. They are allowed to use their notes, and they are allowed to work together. Once the 6 minutes are up, all work is collected and we go over the solutions (3 minutes).

Next, we distribute the iRAT paper. Students have 7 minutes to complete this assignment. Students must work individually and is closed book. Once time is up, the teacher collects all answers.

Then, students move into their team and are given 9 minutes to complete the same assignment as a team. This assignment is still closed book, but they are to discuss all answers with their team. The teacher hands out the tRAT form, where students scratch off which answer choice they think is the correct answer. If there is a serious misunderstanding about a particular question then we can go over it as a class, but in general, most iRAT/tRAT questions do not need to be gone over by the teacher. If there are any disputes about the answer, they can contact me via email with the dispute with evidence for support.

Next is the team application. Students are given about 15 minutes to complete this assignment.

Next, a discussion begins with each question on the team application. All groups report what answer they have chosen, and the teacher leads into further discussion with probing questions. This will take about 20 to 30 minutes.

Finally, the students will complete a homework assignment at home. They will also be required to read an information packet that will be necessary for the next team-based learning activity the following class period.

iRAT/tRAT questions:

1) Which sampling method requires you to organize your sampling frame into groups and then randomly select an amount of subjects from each group?

- (a) Simple Random Sample
- (b) Stratified Sample (correct)
- (c) Cluster Sample
- (d) Systematic Sample

2) Which sampling method requires you to organize your sampling frame into groups and then randomly select one or more groups and sample all subjects in the selected group?

- (a) Simple Random Sample
- (b) Stratified Sample
- (c) Cluster Sample (correct)
- (d) Systematic Sample

3) Which sampling method requires that not only does every person have an equal chance of being selected but every sample has an equal chance of being selected?

- (a) Simple Random Sample (correct)
- (b) Stratified Sample
- (c) Cluster Sample
- (d) Systematic Sample

4) Which sampling method requires that you list all of the subjects and then select every “nth” subject for data collection?

- (a) Stratified Sample
- (b) Cluster Sample
- (c) Systematic Sample (correct)
- (d) Convenience Sample

5) Which sampling method requires that you let the subjects decide whether or not to participate in the sample?

- (a) Cluster Sample
- (b) Systematic Sample

- (c) Convenience Sample
 - (d) Voluntary Response Sample (correct)
- 6) Which sampling method requires that the person conducting the sample pick which subjects participate in the sample?
- (a) Systematic Sample
 - (b) Convenience Sample (correct)
 - (c) Voluntary Response Sample
 - (d) Simple Random Sample

Team application questions:

1) You want to get an idea what the average tree height is in a rural county in Colorado. This county contains 100,000 acres of land. You want to select 1,000 trees for this sample. Determine which sampling method would be **BEST** to use in this situation.

- (a) Convenience Sample
- (b) Simple Random Sample (correct)
- (c) Stratified Sample (correct)
- (d) Cluster Sample (correct)

2) The director of a college's alumni program wants to collect data on the median salary earned by their alumni (6,828 alumni total). Which sampling design would result in a sample that is **MOST** representative of the population?

- (a) Select a simple random sample of members of the class and contact the selected members directly by phone. Follow up to ensure all responses are obtained. Because this process will require a lot of time, the staff estimates the only 100 members of the class could be contacted using this method. (correct)
- (b) Send out an e-mail to all 6,828 members of the class asking them to complete an online form. The staff estimates that roughly 600 people will respond.
- (c) Organize the alumni by the year they graduated and randomly select 30 alumni from each year. Obtain the salary earned. Follow up to ensure all responses are obtained. (correct)
- (d) Organize the alumni by the year they graduated and randomly select 3 graduating classes. Obtain the salary earned. Follow up to ensure all responses are obtained. (correct)

3) A researcher wanted to estimate the number of siblings students have at Royal Palm Beach High School. The researcher decided that they wanted to use a systematic sample. Which of the following sample designs **BEST** describes a systematic sample?

- (a) The researcher picks every 10th student that walks onto campus on a particular day.
- (b) The researcher picks every 5th student that is currently in a classroom in building 2 upstairs.
- (c) The researcher picks every 15th student that enters the cafeteria during lunch.
- (d) The researcher obtains a list of all students who attend Royal Palm Beach High School. The researcher then picks every 20th student on this list. (correct)

ASSESSMENT SUGGESTIONS:

Objective 1 and 2 will be assessed by the iRAT/tRAT and the team application, which is provided above.

EXTENSIONS:

None that I am aware of.

RESOURCES/REFERENCES:

Stats: Modeling the World, Bock, Velleman, De Veaux