Possible Worlds (I)

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Overview

This unit is about worlds that do or could exist. The three books we will read are *Brave New World*, by Aldous Huxley, *Blood Child*, by Octavia Butler, and *I, Robot* by Isaac Asimov. Each of these books shows a world that could exist, and each world follows a different set of rules and social mores. Through these books, we'll examine the science, technology, and the rules that govern the people, both governmental and social structures. In *Brave New World*, the world is divided into five different classes- Alpha through Epsilon- and each one is specifically conditioned from birth- both physically and psychologically to think their specific set of limitations and conditions are the best. *Blood Child* is a short story in which Earth humans who have traveled to another planet are used by the bug-like inhabitants of that planet to propagate their own species- at times against their will. Finally, *I, Robot* is a collection of short stories, from which we'll read the first and the last stories. In the first story, the three laws of robots are introduced. When one of the laws is seemingly violated in the last story, you find that the robot was, indeed living within its parameters- but thought it had better information than did the humans. We'll also watch three movies- *GATTACA*, *Matrix*, and *Aeon Flux*. These movies each have different perspectives- *GATTACA* is an analogue of *Brave New World*; a society in which genetic information is as free as a spit swab, and is used to permit or deny life opportunities. *Matrix* will be used to show the power of society as a control mechanism, and to introduce the possible worlds within our minds. Lastly, *Aeon Flux* offers yet another utopian civilization ideal- scientists run the only city-state that survived the virus that wiped out the rest of humanity. These stories have in common that the civilizations are held together by strict adherence to rules, some of which may be repugnant to us today, due to our belief in the supremacy of our own free will.

Additionally, these stories are built on the premises of human biological systems. At the School of the Future, our curriculum is planned around project level and learning cycle. In a 200 level project, in second learning cycle, the science standards include the biological sciences that would be covered by this proposed curriculum. The science topics that I'd need to uncover are the expression and transmission of genetic information, how genetics impact populations, and how populations, diversity, and natural processes impact the environment and environmental systems. The possible worlds we'd study through these books and movies will tie in with these topics easily- in fact, a detailed study of biological sciences will enhance my learners' understandings of the stories.

Rationale

This curriculum unit teaches, through story, many of the biological concepts required in city, state, and national biological science standards. It also examines the writing of novels and novellas, and the structures that govern society. Finally, it addresses how those same structures can (and do) govern our technology. For science topics, it will start at the beginning.

Genetic information is inherited on an organism's DNA. The DNA is a double helical chain of nitrogenous bases, of which there are four types. The four bases are guanine (G), thymine (T), cytosine (C), and adenine (A). With these four nitrogenous bases, there are multiple possible combinations of orders of the bases. For example, a series of four nucleotides could be GGGG, GGGC, GGGT, GGGA, and you can see that there could be many more different combinations. This example is with a simple strand of four nucleotides! In fact, our DNA is sequences of hundreds of millions of these bases, and a single gene is a shorter sequence of the strand. The genes are arranged in order on the structure called a chromosome. An organism created by sexual reproduction has two copies of each chromosome; one was inherited from the mother and the other was inherited from the father. Each type of organism has a specific number of chromosomes that usually does not vary. Humans, for example, have 23 chromosomes (two copies of each make it 46 total.) When the organism creates gametes, or sex cells, those gametes only have one of the copies of each chromosome.

The creation of the gametes, also known as *gametogenesis*, occurs by a highly specialized type of cell division. Typical cell division, called mitosis, creates two daughter cells that are genetically identical to the parent cell. In gametogenesis, a different type of cell division, meiosis, is required. *Meiosis* has two cycles of cell division that result in four daughter cells, some of which are genetically different from one another. Depending on the species and the type of gamete created (male or female), some (or all) of these daughter cells of meiosis will go on to become a gamete- a sperm or an egg. When these specialized cells join, a genetically unique cell is created- it has all of the genetic information of the species, including genetic information from each parent, but the new cell has a previously unseen genetic combination.

But how does DNA get changed into phenotypic expression? In other words, why do we see what we see on a macroscopic level? DNA is this sequence of nitrogenous bases, the patterns in which are genes. The sequence is the expressed gene codes for the creation of a specific protein. The delicate biochemistry that results in a trait's expression relies on several well-orchestrated steps. The DNA, trapped in the cell's nucleus, must instruct the cell to build the proper protein. When the cell builds the proper protein, the cell can be said to be "expressing" that trait; eye cells that produce proteins that absorb light of specific wavelengths are expressing the trait of color vision, for example. Since the DNA is trapped in the nucleus, the cell has evolved a simple solution- send something else out of the nucleus with the message encoded. This molecule, the mRNA, is the single stranded sister of the DNA molecule. Shorter and smaller than the DNA, the mRNA can escape the nuclear envelope and pass messages on to the ribosomes, which will do the work of building the protein. Each set of three nucleotides on the mRNA is called a codon, and codes for a specific amino acid. The chain of amino acids produced by the pattern of codons in the mRNA will become the protein.

But with hundreds of thousands of nucleotides, not to mention the millions of replications, DNA can sometimes develop tiny mistakes, called mutations. There are many different types of mutation, including deletions, insertions, and point mutations. Deletions are errors in which bases or sequences of bases are missing, insertions are errors in which DNA bases or sequences of bases are included where they don't belong, and point mutations are errors in which the correct base is a certain location is replaced by an incorrect base. These mutations are designed to be caught- fixed by a protein that finds and fixes DNA mistakes. Mutations can be random, and when they're not fixed, they're passed down to the next generation. When these mutations are not lethal, they can cause mistakes in the protein that prohibits it from doing its job. In our color-sight example, a mutation that changes the composition and shape of the protein means that the protein no longer absorbs light of those specific wavelengths, resulting in color-blindness. (This is an extreme simplification.)

Though a mutation is a genotypic change, its expression is a phenotypic change. Whether or not the phenotype is expressed depends on the type of inheritance pattern that specific mutation follows. Some changes, called dominant traits, will be expressed if even **one** of the organism's original chromosomes carries that gene. Other changes, called recessive traits, will only be expressed if the organism received two copies of that gene. There are other inheritance patterns, incomplete and co-dominance dominance, that result in either a blended phenotype (pink flowers from red and white parents), or expression of both traits simultaneously (A and B blood types, for example). When traits are carried on the sex chromosomes, like color blindness is, they exhibit an inheritance pattern called sex-linked, and are more frequently expressed in males because in males, one recessive gene on an X-chromosome will be expressed- there's no other X-chromosome that could carry the dominant gene. Two copies of the same gene are called alleles, and if two of the same alleles are required for expression, that trait is called recessive. If only one copy of the allele is required for phenotypic expression, that trait is called dominant.

In the wild, these variations among genes will result in species diversity. This will cause slight differences in organisms. These slight differences allow for survival of the species, because diversity provides resistance to disease and other benefits. On the other hand, if the natural environment changes, one (or more) of the different types of organism can be better suited to thrive and reproduce. Similarly, there could be false pressure to pick certain traits to continue in a species. Dogs are a prime example of this. Humans choose dogs for cuteness, loyalty, or specificity for a task. As a result, humans have bred dogs with these traits over time. We now have different "breeds" of dogs- which are derived from the same animal, but are now as different as well, as a toy poodle and a Rottweiler. Selective breeding can also explain why we're now plagued with antibiotic resistant bacteria. When bacteria are exposed to antibiotics, most will die. The ones that don't are resistant to that drug. When these adaptable drug-resistant bacteria proliferate, we have to adapt as well; we have to develop new drugs that can kill bacteria! When in nature, random breeding will result in wide genetic diversity, but our selective breeding gives us the good (tasty tomatoes) and the bad (farm animals so packed with meat that they can barely walk).

This brings another issue to the forefront: ethical and moral issues. The question that we're struggling with as a human race right now can be seen as, "Just because we can, does that mean we should?" Selective breeding allowed humans to grow and proliferate, bringing us advances in agriculture that kept us fed, but should this evolving technology be applied to our brothers, our sisters, our children?

The world works in cycles. We are made of the same materials that were once part of mountains, soil, bacteria, plants, and animals. We are not new. We are recycled. But our society doesn't recognize that; as Americans we believe we're above this cycle. We are the food we ate, our tears are rivers and ice caps, our flesh are mountains. When we ignore these realities, we create a possible world in our own future- one that can't support the life we've learned to keep so precious. Humans impact environmental health by the choices that we make. Even deciding to eradicate disease will impact the health of our environment. If our population continues to grow, we will have to evolve ever more productive food sources. In addition, we'll have to examine where we get our energy. Our need will soon outstrip our resources, and this will become more dire as more and more of human kind lives to be a healthy 100. Where will we put our waste? Will we continue to landfill? If so, what happens to the groundwater polluted as leachate sinks down? What if we turn more and more to incineration? What impact will this have on air quality? What will happen to soil as we strip all the nutrients in our increasing need for food?

These questions have no answer, and each one leads to more questions… But each leads to a possible world, and these stories can help put the answers within reach. On the one hand, there are hundreds of diseases that could be cured or prevented: painful, tragic, and usually adult onset (evolution at work), diseases that break apart families like Parkinson's, Alzheimer's, and cancer. Or what about the prospect of an end to quality of life diseases: no more diabetes, obesity, fibromyalgia, or alcoholism? Not to mention the diseases that wreak havoc in children's lives: cystic fibrosis or autism. What if we could end the pain, the suffering, or the sorrow inherent in life? One possible world is the world of *Brave New World*, where we engineer so much of life that the words mother and father become imbued with filth, and people are designed to occupy one social strata or another. Another possible future is in *GATTACA*; the transition world where stereotype is not against you; your life is predicted by a blood test on birth, and all future discrimination is construed as scientific fact. However, our hero will show that prediction is not fact. Each story will show a different way that people have adapted to biological futures. *Brave New World* also deals with consumerism; some people are "designed" to throw things out after one use, others to repair & reuse. Though slightly tangential to the *Brave New World* story, these facets of the story can be used to study human impacts on environmental health.

After learning the relevant science, writing their own short story following the model of *Blood Child* will be the natural conclusion of this unit. The story will be accompanied by a scene in Alice that accompanies the climax of their own story. In addition, it will explain the science of the world, in a pre-Heinlein fashion. Lastly, it will explain the five rules that govern the people, from government or social structures. Each of these facets will be dealt with by me or my colleagues during the unit.

This unit will fit in to the School of the Future curriculum, which is slightly different than the School District of Philadelphia curriculum. This will fit learners at the first or second year of high school who are learning basic biology and the nature of science.

Objectives

The objective of this project is to develop an understanding of biological concepts, society, and the possible worlds that are written about, exist, or could exist. Learners will read books, watch movies, program computers, and ultimately write a science fiction story of their own. The project will be standards-referenced. In other words, each shorter unit of study will stem from, and refer to, a standard from the Pennsylvania State Science Assessment Anchors and the Pennsylvania State Science & Technology or Environmental & Ecology Standards. The curriculum design allows direct translation from standards to curriculum.

Strategies

Possible Worlds is a project that is being written as part of a three-person team. The learners in this project will be cross-curricularly enrolled in the same math/technology class (Numeracy), the same science class (Phenomena) and the same social studies/English class (Humanities). They may not be together all day, but they will all see the same educators during the day. In this way, we can ensure that they will read the books, see the movies, learn the science, discover the technology, be trained in the writing skills, and generally have the experiences that will enable them to successfully complete the project, including the final short story they'll write & publish.

In my class, my strategies will include covering the required science content, blended with science skills that are required for the level of learning. Each shorter phase of learning will be complemented with what we call a "performance of understanding," an activity in which the learners perform that they have learned the content and skills of the last few weeks. Performances of understanding are generally the tasks on which learners are assessed, and are tasks in which we ask learners to use the knowledge gained over the last few weeks in an authentic manner. Some typical tests or quizzes will be used, but generally, we will assess understanding through the application of knowledge through debate & creation.

As this is a project that is longer in duration, you can expect to see or use many different educational strategies. Occasionally, lecture will be used, and since our school is designed for overhead projection, Power Points will be developed to help guide learners through the lectures. Learners will be presented with, and will create their own Inspiration graphic organizers- flow charts and Venn diagrams. As learners read both the novels and the science content sources, they will take notes using either a notebook or OneNote, a digital notebook. Learners will participate in POGILs, or activities designed around Process Oriented Guided Inquiry Learning. These activities take learners through the learning cycle while in learning teams. The learning cycle has three phases; exploration, formation, and application. (Hansen 5) Learners will prepare for and participate in a debate, they will read books & stories, watch movies, make predictions, make a poster, write a short story, and program a scene from their story.

Classroom Activities

This will be a 12 week project. Some of the facets of the work will be done in other classes; for example the lion's share of the reading will be done in the Humanities Class. On the other hand, I have the requirement to make sure that the science is strong.
My classroom units will be as follows:

Nutrient Cycling: Where do we come from? Where do we go?
Genetics: Can you predict DNA's outcomes?
Debate: Just because we can, does that mean we should?

Systems: How do we handle things?
Spaceship 3000: We have to abandon the Earth, how can we design our spaceship?
Final POU (Performance of Understanding): Describe the science in your story.

Nutrient Cycling

The first unit of study will be Nutrient Cycling. In this unit, learners will investigate the Law of Conservation of Matter. If matter is neither created nor destroyed, then where did our physical bodies come from? Where do we go when we die? Why do we eat? Why do we get rid of waste? If food contains "nutrients," where did it get them? How can we use the nutrients? For learners, it is often a surprise to find that our very elements were created in a giant stellar explosion called a supernova, and that we are breathing the very air that our ancestors breathed; that our tears were once rivers or rain or snow; and that we, in fact, are what we eat.

In the final activity, learners will plot the life of nutrients as they cycle thorough our ecosystems. They will play a dice game that shows the fate of nutrients as they cycle the environment. If they roll a 6, 7, or 8, the nutrient will move on to the next step. If they roll any other number, the nutrient will stay in its current location, in its current form. Learners will describe the changes that can happen in each step, as well as how long it takes for the change to occur. (Each dice roll takes an average of a decade.)

For example: N_2 is a gas in the air. Roll the dice to see what happens to N_2.
If 6, 7, or 8 is rolled, learners will have to describe the next thing that could happen is that bacteria in the soil could turn the N_2 into ammonium (NH_4^+) found in the soil. If any other number is rolled, the learner will write that N_2 remains as gas in the atmosphere for a decade. This activity can be accompanied by a lesson on probability- that would segue nicely into the probabilities associated with genetics.

Genetics 101

The second unit will be Genetics 101. Learners will learn about DNA, chromosomes, and genes, and how they influence phenotypic expression. After some typical lectures, learners will complete four laboratory activities. The first will involve flipping coins and teach about probability and genetic expression. The second will teach about complete dominance using colored opaque disks that the kids will label on both sides. The third will teach about incomplete dominance. This activity uses two transparent colored disks- one yellow and one blue. This activity shows that sometimes, when the traits are combined, the phenotypic expression is also a combination- like when red and white flowers are crossed to make a pink flower. The last activity will be more complex. This one uses four-sided dice. Each number represents one combination in a dihybrid cross. For example 1 represents a combination of dominant genes, 2 represents one dominant and one recessive gene, Ry, 3 represents one dominant and one recessive gene, rY, and 4 represents a combination of recessive genes. One die represents the law of independent assortment in the mother's oogenesis, while the other represents the same thing in the father's spermatogenesis. The combinations of die, when rolled, will show the law of independent assortment in action. These labs are pretty typical high school biology labs.

Just because we can, does that mean we should?

The third unit will be 'Just because we can, does that mean we should?' In this unit, we discuss genetic changes that humans CAN make. We will also discuss some of the ethical implications of making those changes. To begin this unit, we'll watch *GATTACA.* In this movie, a man is born as "love child," one of the last children born by natural means in a time of great genetic and cultural change. The baby is labeled at birth to be at high risk of early death from a heart defect, and as a result he is banned from schools and playgrounds as a child, and is relegated to menial labor as an adult. He goes to extreme lengths to exchange places with a genetically superior man who has been injured in an accident and has resorted to alcoholism. He gets the job of his dreams, and is poised to go in to space as an astronaut when a high level official at his job is murdered. Murder is a rare crime, as genes for violence are typically bred out of the people. Despite his best efforts, the hero has lost one eyelash, and the detectives find it! A thorough investigation ensues, while the hero falls in love, tries to elude discovery, and attempts to retain his position in the space race.

This movie ties in neatly with *Brave New World*, because that work also has a social structure that is closely monitored by science. Babies are so far removed from the natural births to which we are accustomed, words like "father" and "mother" are socially taboo. The science and societies of *Brave New World* have taken the genetic engineering of *GATTACA* one step further, and have created five classes of people, each of whom have a role and a place in society. The genetic engineering is dovetailed with social engineering as kids are psychologically manipulated to blend in seamlessly with society; from how frequently to purchase new items to how many times you ought to have sex with one partner, social mores are trained from a very young age in this classic novel.

These two stories of possible worlds show a kind of progression of what could be our future. To finish up this unit, I'd have a debate called "Just because we can, does that mean we should?" This debate will try to get to the heart of the issues of genetic manipulation. The roles the learners could take are listed on the following page:

Pro	Con
Genetic Counselor	Religious Leader
Child of a parent with Alzheimer's who wishes to stop his/her pain.	Child of a parent with Alzheimer's who is scared to find out if she/he will also have the disease later in life.
Parent of a child with a genetic disorder	Parent of a child with a genetic disorder
Celebrity who suffers Parkinson's	Celebrity who believes that populations are growing too large and that people shouldn't change "the natural order."
College student majoring in genetics	College student majoring in law
World famous doctor who treats children with genetic disorders	World famous doctor who treats extremely elderly patients
Farmer who grows crops genetically modified to be resistant to disease	Farmer who grows crops genetically modified to not make seeds, so they have to buy seeds each year.
Child in America who wants to buy the "glow in the dark" fish	California lawmaker who voted to prohibit the sale of glow in the dark fish.

Each learner will develop THREE reasons why their character chooses that position. Each reason must be supported with facts, discovered through research. Each learner will develop THREE things they think their opponent will say, and ONE rebuttal point.

The debate will proceed as follows:

A "Pro learner" will have 1 minute to present their position. The "Con learners" can pose questions to the presenter for 1 minute. Only the learner who presented will have the opportunity to answer questions. The same procedure will be followed by the "Con learners," and the cycle will repeat until each learner has presented. The debate will then adjourn, and learners will have to judge the merits of the arguments. Each learner will write three facts or opinions they found persuasive in the presentations. They will then vote for the most persuasive argument; Pro or Con. At this point, I could work with their humanities educator to help them write a position paper, or a persuasive essay answering the question "just because we can, does that mean we should?" In the past, I've found that learners are often very opinionated on this topic, and especially as high school learners, they've had some type of family experience through which they can relate to this topic. Learners will frequently be very vocal about their desire to know and get tested for genetic diseases or disorders that plague their families, or they can be just as vocal and opinionated that they do not wish to know the future. The goal of this activity is to help learners develop factual evidence for their claims and to help them use research to support their opinions.

Systems

The fourth unit will be Systems, in which they'll learn about the systems our culture has developed to deal with our need for energy and our accumulation of products, and our elimination of waste. The systems we'll focus on are:

- Energy production
- Industrial production of goods
- Agricultural production of food
- Landfilling, waste incineration, and recycling

Learners, in my experience, have little or no concept of how things get to them. I don't really blame them; an understanding of the ways in which agricultural, industrial, and commercial systems interact to provide us with the services and products needed to sustain urban life eluded me until my adult years.

This unit is chock full of interesting facts and information; from how we get electricity from spinning turbines to how farms produce crops. Factories produce the products we purchase, and the materials or the product (or both!) can travel hundreds of thousands of miles before we purchase them. The first thing we do when we get the product home is often throw away the packaging that was used to keep the product safe or intact during its travels. When we leave electricity running, when we litter, when throw things away, we impact the natural environment. When we recycle, compost, and reduce our energy use, we impact the natural environment. Those different sets of actions can have different consequences.

This unit will be designed to teach the systems that we use to keep our societies running in the manner to which we are accustomed. It will also begin to pose the question, "Is this sustainable?" This unit, however, will end with a typical end of unit exam, ensuring that the learners know what the systems are and how they work. This will be crucial, as the next unit will build upon this knowledge.

Spaceship 3000

The fifth unit will be Spaceship 3000, which will be a way for the learners to integrate and apply the knowledge gained in the previous unit, Systems. In this activity, learners will be told that it is the year 3000. The Earth can no longer support life, and they need to pick a team of top-notch scientist to help them build a spaceship that can carry human life into the future (and space) which is self-sustaining. We have seen a planet that we may be able to inhabit, but it is so far away that most likely our grandchildren will be the ones landing on it! The challenge will be to design a spaceship whose waste removal systems can be used to recapture any useful materials- this spaceship must follow the law of conservation of matter! How will we get energy? Will there be any waste produced by that method? If so, how will we deal with the waste? The same series of questions will be asked about the food we eat, the clothes we wear, the recreation we participate in, the products they plan to sell on the spaceship. This activity is designed to get kids thinking about the obvious (to us) analogy- the Earth is a spaceship, and we need to design systems for living on Earth that don't end BEFORE we put the materials back into the "cycle of life." When we don't know where our food comes from, or where our trash goes, we can't make complete decisions.

The Final Performance of Understanding[1]

The final POU will be to write a short story that shows a possible world. As a culmination of their work in the Humanities, Math/Technology and Science over the learning cycle, learners will complete a cross-curricular final project. They will be asked to create, outline, write about and program a Possible World. The science component of this project will include writing a section of the short story that takes explains the scientific laws that govern this possible world.

In this activity, the learner will need to include a chapter, section, or passage that explains how this world works. During this time, the learner will be working in a very independent manner. The learner will have to write the story, and I will be acting as a science fact consultant. The world they create could be one in which we are used as the energy for an alien species (like in the *Matrix*) or one in which the future job & education for which they're destined is determined before birth by the genetic engineering (like *GATTACA* or *Brave New World*) or one in which humanity is now located on a different planet whose inhabitants use us as incubators for their young (as in Blood Child). In their story, they could have constructed a society on another planet, or in an alternate universe, and their ideas can be as many and varied as the vast expanse of the science fiction that exists in the world. My role will be to ensure that they adequately describe the scientific rules that govern this world, and that they match the laws we know to be true.

In order to ensure their work is scientifically accurate, I have two plans. The first involved the pitch. When the learner is pitching the story, I'll require a pitch. In the pitch, the learner writes a short explanation of the setting of the story, and a few ideas of characters and plot. In this way, I'll be able to hold them true to their ideas. The second part of the plan involves one on one meetings with each learner. These meetings can be scheduled such that each learner will have ten minutes with me, as if they had office hours. In this meeting, they can mull over their options, they can ask any questions, and they can have another pair of eyes reading their story. Hopefully, this will help to fulfill the dual task of keeping them on track and helping them describe the science that governs their world.

This POU is really the culminating activity in the whole project. It is a completely unique piece of writing that can be printed, bound, or catalogued. The learners will be able to draw on all they've learned, all they've read and watched, all they've designed in the virtual world, to develop their own world. In addition to being interdisciplinary, this final performance of understanding will be enduring and interesting!

This detailed description of the POU was designed by Kate Reber. Because the project is interdisciplinary, learners will work on it in each class, and the project will be jointly graded by the educators.

Learning Goals

The Learners will develop systems, institutions, philosophies and scientific laws of their possible worlds. Learners will understand the implications of the decisions they make about the systems and structures of their world, and will write descriptively about their world and the characters in it.

Objectives

Learners will be able to:

- Draw on readings to create their possible world.
- Synthesize essential ideas from texts.
- Understand and develop consistent and workable social systems and scientific laws.
- Predict outcomes.
- Identify causes and effects.
- Write with focus and creativity.
- Include literary elements and literary devices in their writing.
- Revise writing.
- Use media for learning purposes.

Materials

- Computers with internet access.
- Guiding Questions sheet
- Writing tools – paper/pen or computer for drafting, revising, editing, etc.
- Resources & Educator-provided checklist for revision.

Learning Plan

Introduction to Project

Learners will receive a project description sheet, including a rubric for assessment, and will discuss project specifications with the educators before beginning the writing process.

Research & Planning

Research will be done in class and at home. Learners will be provided with some models of possible worlds. Learners will have read or seen movies that depict multiple utopian and dystopian possible worlds, with the intent that they can mine these sources for ideas as they write their stories. As they conduct their research, learners will also work to develop their own version of a possible world.

Guiding Questions

Learners will use the Guiding Questions sheet to help them think through the structures and systems that support the world they envision. This will also help the learners focus on what details need to be included in the exposition of their short stories in order for the reader to understand the Possible World. Learners will need to explain the governance of their world in the Humanities class. They will need to explain natural phenomena of the world in their Science class.

The Rules

Learners must define at least 5 rules that govern their Possible World. These rules should be consistent throughout the short story. These rules must be explained in some way by the events or description in the story. These rules must be consistent with real scientific law.

Short Stories

Learners will first brainstorm ideas for the short story that will take place in their possible world. We will use a variety of classroom strategies to help the learners identify the plot, setting and characters of their story. As their story takes shape, learners will map out the sequence of events using storyboarding (a scene-by-scene approach to narrative writing). They will then work to draft writing around the ideas presented in their storyboards. The storyboards and first drafts of the short stories will be workshopped in small groups so that learners can get feedback from their peers. When learners are satisfied with their second draft they will submit it for educator review. The educator feedback and more peer feedback will help learners prepare the final draft of their stories. Most of the writing process will take place in class, so that learners can have support from their educator and peers as they work on their stories.

Publishing & Presenting

Learners will publish their short stories to a class website. Learners will present the virtual version of their possible world (developed with the Math/Technology Educator) to the class.

Annotated Bibliography/Resources

a) For teachers

Asimov, Isaac. *Robot Visions*. New York: Byron Preiss Visual Publications, Inc., 1990.
This book includes the two short stories that we'll need to read; the first that teaches the three rules of robots, and the last in which the rules seem to be broken. This is one of our possible worlds.

Brain, Marshall. "How Power Grids Work." 01 April 2000. HowStuffWorks.com. <http://science.howstuffworks.com/power.htm> 12 June 2008.
I used this resource to verify some information about power grid resources and how energy is created and delivered to resources.

Butler, Octavia E. *Bloodchild and Other Stories*. New York: Four Walls Eight Windows, 1995.
This book of stories can be completely read by advanced readers, but all learners will read the Bloodchild story, and learn about one possible world on a different planet.

Hanson, David M. *Instructor's Guide to Process-Oriented Guided-Inquiry Learning*. Lisle: Pacific Crest, 2006.
I have used this resource frequently to design POGIL exercises to use in my classroom. The nutrient cycling unit of this project relies heavily on POGILs, so I referenced this resource.

Huxley, Aldous. ***Brave New World***. Philadelphia: Chelsea House Publications, 2004.
This is the only full length book we're reading in this project, and it is one that really displays the biological science principals that we need to cover during this project. It also lends itself to the question; 'just because we can does that mean we should?' Finally, the biological control is closely married to the psychological conditioning, which ties into the idea that society is governed by the social rules as much as the science of the world.

Films

Gattaca. Dir. Andrew Niccol. Video, Columbia TriStar, 1997.
This movie is an analogue of Brave New World, in which the main character has to cover his own identity and assume that of another in order to pursue his dreams because he is genetically inferior to others in his society.

Matrix. Dir. Andy and Larry Wachowski. DVD, Warner Bros. 1999.
This movie is used to show that possible worlds can be dystopian, can be dire, and can be largely inside one's own head. This movie opens different possibilities for the learners' own short stories.

Aeon Flux. Dir. Karyn Kusama. DVD, Paramount Pictures, 2003.
This movie is another dystopian view of the future- though science is in leadership, a virus has wiped out most of the populations. This also shows different possible futures.

b) Reading list for students

Asimov, Isaac. *I, Robot*. Greenwich: Fawcett Publications, 1970.

Butler, Octavia E. *Bloodchild and Other Stories*. New York: Four Walls Eight Windows, 1995.

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c) **Appendices-Standards**

The Nature of Science	S11.A.1.1.1 Compare and contrast scientific theories, scientific laws, and beliefs (e.g., the law of gravity, how light travels, formation of moons, stages of ecological succession).
	S11.A.1.1.3 Evaluate the appropriateness of research questions (e.g., testable vs. not-testable).
	S11.A.1.1.4 Explain how specific scientific knowledge or technological design concepts solve practical problems (e.g., momentum, Newton's laws of universal gravitation, tectonics, conservation of mass and energy, cell theory, theory of evolution, atomic theory, theory of relativity, Pasteur's germ theory, relativity, heliocentric theory, gas laws, processing and feedback systems).
	S11.A.2.1.1 Critique the elements of an experimental design (e.g., raising questions, formulating hypotheses, developing procedures, identifying variables, manipulating variables, interpreting data, and drawing conclusions) applicable to a specific experimental design.
	S11.A.2.1.2 Critique the elements of the design process (e.g. identify the problem, understand criteria, create solutions, select solution, test/evaluate and communicate results) applicable to a specific technological design.
	S11.A.2.1.4 Critique the results and conclusions of scientific inquiry for consistency and logic.
	S11.A.2.1.5 Communicate results of investigations using multiple representations.
	S11.A.3.1.2 Analyze and predict the effect of making a change in one part of a system on the system as a whole.
	S11.A.3.1.3 Use appropriate quantitative data to describe or interpret a system (e.g., biological indices, electrical circuit data, automobile diagnostic systems data).

Biological Sciences	S11.A.3.1.4 Apply the universal systems model of inputs, processes, outputs, and feedback to a working system (e.g., heating systems, motor, food production) and identify the resources necessary for operation of the system.
	S11.B.2.2.1 Describe how genetic information is expressed (i.e., DNA, genes, chromosomes, transcription, translation, and replication).
	S11.B.2.2.2 Compare and contrast the functions of mitosis and meiosis in passing on genetic information.
	S11.B.2.2.3 Explain how different patterns of inheritance affect population variability. (i.e., multiple alleles, co-dominance, dominance, recessiveness, and sex-influenced traits).
	S11.B.3.2.1 Use evidence to explain how cyclical patterns in population dynamics affect natural systems.
	S11.B.3.2.2 Explain biological diversity as an indicator of a healthy environment.
	S11.B.3.2.3 Explain how natural processes (e.g., seasonal change, catastrophic events, habitat alterations) impact the environment over time.

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3.3.10.C Describe how genetic information is inherited and expressed.

- Compare and contrast the function of mitosis and meiosis.
- Describe mutations' effects on a trait's expression.
- Compare random and selective breeding practices and their results (e.g., antibiotic resistant bacteria).
- Explain the relationship among DNA, genes and chromosomes.
- Explain different types of inheritance (e.g., multiple allele, sex-influenced traits).
- Describe the role of DNA in protein synthesis as it relates to gene expression.

3.1.10.C Apply patterns as repeated processes or recurring elements in science and technology.

4.2.10.D Explain different management alternatives involved in recycling and solid waste management.

- Analyze the manufacturing process (before, during and after) with consideration for resource recovery.
- Compare various methods dealing with solid waste (e.g., incineration, compost, land application).

4.3.10.B Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices.

- Explain how human practices affect the quality of the water and soil.
- Identify evidence of natural events around the world and their effects on environmental health (e.g., Yellowstone National Park fires).
- Identify local and state environmental regulations and their impact on environmental health.

4.3.10.C Explain biological diversity as an indicator of a healthy environment.

- Explain species diversity.
- Analyze the effects of species extinction on the health of an ecosystem.

LRP Calendar for this unit (Long Range Planning)

Week #	Mon	Tue	Wed	Thu	Fri
Week 0				Sept 4	5
Week 1	8	9	10	11	12
Week 2	15	16	17	18	19
Week 3	22	23	24	25	26
Week 4	29	30	Oct 1	2	3
Week 5	6	7	8	9	10
Week 6	13	14	15	16	17
Week 7	20	21	22	23	24
Week 8	27	28	29	30	31
Week 9	Nov 3	Staff Only 4	5	6	7
Week 10	10	11	12	13	14
Week 11	17	18	19	20	21
Week 12	24	25	26	27	28

Unit 1: Where do we come from, where do we go?

Unit 2: Genetics 101

Unit 3: Just because we can, does that mean we should?

Unit 4: Systems

Unit 5: It’s not that easy! (Spaceship 3000)

Final POU: Your Possible World Story

Notes

1. I must cite Kate Reber for the bulk of the learning plan for the final POU.