

APPROACHING A COMPLEX TASK

Purpose:

This lesson will help students gain insight into steps involved in approaching a complex task.

Concept:

1. Many steps must be identified and addressed in planning and completing a complex task.
2. Complex technical and societal challenges must be addressed and solved in making decisions about the management of nuclear waste.

Duration of Lesson:

One 50-minute class period

Objectives:

As a result of participation in this lesson, the learner will be able to:

1. identify major steps involved in completing a complex project;
2. design a flow chart illustrating the steps necessary for completion of a complex project;
3. compare and contrast his/her perception of the complexity of a large scale project before and after participation in the design of the activity flow chart; and
4. draw a conclusion about the complexity of the task DOE is faced with regarding the nuclear waste management program.

Skills:

Analyzing, comparing and contrasting, concluding, decision making, designing, discussing, evaluating, graphing

Vocabulary:

Flow chart, societal, technical

Materials:

Activity Sheet

Swimming Pool Construction Flow Chart, p. 55

Suggested Procedure:

1. Explain to students that a decision has been made to build an inground swimming pool. Students are responsible for building this pool. They must consider everything that must be done to complete this project from the time the decision is made until the first swim. Point out to students

that there are a number of steps which should be considered prior to breaking ground for a project of this size. Be sure students understand that they own the land the pool is to be built on and have the necessary money for this project.

- Because students will be asked to create a flow chart documenting their swimming pool design, you may wish to draw an example of a flow chart, such as the one appearing on the activity sheet entitled *Swimming Pool Construction Flow Chart*, on the chalkboard. Discuss, as a class, the flow chart they will use to help them organize their planning. Be sure students understand that the flow chart is to serve as a planning aid for this complex project; it is to be used to illustrate the steps they have decided are necessary for completion of this project. A number of examples of suggested steps follows.

- | | | | |
|-----------------------|----------------------------|---------------------|---------------------|
| a) decision to build | i) license to operate | q) fill pool | y) State inspection |
| b) someone in charge | j) State guidelines | r) new bathing suit | z) first swim |
| c) budget | k) safety regulations | s) suntan lotion | |
| d) design | l) buy supplies | t) lifeguard | |
| e) cost estimate | m) buy equipment | u) fencing | |
| f) builder/contractor | n) make schedule | v) restrooms | |
| g) Q/A* inspector | o) connect to water source | w) lawn furniture | |
| h) license to build | p) design test | x) pool chemicals | |

- Break students into small groups and allow them 15 minutes to discuss their approach and gather ideas. Have each group use the activity sheet entitled *Swimming Pool Construction Flow Chart* to create a chart illustrating the steps they have decided are necessary for completion of this project.

Ask each group to share their flowcharts with their classmates; explaining the steps they have decided are necessary for completion of the swimming pool project.

If you have time, ask students to identify which of these steps are purely technical considerations, which are purely societal considerations, and which are combinations of both technical and societal considerations. Students should be prepared to discuss why it is necessary to consider both technical and societal challenges in the development of a swimming pool or other complex structure.

- Ask students if they think this particular project was more complicated than they would have previously thought.
- Ask students to compare their perception of the magnitude of the technical and societal

* Quality Assurance

challenges involved in the completion of their swimming pool construction activity with those involved in the construction of a geologic repository for the storage of high-level nuclear waste.

What follows is a list of guidelines that the U. S. Department of Energy (DOE) must adhere to in their construction of a geologic repository. Briefly discuss these guidelines stressing that all these criteria must be considered and met prior to the construction of a geologic repository for the purpose of permanent disposal of high-level nuclear waste. Be sure to compare the complexity of the geologic repository construction project with that of the swimming pool project just completed.

- a) Responsibility — The organizational structure, functional responsibilities, levels of authority, and lines of communication for activities affecting quality must be documented.
- b) Quality Assurance Program — A documented quality assurance program shall be planned, implemented, and maintained.
- c) Design Control — The design shall be defined, controlled, and verified.
- d) Procurement Document Control — Applicable design bases and other requirements necessary to assure adequate quality shall be included or referenced in documents for procurement of items and services. Suppliers must have a quality assurance program consistent with the minimum standards required here.
- e) Instructions, Procedures, and Drawings — Activities affecting quality shall be prescribed in accordance with instructions, procedures, or drawings of a type appropriate with the circumstances.
- f) Document Control — The preparation, issue, and change of documents that specify quality requirements or prescribe activities affecting quality shall be controlled to assure that correct documents are being used.
- g) Control of Purchased Items and Services — The procurement of items and services shall be controlled to assure conformance with specified requirements.
- h) Identification and Control of Items — A system shall be established for the identification and control of all materials, parts, and components. (This system should be designed to prevent the use of incorrect or defective material, parts, and components.)
- i) Control of Special Processes — A system should be developed which guarantees that only fully qualified personnel will perform specialized jobs such as welding, heat treating, etc.
- j) Inspection — A program for inspection of activities affecting quality should be established and carried out to verify adherence to instructions. These inspections should be performed by people other than those who are doing the work.
- k) Test Control — A test program should be established to assure that all structures, systems, and components work satisfactorily and in compliance with the design specifications.
- l) Control of Measuring and Test Equipment — A system should be instituted to assure that all equipment used in testing is in proper working order.

- m) Handling, Storage, and Shipping — A system shall be instituted to control the handling, storage, cleaning, and preservation of material and equipment to prevent damage or deterioration.
 - n) Inspection, Test, and Operating Status — A system shall be established which clearly indicates the status of inspections and tests performed on individual items used in construction.
 - o) Control of Nonconforming Items — A system shall be established to control materials, parts, or components which do not conform to requirements in order to prevent their inadvertent use or installation.
 - p) Corrective Action — A system should be established to assure that conditions adverse to quality are promptly identified and corrected.
 - q) Quality Assurance Records — Records should be maintained to provide evidence of any activities affecting quality.
 - r) Audits — A system of planned and periodic audits should be carried out to verify compliance with all aspects of the quality assurance program and to determine the effectiveness of the program.
6. Students should be asked to draw a conclusion regarding the degree of difficulty of the task DOE is faced with in the nuclear waste management program and share this with their classmates.
7. If time is short you may wish to assign suggested procedure 6 for homework.

Teacher Evaluation of Learner Performance:

Discussion and group activity participation will indicate comprehension.

NUCLEAR WASTE CHALLENGES AND SOLUTIONS

Purpose:

This lesson provides students with an opportunity to analyze the provisions of the Nuclear Waste Policy Act and the nature of our Nation's nuclear waste dilemma.

Concepts:

1. In making decisions about the management of nuclear waste, both technical and societal aspects of the challenge must be addressed.
2. In making decisions about managing nuclear waste, public risk perception and the distribution of risk must be considered.
3. In a democratic society, national challenges are solved through striving for legitimate and acceptable decisions arrived at through open and balanced dialogue.
4. Societal decisions are shaped by people's values, perceptions, and analysis of facts.
5. The Nuclear Waste Policy Act of 1982 and amendments established a plan for the safe handling, storage, and disposal of our Nation's spent fuel and high-level radioactive waste.
6. State and public participation in the planning and development of the system is essential in order to promote public confidence in the safety of disposal of high-level nuclear waste and spent fuel.
7. Despite the controversy associated with the managing of our Nation's nuclear waste, it is imperative that this growing national challenge be addressed promptly and responsibly.

Duration of Lesson:

One 50-minute class period

Objectives:

As a result of participation in this lesson, the learner will be able to:

1. identify challenges and solutions associated with nuclear waste;
2. differentiate between technical and societal issues related to disposing of nuclear waste;
3. state ways in which people living in a democratic society make decisions about risks related to technology;
4. explain how and why the Nuclear Waste Policy Act provides for public participation; and
5. explain the Federal role in the management of nuclear waste.

Skills:

Analyzing, discussing, explaining, evaluating, group dynamics, reading, synthesizing

Vocabulary:

Democracy, NIMBY, risk perception, societal, technical

Materials:

Reading Lesson

The Nuclear Waste Policy Act: An Overview, p. SR-1
(Reference)

Activity Sheet

Nuclear Waste Challenges and Solutions (Parts I & II), pp. 57, 59

Transparency

Nuclear Waste Challenges and Solutions (Part I), p. 47

Suggested Procedure:

1. This activity lends itself well to group discussion, but can be equally as effective when assigned as an individual lesson. The suggested procedures that follow relate to presentation of this lesson as a group activity or as a class discussion.
2. Ask students to complete Parts I and II of the activity *Nuclear Waste Challenges and Solutions*. Before they do the activity, it may be helpful to discuss Question a). After students complete the activity, stimulate group discussion by inviting students to share their answers to the questions on the activity sheet. The questions which follow may be used to stimulate further class discussion.

Note:

Part I: *There are no “right” or “wrong” answers to Part I but students should be able to defend their answers by explaining their reasons for placing check marks.*

Part II: *Answers are indicated for Part II. However, students may have different answers that may be acceptable if they can defend their reasoning.*

For Small Group Discussion

- a) Before dividing students into groups, review the nature of the Nation’s nuclear waste dilemma and how the Nuclear Waste Policy Act addresses these issues. Be sure to discuss the differences between challenges and solutions and the terms *societal* and *technical* as they relate to the nuclear waste issue.
- b) Divide students into groups of 3-5. Go over the instructions for the work sheet and have them work as a group on Part I of the activity *Nuclear Waste Challenges and Solutions*.
- c) When all groups have completed their assignment, discuss this activity using the

- transparency “Nuclear Waste Challenges and Solutions.”
- d) Assign Part II of the activity to be completed individually during class. Discuss.
 - e) To culminate your discussion of Parts I and II, ask students if they can identify additional challenges and solutions and categorize them as technical or societal.

For Class Discussion

- a) The activity entitled *Nuclear Waste Challenges and Solutions* asks you to identify challenges and solutions as either technical or societal. What do these two terms mean?

(Technical challenges and solutions are those that depend on mechanical or scientific practicability or whether the solution will work or not. For example, a technical challenge is designing casks that will keep radioactive materials from reaching the environment. Societal challenges and solutions are related to human society and interactions among people. The political and economic impacts and effects on people of the environmental impacts of solving the challenge of disposing of high-level nuclear waste are examples of the societal aspects.)

- b) Although the technical and the societal aspects have been distinguished for the purposes of this activity, you may want to discuss whether students can think of ways in which these aspects interact, e.g., design decisions will have societal implications if they affect the number of or timing of need for construction workers required to build a facility. Societal aspects of a community will have technical implications, e.g., the presence of workers with the necessary skills to construct and operate the facility.
- c) How does the way the Nuclear Waste Policy Act and amendments are written take into account both technical and societal aspects of nuclear waste disposal? Why is this important?

(The NWPA requires that every aspect of the technical plans for the repository and the entire waste management system be thoroughly studied. For example, site characterization is designed to study all important factors of the Yucca Mountain site to ascertain whether the site meets guidelines established for the repository. The findings will be used to design the repository and the waste canister to maximize safety. The NWPA also requires extensive testing of the cask that will be used for transportation. In addition to the characterization of the site, the potential impact of the repository on the economy and environment is being considered and ways of mitigating impact are being developed. The participation of the affected State and local governments and the public that is mandated by the NWPA shows the importance of addressing the societal aspects of nuclear waste management. One reason this participation is important is that it is part of the democratic process and will promote confidence in the safety of disposal of high-level waste and spent fuel. Furthermore, local people may have insights to contribute that might otherwise be overlooked.)

- d) One challenge encountered in planning for the disposal of nuclear waste is that there is no accumulation of experience against which the calculations of analysts can be verified, and the time frame for predicting and preventing risk extends thousands of years into the future. How do you feel about this?

(Answers will vary)

- e) Experts acknowledge that there are and will be risks in disposing of nuclear waste. In your opinion, are there risks associated with doing nothing about disposing of the existing accumulation of nuclear waste? Explain.

(Answers will vary)

- f) How does the fact that the United States is a democracy influence the way we solve national challenges? How does the way the Nuclear Waste Policy Act of 1982 (NWPA) and the Amendments Act are written take into account the fact that this is a democracy?

(In a democratic society, national challenges are solved through striving for open and balanced dialogue in arriving at legitimate and acceptable decisions. When Congress drafted the NWPA and the Amendments Act, it took this into account by providing for participation by affected States, Indian Tribes, and local governments and also by the public.)

- g) Societal decisions involve questions of values and people's values differ. A major challenge is distribution of risk. How does the NWPA address the question of distribution of risk?

(In our democracy, insistence on basing decisions only on facts developed by experts will not work very well. Technical information is critically important. However, the experts and various publics have to engage in a two-way exchange of ideas and opinions in settling difficult challenges. It is inevitable that the risk cannot be distributed to everyone in the Nation in the same way. This is also the case with many other risks in our society. The NWPA makes special provision for input from those who will bear the greatest burden of risk and also provides for some mitigation of risk in the form of benefits.)

- h) Discuss the NIMBY (Not In My Back Yard) phenomenon. Ask students to identify controversial situations in their community or State and relate their thinking about the resolution of the controversy, including the process and how their personal values influence their thinking.

(Answers will vary)

- i) Why are Indian Tribes named specifically by the NWPA? How could they be affected by the siting of a geologic waste repository?

(Indian Tribes have a unique status with relationship to individual States and to the Federal government. They have treaty rights with the U.S. Government that could be affected by the repository and the transportation of waste. Therefore, Congress decided to include Indian Tribes in the NWPA and gave them equal status with the States.)

- j) What are some societal and economic challenges and benefits associated with siting a nuclear waste repository in an area?

(The most important concern people have about siting a nuclear waste repository relates to the health and safety of their families. They want to be sure the facility will not harm them, others in the community, or the environment. An increase in the number of people

in an area can create challenges, especially in rural areas where services are limited. The area would need more housing, shopping areas, schools and classrooms, hospital beds, etc. The area would need more teachers, doctors, dentists, firemen, police, and services such as water supply and garbage pickup. The roads in the area would have more traffic and might need to be improved. Some people also are concerned about the particular effects that might occur; e.g., that using land for a repository might also have a negative impact on the area by discouraging new families or businesses from locating there or discouraging tourism. Others may be concerned more generally about how the repository might affect their present way of life.

A repository would also bring some benefits. Grants would compensate for expenses incurred by the community. Workers would be employed for construction of the repository. Afterward, workers would be employed to operate the facility. The wages earned by these people would add to the local economy. Some of their earnings would help pay taxes. They would spend money on housing, transportation, food, clothing, medical and dental care, and other goods and services. People already living in the area might welcome the positive changes that a repository might bring, such as better degree of cultural diversity. This would create additional jobs and strengthen the area economy.)

- k) Why do you think the Federal Government is responsible for the high-level nuclear waste management program?

Have students write a brief summary of what they have learned in this lesson.

Teacher Evaluation of Learner Performance:

Teacher observation of group discussions, class debate, and completion of activities will indicate understanding.

Enrichment:

1. "...Furthermore, questions of acceptable risk, not so critical in other issues, will be paramount on science-related issues. Who gets to define acceptable risks where the people making the decisions and the people actually at risk are not the same? Or consider the dilemmas that arise when scientists preference for 'maybe' answers runs head-on into a political system that needs to decide 'yes' or 'no' — and make decisions more quickly than the pace of research might dictate."*

Apply this quote in an essay or class discussion to what you have read and discussed so far in this Unit. Be sure to include consideration of the NWSA, the Amendments Act, and the questions discussed previously in this lesson.

2. Actual newspaper clippings (**order free of charge from the OCRWM National Information Center at 1-800-225-6972; within Washington, DC, 488-6720**) expressing various points of view regarding the site characterization of Yucca Mountain, Nevada, for purposes of determining suitability for a geologic repository may be used in any number of different ways. For example:
 - a) Assign a different article to each student. Have students share the point of view expressed in their article with the class and discuss whether they agree or disagree with the author. Students should be able to defend their position.