High School Lesson Plan #4

COURSE(S): Algebra I; Mathematical Modeling with Applications; Environmental Studies; Aquatic Sciences; US History Since Reconstruction; World Geography Studies

TOPIC: Water Availability, Usage and Future Demand in Texas

TITLE: How Texas is Planning to Manage its Water

OVERVIEW: The student will research water management strategies in Texas to meet the projected demand for water in the year 2050. The student will interpret graphs and tables and then discuss the data as part of a written report.

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS:

Algebra I

(b) Foundations for functions: knowledge and skill and performance descriptions.

(1) The student understands that a function represents a dependence of one quantity on another and can be described in a variety of ways.

Following are performance descriptions.

(B) The student gathers and records data, or uses data sets, to determine functional (systematic) relationships between quantities.

(D) The student represents relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities.

(E) The student interprets and makes inferences from functional relationships.

(c) Linear functions: knowledge and skills and performance descriptions.

(1) The student understands that linear functions can be represented in different ways and translates among their various representatives.

Following are performance descriptions.

(A) The student determines whether or not given situations can be represented by linear functions.

(C) The student translated among and uses algebraic, tabular, graphical, or verbal descriptions of linear functions.

(2) The student understands the meaning of slope and intercepts of linear functions and interprets and describes the effects of changes in parameters of linear functions in real-world and mathematical situations.

Following are performance descriptions.

(A) The student develops the concept of slope as rate of change and determines slopes from graphs, tables, and algebraic representations.

(B) The student interprets the meaning of slope and intercepts in situations using data, symbolic representations, and graphs.

Mathematical Models with Applications

(c) Knowledge and Skills

(1) The student uses a variety of strategies and approaches to solve both routine and non-routine problems. The student is expected to:

(A) compare and analyze various methods for solving a real-life problem.

(B) use multiple approaches (algebraic, graphical, and geometric methods) to solve problems from a variety of disciplines.

(2) The student uses graphical and numerical techniques to study patterns and analyze data. The student is expected to:

(A) interpret information from various graphs, including line graphs, bar graphs, circle graphs, histograms, and scatter plots to draw conclusions from the data.

(B) analyze numerical data using measures of central tendency, variability, and correlation in order to make inferences.

(C) analyze graphs from journal, newspapers, other sources to determine the validity of stated arguments.

Environmental Studies

(c) Knowledge and Skills

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:

(B) identify source, use, quality, and conservation of water.

(C) document the use and conservation of both renewable and non-renewable resources.

(E) analyze and evaluate the economic significance and interdependence of components of the environmental system.

(7) Science concepts. The student knows the relationship between carrying capacity and changes in populations and ecosystems. The student is expected to:

(A) Relate carrying capacity to population dynamics.

(C) evaluate the depletion of non-renewable resources and propose alternatives.

(D) analyze and make predictions about the impact on populations of geographic locales, natural events, diseases, and birth and death rates.

(8) Science concepts. The student knows that environments change. The student is expected to:

(A) analyze and describe the effects on environments of events such as fires, hurricanes, deforestation, mining, population growth, and municipal development.

Aquatic Sciences

(c) Knowledge and Skills

(8) Science concepts. The student knows that aquatic environments change. The student is expected to:

(B) analyze the cumulative impact of natural and human influence on an aquatic system.

(C) identify and describe a local or global issue affecting an aquatic system.

(D) analyze and discuss human influences on an aquatic environment

including fishing, transportation, and recreation.

United States History Studies Since Reconstruction

(c) Knowledge and Skills

(8) Geography. The student uses geographical tools to collect, analyze and interpret data. The student is expected to:

(B) pose and answer questions about geographic distributions and patterns shown on maps, graphs, charts, models, and databases.

(11) Geography. The student understands the relationship between population growth and modernization on the physical environment. The student is expected to:

(A) identify the effects of population growth and distribution and predict future effects on the physical environment.

(24) Social studies skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:

(B) analyze information by sequencing, categorizing, identifying cause-and-effect relationships, comparing, contrasting, finding the main idea, summarizing, making generalizations and predictions, and drawing inferences and conclusions.

(H) use appropriate mathematical skills to interpret social studies information such as maps and graphs.

(25) Social studies skills. The student communicates in written, oral, and visual forms. The student is expected to:

(A) use social studies terminology correctly.

(B) use standard grammar, spelling, sentence structure, and punctuation.

(C) transfer information from one medium to another, including written to visual and statistical to written or visual, using computer software as appropriate.

(D) create written, oral, and visual presentations of social studies information.

World Geography Studies

(c) Knowledge and Skills

(8) Geography. The student understands how people, places, and environments are connected and interdependent. The student is expect to:

(A) explain the interrelationships among physical and human processes that shape the geographic characteristics of places such as connections among economic development, urbanization, population growth, and environmental change.

(B) compare ways that humans depend on, adapt to, and modify the physical environment using local, state, national, and international human activities in a variety of cultural and technological contexts.

(22) Social studies skills. The student communicates in written, oral, and visual forms. The student is expected to:

(A) design and draw appropriate maps and other graphics such as sketch

maps, diagrams, tables, and graphs to present geographic information including geographic features, geographic distributions, and geographic relationships.

RELATED ESSENTIAL KNOWLEDGE AND SKILL:

Environmental Studies

(c) Knowledge and Skills

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:

(F) evaluate the impact of human activity and technology on land fertility and aquatic viability.

United States History Studies Since Reconstruction

(c) Knowledge and Skills

(11) Geography. The student understands the relationship between population growth and modernization on the physical environment. The student is expected to:

(B) trace the development of the conservation of natural resources, including the establishment of the National Park System and efforts of private nonprofit organizations.

(26) Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. The student is expected to:

(A) use a problem-solving process to identify a problem, gather information, list and consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.

(B) use a decision-making process to identify a situation that requires a decision, gather information, identify options, predict consequences, and take action to implement a decision.

English I

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:

(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.

(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English II

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:

(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.

(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English III

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:

(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.

(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English IV

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning and research. The student is expected to:

(E) organize notes from multiple sources in useful and informing ways such as graphics, conceptual maps, and learning logs.

(G) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

DID YOU KNOW?

The Texas Water Development Board has developed a State Water Plan for Texas. This plan includes statewide water management strategies as well as descriptions of the water resources historically available to Texas and the projected water resources that should be available in the year 2050. These water resources cover surface water available in the 15 major river basins and the groundwater located in aquifers.

Management strategies break the users of water into six demand segments.

1. municipal
2. manufacturing
3. electrical steam generation cooling
4. mining
5. livestock
6. irrigation

The water management strategies projected to be used include:

1. conservation of existing local supplies,
2. the current water infrastructure,
3. expanded infrastructure to local supplies,
4. reuse/return flows,
5. reallocation of reservoir storage,
6. water marketing,
7. new groundwater development,
8. new inter-basin transfer of existing supplies, and
9. new reservoir development.

The development of conventional new water resources is limited in that Texas has already developed 75-80% of its conventional (fresh ground and surface) water resources.

Current projections are that approximately 17,600,000 acre-feet of water will be used in Texas per year by 2050.
Projections for irrigation water needed in Texas in the year 2050 do not identify affordable water supplies due to the declining availability of water resources (primarily groundwater) and the relatively high cost of replacement water supplies. While water supplies could be available the question becomes one of the economics of using water resources for irrigation in lieu of using those same water resources for another use.

Conservation and reuse/return options allow the extension of existing water supplies at a fraction of the capital expenditure expected the spent on the other water management

strategies.

LEARNING EXPERIENCE:

GENERAL TIME FRAME: 3-4 hours depending on student responses.

Description: Students will research and describe water management strategies from the 1990's to the year 2050. Students will also map recommended major water supply and conveyance projects in Texas. Graphs will be prepared comparing planned water management strategies and also of the projected costs associated with construction/development of water infrastructure projects. Students will write a short report comparing planned Texas water management strategies and the economic value of savings realized from conservation and reuse/return of water into the overall supply system. This report will include calculations, maps and graphs of the gathered data.

Time Frame: 4 to 5 – 45 minute periods

Advanced Preparation:

1. If Internet access is available to students at the school, arrange for students to spend a minimum of one period doing research on water resources in the local Water Planning Region.
2. Contact the local water utility for information on water management strategies planned to meet further demand. Also request information on the cost per 1,000,000 gallons if any additional construction is required on the local water supply infrastructure.
3. Contact the Council of Governments for the local area for information on water management strategies planned to meet further demand. Also request information on the cost per 1,000,000 gallons if any additional construction is required on the local area water supply infrastructure.
4. Contact the Texas Water Development Board for information on water management strategy data for the period from the 1990's to 2050. (see Resources)

Procedure:

1. Research and map the locations of recommended major water supply and conveyance projects for the overall period from 1996 to 2050. Group the projects into 3 categories date needed - 1996 to 2000, 2000-2020, and 2020-2050. Color code the projects by date needed category.
2. Construct a bar graph showing management strategies to meet 2050 water needs.
3. Construct a pie graph showing the projected capital cost of water related infrastructure activities for the period of 1996 to 2050.
4. Construct a line graph showing urban and agricultural water use from 1990 to 2050.
5. Calculate the possible yearly savings in costs if as little as 1,000,000 gallons per day could be conserved in the local area by the year 2020. If projected costs are not available from the local water utility, calculate the possible yearly savings in the year 2000 for conservation of 1,000,000 gallons per day by using the current rate per 1,000 gallons (found on any water bill).
6. Write a short report discussing water availability versus demand up to the year 2050. The report is to incorporate research findings, maps, and graphs.

Teacher Talk:

The demand on water resources in Texas will continue to increase for the foreseeable future. To meet this increasing demand for water the Texas Water Development Board has developed long term water management strategies meet the need projected for the year 2050. Water conservation has been included as one of the management strategies. Current estimates are that approximately 2,600,000 area feet or 12.4% of the total water demand in Texas in 2050 can be meet through water conservation.

Teacher Questions	Possible Replies
1. What might happen if the current estimate of water availability in the year 2050 due to conservation are not met?	1. Student answers will vary. Likely responses include less water than projected for irrigation, significant increases in cost of water to the consumer, prioritization of available water supplies. At a minimum, additional funds would be required for the construction of more water related infrastructure projects.
2. How will the projected urban and agricultural uses of water change between now and the year 2050?	2. By the year 2050, urban uses of water will be greater than the agricultural uses. Currently the reverse is true.
3. Why are conservation measures a very cost effective method for extending existing water resources?	3. Student answers will vary. Examples of possible answers: a. Many conservation measures are very inexpensive to put in place and by lowering water usage they can actually save the consumer money. b. Everyone can conserve water.
4. Using current water rates, how much money could a family save in a year if they conserved 1,000 gallons per month? 10,000 gallons per month?	4. The problem set up should be: 12 months (1,000 gallons/month) x the monthly rate for water per gallon. Use 10,000 gallons in place on 1,000 gallons.
5. Compare the savings if 1,000,000 gallons of water could be conserved versus if the local water utility had pay for a 1,000,000 gallon expansion to the existing water infrastructure.	5. Student answers will vary depending on local water costs and projected water utility figures for increasing capacity by 1,000,000 gallons.
6. How can water be reused? Returned to the water supply?	6. Student answers will vary. However the filtration of the used water and removal of contaminates should be mentioned.

RESOURCES:

Literature on water conservation by the Texas Water Development Board. View and order currently available brochures at http://www.twdb.state.tx.us/assistance/conservation/pubs.htm, contact Patsy Waters at patsy.waters@twdb.state.tx.us, fax the form to (512) 936-0812, call (512) 463-7955, or write to:

Conservation
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

Maps of Texas River Basins, Aquifers, and Regional Reservoir Basin Maps are available on TWDB's website at http://www.twdb.state.tx.us/mapping/index.htm

Use TWDB's website to obtain information on water availability, historical/ projected water usage, and water demand data for the period from the 1990's to 2050 (**http://www.twdb.state.tx.us/data/data.htm**).

The local water utility should be able to provide information on costs associated with any anticipated physical plant upgrades necessary to be increased demand.

The Council of Governments for the local area may be able to provide additional information on costs associated with capital costs required to meet anticipated increases in water demand.

EXTENSIONS:

1. Invite a representative from the local water utility to speak to the students about water resources that are currently available for use.

2. Invite a representative from the local water utility to speak to the students about any water management strategies the water utility may currently have. Ask the water utility representative to discuss the costs associated with plans to meet the increased demand for water in the local area.

3. Divide the students into groups with 4 to 5 members. Have each group research water supply related infrastructure needs and give an oral presentation to rest of the students on their research findings.