Death by Radiation

Harold Stevens

The Academic Setting

Del Norte High School is in the northeast section of Albuquerque. The school population has changed as the city has grown farther north and east. It used to be the school with students from many of the most affluent families. Now the APS administration has reduced the school's boundaries so that it currently has 1673 students, the lowest enrollment of any regular Albuquerque high school. The student population represents all of the Albuquerque community's economic groups with the exception of the richest sector. Seventeen per cent of students according to APS RDA staff calculations are eligible for reduced or free meals. Such students are more likely than others to have special needs relating to poverty. That percentage is about average in Albuquerque since all APS high schools average eighteen percent eligible for federal meal programs.

Student ethnicity at Del Norte reflects the ethnicity of the state of New Mexico. Indeed, it is the APS high school which most closely matches the diversity of the state. Forty-one percent of the students are classified as Anglo, forty-two percent Hispanic, eight percent Native American Indian, six percent African-American, two percent Asian, and a smidgen of other. That makes the students slightly less Anglo and Hispanic than the APS average and about twice as Black and Indian as the APS average. Ethnically Del Norte is a bridge between the much more homogeneous Anglo schools of the far northeast heights and the much more homogeneous Hispanic schools in the valley. Del Norte is an integrated student population.

Classes

This unit would fit into the U.S. history class that is offered throughout APS at the junior level. It could just as well fit into a world history class, a contemporary issues class or, outside the social studies department altogether, an environmental studies class.

Goals and Objectives

Juniors and seniors are either voting citizens or very soon will be. They will choose, by commission or omission, local, state and national leaders who will decide what actions our governments will take. One issue governments have been forced to deal with since July 16, 1945, has been how to control the tremendous energy of nuclear power. If our students become wise citizens who know enough to choose wise leaders, that energy can be harnessed to improve life. On the other hand, ignoring the issue or basing decisions on hysteria can lead to disaster. This unit aims at sensitizing citizens to one of the issues they and their leaders must deal with.

From the New Mexico Content Standards with Benchmarks, Social Studies Unifying Concepts and Processes, this unit meets the following criteria:

> STANDARD 1: Students will use knowledge … to explain how the world's people cope with ever-changing conditions, examine issues from multiple perspectives….

1A Analyze the influences of people, history, economics and geography in New Mexico which created opportunities for New Mexico as the state in the 20th and 21st century.

1B Describe and analyze the role of the United States as it faced internal and external challenges as a nation.

1C Analyze and explain how nations share commonalties and differences and that influences within nations generate their history's direction and distinction.

STANDARD 2: Students will use democratic understanding and civic values to work together, make informed judgments and decisions, and act in accordance with democratic processes and principles to … serve their interests and promote the common good in order to become effective United States citizens….

2C Analyze consequences of particular political, social and economic conditions.

STANDARD 3: Students will know, understand and apply the language, tools, and skills of social studies.

Students will:
3A analyze the reliability and validity of social studies information sources:

3B Evaluate and choose the most persuasive social studies concepts and vocabulary to explore issues and problems; and

3C Evaluate the roles of citizens and their participation and involvement in civic projects.

STANDARD 5: Students will know and understand relationships and patterns in history in order to understand the past and present and prepare for the future.

Students will:
5A Apply ideas, theories and modes of historical inquiry to understand historical and contemporary developments in order to make informed decisions and take appropriate action concerning public policy issues.

5B Investigate and analyze the people, events, problems and ideas that created the … history of New Mexico and the Southwest.

5C and the U.S. and Western Hemisphere.

STANDARD 9: Students will understand, develop and employ the civic skills necessary for participatory citizenship.

STANDARD 12: Students will know and understand physical environments and their relationships to ecosystems and human activities.

12D Evaluate the relationships among various regional and global patterns of geographic phenomena….

12G Evaluate and predict how environmental changes and crises impact society and the economy around the world.

STANDARD 13: Students will know and understand the impact of science and technology on societies.

Students will:
13A Analyze the influence of science and technology upon society.

13B Evaluate how science and technology have transformed the physical world and human society: and

13C Analyze how science and technologies influence and are influenced by core values, beliefs and attitudes of society, including public policies.

STANDARD 14: Students will know and understand the role of global connections and interdependence between and among individuals, groups, societies, and nations.

Students will:
14C Analyze and assess the causes, consequences, and evaluate possible solutions to persistent contemporary and emerging global issues:

14F Compare and evaluate relationships and tensions between national sovereignty and international interests in such matters as … nuclear and other weapons….

Narrative

Hiroshima

Not all the survivors of the August 6, 1945, atomic blast at Hiroshima were lucky to have survived. The blast was the equal to a blast caused by 15,000 tons (15 kilotons) of TNT (Shohno 19). Imagine for a second just one ton of TNT.

The explosion made a fireball of 10,000 degrees in temperature with a radius of about two football fields. It sent out a shock wave that traveled about seven miles from ground zero, the point on the ground directly beneath the explosion. The intense thermal rays incinerated wooden buildings, and the blast of the shock wave turned many brick and even concrete buildings into piles of rubble (Shohno 15).

People fared even worse. Fifty percent of the energy of an atomic explosion is consumed in the blast. Thousands of people were consumed by the initial blast at the center of a city of 280,000 inhabitants. Most were killed, not by the blast itself, but by flying shards of glass, rock, wood and falling roofs and walls. Some close to ground zero were vaporized, leaving only dim shadows silhouetted on sidewalks

Yoshitaka Kawamoto described the effects of the blast. When the bomb exploded he was a thirteen-year-old student in a classroom who was getting out of his desk to look at a B-29 flying by. In the next instant he was knocked unconscious. He awoke under a pile of rubble. He was able to free himself, but he could not uncover those whose voices he heard pleading for help because of a fire that swept through the rubble. He describes looking back at a half-buried classmate: "Smoke was filling the air. I turned back and I saw my classmate Wada looking at me. I still remember … and it still appears in dreams. I felt sorry for him…I was running (*Voice*).

Thirty percent of the energy of an atomic explosion reveals itself as heat rays. Within a mile of ground zero, these thermal rays ignited all things flammable and created third degree burns on human skin. Third degree burns occur when the skin is destroyed so it turns white and coagulates. Coagulation occurs when burnt flesh becomes a soft, semisolid mass. When a quarter of the body has third degree burns, death is the prognosis unless there is massive medical intervention. Farther out, between a mile and a mile and a half from ground zero, some fires occurred and human skin suffered second degree burns. Second degree burns usually eventually cause death if they cover a third of the body. These burns are white, and there is some coagulation. Thermal rays of the blast taper off in intensity the farther one gets from ground zero. From about a mile and a half to two and a quarter miles, people only suffered first degree burns. These are non-life threatening red spots (sunburn). Thousands were burnt to death by the heat energy of the bomb. (Incidentally, the fires created in the destroyed buildings killed thousands more after the explosion itself subsided).

Damage by thermal rays are described by Michiyoshi Nukushina, a Hiroshima survivor who was in a boat approached by a schoolgirl of fifteen or sixteen. "She happened to look up, and then the skin of her face suddenly split open as if a mask had come off. Only half of her head, which appeared as smooth as a pink pebble, remained, except for some pits which had been her eyes, nose and mouth." (Shohno 21)

Fifteen percent of the energy released by the atomic explosion took a more sinister form. It became radiation. The various types of radiation were most intense at ground zero and tapered off to just about nothing at about one and a half miles from the blast. Unlike the blast itself and the thermal rays, radiation's effects are not evident and not immediate. Those who were lucky enough might have been shielded from the blast and the thermal rays because of a hill or a rock. Many, apparently uninjured by the initial explosion, found they had not escaped the bomb after all. Within days, their hair began to fall out, their gums began to bleed and within a month, many more joined the thousands immediately killed by the blast. That was not the end of it. Some effects of the bomb were deceptive. They did not show up until five years, or ten years or apparently even forty years after exposure. This silent, invisible killer was radiation poisoning.

Radiation

The effects of radiation are not as exotic as humans have hoped. In pop culture the bite of a radioactive spider can transform a poor, downtrodden youth into a superhero. An accident with cosmic rays makes a geeky scientist into the powerful Hulk. The X-Men, too, get changed by radioactive rays into beings with the ability to shoot beams out of their heads, read people's minds, and do other wonderful stuff. The reasoning must be since radioactivity results from one element changing into another, it surely can change regular humdrum humans into the creatures they dream of being. So far science has yet to observe any human mutations including, regrettably, those of the superhuman variety resulting from radioactivity.

The early researchers into radioactivity did not know of the effects of the substance with which they were working. Madam Marie Curie won a Nobel Prize for discovering and separating from uranium two new radioactive elements, radium and polonium. One of the prizes she proudly wore as a reward for her work was a pendant of radium. She eventually died a victim of leukemia or cancer of the blood that has been strongly linked to radiation overexposure. Her daughter continued her work and likewise died of leukemia. Indeed, forty percent of the early researchers in radioactivity (radiologists) have died from cancers (*UIC*).

Soon after radioactivity was first discovered, people believed it might have great medicinal uses. Since radium gave off energy, there were those who believed drinking or injecting it would increase the health and energy of people. Sometime after its discovery, an American entrepreneur created a beverage with radon and extolled its effects as an elixir. It was called Revigorator. In 1925 a snake oil was made from radium and sold as a cure for sexual dysfunction. The inventor eventually died of bladder cancer. Ironically, it's radioactivity's ability to kill cancer cells that makes it a powerful medical tool (*UIC*).

In 1929 doctors in Germany and Czechoslovakia noticed that 50% of the miners working Europe's only uranium mine had lung cancer. They suspected that radioactive radon gas that naturally results from the decay of uranium was being breathed by miners and emitting deadly particles into delicate lung tissue. Young female dial painters also suffered from exposure to radioactive materials. They were hired to paint luminous radium paint on watches and dials that could then be read in the dark. To keep their brushes sharp, from time to time they would moisten the brushes with their lips. For fun they would paint their nails, lips or teeth. Within a year their teeth began to fall out and their jaws disintegrated. When they began to sicken and die in large numbers, doctors discovered their bodies had large amounts of radon and other radioactive substances. By 1941 the medical community arrived at a dose limit of radon exposure to deal with the disease. When the Manhattan Project began, the scientific community realized that radioactivity was dangerous enough that a medical-safety staff was created to study and protect scientists from possible harm from radiation (*Containing* 23).

Hiroshima and Nagasaki revealed that there are many ways for atomic bombs to kill. Scientists expected the casualties caused by the blast and shock wave. They expected the death from thermal rays and secondary fires. The lingering deaths caused by radiation were not a major consideration at the time of the decision to build or drop the bomb.

Radiation represented about 15% of the energy released by the fission of uranium-235 at Hiroshima. In measuring radiation scientists refer to the half-lethal dose. This is the amount of radiation, that will kill half of the people exposed to it within days. At Hiroshima Little Boy emitted a half-lethal dose of radiation out to a distance of a little more than a half a mile (Shohno 24). Perhaps mercifully, most of the people this close to ground zero did not have to suffer the excruciating, slow death of radiation poisoning:

they were already dead because they had already been blown apart by the blast or burnt to ashes by the thermal rays.

Fumiko Nakahiro described her father, a victim of massive radiation dosage at Hiroshima: "Father’s hair had all fallen out and he was covered in blue stigmata. He died shouting in delirium and his hands clawing the air" (Shohno 49).

If the initial blast of radiation were not bad enough, radiation has a secondary way of killing. Secondary or residual radiation results when particles of the fission reaction strike and change other substances so that they become radioactive. These new radioactive substances tend to have short half-lives so that after a hundred hours of their creation, they cease to be radioactive. During that time, however, thousands of rescue workers, soldiers and family members searching for loved ones entered the center of the radiation zone and contaminated themselves (*Committee*).

Fallout results from the parts of the nuclear bomb that do not get consumed in the blast. This radioactive debris remains dangerous for long periods of time. Furthermore, meteorological conditions such as wind and rain can move fallout great distances from ground zero. Huge fires frequently stir up the atmosphere so that rain results. Both at Nagasaki and Hiroshima rain followed the explosion. The air was so full of radioactive ash that the rain turned to a dark tarry "black rain" (Hersey 38). Fish in the rivers died and cattle that ate grass covered in the black rain died.

Fumiko Nakahiro describes how a lower dosage killed her sister. "She did not eat anything for several days, bleeding at the nose and vomiting blood, but she was still alive. The longer she lived the more she struggled with pain. When I spooned up a bit of canned orange and fed it to her, she cried complaining it hurt her throat. At last she died one month after the bombing" (Shohno 50).

How Radiation Kills

Radioactive materials throw out four types of emissions, all of which can damage human cells and kill people in large enough dosages. A radioactive means an element will eventually turn into another element with a lower atomic number. Uranium which is usually 238 atomic weight will over a few billion years decay into lower radioactive elements called daughters of uranium such as radium-226 or radon-222. Eventually these radioisotopes, which all started out as uranium, will decay to become lead 206, which is stable: it will not decay and it is not radioactive *(UIC*).

Whenever decay takes place, the mass of the new products is less than the mass of the original product. The disappearing mass has been turned into energy, which the atom has emitted. This all proves that Einstein was right, $e=mc^2$. Some of this energy is radiation.

Sometimes radioactive substances emit alpha particles from the nucleus of the atom when decay happens. These are massive positive charged particles that can be stopped with air molecules or a thin sheet of paper. However, they emit energy of their own and should an alpha particle end up in someone’s lung, for example, it can completely destroy human tissue all around it. Plutonium, for example, is so dangerous because it emits alpha particles. When the smallest amount of plutonium gets inhaled, it damages neighboring cells that quickly turn into fibrous growths that fill the lung and kill the victim (*UIC*).

Sometimes radioactive substances emit tiny, fast moving electrons. These beta rays can penetrate more deeply than alphas and damage human cells as they do so.

Sometimes radioactive substances give off neutrons that are very fast and penetrating. These mostly come from fissioning certain atoms in nuclear reactors or in certain bombs. The neutron bomb, for example, was designed to produce little blast but large amounts of neutron radiation to kill all humans in a city while leaving the buildings intact.

Gamma rays given off by nuclear reactions are pure energy very similar to X-rays. They have no mass but move very fast so they can travel right through a human body. To stop them takes thick barriers of concrete, water, and lead (*UIC*).

All of these particles and rays can damage or kill human cells when they rupture cell membranes or strike the nuclei. Rays that hit strands of DNA can knock out whole sequences of amino acids where the basic instructions to the cell are encoded. Cells with the radioactive mutated DNA may die or produce benign tumors or begin reproducing wildly to form malignant tumors such as cancer.

Symptoms

On August 21, 1945, at Los Alamos Labs, Harry Daghlian dropped a piece of metal on a plutonium assembly. The plutonium went critical (began to fission). Although it did not explode, it did produce a flash of blue radiation. He died within a month is spite of medical intervention. He suffered all the effects of radiation sickness that the Japanese victims of Hiroshima were reporting (Bartimus 108).

Atomic sickness produces a general malaise. Its victims report debilitating bouts with extreme fatigue and excruciating headaches. Nausea, vomiting, anorexia and diarrhea weaken the victims. There is loss of hair from the whole body. Painful sores fill the throat and mouth. The circulatory system is especially sensitive to the effects of radiation. People discharge blood orally, nasally, and anally. The count of white blood cells in the blood stream drops tremendously, and victims become anemic. At Hiroshima those with the most acute symptoms died within four months (Shohno 60).

After the most serious cases died off at Hiroshima, victims began to recuperate and hope that the ordeal was over. The damage radiation causes to DNA stays latent and often does not reveal itself for many years. Keloid scars- huge, smooth rubbery growths of tissue- covered the wounds of those exposed to radiation several months after the explosion. Teenagers tended to be most likely to develop this condition up to two years after the bombing.

Many of those within a mile of ground zero at Hiroshima developed cataracts about two years after the bombing. A cataract is a darkening of the crystal lens of the eyeball. Untreated cataracts cause blindness.

From three to thirty years after the bombing the number of cases of leukemia in Hiroshima was fifteen times higher than that of the rest of Japan (Shohno 62). Leukemia results when abnormal white blood cells produce wildly; it is a type of blood cancer. The blue stigmata (marks) that radiation victims exhibit are a symptom of leukemia. They result from blood so filled with white cells that it loses its red color. The white blood cells caused by leukemia tend to clump together instead of fighting bacteria. Therefore, those with leukemia are very susceptible to other infections. Usually they die from pneumonia that their immune system cannot fight off.

Most cancers have a longer incubation period than does leukemia. At Hiroshima fifteen years after the bomb, death by non-blood cancers began to increase among survivors who had been exposed to more than 100 rads of radiation (Shohno 62). Lung cancer, breast cancer, and thyroid cancer are all stimulated by high dosages of radiation. Cancers of the colon, stomach, urinary organs, and blood marrow are also probably linked to dosages of radiation. The uranium miners in the United States who provided the raw material to fuel the nuclear programs have reported much higher incidence of lung cancer than normal (Justice).

Decisions

Democracies impose responsibilities on their citizens. Citizens cannot blissfully assume the government knows best and will make wise decisions for the common good. Indeed, the history of the United States government and its stewardship of atomic energy are filled with egregious errors and incredible risks with the health and lives of incredible numbers of American citizens.

How does a citizen make a decision regarding something so dangerous and so esoteric as radiation?

Complacency and hysteria based on ignorance can both lead to disaster. American citizens must become members of an informed, rational electorate in order to elect decision-makers who can make hard decisions that need to be made in dealing with radioactive material.

In the rational decision-making process, people compare costs and benefits. Risks must be weighed. Simply because an activity entails a risk of danger does not necessarily mean it is not worthwhile.

The Hiroshima experience proved that nuclear fission had the capability of killing thousands of people in horrible ways. Accidents at Three Mile Island, Tokaimura, Japan, and especially at Chernobyl, Ukraine, showed that power plant accidents could release dangerous radiation into the atmosphere where many people could be exposed to the dangers of radiation poisoning. Obviously using nuclear materials entails risk of massive damage.

There are those who believe these risks are so great that the United States should unilaterally rid itself of its nuclear weapons and close all nuclear power plants. Indeed, there have been no new nuclear power plants built in the United States since the Three Mile Island accident.

Before uncritically accepting such a position, rational decision-makers need to consider all sides of the issue. There are many mundane things Americans use everyday without much thought that have killed many more people than nuclear fission. Last year around 43,000 Americans died in car accidents and 2,000 died due to the use of firearms (Famighetti 879). No deaths last year resulted directly from acute radiation poisoning. Americans apparently feel that the benefits of owning guns or cars outweigh the risk of death or disability caused by their use.

There is an irrational level of fear about radiation that makes people forget to ask if the benefits outweigh the risks (Weart). There is a great deal of what might be called radiotiophoia that interferes with rational decision-making. Perhaps the hysteria about radiation results from the secrecy about atomic research during the Cold War (Gastil).

Bring up the specter of radiation and many people rely on emotion instead of reason to make a decision. My seventy-five year old mother-in-law found out that smoke alarms depend on radioactive Cesium to operate. The idea that she was getting nuked by her smoke alarm made her want to get rip the safety device down and get it out of her apartment. Yes, there is a negligible chance that her seventy-five year old body might be damaged somehow by the radioisotope. But there is a much greater likelihood that the smoke alarm would save her from fire. Fire, incidentally, killed about 4,000 people in the U.S. last year (Famighetti 879). She was finally convinced to keep the alarm, but she still looks at it suspiciously. Such fear makes making decisions about radiation very difficult. Yet not facing the promise and perils of radiation is surrendering to ignorance.

Implementation

Assessment

There are several activities used to measure the effectiveness of the unit and instruction. A traditional test determines if students have the pertinent facts for discussing and thinking about radiation poisoning. The test will be partially objective questions and partially essay.

As a section of the notebook required of all students in my classes would be the completed and corrected worksheets, activities, and materials dealing with this unit.

Internet assignments in the computer lab will require teacher observation.

Lesson: *Hiroshima*

Many students have a difficult time reading. Assigning reading and assuming students will do it has been a recipe for failure. Even when I've managed to pump up student enthusiasm before reading, the intention to read often fails when the time comes to get the work of reading done. Many students require a concrete task to help them concentrate on reading. The worksheet in the documentation section of this unit can be used in class or at home to focus students on reading the book *Hiroshima*.

John Hersey wrote *Hiroshima* originally as a magazine article. It is credited with awakening many Americans to the sober truths about the effects of nuclear weapons.

After the students have read the first chapter, divide the class into six groups. Make each group responsible for one of the people in the book. Place a table on the board or overhead with six columns. In column one put the names of the six people whose stories are told. Column two would be distance from the blast. Column three is their description of the light. Column four is damage the blast caused them personally. As a basis for class discussion, fill out the chart.

After the students have finished reading the first four chapters, class discussion should deal with why people consider use of the atomic bomb different from the fire bombings of Dresden and Tokyo. After the bombing what is it Mr. Tanimoto so proud of?

Lesson: Radiation Poisoning Lecture

Lectures can be a fun, informative way of communicating information. Sex, violence and gore tend to be factors necessary to keep many students listening to speakers. By the time I will have gotten to this unit, students will have already been taught the rudiments of note-taking. I write a bare-bones outline on the board and, as I talk, I write down new vocabulary or difficult spellings. My lectures tend to be informal, so students are free to ask questions or interject opinions whenever they raise their hands.

Most of the material for this lecture would come from the narrative in this unit. The major purpose of the lecture would be to acquaint students with the effects of atomic radiation.

Lesson: Field Trip

When doing a unit on any thing nuclear we in Albuquerque are lucky to have the National Atomic Museum in commuting range. The best way to use this resource is to call the museum and arrange a bus pick-up and a tour led by a docent.

If the process of arranging a field trip is too cumbersome, give students who will go on their own time extra-credit. In the documentation are some search-and-find questions that students who go on their own can answer so that there is some documentation that they did actually spend some time looking at the exhibits.

Lesson: The Internet

The Internet, of course, is loaded with sources of various degrees of credibility dealing with atomic issues. So far, the lessons in this unit have stressed the dangers of radiation. This lesson will have the students use the Internet to discover the benefits of radiation. Students will be given one of three topics: radioimagery, nuclear power, or radiation therapy. Each will discover what the Internet says about how each of the above uses radiation. What advantages do each of the above have compared to traditional methods? What risks do each of the above have? Students will be asked to write an evaluative essay about their topic. They will be asked to weigh risks against benefits and reach a conclusion about the advisability of using nuclear technology.

Lesson: Decision-Making

Ask students what questions need to be asked when deciding whether or not to take a risk. Write their responses on the board. Questions might include:

> How much benefit will the action cause?
> How widespread will the benefits be?
> How much will the action cost?
> What type of damage might the action cause?
> How widespread might the damage be?
> How much might it cost to fix the damage the action might cause?

After the questions, give some case histories and have students use their questions to deal with the questions. A list of some case histories is located in the documentation section.

Documentation

Hiroshima Vocabulary List (In order of appearance)

Parish	incendiary	convection	putrid	canter
theology	debris	vortex	immolate	caricature
philanthropy	pommel	succor	deride	macabre
notorious	dilapidated	excruciating	inconsolable	verdancy
tyranny	plight	suppurate	moribund	capricious
estuary	askew	slough (v)	impromptu	cache
reconnaissance	prostrate	contusion	talisman	emanation
grotesque	punt	charnel	specie	torii
paroxysm	tableau	succinct	decrepit	incessant
atavistic	Occidental	lieu	disheveled	familial
convivial	affliction	repugnant	solicitous	maim
torso	breviary	diocese	stupefy	disarray
xenophobia	extricate	cumulative	laceration	apathetic

Guided Reading for *Hiroshima*

Chapter 1

What is the copyright date? How long is that from the time the bomb had been dropped?
How many people does the book say died because of the bomb?
What was it that the Japanese called B-*san*?
What rumor made Mr. Tanimoto jittery?
Why did some Japanese not trust Mr. Tanimoto?
Why did radar operators sound the all clear?
How far from the center were Mr. Tanimoto and his friend when the blast occurred?
How far away was the fisherman who heard the explosion?
What had Mrs. Hatsuyo done with her three children at midnight, August 5th?
What had all secondary school girls been ordered to do?
What had happened to Mr. Hatsuyo?
What were two ways Japanese hospitals differed from American ones?
What did the blast do to the hospital?
What did Father Kleinsorge belong to?
What did Dr. Sasaki say when he saw the flash?
What hurt Miss Sasaki most?

Chapter 2

Why did Mr. Tanimoto run to the city?
What does *Tasukete* mean?
What puzzled Dr. Fujii and Dr. Machii?
Why did so many citizens who might have lived, die?

How many were hurt by the bomb?
What did Mr. Fukai want?
Why did the burns make patterns?
Why did Mr. Tanimoto say, "Excuse me for having no burden like yours"?
Whom did he meet by chance?
Why did the burned people cry, "Miza"?
Describe the odor of the bomb?
What did Father Kleinsorge find to be the most dreadful and awesome phenomena?
What theory did the Japanese have for the destruction?
Why did Mrs. Kamai want to see her husband once more?

Chapter 3

What strange complaint did the young girl make to Father Kleinsorge?
How many victims came to the Read Cross Hospital?
What happened to the wounded people Mr. Tanimoto tried to save from drowning?
Why didn’t the army doctor treat the heavily wounded?
What had run down the soldiers’ cheeks?
Why did the woman give Father Kleinsorge tea leaves?
How did Mr. Tanimoto help Mr. Tanaka?
What did Mrs. Nakamura learn about her family?
What was a greater moral responsibility to the Japanese than care for the living?
What wonderful blessing did Mr. Tanimoto think came on August 15th?
How did Mr. Tanimoto feel about the emperor?

Chapter 4

What about Father Kleinsorge surprised the rector?
What did Mrs. Nakamura notice on August 20th?
How did she feel onAugust 26th?
What did Miss Sasaki notice about Hiroshima that gave her the creeps?
What strange symptom did she exhibit?
How much radiation was there more than normal background radiation?
What did the scientists announce?
What were petechiae?
What symptoms did Father Kleinsorge exhibit?
What happened during the three stages of atomic disease?
How did Dr. Sasaki feel about those who used the bomb?
What does "Shikatuganai" mean?
What did Toshio say about his friends' mothers?

Decision-making Case Histories

During the late 40’s and the 50’s Los Alamos labs dumped radioactive waste in the arroyos around their city. After a severe forest fire the ground's ability to absorb monsoon rains has been impaired. Run off from the rains will wash the material down stream into the Rio Grande. What should be done?

Chernobyl nuclear power plant is still dangerous. It will cost millions of dollars that the economically weak Ukraine does not have to continue maintaining safeguards at the power plant. The president of the United States wants to give the Ukraine 80 million dollars of the American taxpayers' money to help keep Chernobyl safe. Should Congress approve?

The Waste Isolation Pilot Project wants to transport radioactive waste across

New Mexico's roads and bury it in a special underground depository near Carlsbad. Should New Mexico support such a project?

Radioactive waste from Sandia Labs was buried in Albuquerque parks and in medians along Ridgecrest Avenue. Many families with young children use those parks every day. Should the contaminated soil be dug up and transported out of harm's way?

Field Trip Search and Find

1. What did Roentgen discover?
2. Who came up with the theory that E= mc2?
3. What government project caused the development of Los Alamos?
4. What is trinitite?
5. What was the yield of Fat Man? What was the yield of Little Boy?
6. Describe the Davy Crockett.
7. What happened at Paloma, Spain?
8. What does Broken Arrow mean?
9. How many Trident submarines are there? How many missiles does each Trident carry? How many warheads does each Trident missile have?

Figuring Odds of Premature Death (Pion)

The earth gets hit by an asteroid big enough to cause global damage once every 500,000 years. So the chances of it happening in any one year is 1 in 500,000. Assuming such an impact averages killing off a quarter of the human population, the odds of it killing any individual are 1 to 4. Multiply those two and the result is 1 to two million. But people live an average of 75 years the odds become 75 to two million or 1 to 25,000.

Using that type of calculations, here are some other chances of premature death:

		Deaths in 1997 in U.S.
Food poisoning:	1 in 3 million	
Fireworks accident:	1 in a million	
Poisonous bite or sting:	1 in 100,000	
Airplane Accident:	1 in 20,000	854

Electrocution:	1 in 5,000	
Guns:	1 in 10,000	
Fire:	1 in 5,000.	3.700
Murder:	1 in 800.	19,650
Car wreck:	1 in 300.	43,200
Smoking for smokers:	1 in 2.	400,000
Flood:	1 in 30,000.	
Tornado:	1 in 60,000.	

In that same year the number of people known to have died from acute radiation sickness in the U.S. was zero. On the other hand some of the people who died from cancers during that year probably developed cancer due to exposure from atmospheric testing of nuclear weapons before 1963. Former uranium miners also are now dying from cancers apparently provoked from exposure during the Fifties and Sixties (Justice)

Radioactivity of Common Materials

There is a web-site for a group dedicated to the eradication of radiation. One might as well organize to eradicate gravity. Like gravity, radiation is a natural, omnipresent phenomenon. There are radioactive molecules on the ground we walk on, the water we drink, and the air we breathe. Furthermore, cosmic rays from the stars are passing through our bodies even as we think.

Radioactivity is measured in units called bequerels (*UIC*).

One human (adult)	7000 Bq (Vegetarians are more radioactive since plants store radioactivity).
1 kg coffee	1000 Bq
1 kg lawn fertilizer	5000 Bq
1 smoke detector	30,000 Bq
Radioisotope for x-rays	70 million Bq
1 luminous Exit sign (from the 70’s)	1,000,000 million Bq
1 kg 50-year old high-level nuclear waste	10,000,000 million Bq
1 kg uranium ore	25 million Bq
1 kg low level nuclear waste	1 million Bq
1 kg granite	1000 Bq
1 sq meter of air in a home (radon)	3000 Bq

How afraid should people be How afraid should people be of radiation? How afraid should people be of height? Small amounts are tolerable but large amounts increase the risks to unacceptable levels.

Where are all those old exit signs?

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