

High School Lesson Plan #1

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: Water - Is There Going to be Enough?

OVERVIEW: The student will research the availability, usage and demand for water in the local area historically and use projections of the availability, usage and demand for water up to the year 2050. The student will gather data and present the information in various types of graphs 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.

Environmental Studies

(c) Knowledge and Skills

- (4) Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to:
 - (C) evaluate the impact of human activity such as methods of pest control, hydroponics, organic gardening, or farming on ecosystems.
- (5) Science concepts. The student knows the interrelationships among the resources within the local environmental system.
 - (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.
- (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.

(10) Science concepts. The student knows the origin and use of water in a watershed. The student is expected to:

(A) identify sources and determine the amounts of water in a watershed including groundwater and surface water.

(B) research and identify the types of uses and volumes of water used in a watershed.

(C) identify water quantity and quality in a local watershed.

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:

(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 expected 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.

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

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

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?

Texas has varied water availability and demand throughout the state. Each local area has its own water needs met by the area's water utility. As the population of Texas grows and water demand increases, the overriding question for local areas is whether or not the local area will have sufficient water resources available to meet the total demand for water by the year 2050. The different sectors vying for water include:

1. domestic/residential consumers,
2. recreational consumers,
3. commercial consumers,
4. manufacturing plants,
5. electrical steam generation plants,
6. mining operations, and
7. agricultural consumers.

Planning has already begun and measures have been undertaken to develop and implement projects that will address any short fall in the future water supply. Examples of these projects are:

1. promoting conservation,
2. development of new water resources,
3. construction of new water infrastructures projects, and
4. development of alternative water supplies.

The costs associated with these types of projects, with the exception of conservation, are expected to grow significantly in order to meet the total demand for water by 2050. Conservation is an extremely cost effective means for extending current water supplies and can be undertaken by all water demand sectors.

LEARNING EXPERIENCE:

GENERAL TIME FRAME: 3-5 hours depending on student responses.

Description: Students will research and describe water resources in terms of historical availability and demand in their local area and then use projections to predict the availability, usage and demand for water to year 2050. The students will also describe existing and projected water problems for the local area. The description will take the

form of a written report that will include 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 and use in the local area.
2. Contact the local water utility for information on historical/projected water availability, usage, and demand in the students' area of Texas. Ask for information extending as far back as possible.
3. Contact the Texas Water Development Board for information on water availability, historical/projected water usage and water demand data for the period from the 1990's to 2050. (see Resources)
4. Contact the Council of Governments for the local area for any historical and/or projected water availability and usage data they might have.

Procedure:

1. Research the following information for the local area.
 - a. local water resource problems and needs
 - b. the average annual net evaporation
 - c. the average annual precipitation
 - d. the average amount of runoff (in inches/unit area)
 - e. historical and projected population information from as far back as data is available to the year 2050
 - f. historical and projected water usage information from as far back as data is available to the year 2050
 - g. historical and projected capital expenditure for water/wastewater infrastructure information from as far back as data is available to the year 2050
2. Construct a bar graph showing 1995 and 2050 population estimates and projections for cities and/or towns in the local area.
3. Construct line graphs showing historical and projected regional population and water demand information from 1900 - 2050 for the local area. (If needed, the Texas Water Development Board has information covering the period 1990 - 2050 for the Water Planning Region which includes the local area.)
4. For the local area, construct pie graphs showing historical and projected water use by demand segment for 1930,1950,1970,1990, 2010, 2030, and 2050. (If needed, the Texas Water Development Board has information covering the period 1990 - 2050 for the Water Planning Region which includes the local area.)
5. Construct pie graphs showing municipal water use projections for cities and/or towns in the local area for the years 2000 and 2050. Make sure to include the city or town where students reside or that is closest to the each student's place of

residence.

6. Write a report discussing water availability versus demand in the local area historically and up to the year 2050. The report is to incorporate research findings and the constructed graphs.

Teacher Talk:

The demand on water resources in Texas will continue to increase for the foreseeable future. This increasing demand for water results in the need to extend existing water supplies, increasing the current infrastructure for water and wastewater, and the development of new water resources. One of the quickest and least costly options to extend existing water supplies is to promote conservation. Conservation is also one option that can be undertaken by different water demand sectors - residential/domestic, commercial, manufacturing, and agricultural.

Teacher Questions	Possible Replies
1. Which water demand sector in the local area is expected to show the greatest increase between 1990 and the year 2050? What will be the effect on the local area of this increased water demand?	1. Student answers will vary. The increased projected population, particularly east of I-35 will definitely be a factor for increased pressure of water resources. In many areas of Texas the use of water for agricultural purposes is expected to decrease.
2. What are some of the ways to meet the increasing demand for water?	2. Student answers will vary. Likely responses are: conservation, finding and using new water resources, building additional water and waste water infrastructures.
3. What might happen if water resources are insufficient to meet the increased demand?	3. Student answers will vary. Likely responses include rationing, significant increases in cost of water to the consumer, prioritization of available water supplies. The situation could be similar to what happens during a drought.
4. Why are conservation measures a very cost effective method for extending existing water resources?	4. 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. Many conservation measures can be as simple as using low water use appliances, fixing leaks, and turning off faucets.
5. Net evaporation, run off amounts, and annual precipitation are all important in determining the volume of water available	5. Student answers will vary. Students should understand that years with higher net evaporation due to hot, dry weather and lower

Teacher Questions	Possible Replies
during any one year. How do these factors influence water availability?	than normal precipitation can result in less water availability. If these conditions persist, drought conditions will result.
6. How can human activities effect the amount of run off in the local area?	6. Student answers will vary. At minimum, students should note that increased construction and paving can both increase run off in some areas and change drainage patterns leading to less water reaching an aquifer and increasing the chances of flooding in some areas.

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** or **regional water planning group** should be able to provide information on area wide water resources and planning being done locally to meet the future demand for water along with historical water availability and usage data. The **Council of Governments** for the local area may be able to provide additional information on historical water data and current planning to enable the local area to meet the future demand for water.

Literature on water quality is also available from the Texas Commission on Environmental Quality at <http://www.tnrc.state.tx.us/admin/topdoc/index.html>. Search for the following publications by number on TCEQ’s website.

Clean Water for Texas, Working Together for Water Quality- GI 284

Texas Clean Rivers Program GI-063

Nonpoint Source Pollution: Answers to Frequently Asked Questions GI- 162

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 the future availability of water in the local area to meet increasing demand. Ask the water utility representative to discuss the costs associated with plans to meet that increased demand.
3. Have students explore conservation measures as a means of extending available water resources.