The effects of Team Based Learning (TBL)
on Learning Acquisition during
a Lesson about Ebola Virus as an Emergent Pathogen

Herbert Maysonet
Science Teacher
Gause Academy
Bartow FL   33830

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Herbert Maysonet (Polk County)
Gause Academy
1395 W. Polk Street
Bartow FL 33830

Abstract
This action research's goal is to demonstrate that there is learning taking place using a Team Based Learning (TBL) and a lesson plans from bola virus as an emergent pathogen.   After giving students a pre and posttest, students are expected to show a significant difference between tests. In the lesson, we will be looking at the phylogeny tree of the Ebola viruses, and utilizing the outbreak to teach benchmarks associated with genetics, mutations, and the negative impact pathogens have to our human healthy populations. Most students have problems understanding how a simple mutation can lead to drastic changes in genome of an organism. Some of my student misconceptions in past years have been that all mutations are harmful; many believe that once a mutation is discovered it can be fixed; and students believe that only certain people or organisms have mutated genes.

Rationale
My students are from a title one school who are in a free lunch program. My students tend to be "resistant learners."   If Michaelsen, Larry K. (1992). Is correct, TBL approach will have many positive benefits for my student which may include: 1) lasting and goal directed diverse student teams; 2) grades are derived by combining individual, and group performance as well as peer evaluation. 3) most of class time is devoted to small group activities; and 4) a six-step instructional activity sequence that makes it possible to focus the majority of class time on helping students develop the ability to use concepts as opposed to simply learn about them to "cover" a topic.   In Michealsen et al study (1989) demonstrated that the majority of groups can outperformed their most single knowledgeable member on decision-making tasks. According to Michaelsen et al. (2009) "TBL is designed to provide students with both conceptual and procedural knowledge" (page 1).   Students have many misconceptions about the nature and consequences of mutations. The reason for this proposal is to help student dispel those false believes and help them adopt thinking derived from science research. This research will demonstrate the learning acquired by students after exposed to a Team Based Learning (TBL) lesson cycle will yield better results, in posttest than in the pretest.

How can we describe the impact that various types of mutations that may occur in a DNA sequence?
• Explain that mutations are a permanent alteration of the nucleotide sequence of the genome of an organism that may or may not result in phenotypic changes.
 • Recognize that mutations in sex cells, or gametes can be passed on to offspring and, therefore, may result in phenotypic changes.
• Analyze different types of mutations (chromosome & point mutations in DNA including; inversion, translocation, nondisjunction, substitution, and frameshift mutations (deletion and insertion). Include a discussion of genetic disorders.
What evidences led to the development of modern classification systems over time?
Understand that it is the nature of science to change as new evidence is provided.
• Explain the historical development and changing nature of classification systems.

• Describe how genetics provides more evidence of how closely organisms are related, causing groupings to have to be adjusted.
 • Explain how the development of the microscope provide for the study of microscopic structures, allowing scientists to find differences between fungi and plants to form another phylum

Intervention/Description of teaching unit or module(s), including expected outcomes:
The intervention that will be utilized in this action research proposal will be the Team Based Learning (TBL) to teach a lesson on an emergent pathogen like Ebola, we predict test scores will yield higher scores in the posttest than in a pretest. I plan to observe my students in either Biology or Environmental science.

SC.912.L.16.4
Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how Mutations in gametes may result in phenotypic changes in offspring. Assessed as SC.912.L.16.3
SC.912.L.15.4
Describe how and why organisms are hierarchically classified and based on evolutionary relationships? Assessed as SC.912.L.15.6.
SC.912.L.15.4
Describe how and why organisms are hierarchically classified and based on evolutionary relationships. Assessed as SC.912.L.15.6.
 SC.912.L.15.5
Explain the reasons for changes in how organisms are classified. Assessed as SC.912.L.15.6.
Student learning outcomes are as follows:
• Students will learn that some mutations do not result in phenotypic changes
• Students will understand that even when the function of a small proportion of the DNA is known, it has been shown that genes do not operate in isolation. Instead genes interact in a complicated way, altering their behavior in response to influences from other genes. Additionally, delivery of gene therapy that works long-term is not guaranteed.
• Students will learn that many people possess harmless mutated genes and what happens as a pathogen mutates.

DATA COLLECTION AND ANALYSIS:
Data for the pre and posttest, all the RAT cycle scores for all students, and group activities will be collected. We will first randomize the items in the pre and posttest. I predict that the distribution of scores will show a difference in their descriptive statistics, and that scores may show that there is a negative correlation between tests. Pre and posttest will be the same tests, but questions and answers will be randomly selected in their arrangement. We will provide descriptive statistics of these two tests. Run a Pearson correlation test will be performed to find r., a paired sample t-test will be performed on the data to see if null hypothesis can be rejected.

CONNECTIONS TO CATALySES SUMMER INSTITUTE:
I will be using a lesson and activities given to us during our summer institute. We will teach students about Ebola which is an emergent pathogen using a TBL instructional method. This method was taught to us during this summer institute training.

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KEY QUESTION (s):
How genetics provides more evidence of how closely organisms are related, causing groupings to have to be adjusted?
How mutations in the DNA sequence may or may not result in phenotypic change?

SCIENCE SUBJECT: Biology

GRADE AND ABILITY LEVEL: 9-12

SCIENCE CONCEPTS: Ebola, mutation, virus, vector, Transmission, sequencing,

OVERALL TIME ESTIMATE: 180 MINUTES

LEARNING STYLES: VISUAL, AUDITIORY, AND KINESTHETIC.

VOCABULARY:
Antibody: a protein produced by the immune system when it detects a foreign substance
Antigen: a substance that causes the immune system to produce antibodies
Circulatory failure: the inability of the circulatory system to function well enough to sustain health
Endemic disease: a disease that is common and occurs at a predictable rate within an area
Enzyme: a protein that is a catalyst for a specific biochemical reaction
Hemorrhagic: bleeding, usually severe bleeding
Pathogen: a disease-causing agent
Risk factor: a condition or behavior that make someone susceptible to contracting a disease
Subtropical: a climate characterized by hot, humid summers and mild winters
Symptom: a condition that is an indication of disease
Tropical: a climate characterized by warm, humid weather year-round
Vaccine: a preparation that stimulates the immune system to produce antibodies against a pathogen
Vector: an organism that delivers a pathogen to a host organism

LESSON SUMMARY:
During this lesson, students will analyze Ebola DNA sequences that were obtained from patients from Sierra Leone during the 2014 outbreak of West Africa. Students will perform a class activity. Students will be challenged to place sequences into groups based on similarities and create a story for transmission of the virus. They will then compare their results to those of their peers and those of scientist at the Broad Institute of MIT and Harvard, who followed similar procedure at the beginning of the outbreak.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

1. SC.912.L.16.4 Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in phenotypic changes in offspring. Assessed as SC.912.L.16.3
2. SC.912.L.15.4 Assessed as SC.912.L.15.6. Describe how and why organisms are hierarchically classified and based on evolutionary relationships?
3. SC.912.L.15.4 Assessed as SC.912.L.15.6. SC.912.L.15.5 Describe how and why organisms are hierarchically classified and based on evolutionary relationships. Explain the reasons for changes in how organisms are classified. Assessed as SC.912.L.15.6.
   • Explain that mutations are a permanent alteration of the nucleotide sequence of the genome of an organism that may or may not result in phenotypic changes.
   • Recognize that mutations in sex cells, or gametes can be passed on to offspring and, therefore, may result in phenotypic changes.
   • Analyze different types of mutations (chromosome & point mutations in DNA including; inversion, translocation, nondisjunction, substitution, and frameshift mutations (deletion and insertion). Include a discussion of genetic disorders.

MATERIALS:
1. Pre-Test and Post Test (50 items)
2. Paper for Copying
3. Copy iRAT and tRAT forms
4. Obtain IF-AT Cards
5. Ebola sequences printed in color on card stock in color for each group (10 groups)
6. Projector and Screen
7. Set of 10 ABCDE Color Cards and laminated
8. Set of 10 Numbers 1-10 Laminated.

BACKGROUND INFORMATION:

Ebola as an emergent pathogen-Ebola virus and associated disease is a rare and deadly disease passed to people and nonhuman primates. It is known to cause an infection with one of five known Ebola viruses. There is one specie that only causes disease in animals.

According to CDC, Ebola virus was discovered in 1976 near the Ebola River in what is the Democratic Republic of Congo. Since then, there has been other outbreaks in several African countries. Scientists do not know exactly where Ebola virus comes from, but they believe the virus came from bats as the likely vector. This virus can be transmitted to other animals, like primates, pigs, and humans.

Ebola virus spreads through direct contact with bodily fluids of a person who contracted the virus and became sick with or died from the Ebola Virus. If a person touches the infected body fluids, and/or fomites, the virus invades a body through the mucous membranes of the eyes, nose, or mouth or through a breach on the skin. The virus can also spread if people touch the blood, body fluids and tissues of infected fruit bats or primates that are infected. People can transmit the virus through sexual contact to other people through semen, vaginal and anal secretions.

There is no evidence of a vector like an insect or mosquito transferring the virus. When a person does not show signs and symptoms of the disease, they cannot transmit the virus. For those people who recover from the viral disease, the virus remain hidden in internal body organs like testis, eyes, and spinal cord. This means that the virus can be found in the semen, breast milk, eyes, and spinal cord fluids of a person who has recovered from the infection.

The virus can live several hours in places like countertops and door knobs. House pets like dogs and cats show they have been infected in outbreak areas, but none have been known to transmit it. Pigs and primates are susceptible, but when pigs were inoculated with an animal strand of the Ebola virus, they have shown to recover, and not pass on the virus.

Symptoms of Ebola Virus Disease include: vomiting, diarrhea, fever, severe headache, muscle pain, weakness, and abdominal pain, and unexplained hemorrhage bleeding and or bruising. These symptoms can appear 2-21 days after contracting the virus, but the average is 8-10 days. This can be confusing to diagnose because it resembles other diseases like malaria or influenza. Ebola is deadly, and recovery depends on good clinical support, and good immune system response on the part of the patient.

Symptoms are treated as they appear. Early intervention is fundamental which include: Providing fluids and electrolytes intravenously, oxygen therapy to maintain oxygen status, using medication to lower blood pressure, reduce vomiting and manage diarrhea, fever and pain, and treating opportunistic infection as they appear.   At the present time there is no antiviral drugs, according to FDA to treat people. The drugs available work by preventing the virus from making copy of itself. Blood transfusions of survivor, and filtering the blood of patients have been considered as potential treatments in the future. There is an experimental vaccine that has been used for the latest outbreak in the Democratic Republic of Congo on May 2018. They used a new experimental vaccine called "Ebola vaccine rVSV-ZEBOV."

Tracking mutations is very important for many reasons. Identifying the virus genetic sequence is very important for testing infected patients. Tracking mutations over time becomes very important so that we can make sure we are testing the write mutation of the virus that caused the outbreak. There are many therapies and treatment being developed to attack the sequence of this virus, so knowing their genome becomes essential to test for effectiveness of those therapies. Keeping track of mutations is also helpful in showing how the virus is moving though out the world. Like Zika virus has been tracked moving throughout the world. Scientist hope to predict with this data how the virus is transmitted and where it is going next.

In this lesson, the Ebola virus is being analyze as a DNA virus to make the comparison task simpler.   In reality it is an RNA virus. Scientist use reverse transcriptase to turn an RNA sequence into DNA before they sequence the virus. The data students will be analyzing will be actually be DNA sequences from Pardis Sabeti's lab who helped in the Sierra Leone outbreak. The sequences were derived from 78 patients' blood samples, and thanks to them the experimental drug ZMapp was developed and help curtail the 2014 outbreak.

Team Based Learning (TBL)-Is a small group leaning method. Students are expected to come to the classroom prepared to spend time in activities that help them learn how to utilize the course objectives and solve real world problems. There are four steps to perform TBL effectively. (1) Teachers must strategically form teams that are diverse and managed. These teams need to work in a long-term basis "to improve learning and promote the development of self-managed learning teams." (2) Students are held accountable for the quality of their individual and group work. This is done through the Readiness Assurance Process (RAP), which consists of five steps.   Students are first assigned preparatory materials as homework including questions that need to be answered (Pre-class Preparation). During the next day, students are ready to take a 10-20 in class multiple choice questions. This part of the RAP process is called Individual Readiness Assurance Test (iRAT). Next, the students take the same test in their teams and write them down in pen. They can allocate points individually based on their confidence individually and as a team. They can write a 4 or distribute their answer across to guess. Later, they use an IF-AT cards that they scratch to obtain immediate feedback. This is called the Team Readiness Assurance Test (tRAT). Teacher will ask if any group would like to appeal a particular question. The appeal must be written and stated and logic argument with cited evidence. Teacher gather's them and considers them after class.   To conclude the RAT, the teacher gives a short mini-lecture to clear up concepts that remain difficult for students. (3) This is the part of the TBL that is structured in a 4s framework so that teams work the same problem, make specific choices, and report at the same time. This is the **Application Activities**. This is when teams apply what they know as they analyze scenarios, extend their knowledge, make decisions and judgement, and commit to a decisions. (4) Students must be accountable in all aspects TBL and must obtain immediate specific feedback. TBL can be repeated in each major instructional unit in about 5-7 cycles per course.

ADVANCE PREPARATION:
1. Students will be randomly assigned to a control/experimental group
2. Pre-Test and Post Test (50 items)
3. Advanced Assignments:
• Copy New York Times Article, "The Virus Detective: Sifting Through Genes in Search of Answers on Ebola."
• Copy Worksheet for the Virus Detectives
4. Copy iRAT and tRAT forms
5. Obtain IF-AT Cards
6. Ebola sequences printed on card stock in color for each group (10 groups)
7. Copy Analysis Instructions-Visualizing the Data
8. Copy Disease Detectives –Introduction to Sequence Analysis
9. Copy Handout-Scientist Visual

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATE:

Before the Lesson Begins:

1. Teacher will teach a lesson to on viruses to have students practice an entire TBL cycle. (Two 45 minutes lessons).
2. Teacher will give the pretest on another day. (45 minutes).
3. Pre-class preparation homework is handed out to all students. Article Title: The Virus Detectives: Sifting Through Genes in Search of Answers on Ebola by the New York Times. Also, Virus Detectives Homework Worksheet.
4. Perform iRAT and tRAT, and Appeals.

During Lesson
5. Show video "**Can DNA Help Us Fight Ebola**? To introduce key scientific concepts related to Ebola. https://vimeo.com/137531240 (3:04 Minutes)
6. Use PowerPoint: **Ebola Virus Genomes: Using Science to Address Disease**. https://drive.google.com/file/d/0B2CjiL3pbbcNdjloTkd0cGtXZGc/view, (Six Slides). This is to give students an overview of 2014 Ebola outbreak. (2 minutes)
   Have groups answer these two questions before they see the PPT:
   What do you know about Ebola?
   When you look at the genome sequences what will you see?
   Review answer from Teams and award points. (5 minutes)
7. Explain to students that they will be analyzing sequences from the Ebola outbreak, which are important for sequencing this virus. Tell them that they will be using a similar procedure for analyzing the data by grouping similar sequences alike scientist did.
8. Teacher will give students the Ebola Sequences to the teams.
9. Teacher will point out that the sequences in the handout are identical to the data shown in the video. The colored squares in sequences 1-15 represent mutations that are compared to a reference sample the first outbreak in Guinea.
10. Teacher will give students Worksheet: **Disease Detectives-Introduction to Sequence Analysis**. (15 minutes).
11. Teacher will review answers provided by all the teams. Teacher will gather all group answers to the worksheet. (5-10 minutes)
12. Teacher will handout **Scientist Visual** Key.
13. Teacher will discuss with Teams: What criteria your team used to group the sequences? How many teams got identical results? Did we have some that were very different? Which were the problem sequences? (10 minutes)

Extension:
14. Teacher will have teams answer the question: If a mutation was adventitious to the virus, because allows it to spread faster, what would you notice happening over time to the sequences of the virus you collected in the population? (5 minutes)
15. Teacher will provide all student with a copy of the extension activity.
16. Teacher will show release students to" work as a team on the interactive "Virus Explorer" https://www.hhmi.org/biointeractive/virus-explorer
17. Students will complete he quick exploration activity. (15 minutes)
18. Teacher will provide the Posttest to both control and experimental group. (45 minutes)

ASSESSMENT SUGGESTIONS:
1. 40 points for Pre-class Preparation homework questions.
2. 100=2 X 50 points. Students will be given a Pre and Posttest to assess knowledge of the Ebola 2014 outbreak and analysis of the DNA sequence.
3. 20=2 X 10 points   Students will also be assessed individually with the iRAT and as team with tRAT.
4. 20 points. The students will also be assessed with the answers to the questions in the activity.
5. 10 points from the two pre-video questions.
6. 5 points Pre-extension question.
7. 5 points. Extension activity.
8. 40 points for peer assessments.

EXTENSIONS:
Students will work as a team on "**Hands-on Activity** from Ebola Disease Detectives. Students should realize that over time all the virus sequences collected in samples from that population will have that mutation.

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Team Based Learning (TBL)

Peer Evaluation Form (PEF)

Name _____

Date:_____ Period:_____

Please write the name of each of your team members in a separate column.

For team member, indicate the extent to which you agree with the statement on the left,

Using a scale of **0-3 (0=strongly disagree; 1=disagree; 2=agree; 3=strongly agree)**.

Total the numbers in each column.

Peer Observations	Group member:	Group member:	Group member:
Attends group meetings regularly and arrives on time.			
Contributes meaningfully to group discussions.			
Completes group assignments on time.			
Prepares work in a quality manner.			
Demonstrates a cooperative and supportive attitude.			
Contributes significantly to the success of the activity/project.			
TOTALS			

Feedback on team dynamics:

1. How effectively did your Team work together?

2. Were the behaviors of any of your team members particularly valuable or not helpful to the team? Explain.

3. What did you learn about working in a team from this project that you will carry into your next team experience?

4. What did you learn about yourself as you interacted with your team members?

Pretest/Posttest

Please make the appropriate decisions and chose the right answers.
Write your answer in the space provided.

_____ 1. What is a zoonotic virus?
   a. It is a virus that can spread to humans
   b. It is a virus that can spread from animals to humans?
   c. It is a virus that can spread from plants to humans?
   d. It is a virus that can spread from humans to reptiles?
   e. None of the Above.

_____ 2.   Calling Ebola a hemorrhagic fever disease means that
   a. Ebola can cause problems with brain and nerve cell.
   b. Ebola can cause problems with the heart and ears.
   c. Ebola can cause problems with liver and Kidneys.
   d. Ebola can cause uncontrollable fever and internal bleeding.
   e. None of the Above

_____3. This disease emerged as an outbreak in 1979 in Kikwit, Zaire,
       Which is now the Democratic Republic of Congo?
   a. Ebola
   b. Malaria
   c. Zika
   d. Chikungunya
   e. None of the above

_____ 4. What are the symptoms associated with Ebola virus disease?
   a. Nausea
   b. Vomiting
   c. Diarrhea
   d. Fever
   e. All the above

_____5.   Which of these can pass on the Ebola virus?
   a. Dandruff
   b. Coughing
   c. Tears
   d. Cellphone
   e. All the Above

_____6. You can catch Ebola virus from sitting near someone on a plane.
   a.   False
   b. This is not known
   c. True
   d. All the Above
   e. None of the Above

_____7. Ebola is contagious only when someone has symptoms.
   a. False
   b. This is not known
   c. True
   d. All the Above
   e. None of the Above

_____8. Scientists think Ebola first came from:
   a. Bats
   b. Gorilla
   c. Mosquitos
   d. Birds
   e. All the Above

_____9. Men who recover from Ebola should do this for 3 months:
   a. Test blood sugar.
   b. Use private toilets
   c. Wear condoms
   d. None of the Above
   e. All the Above

_____10. How many strains of the Ebola virus are there?
   a. One
   b. Two
   c. Three
   d. Five
   e. More than 100

_____11. How long can the Ebola virus live on something outside the body (formite)?
   a. 6 Minutes
   b. 6 Hours
   c. 6 Days
   d. 6 Weeks
   e. None of the Above

_____12. How many proven treatments are there for Ebola?
   a. None
   b. One
   c. Two
   d. Five
   e. None of the Above

_____13. If you've had Ebola, you're less likely to get it again.

a. False
b. This is not known
c. True
d. All the Above
e. None of the Above

_____14. What is the Ebola virus named after?
a. A. City
b. Scientist who discovered it.
c. E-Coli
d. A River
e. None of the above

_____15. Which is the bigger threat?
a. Ebola
b. Flu
c. Yellow Fever
d. SARS
e. None of the Above

_____16. Ebola virus was first discovered in?
a. 1976
b. 1986
c. 2014
d. 2006
e. 1985

_____17. The incubation period of Ebola virus_____to_____days after infection?
a. 1 to 7 days
b. 2 to 21 days
c. 2 to 85 days
d. 3 to 14 days
e. 1 to 14 days

_____18. What is the death rate of Ebola virus once it infects a victim?
a. 85%
b. 90%
c. 0%
d. 15%
e. 65%

_____19. What is the term used by scientist to indicate that a host has been infested by the virus?
a. Extreme amplification
b. Nosocomial transmission
c. Organic liquefaction
d. Internal solidification
e. None of these

_____20. How was Ebola brought to the U.S?
   a.   Illegal immigrants
   b.   Laboratory monkeys
   c.   Mosquitos
   d.   Fruits
   e.   Vegetables