CATALySES Action Research Proposal 2018 (DRAFT 1)

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Title: Developing critical thinking skills in lower level High School Biology students by improving Reading Skills and Strategies through the use of Emerging Pathogens cases.

Abstract: There is a gap in achievement levels, especially on state-standardized tests in Biology students at my current school. This action research will attempt to see if the gap in achievement can be improved if students were able to utilize reading skills and reading strategies in their high school Biology course thereby improving critical thinking skills. These skills are vital to improving student scores. Reading strategies, designed to increase comprehension, will be used before, during, and after reading various relevant course related articles. Emerging pathogens are currently of great importance to everyone. The Ebola outbreak in 2014 Sierra Leone in West Africa had tremendous global impact. This case will be used to assist students in reviewing their content on mutations. This action research project will explore the premise that students working together in teams may actually help in improving scores. Team Based Learning (TBL) strategy will be utilized for this project. The research will be measured using state standard-based comprehension pre and post-tests scores, and iRAT and tRAT scores. Students within each TBL will also complete a peer evaluation instrument rating each member's contribution. Mind Maps will also be useful in gauging student learning as well. Using Emerging Pathogens as a teaching tool to relate real life to the concepts being taught during the course is a great way to get students interested in reading the material and also in global issues affecting us all.

Rationale: Critical thinking is one of the most desirable characteristics of school graduates is that they can think critically This helps them individually and also the societies in which they play a role (Ellerton, 2015). Critical thinking should be a part of all science classes taught in schools, but thanks to standardized testing science is usually taught as a set of facts instead of a process. Peter Ellerton, Lecturer in Critical Thinking, The University of Queensland 2015, stated that 'too often an instructing syllabus focuses on the recall of content, and this in turn forms the basis for assessment. In standardized assessment in particular it is simply cheaper and quicker to algorithmically mark multiple-choice questions than it is to read and assess nuanced responses showing an advanced use of cognitive skills. People often define a rigorous course as one that is heavy in content. This is misleading. Intellectual rigor lies in the sophisticated use of a range of cognitive critical thinking skills such as analysis, justification, synthesis and evaluation. Recalling content or demonstrating algorithmic procedures makes up only a small part of this. The desire to teach to the test at the expense of skills not measured by them is a universal characteristic of standardized testing. The danger is that if critical thinking is not explicitly assessed, it will not be valued and therefore not taught. Like language, critical thinking is not something you can learn alone. The best way to produce a critical thinking student is from within a critical thinking community."

How well an individual comprehends and learns from reading expository texts depends on relationships between individual differences such as prior knowledge, reading skill and the text itself (high or low cohesion). The study indicated that the difficulty in learning new concepts could be much more attainable by the students if the new text is more cohesive (a little longer with repetition), however this is only if they had sufficient reading skill (Ozuru, Dempsey & McNamara 2008). It was found that there was no significant difference between the

achievement between lower knowledge students, and higher knowledge students once they excelled in reading skills. It was shown that reading skills helped those students who lacked in background knowledge (O'Reilly & McNamara 2007).

Not all students come to the table with prior knowledge and many do not have the reading skills. Many studies agree that background knowledge is essential to how well a student is able to, not only comprehend, but be able to apply the new information. "Failure to employ effective strategies causes the student to process the information "mindlessly" and settle for superficial understanding" (O'Reilly & McNamara 2007). "In recent studies, low knowledge students reading skill improved students achievement, and a high level of reading strategy knowledge did improve achievement" as well (O'Reilly and McNamara 2007). In conclusion, not only do we need to improve text quality, and reading skills but we need to take the time to provide training on reading strategies (Ozuru, Dempsey & McNamara 2008).

Harrington (2014) states that before developing high level critical skills, three foundational conditions are needed. In essence, these are pre-requisite skills for engaging in high level cognitive tasks. These conditions are: a content knowledge base (built by emphasizing key points, frequent quizzes and reading assignments so students interact with content on a regular basis), high self-efficacy (built through successful experiences and effective feedback) and desire and drive (built by explaining the importance for assignments, offering choices and assigning tasks that have real world value and meaning). Once the foundational conditions are met, students need to experience learning conditions that will promote critical thinking skills. This can be done by assigning challenging learning tasks and offering effective support.

Reciprocal teaching is a widely used method of instructing and guiding learners in reading comprehension (Okkinga, Steensel, van Gelderen, Sleegers, 2018). It consists of a set of three related instructional principles: a) teaching comprehension-fostering reading strategies, including predicting, question-generating, summarizing and clarifying; b) expert modelling, scaffolding and fading; and c) student practicing and discussing reading strategies with other students, guided and coached by the teacher. The article further states that reciprocal teaching assumes a gradual shift of responsibility for the learning process from teacher to student, which includes the teacher explicitly modelling the use of reading strategies as well as scaffolding the application of reading strategies within the groups of students working together. It is, also assumed that by gradually fading teacher's support, students become increasingly more capable of regulating their own reading process. In theory, this seem to work. However, based on the findings of this study, this method will only work if teachers are trained extensively and practice rigorously where the method becomes routine, and where teachers are also provided with the tools to be able to guide students in their collaborative learning process (Okkinga, Steensel, van Gelderen, Sleegers, 2018). This method will help in attempting to incorporate some reading strategies in my lessons.

Other reading strategies could also include K-W-L (what I know; what I want to know; what did I learn), KLEW (what I think I know, what I am learning, evidence to support what I am learning, what I wonder about based on the new information I have learned) and THC (What do you think? How can we find out? And What do we conclude?) (McCloud, 2007). These strategies are evident in science classrooms as more teachers discover that teaching reading in the content areas and utilization of comprehension strategies helps students learn and retain subject-area material. The use of comprehension strategies to aid struggling readers in the science classroom will enhance their comprehension of science reading material also improve reading achievement (Johnson and Martin-Hansen, 2005). Johnson and Martin-Hansen (2005) also suggests front-load meaning when preparing students to read expository texts. This prepares students for reading and helps comprehension, as they have some prior knowledge of the subject matter. Prediction and vocabulary work are important for students to do before they begin reading. During reading, activities designed to have students reflect are effective (e.g. Students keep a response log). This will allow the teacher to identify comprehension problems as soon as they occur. After reading, science teachers can provide students with opportunities to further process their reading, which in turn can deepen student comprehension. One way would be having students recreate the material in a different form.

This action research will attempt to incorporate many of these reading comprehension skills and strategies to help improve my students' achievement in high school Biology tests, most specifically in the comprehension of emerging pathogens. A list of strategies will be employed that have been created to deepen student comprehension by providing prior knowledge exercises, and skills to deepen knowledge during and after reading. By the end of this action research, I hope to create students who possess the skills to make them good critical thinkers.

Intervention: The overall objective of this action research is to implement the following reading strategies throughout the school year, including during the action proposal time. By using these strategies from the beginning of the school year, it will allow time for better execution and for students to have a better understanding of what is required to properly execute these reading skills and strategies. If the reading strategies were implemented only during the action proposal time frame, the students would not be gaining from the reading because they would still be learning the strategies.

I have been teaching at Jones High School which is located in Orange County School District, Orlando Florida for one year. This was the first public school for African Americans in Orlando and was formed in 1895 and housed in a building on the corner of Garland Avenue and Church Street. The school was renamed Johnson Academy and moved to a new building on the corner of Parramore Avenue and Jefferson Street. In 1921, a brick Colonial Revival building was constructed on the corner of Parramore Avenue and Washington Street at a cost of $34,000. The school was renamed for the final time in honor of L. C. Jones, a longtime school principal and donor of the property.

In 1952, the school moved west of downtown to its current location on Rio Grande Avenue. A new campus consisting of a two-story academic building, separate buildings for science,

technology, and music, an administrative building, cafeteria, gymnasium, media center, and dedicated historical museum was constructed during the period 2001–2004. During construction, students attended classes in portables across the street from the campus. The new campus was opened for the start of the 2004–2005 school year. Retrieved 6/23/18 https://en.wikipedia.org/wiki/Jones_High_School_(Orlando,_Florida)

Jones High School is presently a Tier 1 school. The school population presently consists of 89.7% Black, 9% Hispanic, 0.6% White, 0.1% Asian, 5.6% ELL, 12.3% ESE and 0.8% multiple as stated on the OCPS website's school report card for the 2017/18 school year. This school is currently rated below average in school quality compared to other schools in the state. Many students are performing below average on state tests, have below average college readiness measures, and the school has below average results in how well it seems to be serving disadvantaged students. https://www.greatschools.org/florida/orlando/2096-Jones-High-School/ Many of the students that I have encountered in my observations this past year seem to be below grade level and lack proper reading/critical thinking skills. Additionally, there is a problem of frequent absenteeism and a tendency to generally not do homework. I hope to attempt to develop in my new students for this coming academic year proper critical thinking and reading skills. I am also hoping that by working in teams, they will gain confidence individually as the help each other to practice these skills. As each student's confidence grow I hope students will attend classes more regularly and be actually prepared. These skills will be beneficial to each student in all their other courses as well.

INTERVENTION STRATEGIES

Team Based Learning (TBL)

Team-Based Learning ("TBL") is an educational technique developed in the 1970s by Larry Michaelsen that dramatically shifts the focus of classroom time from conveying course concepts by the instructor to application of course concepts by student teams. In the TBL process, students acquire their initial exposure to the content through readings and are held accountable for their preparation using a Readiness Assurance Process ("RAP"). Before any in class content work, students must study assigned materials because each unit begins with the RAP. The RAP consists of a short test (over the key ideas from the readings) which students first complete as individuals (these answer cards are collected immediately after the activity), then the team takes the exact same test again coming to consensus as a team. Students will receive immediate feedback on the team test and will have the opportunity to write evidence-based appeals if they feel they can make valid arguments for their answers to questions which they got wrong. Following the RAP, class time is used to practice applying content in a series of team application exercises (Michaelsen, Sweet and Parmalee, 2009). The components of TBL are adaptable to many situations, and special resources, including the Immediate Feedback Assessment Technique (IF-AT) developed by Epstein Educational Enterprise Inc., are great tools for advancing the goals of TBL. A great advantage of using IF-AT forms in group learning is that it quickly becomes apparent to participants that "loud and forceful" is not always "right"; each member is empowered by knowledge rather than personality.

Mind mapping

Mind maps are 2D visual diagrams used for showing relationships between things, ideas, etc. It is a graphical way to represent ideas and concepts. It is a visual thinking tool that helps structuring information, helping you to better analyze, comprehend, synthesize, recall and generate new ideas. Just as in every great idea, its power lies in its simplicity. In a mind map, as opposed to traditional note taking or a linear text, information is structured in a way that resembles much more closely how your brain actually works. Since it is an activity that is both analytical and artistic, it engages your brain in a much, much richer way, helping in all its cognitive functions. Mind mapping avoids dull, linear thinking, jogging your creativity and making note taking fun again (What is mind Mapping? (and How to Get Started Immediately Litemind) https://litemind.com/what-is-mind-mapping/ Retrieved 6/24/2018). These maps can be done on paper, using PowerPoint or using graphing software such as yWorks.

Mind maps can be used for:

- Note taking
- Brainstorming (individually or in groups)
- Problem solving
- Studying and memorization
- Planning
- Researching and consolidating information from multiple sources
- Presenting information
- Gaining insight on complex subjects
- Jogging your creativity

How is it done?

- **Start** in the middle of a blank page, writing or drawing the idea you intend to develop. I would suggest that you use the page in landscape orientation.
- **Develop** the related subtopics around this central topic, connecting each of them to the center with a line.
- **Repeat** the same process for the subtopics, generating lower-level subtopics as you see fit, connecting each of those to the corresponding subtopic.

Previously this Unit was taught using a variety of strategies that incorporated technology (A one-one school – i.e. each student had their own laptop) and course content were uploaded to the LMS (CANVAS). It involved students reading and doing a lot of the activities on the computer with guidance on their own 'student-centered'. Students were in cooperative groups for some activities. These groups were not functioning as a unit, many students were frequently absent from classes and many also did not do homework. I am hoping that by using the TBL strategy students will take more interest in the classes and be motivated to do well.

The DNA Replication and Protein Synthesis Unit (9/27/18- 10/12/18) will be used for the action research proposal. Throughout the Unit, students will engage in reading skills and strategies

(Table 1), and interactive lessons with the expectations that the reading strategies will enhance their comprehension of the unit (Table 2). One week before the start of the Unit, students will be given a study guide with cloze passages included and other activities. This will be done to build their prior knowledge before coming to classes. In classes activities will be carried out in teams. Once reading and comprehension skills are improved, students will become confident in their ability to read and understand. They will not have a negative attitude towards reading in science thereby increasing their critical thinking skills and achievement levels.

TABLE 1: Table showing a list of strategies that will be employed during the action research.

STRATEGIES	DESCRIPTION
Team based learning (TBL)	Gives students an opportunity to practice using course concepts to solve problems (application of knowledge). This allows for a better understanding of content.
Cloze Reading	Increase prior knowledge helps increase comprehension.
K-W-L, KLEW, T-H-C	
Kagan reading strategies	
Kagan thinking strategies	
Mind mapping	Helps students create connections. It is a graphical way to represent ideas and concepts. It is a visual thinking tool that helps structuring information, helping you to better analyze, comprehend, synthesize, recall and generate new ideas.

TABLE 2: Table showing a general timeline for completing the Unit including the lesson that will be used for the action research.

***Connections to CATALySIS 2018 is highlighted in red.

DISTRICT PACING GUIDE TIMELINE	OBJECTIVES	ACTIVITY
BEGINNING OF SCHOOL YEAR	• Establish TBL teams	
THROUGHOUT SCHOOL YEAR	• Practice reading strategies and skills • Practice Mind mapping • Work in established TBL Teams	

DAY 1 of Unit **9/27/18**	**SC.912.L.16.3** • describe the structure of a DNA molecule • model the structure of a DNA molecule	• Pre-test • Unit Mind Map #1 • Reading assignment / EdPuzzle HW
DAY 2 **9/28/18**	**SC.912.L.16.3** • describe the structure of a DNA molecule • model the structure of a DNA molecule	Cloze read activity
DAY 3 **10/01/18**	**SC.912.L.16.3 & SC.912.L.16.4** • describe the structure of a DNA molecule • list and explain the steps involved in DNA replication • describe the impact of a mutation during DNA replication • describe DNA mutations	
DAY 4 **10/02/18**	**SC.912.L.16.5** • describe the process of transcription • describe the process of translation • compare and contrast the structures of RNA and DNA	
DAY 5 **10/03/18**	**SC.912.L.16.5 & SC.912.L.16.9** • model the processes of transcription and translation • explain the role of mRNA and tRNA in the transmission of genetic information	
DAY 5 contd. **10/04/18**	**SC.912.L.16.5 & SC.912.L.16.9** • model the processes of transcription and translation • explain the role of mRNA and tRNA in the transmission of genetic information	
DAY 6 **10/05/18**	**SC.912.L.16.5 & SC.912.L.16.9** • model the processes of transcription and translation • explain the role of mRNA and tRNA in the transmission of genetic information	
DAY 7 **10/08/18**	**SC.912.L.16.5 & SC.912.L.16.9** • explain the significance of base pairing	Home Work (Preparation for TBL

	in replication, transmission and translation • explain the importance of protein synthesis in the passage of genetic traits • describe the relationship between DNA base pairs, RNA, and proteins • determine commonalities between organisms based on their percentage of similar DNA sequences	activity): • Ebola Disease detectives background reading. • Watch "What is a virus? How do viruses work?" video • Watch "Think like a scientist: Natural Selection in an outbreak." video
DAY 8 Action Research day lesson 10/09/18	**SC.912.L.16.3, SC.912.L.16.4, SC.912.L.16.5 & SC.912.L.16.9** • describe the structure of a DNA molecule • list and explain the steps involved in DNA replication • describe the impact of a mutation during DNA replication • describe DNA mutations • explain the significance of base pairing in replication, transmission and translation 1. explain the importance of protein synthesis in the passage of genetic traits 2. describe the relationship between DNA base pairs, RNA, and proteins 3. compare and contrast different organisms based on commonalities in their DNA sequence	• iRAT quiz • tRAT quiz • Ebola disease detectives team activity • Clarification of any concept that remain problematic. • Peer evaluation of TBL group members • Home Work (review activity)– Complete the 'Catch the Killer' transcription and translation practice activity individually.
DAY 9 10/10/18	**SC.912.L.16.3, SC.912.L.16.4, SC.912.L.16.5 & SC.912.L.16.9** • explain the significance of base pairing in replication, transmission and translation • explain the importance of protein synthesis in the passage of genetic traits • describe the relationship between DNA base pairs, RNA, and proteins	• Unit Mind Map # 2 • Unit Review

	• compare and contrast different organisms based on commonalities in their DNA sequence	
DAY 9 contd. 10/11/18	**SC.912.L.16.3, SC.912.L.16.4, SC.912.L.16.5 & SC.912.L.16.9** • explain the significance of base pairing in replication, transmission and translation • explain the importance of protein synthesis in the passage of genetic traits • describe the relationship between DNA base pairs, RNA, and proteins • compare and contrast different organisms based on commonalities in their DNA sequence	• Unit Mind Map # 2 • Unit Review
DAY 10 10/12/18	**SC.912.L.16.3, SC.912.L.16.4, SC.912.L.16.5 & SC.912.L.16.9** • explain the significance of base pairing in replication, transmission and translation • explain the importance of protein synthesis in the passage of genetic traits • describe the relationship between DNA base pairs, RNA, and proteins • compare and contrast different organisms based on commonalities in their DNA sequence	• post-test

Data collection and analysis:

Data will be collected via the use of quantitative analysis. A multiple-choice assessment for the Unit will be created on UNIFY (the District's testing platform) using 15 state standard based questions. This assessment will be given as the pre-test (at the beginning of the Unit) and post-test (at the end of the Unit). The results will be analyzed to determine student learning gains. As students work in their teams, the iRAT score and tRAT scores for each individual and team will be collected and analyzed. Lastly, Mind maps will be used to gauge and see how much students know by the end of the topic. There will be a comparison between the Mind Map done at the start of the unit and the one done at the end by students. During the Action Research lesson, students will also do peer evaluation of their TBL team members. This data will be pooled and analyzed.

Connections to CATALySES Summer Institute:

The following listed identifies the activities from the CATALySES Summer Institute 2018:

- Mind mapping (done at the beginning and end of Unit)
- Team based Learning (TBL) (done throughout the school year)
- Lesson Plan – Ebola disease detectives

Literature cited:

Ellerton, P (2015): *Working together for critical thinking in schools*. Retrieved 6/23/18 from (http://theconversation.com/working-together-for-critical-thinking-in-schools-41976)

Harrington, C. (2014): *The Process of Becoming a Critical Thinker*. Retrieved 6/23/18 from https://blog.cengage.com/process-becoming-critical-thinker/

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Luciano Passuello. Litemind: *Exploring ways to use our minds efficiently*. Retrieved 6/24/18 from https://litemind.com/what-is-mind-mapping/

McCloud, C. (2007): *Reading Strategies Enhance Comprehension in the Science Classroom*. Comments from CRISS, Winter 2007. Retrieved 6/23/18 from http://esubrin.weebly.com/uploads/3/1/3/1/31311497/kwl_strategies_in_science-1.pdf

Michaelsen, L., Sweet, M. & Parmalee, D. (2009): *Team based learning: Small Group Learning's next big step. New direction in Teaching and Learning, 7-27*. Jossey-Bass

Ozuru, Y., Dempsey, K., & McNamara D.S. (2008) *Prior knowledge, reading skill, and text cohesion in the comprehension of science texts*. University of Memphis, Psychology Building

Tenaha O'Reilly and Danielle S. McNamara. (2007) *The Impact of Science Knowledge, Reading Skill, and Reading Strategy Knowledge on More Traditional "High-Stakes" Measures of High School Students' Science Achievement*. American Educational Research Journal Vol 44, Issue 1, pp. 161-196

Permissions: No permissions are required for the quanitative survey of the students as the content and delivery will not be changed. The only difference will be that students will be working through the activities in teams.

LESSON PLAN

TITLE: Ebola disease detectives.

KEY QUESTION(S):

1. What is mutation?
2. Does the Ebola outbreak in Sierra Leone confirm the hypothesis that mutations could accumulate over time?
3. Were the mutations that occurred beneficial to the virus?

SCIENCE SUBJECT: Biology

GRADE AND ABILITY LEVEL: Grade 11 regular

SCIENCE CONCEPTS:

- As viruses reproduce using living cells, they accumulate mutations in their genomes.
- Since mutations accumulate over time, analyzing virus sequences from infected individuals can help researchers track, understand, and treat diseases.

OVERALL TIME ESTIMATE: 48 minutes (one class period).

LEARNING STYLES: Visual, auditory, and or kinesthetic.

VOCABULARY: Ebola, mutation, outbreak, virus, sequencing, reverse transcription, genome, transmission, zoonotic virus, disease.

LESSON SUMMARY:

This lesson will be a review of mutations. Students are expected to be able to (Standards: **SC.912.L.16.3 & SC.912.L.16.4):**

- describe the structure of a DNA molecule
- list and explain the steps involved in DNA replication
- describe the impact of a mutation during DNA replication
- describe DNA mutations

The lesson will have students learning a little about viruses and how they replicate using living cells. Viruses are of great importance globally. Some cause disease. Students will look at a case study of the Ebola outbreak in Sierra Leone in 2014 and look at the changes in the sequences that occurred in the Ebola virus when compared to the reference sequence obtained from a patient's sample in Guinea which had an Ebola outbreak prior to the outbreak in Sierra Leone. As viruses reproduce using living cells, they accumulate mutations in their genomes. Students will also learn a little background information about Ebola.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

The student will be able to...
(STANDARD: SC.912.L.16.4)

1. Define the term 'mutation'.
2. analyze sequenced data.
3. interpret sequence data.
4. develop visuals to summarize and convey their findings.
5. Compare group data to field data.
6. Work cooperatively as a team.
7. Transcribe and translate given DNA clues to "catch the killer"

MATERIALS:

***TO DO: Sort materials and indicate number required for different types of grouping formats (Per class, Per group of 3-4 students, Per pair, Per student). Be as specific as possible. No need to list basic instructional items like paper, pencil, chalkboard, or overhead projector.

ESSENTIAL:
SUPPLEMENTAL:

BACKGROUND INFORMATION:

KEY VOCABULARY: ***TO DO
Ebola:
Mutation:
Outbreak:
Virus:
Sequencing:
Genome:
Reverse transcription:
Transmission:
Zoonotic virus:
Disease:

In this lesson, students will analyze Ebola sequences that were obtained from patients in Sierra Leone during the 2014 outbreak in West Africa and compare to the reference sequence obtained from a patient's sample in collected in Guinea which had an Ebola outbreak prior to the outbreak in Sierra Leone . Students are challenged to place sequences into groups based on similarities to determine the transmission history of the virus. Students then compare their results to those of scientists at the Broad Institute of MIT and Harvard, who followed a similar procedure at the beginning of the outbreak.

The Ebola virus is a zoonotic virus, which means that it can spread from animals to humans. Once a person is infected, the virus affects multiple organ systems in the body. Infected cells can attach themselves to blood vessels, causing uncontrollable internal bleeding in some patients, accompanied by high fever—a condition known as hemorrhagic fever. Other common symptoms include liver and kidney failure, vomiting, and diarrhea. On average, 50% of people that contract Ebola die from the disease, though fatality rates of past outbreaks have varied from 25% to 90%.

The first documented outbreak occurred in 1976 in the Democratic Republic of the Congo, in Central Africa, and infected about 300 people. Since then there have been several other outbreaks in Central Africa, but the largest on record began in Guinea, a country in West Africa, in December 2013. The virus spread to the neighboring countries of Sierra Leone and Liberia. By April 2016, over 28,000 cases, and more than 11,000 deaths, were reported in West Africa. The 2013–2016 outbreak was unprecedented in size and duration.

This drastic increase in cases could be attributed to several possible factors. As this was the first known Ebola outbreak in West Africa, regional differences could be one factor. Central Africa is predominantly forested with limited access to roads, while West Africa has several large cities and better transportation infrastructure, making it easier for infected patients to travel between communities and across borders, spreading the disease.

During the 2013–2016 outbreak, the Kenema Government Hospital in Sierra Leone collaborated with scientists in Pardis Sabeti's lab at the Broad Institute to use genetic analysis to screen suspected patients and accurately diagnose infection. They also wanted to determine how the virus was changing over time.

The Ebola virus has a genome made of RNA, made up of a sequence of letters (G, C, A, and U). Over time, as the virus replicates, random changes to the sequence of letters occur, referred to as mutations. During infection, the virus replicates many times, creating many possible mutations. Many of these mutations will be detrimental to the virus and even result in defective viruses, others will be neutral, and a small number of mutations may confer some type of advantage. If the infected patient passes the virus on to a second person, the second person may inherit the mutated virus, which will, over the duration of the infection, accumulate additional mutations. In this way, viruses transmitted from one person to another are related to one another and may accumulate differences over time.

Before conducting this activity, students need to watch the 8-minute video Think Like a Scientist: Natural Selection in an Outbreak (https://www.youtube.com/watch?v=Tq2GhPZvdkU) featuring computational geneticist Pardis Sabeti and epidemiologist Lina Moses, watch the 4 minute 30 second video 'What is a virus? How do viruses work?' https://www.youtube.com/watch?v=7KXHwhTghWI and complete the background reading: Introduction to Ebola which should be assigned for home work 1-2 days before the execution of the lesson.

Discuss with students how mutations occur and how some mutations spread by natural selection. Make sure that students understand that the mutations they are looking at in this activity are single-nucleotide changes in the virus genome. Some changes will have no effect on the virus, while others could affect the structure or function of particular proteins in the virus, but these are subtle changes, unlikely to affect the overall structure of the virus.

Make sure students understand that Ebola is an RNA virus. Scientists studying Ebola and other RNA viruses use reverse transcription to copy the RNA to DNA prior to sequencing, so the data that students analyze is DNA, but the actual genetic material inside the virus particles is RNA.

ADVANCE PREPARATION:

- Assign background reading activity and videos for homework previously (1-2 days before lesson)
- Print 6 question quiz to be used for iRAT and tRAT.
- Print iRAT quiz sheets for each student in each team.
- Obtain IF AT cards (order online if none available)

- Assign Quiz # (noted on the perforated edge of the IF AT Score card) to the six-question quiz for tRAT quiz. Remove perforated edge from IF AT cards.
- Print Ebola disease detectives team activity for each group.
- Print sequence sheet in color and laminate (one copy for each group). Cut out sequences.
- Print Home Work activity – Catch the killer transcription and translation practice activity for each student.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES

This lesson is taken from the **BioInteractive** website (https://www.hhmi.org/biointeractive/ebola-disease-detectives:

- Educator materials (with answer sheet)
- Sequence sheet
- Student worksheet
- Introduction to Ebola (background information sheet)

STEP 1: Students will complete iRAT quiz. Score sheets collected at end. (8 minutes)

STEP 2: Teams will discuss and agree on answers for tRAT. Scores will be tallied. tRAT score sheets will be collected. (10 minutes)

STEP 3: Students will complete Part 1 of team activity (Ebola detective worksheet). (10 Minutes)

STEP 4: Once team has completed Part 1, the team will be given Part 2 to complete. (10 Minutes)

STEP 5: Clarification of any concept that remain problematic. (5 minutes)
STEP 6: Peer evaluation of TBL group members. Turned in at end of class. (5 minutes)
STEP 7: Assign Home Work – Students will complete the Catch the Killer transcription and translation practice activity individually.

READINESS ASSURANCE TEST
(6 questions related to background reading and videos)

iRAT Answer Sheet:

IRAT ANSWER SHEET NAME:_____ TEAM #:_____					
Q #	**A**	**B**	**C**	**D**	**PTS.**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
				TOTAL POINTS	

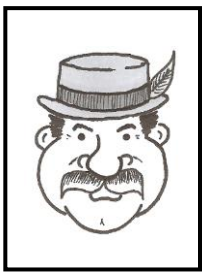
Catch the Killer

(Adapted from OCPS lesson plan)

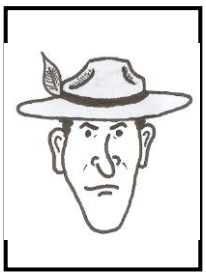
Dr. Tench was recently attacked by a crazed killer, and luckily he was able to escape. He has gone into hiding out of fear that he will be attacked again, but he has sent several clues about the identity of his attacker. Because Dr. Tench is a geneticist, he has sent his clues in the form of a special code: the genetic code. Your job is to **transcribe** and **translate** these messages to determine the correct amino acid sequence. After each sequence is translated, write the **single letter abbreviation** for each amino acid to discover the clue. Use the clues to determine which suspect and weapon were used in the attack.

Alanine	Ala	A
Cysteine	Cys	C
Aspartic Acid	Asp	D
Glutamic Acid	Glu	E
Phenylalanine	Phe	F
Glycine	Gly	G
Histidine	His	H
Isoleucine	Ile	I
Lysine	Lys	K
Leucine	Leu	L
Methionine	Met	M
Asparagine	Asn	N
Proline	Pro	P
Glutamine	Gln	Q
Arginine	Arg	R
Serine	Ser	S
Threonine	Thr	T
Valine	Val	V
Tryptophan	Trp	W
Tyrosine	Tyr	Y

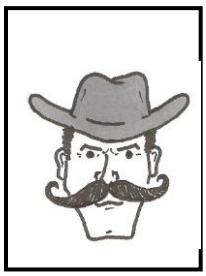
The Suspects:



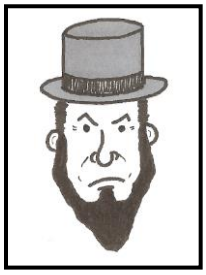
Judge



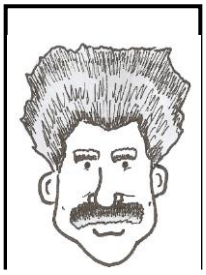
Deputy



Oil Tycoon

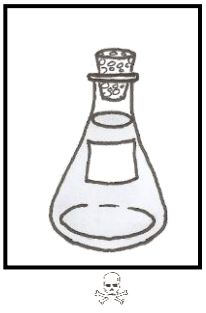


Lawyer

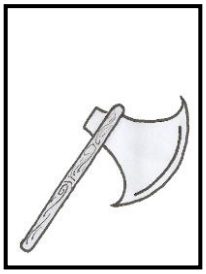


Professor

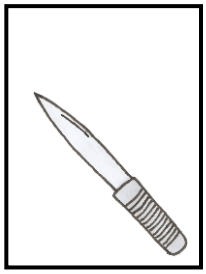
The Weapons:



Poison



Hatchet



Knife

Example DNA message: **TTCTAGGAGGACCTCGCC**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

DNA message #1: **GTACGATGTATTACTATCATT**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

DNA message #2: **GAGCGCACCATCACTATCATT**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

DNA message #3: **AAGCGAACATATCGTGACGTGCGGTAAGCC**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

DNA message #4: **AAACTTCGCTGGGTGCTCTCCAACCTTTCATCG**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

DNA message #5: **AGTGTGCGGGCCGGGACTATTACT**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

DNA message #6: **GTACGATGAACAGTGCTTTGC**

Transcription to mRNA:

Translation of codons to Amino Acids:

What is the Clue?

1. Based on the clues, who do you think tried to kill Dr. Tench?

2. What weapon do you think this suspect used?

3. Why is DNA evidence so reliable in determining identity?

4. How can organisms be so unique if the nucleotides making up DNA are all the same between organisms?

5. How would a mistake in transcribing the DNA message affect your ability to catch the killer?

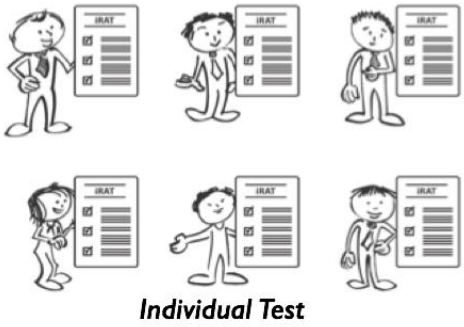
1. STRATEGY TO BE USED – TEAM BASED LEARNING
ARTICLE: The Least You Need to Know About Team-Based Learning – Jim Sibley
http://learntbl.ca/book/other-materials/

TBL is a uniquely powerful form of small group learning. Students come to class prepared and then spend the bulk of class time engaged in activities that help them learn how to use course content to solve problems. TBL has been implemented in every discipline and has been used effectively in classes as large as 350.

Four steps for doing TBL right:

1. Strategically form teams

Instructors use criterion to create diverse teams. Maybe each team needs someone with a previous degree, or work experience, or someone good at stats. The idea is to spread the assets you think all teams will need to be successful. TBL needs large teams (5-7 students), in comparison to other forms of cooperative and collaborative learning. The teams need to be long-term, so team cohesion can build.



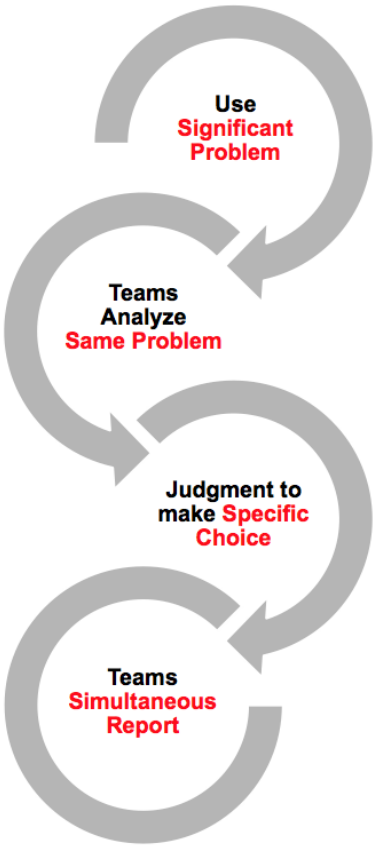
2. Get students to come prepared

The **Readiness Assurance Process** **(RAP)** is used to motivate students to come to class prepared and then turns that preparation into true readiness to begin problem solving.

1. **Assigned Preparation:** Students review preparatory materials before class.
2. **Individual Test:** Students complete a 10-20 in-class multiple-choice question test known as the *Individual Readiness Assurance Test* (iRAT).
3. **Team Test:** Students retake the same test in their teams using IF-AT cards (scratch cards). This is known as the *Team Readiness Assurance Test* (tRAT).
4. **Written Team Appeal**: Following the tRAT the teams can appeal any question they got wrong by completing an Appeals form. The appeal must have (a) a clear statement of argument, and (b) evidence cited from the preparation materials. The instructor collects the completed forms and considers them after class.
5. **Short Mini-lecture:** To conclude the Readiness Assurance Process, the instructor delivers a short facilitated discussion or mini-lecture to clarify only on the concepts that remain problematic for the students.

3. Help students learn how apply course concepts

The **4S framework** is used to structure TBL classroom activities. The 4S's stand for **S**ignificant Problems, **S**ame Problem, **S**pecific Choice, and **S**imultaneous Report. The bulk of class time is spent having student teams solve, report, and discuss solutions to significant problems. The quality of the problem ultimately controls the effectiveness, energy, and learning outcomes of the activity.



The structure of TBL activities gives individuals and their team opportunity to analyze scenarios, make judgments/decisions, and publicly commit to a decision. This public report of a team's decision creates an intense reporting conversation where students get specific and timely feedback on the quality of their thinking and their process for arriving at their decision.

Example 4S Ideas
Historian reconciles conflicting sources.
Doctor decides the best course of action.
Businessperson picks the best location for a business.
Writer identifies the most powerful passage or best example.

4. Hold students accountable and provide frequent feedback

Students must be accountable. There is individual accountability from the iRAT, but what is most motivating is the accountability to teammates during the tRAT's and Application Activities. The combination of peer pressure to be prepared and contribute and peer evaluation with "enough teeth" to motivate students.

Students must get immediate and specific feedback to guide their learning. When you use the 4S problem-solving framework to build activities that require students to make complex decisions and publicly report them, it leads to intense give and take reporting conversations – "Why did you choose that?" "What was the most important piece of evidence?" "What led you to that conclusion?" It is these conversations that give students and teams rich, immediate, and specific feedback on the quality of their thinking/decision-making.

ASSESSMENT SUGGESTIONS:

OBJECTIVES:	ASSESSED BY:
1. Define the term 'mutation':	Worksheet answer.
2. analyze sequenced data:	Results of initial grouping of sequences
3. interpret sequence data:	Results of initial grouping of sequences
4. develop visuals to summarize and convey their findings:	Visual created on worksheet
5. Compare group data to field data:	Answers to worksheet questions
6. Work cooperatively as a team:	tRAT scores; Peer evaluation forms completed.
7. Transcribe and translate given DNA clues to "catch the killer":	Completed Homework assignment.

Peer evaluation of group members form DATE:_____

Your name: _____ GROUP #: _____

Please write your numeric choices for each of the 10 items. Then please add some narrative regarding your evaluation at the bottom of the form.

Use the following scale for all items:

1 = poor; 2 = below average; 3 = average; 4 = above average; 5 = excellent

	TEAM MEMBERS NAMES						
Prepared for group quiz discussions							
Contributions were helpful, relevant, and clear							
Helped to keep discussion organized and task focused							
Helped to constructively evaluate information and ideas							
Participated adequately							
Showed respect toward others and helped maintain a positive climate							
Encouraged others to participate							
Listened to understand and follow discussion							
Demonstrated open-							

mindedness							
Was cooperative and constructive, didn't dominate or withdraw							
Total Points							
Grade you would assign this person							

Comments:_____

_____

_____

_____

_____

_____

EXTENSIONS:

ACTIVITIES: Are there other activities you know of from other resources that relate to this lesson?

LITERATURE: Are there trade books, novels, journal articles, or other print materials that focus on the same topic(s) as this lesson?

RESOURCES/REFERENCES:

Sibley, J. *The Least You Need to Know About Team-Based Learning* . Retrieved 6/25/18 from http://learntbl.ca/book/other-materials/

BioInteractive website: *Ebola Disease Detectives activity*. https://www.hhmi.org/biointeractive/ebola-disease-detectives