Just Say "No" to Drugs: Disability, Pharmaceuticals, and Scientific Ethics

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School

This curriculum unit is recommended for:
International Baccalaureate Diploma Programme Chemistry, Grades 11 and 12

Keywords: Medicine, Drugs, Pharmaceuticals, Ethics, Science, Art

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit. (Insert a hyperlink to Appendix 1 where you've stated your unit's main standards.)

Synopsis: Many scientific mistakes in the past century have led to the development of highly detailed and strongly debated scientific ethics. However, scientific ethics are not nearly as well covered in science classes today as pure scientific content. Standard curriculums generally do not cover scientific ethics at all. In this unit, students will focus on the use of art to provide a window in to the personal effects of disability, especially those disabilities that occur as a direct result of scientific negligence. Scientific negligence has led to very strict regulation of research practices. Students will use multiple methods to discover what research regulations exist and what happens when these regulations are not followed. Students will be given the opportunity to discuss and debate what entity bears responsibility when problems arise as a result of science. The goal of this curriculum unit is to understand the effects of chemicals on humans from multiple points of view and encourage development of a personal and global understanding of scientific ethics.

I plan to teach this unit during the coming year in to 11th grade students in IB Chemistry SL.

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Katherine Semmler

The study of science often focuses on qualities such as lack of bias and objectivity. Scientists are viewed as people who draw conclusions solely based on data and by using this data, their decisions are always in the best interest of society. This assumption, however, is far from the truth. Many scientific mistakes in the past century have led to the development of highly detailed and strongly debated scientific ethics. However, scientific ethics are not nearly as well covered in science classes today as pure scientific content. Standard curriculums generally do not cover scientific ethics at all. However, the International Baccalaureate curriculum places an emphasis on understanding the ways of knowing. The Theory of Knowledge curriculum, which is a philosophical thread that weaves through all IB courses, stresses student understanding of how we know what we know about each subject and topic and how we use our knowledge to help ourselves and our global society. The goal of this curriculum unit is to understand the effects of chemicals on humans from multiple points of view and encourage development of a personal and global understanding of scientific ethics.

Demographics

North Mecklenburg High School is a partial magnet high school that serves a diverse population. We have two magnet programs within the school: a Career and Technical Education hub and the International Baccalaureate program. We serve approximately 1,800 students. The student body is 47% African American, 11% Hispanic, 35% White, 4% Asian, and 3% are of other races. 47% of our students receive free or reduced lunch. We have a student teacher ratio of 18.5 to 1. I serve primarily advanced students, teaching IB chemistry Standard Level and Higher Level and AP Chemistry, though I do teach regular high school chemistry. I teach a total of 38 students in IB Chemistry, 10 students in AP Chemistry, and 20 students in chemistry one. All students are 11^{th} and 12^{th} graders.

Content Objectives

In this unit, I hope to teach students to be conscious consumers of drugs and chemicals, to understand the basic scientific ethics scientists should follow, to debate who holds responsibility when ethics are not followed, and what role serendipity can play in scientific research.

When we pick up prescription drugs from the pharmacy, the pharmacists attaches an information sheet about the drug and its possible interactions and side effects. Many people simply pull this information off and do not bother to read it, whether for reasons of lack of time or the print is infinitesimally small or the words are too technical and

complicated for even well educated people. Many people often turn down the opportunity to talk to the pharmacist about the drug they are about to take. Many times we trust our doctors and the drug companies unconditionally. We believe that nothing bad will happen because we believe that we are fully protected by our doctors and the FDA. However, this is not always true. Negative effects from drugs are not a thing of the past. The misuse of antibiotics has led to a large number of antibiotic resistant "super bugs" that threaten our ability to fight off infections. The number of negative side effects has dropped dramatically, so when things do happen, the effects go unnoticed by larger society.

In addition, the creation of large drug companies has changed the face of how we take drugs. Drug companies are business, and while they have the aim to help people by creating prescription and over the counter drugs to relieve people's aches and pains, they are ultimately businesses that want to make money. As we all know, people sometimes make bad decisions to make more money. Drug companies can pay people who suffer from negative side effects from a drug they produce to prevent them from going public about their experiences. Thus, when it comes to putting a drug on the market, drug companies weigh potential profit against potential harm and not just potential benefits versus potential harm. In this unit, I want the students to view what happens when drug or chemical companies make decisions in the name of profit that end up damaging large numbers of people.

Second, I want my students to study the ethics that scientists should follow. Scientists are often encouraged to be completely unbiased, objective, and data driven. Popular culture even displays some scientists as completely unbiased and lacking in emotion, such as Dr. Spock from *Star Trek* and Sheldon Cooper from *The Big Bang Theory*. We could reason that Dr. Spock is unbiased and without emotion because he is from another world and society; however, Sheldon Cooper is all human but completely disconnected from social emotions. Sheldon attempts to follow social constructs by offering hot beverages when friends are upset, by reciprocating gifts of similar value to reflect depth and quality of relationships, and by singing soft kitty when he or a friend are sick. However, Sheldon makes it clear that the most important thing in his life is science, especially theoretical physics.

It is clear that Hollywood believes that the strongest and best scientists are those who cannot connect with the rest of society. However, a good scientist also sees how their research affects the people and world around them. They study the history of their field in addition to the pure science. They know what has happened in the past so that they can prevent it from happening again. Some scientists even refuse to complete certain types of research because they have weighed the benefits versus the risks. Scientists cannot be completely unbiased and disconnected from society, especially concerning drugs and chemical weapons.

Next, I would like my students to use their studies of the chemistry and the personal experiences of people affected by specific drugs and chemicals to debate

whether or not scientists and researchers should be held responsible for the adverse effects of the drugs or chemicals they develop. Students must also consider that most scientists today work under large chemical and drug companies. They must consider the working conditions and pressures that researchers experience that may influence the outcomes of their experiments. Also, students will need to develop arguments concerning the responsibility drug and chemical companies hold when people suffer because of a chemical or drug the company produces. Students will also need to discuss the retributions that scientists and/or companies must face should they be negligent or at fault. Students will study the regulations and standards put out by the FDA and the global research community as a whole and discuss if these are enough to protect people. Should the regulations be more or less strict? Ultimately, the students must consider the financial and time constraints to create drugs and protect consumers at the same time. For example, many HIV drugs are rushed on to the market much faster than any other category of drugs. Many of the drugs have terrible side effects but the potential benefit of protecting people with a life threatening illness is considered to outweigh any negative side effects.

Last, I would like to discuss the role serendipity can play in research. Recently, the *New York Times* introduced a short film, *The Death and Afterlife of Thalidomide*, on the tragic history and legacy of the drug Thalidomide, one of the chemicals to be studied in this unit. (3) The film discusses how the drug company that created the drug, Chemie Grunenthal, marketed the drug, how widespread the usage of the drug was, and the effects of the drugs on children. The film mentions how in many European countries, no prescription was required to purchase the drug. Thalidomide was almost as common as aspirin when it was at peak production. The film also talks about how a female pharmacologist, Francis Kelly, potentially helped save millions of American children from being born with severe birth defects because of her scrutiny of Chemie Grunenthal's lack of research in to the effects of the drug. When scientists finally linked the birth defects being observed in children with the use of the drug in early pregnancy, thalidomide was almost universally banned. However, since being banned, serendipity has lead to the discovery of some very beneficial uses of the drug.

In the mid-1960's, a doctor working with leprosy in Israel had a patient who could not sleep because his leprosy was so severe. The doctor decided to give the patient thalidomide to help him calm down and sleep as thalidomide was originally marketed as a strong, safe sedative. Ironically enough, the doctor began to observe improvements in the patient's leprosy. Since then, thalidomide has become a routine treatment for leprosy.

Furthermore, in the early-1990's, scientists looking for cancer treatments were trying to find a drug that would inhibit the growth and effectiveness of blood vessels supporting various cancers. They knew they needed a drug that would harm a fetus as it not only had to prevent development of blood vessels, it had to be able to pass through various different tissue barriers, just as a drug would have to pass through the placenta. When looking back, they realized that thalidomide could be the answer. Ironically

enough, thalidomide did work. Today, thalidomide is used to treat various cancers, rare skin diseases, Crohn's disease, and side-effects of HIV. After thalidomide was banned, it became a "drug in search of a disease". It could not safely treat what it was originally marketed to treat, but research did find a suitable use for the drug.

I want to use the story of thalidomide not only to talk about disability and responsibility as scientists, but to study how amazing discoveries can be made without even realizing it. Just as penicillin was discovered from some bread mold and thalidomide can disable and save, science is not as exact as we would like to believe. Luck plays a large role in many of the greatest discoveries.

Teaching Strategies

In my classroom, I use a method called POGIL to teach many foundational concepts. POGIL stands for process oriented guided inquiry learning. It is an inquiry based method that uses data based models and guided questions to bring students to create the necessary knowledge and theories for understanding science.

One of the key components of POGIL is using structured groupings. At the beginning of the school year, I create random groups of students to work together on POGIL activities and labs. As I get to know my students more, I begin to move around my groups so that I have different levels of students in each group. Since POGIL is group lead and paced, I tend to avoid putting very low students and very high students together as the fast pace a very advanced student might progress can frustrate or upset a student who is struggling. I do believe, though, that students benefit from teaching each other, so I do not want groups of students all at one level. I tend to have groups of advanced and average students and average and low students. I tend to avoid putting friends together because I find value in encouraging students to learn to work with everyone. Each group has 4 people and they work together at lab benches in my classroom.

Within each grouping, there are 4 roles that the students take on. The four roles are: Facilitator, Spokesperson, Process Analyst, and Quality Control. Each student receives a role card with their job description and key phrases to use while working in group. The roles rotate through the group and every student will fulfill every role multiple times throughout the year.

The facilitator is the leader of the group. They make sure everyone starts quickly and remains focused throughout the activity. If I observe that the group is off task, I will try to indicate to the facilitator that they are not fulfilling this part of their role. I do not always do this by talking. Sometimes I can do this by simply making eye contact or pointing to their role card. The facilitator is also in charge of time management. I usually designate a period of time that the students have to complete a particular task. The facilitator is usually seated facing the clock so they can keep track of time and they make sure that if the group gets stuck on a problem, they either ask for help quickly or move on

and come back. The last role of the facilitator is to make sure all voices are heard. They must make sure I see every group member contributing. It is all too often that certain members of the group take control and do the entire task, leaving everyone else to copy. Though the facilitator is the leader of the group, they are not to be the only student completing the work. They are to enable everyone to make a contribution.

The next role is the spokesperson. As a teacher, this is my favorite role. This is the only person in the group that can communicate group questions and clarifications with the teacher. By only allowing one person in each group to ask questions of the teacher, students are forced to voice their questions to the group before going to the teacher. By voicing their questions to the group, group members can very often answer the question for their classmate, thus reducing the number of repetitive questions that are asked of the teacher. This student must ensure that all group members have an opportunity to respond to a question before asking outside sources. This student is also the only person in the group that can communicate with other groups. I often see the spokespeople from different groups congregating at the center of my classroom to collaborate between groups on certain questions. This keeps many different students from running around the classroom but it still allows information to be shared between groups, preventing isolation of information and knowledge. Finally, when we return to class instruction, when I ask a group a question, the spokesperson will speak for the group and must be able to present conclusions and the reasoning behind their conclusions to the class.

The third role is the process analyst. The process analyst observes how the group works together in respect to the learning process. They are responsible for catching when a person is falling behind or doesn't understand. The process analyst is responsible for communicating when the group is not being fully productive and needs to get back on track. At the end of the activity, the process analyst completes a questionnaire to communicate with the teacher how well the group worked as a whole, what process skills they felt they master, what process skills they think the group needs to work on, and what is frustrating their group. This role is important because it puts students in charge of understanding how they learn and what processes they use to learn. It allows students to see what they need to do to learn better and it communicates with the teacher how well groups work. I usually take this feedback in addition to my observations to reorganize groups or facilitate re-looping when I see students don't fully understand a concept. As I teach higher level students, I really like for them to put words to their process skills so that they can fully articulate what they are successful at and what they need to work on before they go to college.

The last role is quality control. Most of my students know this role as "the person whose paper gets collected and graded." However, this role is much more than that. This person guides consensus building within the group. I will sometimes place particular students in this role when I give a particularly challenging activity. Sometimes it will be

students who are already peacemakers or students who need to work on their diplomacy skills. This student also verifies that the responses are of high quality. My students are told all year long that they must write in complete sentences and should also write in third person unless a question specifically asks for a first person response. This is an effort to make sure my classroom supports general and scientific literacy. Students are also told that my classroom is a high class establishment and that no naked numbers are allowed. All numbers must include a unit and an uncertainty (if available). The quality control person helps the group go through and make sure everyone in the group is following the classroom guidelines. The quality control person also makes sure all work reflects a consensus within the group. Since I grade only one paper per group, each person in the group has it in his or her best interest to make sure that the answers submitted on the quality control student's paper reflect what they believe to be the correct answers. This helps ensure that the group works together. However, I expect each student to complete his or her own paper so that they can study. I will randomly collect all papers if I believe students are not all completing their own work. Last, the quality control person also takes their graded paper and makes sure that the group goes over the questions that were incorrect. This ensures that the group learns from their mistakes.

In this activity, I will be having my students work in their POGIL groups using the same roles but to complete a group project. Instead of completing a data based activity, they will be using literature and art to guide conclusions about philosophical and ethical questions.

This unit will be taught to students in the International Baccalaureate Diploma programme. The International Baccalaureate is an educational program for students ages 16-19 who intend to enter in to a four year college or university. It has a global and interdisciplinary focus on education and intends to educate the whole student with projects such as the extended essay, theory of knowledge, and Creativity, Action, and Service (CAS) projects. With this unit, I hope to focus in on the interdisciplinary strengths of the programme.

Every student who enters in to the IB program is required to take a course called Theory of Knowledge (TOK). According to the IB Theory of Knowledge Course Guide, "TOK activities and discussions aim to help students discover and express their views on knowledge issues. The course encourages students to share ideas with others and to listen to and learn from what others think. In this process students' thinking and their understanding of knowledge as a human construction are shaped, enriched and deepened." IB teachers are encouraged to incorporate TOK questions in all of the IB classes to demonstrate the interconnectedness of all knowledge. Potential TOK questions are even provided in the course guides. The course guide for chemistry has some particularly good TOK questions about subatomic particles, proof of equilibrium and kinetics, and, of course, the ethics of the use of chemicals and drugs. In order to understand the ethics of chemistry research, not only do the students have to reach out in

to their Theory of knowledge class, but they will also have to reach out and use their knowledge from other IB courses.

Students who enroll in the IB program are expected to become bilingual. Their "Language A" is their native language and "Language B" is their foreign language. In their Language A course, the students study literature that has been translated from its original language in to their native language. Students study literature from around the world focused and examine how literature practices, styles, techniques, genres, and structures vary across cultures. In this unit, I hope to incorporate portions of this world literature in translation by encouraging students to find literature in translation about the effects of different chemicals. I will ask the students about the similarities and differences in how people portray these chemicals through literature.

In addition, students enrolled in the IB program also will take 20th century history. Within the course, students will study the causes, practices, and effects of war. In the 20th century, the way people waged war changed drastically with the introduction of chemical warfare. From the introduction of mustard gas in World War I, the use of Agent Orange in the Vietnam War, or many of the other chemicals used in the past century. Within the 21st century, our students have heard about Anthrax and Sarin Gas being used in war. Understanding the history behind chemical warfare has become very important to understanding the international regulations and its effects on how we handle people abusing war chemicals. Understanding the chemicals being used is also very important to understanding the history and politics of chemical warfare. In this unit, students will student the chemical structures of war chemicals and the immediate effects on the body through traditional scientific study. Students will then examine the effects of these chemicals on people's social and emotional effects by reading literature and examining art related to specific historical events. They will relate this study back to what they have learned about those specific events and time periods in their History classes.

At the culmination of the unit, the students will participate in a Socratic seminar. According to the National Paidaia Institute, a Socratic Seminar, which is based on the writings of Socrates, is "a collaborative, intellectual dialogue facilitated with open-ended questions about a text." This seminar will be a dialogue about multiple texts and about artwork that the students have encountered and will focus around a particular TOK question. Students will use all of the artwork and literature to which they have been exposed to support their arguments throughout the seminar.

Classroom Activities

Day One

Essential Question: How are the effects and emotions related to disability conveyed through art?

Curriculum: TOK Ways of Knowing: Sense Perception

Students will be placed in their POGIL groups that have been assigned for the majority of the year. The purpose of doing this is so that there is a level of comfort and familiarity for each of the students while discussing difficult topics concerning disability and possibly sharing personal stories. The students will be told at the beginning that the rules that are used concerning discussions in their theory of knowledge classes also apply to the chemistry classroom during this unit. Students should not discuss personal matters that are shared in class outside of the classroom. A high level of respect and tolerance is expected and derogatory comments will not be tolerated.

Activity One:

The students will begin the activity by discussing the following questions with their POGIL group members:

- In your own words, what is the definition of disability?
- In your opinion, what conditions, syndromes, or other physical, mental, or emotional conditions qualify as a disability?
- Write as many derogatory terms as you can for different disabilities
- What do derogatory terms tell us about particular disabilities? What do they tell us about the people who use them? What do we know about their origin? Were the terms always considered derogatory? Do the fact that they are now considered derogatory tell us something about our current perception of disability?
- If appropriate: How has disability affected your life? What is your personal connection to disability?

Once the groups have had a chance to discuss the above questions, the spokesperson from each group will share with the class the conditions they believe qualify as disabilities and the derogatory terms. They will also share key comments and questions that arose during their discussion. Once all the groups have shared their information, there will be a short class discussion on what is disability and the whole class will make a commitment not to use any derogatory terms except in discussing their exclusionary use over time.

Activity Two:

In this activity, groups will be given various images of art. Students will be asked to critically examine the art piece to see if they can see a link to disability. Some pieces will have no link, but a few will. Each piece will have a collection of questions on the

back to help guide the student's discussions. Students will have 6-10 art images to examine and will be given 8-15 minutes to look at and discuss each piece.

Once each group has had the opportunity to look at every piece, the spokesperson from each group will have the opportunity to share key points from their group's discussion with the class. I will then reveal the art pieces that are done by people with disabilities. A list of potential artists can be found in the class materials list.

Homework: Students will be asked to find an art piece that they believe connects to a disability, whether their own or a specific category. They will be asked to write 2 paragraphs about the piece and its link to disability in art. They will be asked to send a link to the image via email to the teacher so the link can be posted to the class wiki site for other students to see.

Day 2

Essential Question: What is Thalidomide, how does it work, and what is its historical significance?

Curriculum: IB Chemistry D.1.2- Outline the stages involved in the research, development, and testing of new pharmaceutical products

Activity One

In their POGIL groups, students will use iPads and the wiki to share the art piece that they found with their group members. They will have the opportunity to discuss what they found interesting or powerful. The group will decide on one piece to share with the rest of the class.

Activity Two

Students will be shown a movie from the *New York Times, The Death and Afterlife of Thalidomide*. (3) The movie gives a brief overview of the history of thalidomide. Once the students have seen the movie, they will return to their groups and use iPads to research the stages involved in research and development of pharmaceuticals. Students will also be asked to look for peer reviewed journal articles discussing thalidomide. These will be brought to group to discuss the negative history of thalidomide and potential new uses for the drug.
Questions the students must answer:

- What are the different stages of research and development? What is their importance?

- What was not done in the research and development of Thalidomide that allowed it to be put on the market?
- What was the common misconception about pharmaceuticals and pregnancy in the 1950s?

Each group will be assigned a particular stage of research and development and will create a content poster to be posted in the classroom during the unit.

The essential information the students should find is:

> " In most countries, drugs must be subjected to thorough laboratory and clinical studies that demonstrate their usefulness and safety. Before studies on humans are permitted, the drugs are extensively tested on animals and cell cultures. These include establishment of the range of effective doses, the doses at which side effects occur and the lethal doses in various animals. Because of differences between species of animals, at least three different species are tested to determine an LD_{50} value. An LD_{50} (Lethal dose in 50% of the population) value is used to indicate the dose of a given toxic substance in mg per kg body mass that kills 50% of the laboratory animals under study such as rats, mice and guinea pigs. The smaller the value of the LD_{50}, the more toxic the substance. Since different species react differently to various poisons, any application of such data based on animal studies are often carried out with different animals before such extrapolation is made.
>
> If a drug is found to be safe when given to animals, it may be taken to initial clinical trials (phase 1) on volunteers as well as on patients with 50% receiving a placebo. This is aimed at establishing the drug's safety, dose range, and possible problems and side effects for further study.
>
> Using animals and humans for drug testing raises ethical issues: testing animals is a concern for those who believe that animals should have the same rights as humans. Ethical concerns arise when human volunteers such as those from a prison population or those who volunteer for financial reasons are used.
>
> If phase 1 indicates safety, a drug is subjected to thorough clinical evaluation (phase 2) to eliminate variables such as response and investigator bias. Statistical validation is critical at this stage. Finally, if the drug looks promising, it enters human studies with extended clinical evaluation (phase 3). Most new drugs never get approval for marketing. Most drugs on the legitimate market have reasonable risk/benefit ratios. No drug is completely without risk, but most legal drugs should be relatively safe." (1)

Activity Three

Students will be given a short presentation on how thalidomide works in the body and why thalidomide causes birth defects. The students have already studied chirality of organic chemicals and what it means for a substance to be a racemic mixture. Students will be introduced to the idea that chirality can be the difference between being effective and being lethal.

Homework: Create a timeline of key events in the history of thalidomide. Get permission slip to see movie signed.

Day 3-4

Essential Question: Who are the people affected by the mistakes of ChemieGrunenthal?

Curriculum: TOK Ways of Knowing: Emotion

Activity One

Students will view the movie *NoBody's Perfect*. Students will be asked to write a critique of the film after viewing on the first day and bring questions and comments for the next class.

Activity Two

Students will participate in a Socratic seminar on the movie viewed the previous class. Guiding questions include:

- What was the director/filmographers goal in creating this film?
- What was effective in the movie? What was not effective?
- Is the purpose of the movie effective because of the shock value and emotion or is the effective because the message is conveyed well?
- What emotions did you feel seeing this movie for the first time? Would you have a different experience if you had a particular disability?
- What would you have liked to see in the film?

Depending on student's responses, other questions will arise.

Day 5

Essential Question: How are the effects of thalidomide on its victims reflected in various other art forms?

Curriculum: TOK Ways of Knowing: Perception and Emotion

Activity One

In this activity, students will get in their POGIL groups and critically examine art created by the victims of thalidomide and other related art. Students will be asked to answer questions such as:

- What was the creator's intention when creating this piece?
- What is significant about the placement of this piece of art?
- What do you observe about this art piece?

Activity Two

The class will gather as a whole to focus on two particular pieces of art related to Thalidomide. The first piece is a sculpture placed outside of the ChemieGrunenthal building in Germany, revealed when the company issued its first apology to thalidomide victims in 2011. The second art piece is "Alison Laper Pregnant". Students will be asked to discuss the two pieces in a socratic manner answering questions such as:

- How are the two pieces similar?
- How are the two pieces different?
- What do you think is the purpose of the piece placed outside of ChemieGrunenthal? Is this successfully conveyed through the sculpture?
- What do you think is the purpose of "Alison Laper Pregnant"?
- There was significant controversy surrounding the placement of this sculpture. Why do you think there was controversy?
- What side would you take if you heard that this sculpture were to be placed in a public square of your town?
- What do you think is the significance of Alison Laper's pregnancy in this sculpture?

Other significant questions will arise.

Homework: Students will be asked to write a 2-3 paragraph reflection on the artwork they viewed today.

Day 6

Essential Question: Should Scientists be responsible for the adverse effects of the drugs they create?

Curriculum: IB Chemistry D.1.2

Activity One

Using iPads in their POGIL groups, students will research the costs of discovering new pharmaceuticals. They will then create a "Family Budget" for a fake pharmaceutical company that they create. They will have to answer questions such as:

- How much does each stage of drug development cost?
- What is the most costly portion of drug research?
- What is the highest and lowest payout a drug company has had to make as a result of negative side effects?

Students will then present to the class their findings. Students must record their sources of information and must comment on the reliability of their sources of information. They should comment on whether or not their think their sources were biased.

Activity Two

In a socratic seminar fashion, students will be asked to discuss the essential question : Should scientists be responsible for the adverse effects of the drugs they create? Students will be asked to consider

- The case of thalidomide
- Costs of research
- Drug companies as businesses and the benefits and consequences thereof

Students will also be asked to consider what they think should be the ethics of drug research using the knowledge they have discovered during the unit.

Homework: Students will be asked to write a 2-3 paragraph reflection on the days activities.

Day 7

Essential Question: What are scientific research ethics?

Curriculum: IB Chemistry D.1.2

Activity One:

In POGIL groups, students will read a passage on research ethics from the university of western Michigan. Each group will be given a case study to read and answer the questions included at the end of the study. Each group will discuss the questions and then present the study to the class along with their groups conclusions. (2)

Day 8

Essential Question: What part does serendipity play in scientific research?

Curriculum: IB Chemistry D.6.1 Outline the Historical development of penicillins

Activity

Students will use iPads to discover the history of the development of penicillin as follows:

> "In the 1890's, scientists discovered that certain fungi killed some bacteria. In an experiment, mice were exposed to disease-causing bacteria. Mice exposed to only the bacteria died whereas mice exposed to both the bacteria and the fungus lived. These results were however largely ignored. In 1928, similar observations were made by Alexander Fleming, a bacteriologist working at St Mary's Hospital in Paddington, England. Fleming was working with a bacterium called staphylococcus aureus that causes boils and other types of infection. In one of the cultures in a petri dish whose lid had been left off, he found mold growing, but no bacteria around the mold. He concluded that the mold (penicilliumnotatum) must have inhibited bacterial growth by producing a compound that he called penicillin. However, Fleming gave up the project after he found it difficult to isolate and purify the active ingredient in the mold.
>
> In 1940, Florey and Chain, working at Oxford University renewed the research. They injected mice with deadly bacteria; some mice received penicillin and survived. In 1941, penicillin was used for the first time on a human being, a London policeman who had serious blood poisoning from a cut. The effect of penicillin was immediately favorable. In 1941, a massive development program was started in the U.S. where scientists at the Bureau of Agricultural Chemistry in Peoria, Illinois grew strains of penicillin mold in a medium of corn-steep liquor in large fermentation tanks. By 1943, penicillin was available clinically and by 1945, enough supply was present for everyone needing it, thus saving thousands of lives during World War II. In 1945, Fleming, Florey, and Chain received the Nobel Prize for medicine for their work on penicillin." (1)

Day 9-12

Essential Question: How can I express my disabilities through art

Curriculum: TOK Ways of Knowing Perception and Emotion

Activity:

With the help of the IB Art instructor, students will create collages to express their inner disability. This will be the culminating activity for this unit. Students will not be asked to share what they feel is their disability, but they will be asked to consider what they feel is their disability considering what they have learned through this unit. Students can also choose to express the disability of someone close to them.

Optional Day

Essential Question: How do scientists approach creating chemicals that will intentionally be used to harm others?

Curriculum: TOK Ways of Knowing Emotion

Activity:

Students will be asked to find an art piece reflecting the use of chemical warfare. Particular emphasis will be placed on 20th century pieces as it reflects the student's 20th century history curriculum. Students will also be asked to find information on how a particular chemical weapon works. Choices will include Mustard Gas and Agent Orange. Students will create and present a content poster on the information they have gathers. Students will then participate in a Socratic seminar discussing how they would feel if they were asked to create a chemical to be used in war.

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(1) Green, John and Sandru Damji, *Chemistry 3rd Edition.* Melton: IBID Press, 2007.
(2) Western Michigan University. "An Instructional Guide for Secondary School Science Teachers With Model Lessons for Classroom Use," Accessed November 19, 2013, http://www.wmich.edu/ethics/old-site/ESC/index.html.
(3) "The Death and Afterlife of Thalidomide," published September 23, 2013, http://www.nytimes.com/2013/09/23/booming/the-death-and-afterlife-of-thalidomide.html.

Appendix 1: Course Objectives

IB Course Objectives

D.1.1 List the effects of medicines and drugs on the functioning of the body

D.1.2 Outline the stages involved in the research, development and testing of new pharmaceutical products

D.1.4 Discuss the term therapeutic window, tolerance and side-effects

D.6.1 Outline the historical development of penicillins

D.8.1 Describe the importance of geometric isomerism in drug action

D.8.2 Describe the importance of chirality in drug action

Common Core Standards

CCSS.ELA-Literacy. RI. 11-12.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

Bibliography for Teachers

Green, John and Sandru Damji, *Chemistry 3rd Edition.* Melton: IBID Press, 2007. This text provides an overview of the information required for IB Chemistry. The succinct nature of the text is helpful when attempting to review or learn basics about IB Chemistry. Each section provides the assessment statements covered per the IB Course Guide and even includes short writings on the Theory of Knowledge questions posed in the course guide. The text does not provide significant depth in to the information and very few images are provided.

Western Michigan University. "An Instructional Guide for Secondary School Science Teachers With Model Lessons for Classroom Use." Accessed November 19, 2013. http://www.wmich.edu/ethics/old-site/ESC/index.html. This site provides a complete lesson plan for teaching scientific ethics in a secondary science classroom. In this particular unit, the case studies provided on the website are used to pose ethical questions for students. There are many interesting readings on the role of teaching ethics that are helpful to read prior to the ethics lesson in this unit.

Materials For Classroom Use

Suggested Artists

Roger Bissiere
Bissiere lost eyesight for 10 years but later had restorative surgery

Alfred Manessier, Eduard Pignon
Manessiere and Pignon were members of the Salon de Mai movement that opposed Nazi ideology. The Nazi party condemned what they believed to be degenerate art. Almost all modern art was condemned as it often displayed deformity of the human form. Members of the Salon de Mai continued to create modern art that displayed the true human form despite Nazi occupation of France.

Hans Hartung
Hartung fought in Northern Africa during World War II, losing his leg near Belfort.

Sam Francis
Francis was injured during test flight maneuvers during World War II. Discovered art when visited by artist David Park while convalescing in the hospital.

Niki de Saint Phalle
De Saint Phalle suffered from depression and discovered art while convalescing in the hospital.

Bridget Riley - OpArt - in her 80s, still painting, gets help from studio assistants to complete her intricate paintings

Andy Warhol
Warhol was shot in 1968 by Valerie Solanas. He suffered physical and intellectual trauma following the event.

Judith Scott
Scott was born deaf and with down syndrome. She lived for many years in a state institution where she struggled. Upon being removed from the state school by her twin sister, she was introduced to fiber arts where she excelled.

Rebecca Horn
Horn contracted sever lung poisoning while studying art at the Hamburg academy of Fine Arts. She attributes the poisoning to using glass fibre without wearing a mask.

Nancy Fried
Fried underwent a radical mastectomy in 1986 when diagnosed with breast cancer. Fried began to make terra cotta sculptures of her post-mastectomy body following her surgery.

Harriet Sanderson
Sanderson suffers from post-polio syndrome and fibromyalgia and has chronic severe pain.