Using Team Based Learning to Teach Human Immune Function and its Impacts on Public Health

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Abstract:

This action proposal will incorporate case study teaching and team based learning in order to enhance student understanding of the human immune system. I will employ these two complementary teaching methods in all of my classes including Biology and Anatomy & Physiology. In order to prepare my team based learning lesson plan, I will read *Getting Started with Team Based Learning (Sibley and Ostafichuk).* The case study teaching component of my action proposal is part of my lesson plans from previous years. The novelty in this action proposal will be in the incorporation of case study teaching into a team based learning formatted lesson plan. Data collection and evaluation for this action proposal will be determined at a later date.

Rationale:

I selected the human immune system as the action proposal focus for several reasons 1) it is a tested standard on the biology EOC 2) the relevance of the human immune system to community and world health 3) the opportunity to incorporate math as a co-curricular component 4) the opportunity to empower students to gather critical information from multiple perspectives in order to make informed decisions for themselves (AKA successful adulting). The complicated nature of the science content paired with the important, real world implications make this unit one of the most important to students and society. Most of the time students do not relate classroom lessons as being relevant to their extracurricular lives and the world around them. Opportunities for students to think critically about how the choices they make are going to affect themselves and their community will promote this connection between classroom content and life.

Intervention:

In the past I have presented information on the immune system in several slides. As a follow-up to this lesson I have used case study teaching from the National Case Study Teaching Association (*Vaccines, Social Media and the Public Health)* which involves several critical thinking questions as independent work followed by class discussion. In the past I have finished this lesson with a philosophical chairs exercise. The revisions I plan to institute as a part of this action proposal include using team based learning (TBL). Team based learning will encompass all notes and prep materials, iRAT & tRAT assessments and an application component. The prep materials will be adapted to include an exercise in basic math model of herd immunity vs no herd immunity in a community. The application component will include portions of the original case study (*Vaccines, Social Media and the Public Health*). Case studies are commonly used in TBL lessons in the application portion, however, I have not yet read about why/how. More to come on that in future revisions of this action proposal.

Data collection and analysis:

I plan to implement a student survey aimed at determining individual self reported confidence in individual understanding of the standards and learning objectives outlined at the beginning of the unit. I will compare formative assessment performance to determine student growth. I major flaw in this action proposal is a control. In order to include a control, I will have to double my work on this action proposal, which I would be happy to do but just don't have enough time to include in my first draft.

Connections to CATALySES summer institute:

The decision to implement Team Based Learning is a direct result of Dr. McCormack's presentation to our cohort. The herd immunity model activity is inspired from and based on the plant pathogen modeling exercise that was a part of our day at IFAS. Vaccinations and the immune system content will be heavily influenced by several presentations made by faculty during the program.

Literature cited:

Getting Started with Team Based Learning (Sibley and Ostafichuk)
National Center for Case Study Teaching in Science
More to come!

Permissions:

This proposal will be submitted for approval to the principal of Royal Palm Beach High School, Dr. Jesus Armas. Parent permissions are not needed because student data is being reported anonymously (I will double check on this with our district science fair coordinator).

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KEY QUESTION(S): How do vaccines affect the human population?

SCIENCE SUBJECT: Biology, Anatomy & Physiology

GRADE AND ABILITY LEVEL: 9-12 honors

SCIENCE CONCEPTS: Human Immune System Functioning, Infectious Diseases, Vaccines, Herd Immunity, Vectors & Public Health

OVERALL TIME ESTIMATE: 2-3 days (block schedule)

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY:
Specific Immune Response
Acquired Immunity
Herd Immunity
Bias
Pseudoscience
Anecdote
Contagious
Communicable
Esotoric
Population
Community
Pathogen
Antigen
Antibody
Virus

LESSON SUMMARY: This lesson will focus on the application portion of TBL. The lesson will cover the practice of vaccination with inquiry into the scientific explanation of vaccination mode and mechanism. The lesson will also ask students to apply their understanding of how vaccines work to anticipate the impact of vaccination on whole communities. This lesson will include a modified case study, a class discussion and simulation/model.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

Standards:
SC912L1452 Explain the basic functions of human immune system, including specific and nonspecific immune response, vaccines, and antibiotics.
SC912L146 Explain the significance of genetic factors environmental factors and pathogenic agents to health from perspectives of both individual and public health.
HE912C15 Analyze strategies for prevention, detection, and treatment of communicable and chronic diseases.

Learning Objectives
The student will be able to...

1. Students will be able to use their understanding of the human immune system to explain how and why vaccines work.

2. Students will be able to use their knowledge of vaccine mechanisms to determine how and why herd immunity works to keep whole populations safe from disease.

MATERIALS:

ESSENTIAL: Vaccines, Social Media & the Public Health Case Study, Bead bags with presorted
beads, graph paper.
SUPPLEMENTAL:

BACKGROUND INFORMATION:

Vaccines are essentially a controlled, limited dosage of a pathogen administered to prompt the human immune system to being to build up an acquired, specific immunity. Pathogens possess protein tags that that are unique and allow an immune system to identify it. Once identified, the pathogen's antigen and the process for killing it is stored and catalogued for future reference. If a particular pathogen is ever reintroduced to an individual, the individual relies on its previous experience in fighting that pathogen to mobilize and prevent disease/illness. This is acquired immunity. Individuals are not born with acquired immunity. To a certain extent an individual may obtain antibodies for some pathogens from breastmilk. The only other way an individual can acquire immunity is through exposure to a pathogen. If exposure is carefully controlled, as they are with vaccines. Vaccines prevent disease, not the transmission of the pathogen that causes the disease. Pathogens do not always result in disease and not all pathogens are deadly to everyone, in all situations. However, there is a great deal of uncertainty and suffering that may be avoided by taking advantage of vaccinations and in situations where mortality and morbidity rates are high, vaccines are imperative for the health of the community (also referred to as the herd).

The administering of vaccines is strongly promoted in the USA, where they are readily available. Each pathogen for which there exists a widely disseminated vaccination has a population proportion that is required to maintain herd immunity. This proportion is calculated using rate of transmission for that particular pathogen. Proportions vary slightly between pathogens. Herd immunity or community immunity helps protect populations from epidemics of disease. Many people feel that they should have the freedom to elect not to be vaccinated because they are the only one at risk of infection and disease if not vaccinated. However, there are many members of a community that do not possess a healthy enough immune system to effectively fight the infection introduced by a mild vaccination. These subpopulations are newborns and individuals with immune disorders or diseases. The individuals in these subpopulations are typically exempt from vaccination requirements. Herd

immunity is maintained to protect the unvaccinated newborns and immune-compromised. Each state is permitted to establish its own policy regarding vaccination requirement for public and private schools.
Many people are misinformed about the vaccine ingredients, the human immune system, transmission of infectious diseases and the concept of herd immunity. At some all individuals will be faced with a decision regarding vaccination, either for themselves or for their children or elders. The ability to understand the nature of science and the research and data behind public health practices is a critical skill for all citizens. This generation of young people are bombarded with information from all directions. They may struggle with discerning between science and pseudoscience. It is important that they practice taking in new information, seeking a credible source(s) for clarification and interpreting data in order to make informed, educated decisions. Science is based on empirical data obtained through the scientific process/method and has been successful repeated over time. It is the basis public health policy. Pseudoscience is not based on empirical data or any data at all. It is fraught with logical fallacy and bias. Science directs public health policy in the USA. Pseudoscience directs conspiracy arguments and pollutes empirical evidence.

ADVANCE PREPARATION:
Depending on the class (Biology vs Anatomy & Physiology) the amount of background information will vary. Biology students will have learned about innate vs acquired immunity and the mechanism of each in maintaining homeostasis. In addition to innate vs acquired mechanisms, Anatomy & Physiology students will have learned about the primary and secondary lymphatic organs, hemopoietic stem cell progeny and lymphocyte structure & function. The lesson I have shared will be the final lesson in this unit. Team based learning groups will have already been established, toward the middle of the unit lesson. Students will have already completed NSG-based iRAT & tRAT assessments, as well as, an additional formative assessment to determine where foundational knowledge has been established and if remediation is required before moving on to the application portion of the unit.

The lesson begins with a case study obtained from the National Center for Case Study Teaching in Science repository. Case studies provide opportunity for critical thinking about real-world scenarios. There are various types of case studies ranging from the classical discussion method to Problem-Based Learning and Team Learning (sciencecases.lib.buffalo.edu). The case study I have selected for this lesson would be classified as classical discussion method and incorporates social media, politics and public health discussions. Students will complete the reading individually either prior to class or at the beginning class depending on student ability level. Case study and application questions must be prepared and printed ahead of time.

The final discussion will revolve around the concept of herd immunity. Students will model, chart and calculate immunity in two separate populations. Population #1 will reflect the proportions of vaccinated individuals required to achieve herd immunity for measles. Population #2 will reflect the proportions of vaccinated individuals that are significantly below what is required to maintain herd immunity. The bead bags must be prepared in the correct proportions and labeled ahead of time.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

Team Based Learning (Application)
1-Students will receive individual reading passages with application questions for each passage. Students should read and answer the questions on the sheet of paper provided (25 minutes).
2-Students will discuss in TBL groups and establish group answers (20 minutes).

3-Teacher will facilitate class discussion in TBL style for each question (20-30 minutes).
Model Herd Immunity Activity
1-Pass out a paper bag with prebagged beads, graph paper and instructions.
2- Bags with 100 beads- 12 infected with measles (red), 80 vaccinated (white), 8 unvaccinated (pink) each are handed out to each TBL group. Students draw two beads, 50 times. Each time a red bead is drawn with a pink bead, the pink bead is replaced with a red bead. Students will set up a graph and plot the progression of the disease over 50 trials. Students will take the number of people infected and divide it by the number of people unvaccinated at the beginning of the trial in order to calculate percentage of unvaccinated people who were infected. (10 minutes)
Bags with 100 beads- 12 infected with measles (red), 40 vaccinated (white), 48 unvaccinated (pink) are handed out to each TBL group. Students draw two beads, 50 times. Each time a red bead is drawn with a pink bead, the pink bead is replaced with a red bead. Students will take the number of people infected and divide it by the number of people unvaccinated at the beginning of the trial in order to calculate the percentage of unvaccinated people who were infected. Students will set up a graph and plot the progression of the disease over 50 trials. (10 minutes)

ASSESSMENT SUGGESTIONS: The application questions that test objective 1:
Assessment question #1: A physician administers a measles vaccination to a 6 month old baby as a part of the regularly scheduled course of vaccinations. The baby develops a mild fever and slight rash immediately following the inoculation. The parents search symptoms on the internet and begin to develop a fear that their child has contracted measles from the vaccination. Which explanation best explains these symptoms?
A) The baby has contracted measles because his immune system is not yet strong enough to fight off the pathogen in the vaccine.
B) The baby has contracted measles because the pathogen in the vaccine was improperly prepared and, as a result, is more potent than a regular vaccine.
C) Fever and rash close to the inoculation site are an indicator that the baby is having a normal immune response to a pathogen and as long as the rash doesn't spread and the fever does not persist, vaccine mission accomplished!
D) The baby's innate immune system has identified the antigen of a pathogen and is working to produce antibodies that will fight that specific pathogen if it is ever reintroduced.
The application questions that test objective 2:
Assessment questions #2: Your neighbor drops her 4 year old daughter at the in-home day care. They get a call from the day care provider that 2 year old unvaccinated twin boys who also attend the day care were diagnosed with measles after a recent trip to Legoland. Your neighbor immediately takes her daughter to the doctor. The doctor is concerned and runs a test for the measles virus on the 4 year old. What is the most likely reason the doctor is concerned?
A) Though vaccinated, your 4 year old neighbor may have been a vector for the virus and passed it to her 3 month old brother who is not yet fully vaccinated.
B) The 4 year old neighbor has not been vaccinated for measles and therefor may have contracted it and may have passed it on, as it is highly contagious.
C) The measles virus may have mutated, rendering the vaccination ineffective.
D) There may be a looming outbreak in the area, as many parents are delaying vaccination or not vaccinating at all.

EXTENSIONS:

Not that I know of, but I am sure if I look long enough I will be able to find some.

RESOURCES/REFERENCES:

https://www.cdc.gov
TedEd “How Do Vaccines Work?”
The Center for Case Study Teaching in Science