TRAFFIC JAM

MATHEMATICS

HS

HIGH SCHOOL

This guide links the *Traffic Jam* unit to the Texas Essential Knowledge and Skills (TEKS) for high school students. *Traffic Jam* is a mathematics unit that allows students to study traffic patterns and analyze data using mathematical models. *Traffic Jam* also has interdisciplinary connections to science and social studies disciplines. For example, in order to conduct research in this task, the student must know and apply the laws governing motion in a variety of situations, as outlined in the Physics TEKS. Students also have opportunities to analyze the impact of technology and human modifications on the physical environment, as described in the Social Studies TEKS. The following document includes the applicable TEKS and the details of the *Traffic Jam* unit. The final section of this document presents the applicable Texas College and Career Readiness Standards adopted by the Texas Higher Education Coordinating Board (THECB) on January 24, 2008.

Description of Unit

In this task, students will explore how leading researchers are using mathematics to understand the roots of complex problems such as "phantom traffic jams"—traffic congestion that suddenly appears on a roadway with no apparent cause (i.e., no observable accident, stalled vehicle, or other obstacle in a lane such as construction). Students investigate the connections between mathematics, science, and real-world problems in engineering and urban planning. At the conclusion of the task, students research a location in the community known for traffic congestion. Students identify the possible variables in the system such as the number of vehicles using the road during both high- and low-usage times, the types of vehicles, number of traffic signals and intersections, the timings and coordination of traffic signals, and the roadway's carrying capacity. Students present their research findings using accurate mathematical vocabulary and suggest possible solutions for alleviating the traffic issues in the area studied.

Goals

Students will meet these goals in their explorations:

- Become familiar with how mathematics can be used as a tool to better understand the world
- Gain awareness of applications of mathematics in solving complex global problems such as "phantom traffic jams"
- Identify the intersections between mathematics, science, engineering, and transportation planning and how decisions made by individuals in these disciplines can impact people in a community
- Ask questions and explore theories
- Have opportunities to generate new ideas
- Develop the essential skills of communicating, creative problem solving, and logical thinking

Phase I. Learning Experiences

1. Introduce students to the concept of using mathematics to model and explore problems in the real world. Read news articles and press releases highlighting research from leading mathematicians at MIT, Temple, and the University of Alberta who are using mathematics to investigate the causes for "phantom traffic jams"—jams that seem to occur without an obvious cause such as an accident, construction, or stalled vehicle. A few possible sources include:
    - *A By-the-numbers Look at Phantom Traffic Jams*
    - *Math Model May Decrease Phantom Traffic Jams*
    - *Equation: Factors for Predicting Phantom Traffic Jams*
    - *Math—Combined with GPS—Could Fix Traffic Jams*

2. Discuss the articles and introduce students to some of the mathematics concepts behind the research. How are mathematical tools used to study such phenomena? What are some of the intersections students observe between mathematics, engineering, and science?

3. Experiment with the equation in the article from *Wired*. Using data from area roads, what does the equation tell you about the amount of traffic density needed for a jam to occur?

4. Ask students to view the traffic wave simulations, charts, and graphics on the project's web page at MIT (Note: to play many of these videos, the computer must be able to open .avi files in the DIXX format. The videos of cars driving on the circular road further down the page should play in any browser).

5. The researchers in the traffic project noticed the patterns of traffic jams were similar to the dynamics of explosions. What are some students' hypotheses as to why this might be the case? Ask students to work in small groups to conduct this lab experiment and examine the patterns found from the "explosion." In what ways are the sudden occurrences of traffic snarls similar to the backwards-travelling wave in an explosion? What might be some ways to lessen the impact of these traveling waves of traffic?

6. Ask students to conduct Internet research on companies working to monitor, predict, and eventually lessen traffic congestion. For instance, students may wish to read an article about companies such as Inrix Inc. Inrix uses GPS devices, cellphone data, and sensors in highways to track vehicle usage of thousands of miles of roadways. The company can feed this data into algorithms, and send real-time information to navigational devices, news, web, and traffic reporting services. Visit the company's web page to learn more.

7. Recently, the Texas A&M Transportation Institute (TTI) released the *2012 Urban Mobility Report,* combining national research on traffic problems across the nation. TTI makes the data for 101 urban areas available as an Excel spreadsheet for other researchers. Ask students to use this information to analyze how much time they might spend in traffic making typical commutes in some of these urban areas. How much personal productivity would the student predict is lost in traffic snarls? Students should create graphs and charts to compare the worst cities. How do these data compare to information for the local area (if available)?

8. Read an article detailing work by Rutgers University-Camden mathematician, Benedetto Piccoli, who is using mathematics to study traffic problems. Near the end of the article, Piccoli talks about advances in "infomobility." What are some possible examples he might be referring to? What sorts of future devices can you imagine that could help predict— or even better, prevent— the formation of traffic on roadways? For instance, how might "phantom traffic jams" become obsolete if robots did the driving?

9. In the MIT research, the mathematicians and scientists noticed similarities between traffic, water flow, and explosion patterns—what a casual observer might see as three seemingly unrelated phenomena. What might be some other situations you can observe in human-engineered scenarios or in nature that might mimic traffic jams (e.g., computer circuits, runners at the start of marathon races, ocean currents moving through undersea caverns)? Ask students to brainstorm examples and then narrow down choices to phenomena that scientists might be able to study using mathematics, physics, and technology. For an additional source on how scientists have thought about traffic, likening it to other types of phenomena, visit the Washington Post Archives for the article, *Lab Studying Science Behind Traffic Patterns*.

Phase II. Independent Research

A. Research process

1. Selecting a topic. Depending upon interests, students select one roadway or intersection in the local community on which to conduct an in-depth traffic analysis.

2. Depending upon the topic selected, students should develop 3-5 questions to guide their research proposals. Such questions might include:
   - What is the capacity of this roadway?
   - What is the density of vehicles when traffic begins to form?
   - What municipalities or transit agencies oversee the maintenance of this roadway?
   - What sort of usage fees—such as tolls— are there for this roadway?

- What obstacles, traffic signals, or chronic construction exist in the area that might inhibit traffic flow?
- Describe the geometry of the intersections on the roadway.
- What is the timing on the lights and in what ways are the signals coordinated with other traffic signals nearby?
- During what times of day do traffic jams occur in this area?
- What are some hypotheses about the causes of the traffic?
- In what ways might the traffic congestion be due to wave-like patterns as demonstrated in the MIT research? What might be some of the possible causes for slowdowns?
- How might traffic be alleviated during peak times?

3. Creating a research proposal. In the research proposal, the student should identify several key components such as:

- the location of the roadway or intersection
- the time of day they plan to conduct observations and gather data
- a list of possible secondary sources for background literature research
- a description of the type of data they plan to collect such as number of vehicles per minute, number of vehicles grouped by type (e.g., number of axles, or truck versus car bodies)
- a listing of names or position titles for candidates for interviews and/or focus groups
- a hypothesis explaining the student's initial thoughts on the traffic problem at the location
- a research plan including a timeline, an explanation of the student's proposed data gathering methods, a technology/materials list (e.g., hand-tally counters, cameras, measuring tools, timers, GPS devices, compasses, graph paper), and (if applicable) a budget for materials and supplies.

4. Conducting the research. Students collaborate with local transportation officials, librarians, parents/guardians, and/or the teacher to conduct observations during both low- and high-traffic time periods. Students gather data from literature, previous traffic studies, as well as through observation and/or interviews and focus groups. Additionally, depending upon student interest, students may choose to make a model of the location either in 3-D (such as with cardboard or foamcore) or using technology.

5. Sharing findings. Students will present their research through multimedia presentations that include images, charts, graphics, and summaries of the quantitative and qualitative data. Students should describe their findings and make recommendations as if they were presenting the information to city transportation planners, area transportation commission members, and/or city council members.

B. The product

Each student will develop a multimedia presentation that

- describes the problem roadway or intersection,

- details the research the student conducted,
- presents the student's analysis of both quantitative and qualitative data using accurate mathematical vocabulary terms, and
- lists recommendations for the city or transportation planning board to implement to alleviate the problem.

C. Communication

Each student should present his/her findings using multimedia presentation software (e.g. Keynote, PowerPoint, Adobe PDF). The presentations should identify the problem, convey the research findings, and posit solutions in a manner that is of a professional-quality, visually cohesive, and compelling. Each presentation should allow time for an impromptu Q&A session. Students should accurately use mathematical vocabulary, standard units, signs, graphs, and equations.

D. A completed project consists of:

1. The research proposal
2. Research notes, photos and videos of the location, interview and/or focus group notes/recordings, models (if applicable), charts, graphs
3. Multimedia presentation file (e.g., PowerPoint, Keynote, Adobe Acrobat PDF)
4. A bibliography of cited sources
5. Video or audio of the presentation and Q&A session

Internet Resources

http://math.mit.edu/projects/traffic/
http://articles.philly.com/2010-09-06/news/24999211_1_seibold-labor-day-traffic-jams
http://www.nbcnews.com/id/31325521/ns/technology_and_science-science/#.URKbZI5Igso
http://www.wired.com/magazine/2010/06/st_equation_traffic/
http://discovermagazine.com/2010/jan-feb/39#.URKbPI5Igso
http://www.pbs.org/safarchive/4_class/45_pguides/pguide_904/4494_traffic.html
http://online.wsj.com/article/SB120795092324008845.html?mod=googlenews_wsj
http://www.inrix.com/companyoverview.asp
https://tti.tamu.edu/2013/02/05/as-traffic-jams-worsen-commuters-allowing-extra-time-for-urgent-trips/
http://mobility.tamu.edu/ums/
http://news.rutgers.edu/medrel/news-releases/2011/03/rutgers-camden-mathe-20110314
http://www.washingtonpost.com/wp-srv/national/daily/aug99/traffic05.htm

Texas Essential Knowledge and Skills

The unit may address the following TEKS:

English Language Arts and Reading:

English I

I.1	Understands new vocabulary and use it when reading and writing
I.11	Understands how to glean and use information in procedural texts and documents
I.15	Writes expository and procedural or work-related texts to communicate ideas and information to specific audiences for specific purposes
I.17	Understands the function of and uses the conventions of academic language when speaking and writing
I.20	Asks open-ended research questions and develops a plan for answering them
I.21	Determines, locates, and explores the full range of relevant sources addressing a research question and systematically records the information they gather
I.23	Organizes and presents their ideas and information according to the purpose of the research and their audience
I.24	Uses comprehension skills to listen attentively to others in formal and informal settings
I.25	Speaks clearly and to the point, using the conventions of language

English II

II.1	Understand new vocabulary and use it when reading and writing
II.11	Understands how to glean and use information in procedural texts and documents
II.15	Writes expository and procedural or work-related texts to communicate ideas and information to specific audiences for specific purposes
II.17	Understands the function of and uses the conventions of academic language when speaking and writing
II.20	Asks open-ended research questions and develops a plan for answering them
II.21	Determines, locates, and explores the full range of relevant sources addressing a research question and systematically records the information they gather
II.22	Clarifies research questions and evaluates and synthesizes collected information
II.23	Organizes and presents their ideas and information according to the purpose of the research and their audience
II.24	Uses comprehension skills to listen attentively to others in formal and informal settings
II.25	Speaks clearly and to the point, using the conventions of language

Mathematics:

Algebra II

AII.1	Uses mathematical processes to acquire and demonstrate mathematical understanding
AII.3	Applies mathematical processes to formulate systems of equations and inequalities, use a variety of methods to solve, and analyze reasonableness of solutions
AII.4	Applies mathematical processes to understand that quadratic and square root functions,

	equations, and quadratic inequalities can be used to model situations, solve problems, and make predictions
AII.5	Applies mathematical processes to understand that exponential and logarithmic functions can be used to model situations and solve problems
AII.7	Applies mathematical processes to simplify and perform operations on expressions and to solve equations
Precalculus	
PC.1	Uses mathematical processes to acquire and demonstrate mathematical understanding
PC.2	Uses process standards in mathematics to explore, describe, and analyze the attributes of functions. The student makes connections between multiple representations of functions and algebraically constructs new functions. The student analyzes and uses functions to model real-world problems
PC.4	Uses process standards in mathematics to apply appropriate techniques, tools, and formulas to calculate measures in mathematical and real-world problems
Mathematical Models with Applications	
M.1	Uses mathematical processes to acquire and demonstrate mathematical understanding
M.6	Applies mathematical processes with algebra and geometry to study patterns and analyze data as it applies to architecture and engineering
M.8	Applies mathematical processes to determine the number of elements in a finite sample space and compute the probability of an event
M.10	Applies mathematical processes to design a study and use graphical, numerical, and analytical techniques to communicate the results of the study
Advanced Quantitative Reasoning	
AQR.1	Uses mathematical processes to acquire and demonstrate mathematical understanding
AQR.2	Applies the process standards in mathematics to generate new understandings by extending existing knowledge. The student generates new mathematical understandings through problems involving numerical data that arise in everyday life, society, and the workplace. The student extends existing knowledge and skills to analyze real-world situations
AQR.3	Applies the process standards in mathematics to create and analyze mathematical models of everyday situations to make informed decisions related to earning, investing, spending, and borrowing money by appropriate, proficient, and efficient use of tools, including technology. The student uses mathematical relationships to make connections and predictions. The student judges the validity of a prediction and uses mathematical models to represent, analyze, and solve dynamic real-world problems
AQR.4	Uses the process standards in mathematics to generate new understandings of probability and statistics. The student analyzes statistical information and evaluates risk and return to connect mathematical ideas and make informed decisions. The student applies a problem-solving model and statistical methods to design and conduct a study that addresses one or more particular question(s). The student uses multiple representations to communicate effectively the results of student-generated statistical studies and the critical analysis of published statistical studies

Science:

Physics

PHY.1	Conducts investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices
PHY.2	Uses a systematic approach to answer scientific laboratory and field investigative questions
PHY.3	Uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom
PHY.4	Knows and applies the laws governing motion in a variety of situations
PHY.5	Knows the nature of forces in the physical world
PHY.6	Knows that changes occur within a physical system and applies the laws of conservation of energy and momentum
PHY.7	Knows the characteristics and behavior of waves

Social Studies:

US History

US.14	Understands the relationship between population growth and modernization on the physical environment
US.23	Understands efforts to expand the democratic process
US.28	Understands the influence of scientific discoveries, technological innovations, and the free enterprise system on the standard of living in the United States
US.29	Applies critical-thinking skills to organize and use information acquired from a variety of valid sources, including electronic technology
US.30	Communicates in written, oral, and visual forms
US.31	Uses geographic tools to collect, analyze, and interpret data
US.32	Uses problem-solving and decision-making skills, working independently and with others, in a variety of settings

World History

WH.15	Uses geographic skills and tools to collect, analyze, and interpret data
WH.16	Understands the impact of geographic factors on major historic events and processes
WH.28	Understands how major scientific and mathematical discoveries and technological innovations have affected societies from 1750 to the present
WH.29	Applies critical-thinking skills to organize and use information acquired from a variety of valid sources, including electronic technology
WH.30	Communicates in written, oral, and visual forms
WH.31	Uses problem-solving and decision-making skills, working independently and with others, in a variety of settings

Special Topics in Social Studies

ST.1	Uses problem-solving and decision-making skills, working independently and with others, in a variety of settings

ST.2	Applies critical-thinking skills to organize and use information acquired from a variety of valid sources, including electronic technology
ST.3	Creates written, oral, and visual presentations of social studies information
Social Studies Research Methods	
RM.1	Understands the need for an organizing framework to identify an area of interest and collect information
RM.5	Creates a written and oral presentation of research and conclusions
RM.6	Understands the principles and requirements of the scientific method

Texas College and Career Readiness Standards

This unit may address the following Texas College and Career Readiness Standards:

English Language Arts:	
I.A.1	Determines effective approaches, forms, and rhetorical techniques that demonstrate understanding of the writer's purpose and audience
I.A.2	Generates ideas and gathers information relevant to the topic and purpose, keeping careful records of outside sources
II.A.1	Uses effective reading strategies to determine a written work's purpose and intended audience
II.A.2	Uses text features and graphics to form an overview of informational texts and to determine where to locate information
III.A.1	Understands how style and content of spoken language varies in different contexts and influences the listener's understanding
III.A.2	Adjusts presentation (delivery, vocabulary, length) to particular audiences and purposes
III.B.1	Participates actively and effectively in one-on-one oral communication situations
III.B.2	Participates actively and effectively in group discussions
IV.A.3	Uses a variety of strategies to enhance listening comprehension
IV.B.1	Listens critically and responds appropriately to presentations
IV.B.2	Listens actively and effectively in one-on-one communication situations
IV.B.3	Listens actively and effectively in group discussions
V.A.1	Formulates research questions
V.A.2	Explores a research topic
V.A.3	Refines research topic and devises a timeline for completing work
V.B.1	Gathers relevant sources
V.B.2	Evaluates the validity and reliability of sources
V.B.3	Synthesizes and organizes information effectively
V.C.1	Designs and presents an effective product
V.C.2	Uses source material ethically

Mathematics:

I.A.1	Compares real numbers
I.A.2	Defines and gives examples of complex numbers
I.B.1	Performs computations with real and complex numbers
I.C.1	Uses estimation to check for errors and reasonableness of solutions
II.D.1	Interprets multiple representations of equations and relationships
II.D.2	Translates among multiple representations of equations and relationships
IV.D.1	Computes and uses measures of center and spread to describe data
IV.D.2	Applies probabilistic measures to practical situations to make an informed decision
V.B.1	Computes and interprets the probability of an event and its complement
V.B.2	Computes and interprets the probability of conditional and compound events
VI.A.1	Plans a study
VI.B.1	Determines types of data
VI.B.2	Selects and applies appropriate visual representations of data
VI.B.3	Computes and describes summary statistics of data
VI.C.1	Makes predictions and draws inferences using summary statistics
VI.C.2	Analyzes data sets using graphs and summary statistics
VI.C.3	Analyzes relationships between paired data using spreadsheets, graphing calculators, or statistical software
VI.C.4	Recognizes reliability of statistical results
VII.A.1	Recognizes whether a relation is a function
VII.A.2	Recognizes and distinguishes between different types of functions
VII.B.1	Understands and analyzes features of a function
VII.B.2	Algebraically constructs and analyzes new functions
VII.C.1	Applies known function models
VII.C.2	Develops a function to model a situation
VIII.A.2	Formulates a plan or strategy
VIII.A.3	Determines a solution
VIII.A.4	Justifies the solution
VIII.A.5	Evaluates the problem-solving process
VIII.B.1	Develops and evaluates convincing arguments
VIII.B.2	Uses various types of reasoning
VIII.C.1	Formulates a solution to a real world situation based on the solution to a mathematic problem
VIII.C.2	Uses a function to model a real-world situation
VIII.C.3	Evaluates the problem solving process
IX.A.1	Uses mathematical symbols, terminology, and notation to represent given and unknown information in a problem

IX.A.2	Uses mathematical language to represent and communicate the mathematical concepts in a problem
IX.A.3	Uses mathematics as a language for reasoning, problem solving, making connections, and generalizing
IX.B.1	Models and interprets mathematical ideas and concepts using multiple representations
IX.B.2	Summarizes and interprets mathematical information provided orally, visually, or in written form within the given context
IX.C.1	Communicates mathematical ideas, reasoning, and their implications using symbols, diagrams, graphs, and words
IX.C.2	Creates and uses representations to organize, record, and communicate mathematical ideas
IX.C.3	Explains, displays, or justifies mathematical ideas and arguments using precise mathematical language in written or oral communications
X.A.1	Connects and uses multiple strands of mathematics in situations and problems
X.A.2	Connects mathematics to the study of other disciplines
X.B.1	Uses multiple representations to demonstrate links between mathematical and real-world situations
X.B.2	Understands and uses appropriate mathematical models in the natural, physical, and social sciences
X.B.3	Knows and understands the use of mathematics in a variety of careers and professions
Science:	
I.A.2	Uses creativity and insight to recognize and describe patterns in natural phenomena
I.A.3	Formulates appropriate questions to test understanding of natural phenomena
I.A.4	Relies on reproducible observations of empirical evidence when constructing, analyzing, and evaluating explanations of natural events and processes
I.B.1	Designs and conducts scientific investigations in which hypotheses are formulated and tested
I.C.3	Demonstrates skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures
I.D.1	Demonstrates literacy in computer use
I.D.2	Uses computer models, applications, and simulations
I.D.3	Demonstrates appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data
I.E.1	Uses several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic
I.E.2	Uses essential vocabulary of the discipline being studied
II.A.4	Uses proportional reasoning to solve problems
II.A.5	Simplifies algebraic expressions
II.A.6	Estimates results to evaluate whether a calculated result is reasonable
II.A.7	Uses calculators, spreadsheets, computers, etc., in data analysis
II.B.2	Represents natural events, processes, and relationships with algebraic expressions and

	algorithms
II.E.1	Understands descriptive statistics
II.F.1	Selects and uses appropriate Standard International (SI) units and prefixes to express measurements for real world problems
III.C.1	Prepares and represents scientific/technical information in appropriate formats for various audiences
III.D.1	Uses search engines, databases, and other digital electronic tools effectively to locate information
III.D.2	Evaluates quality, accuracy, completeness, reliability, and currency of information from any source
IV.A.1	Recognizes how scientific discoveries are connected to technological innovations
IV.B.1	Understands how scientific research and technology have an impact on ethical and legal practices
IV.C.2	Recognizes the role of people in important contributions to scientific knowledge
V.B.2	Knows the processes of energy transfer
V.C.1	Recognizes patterns of change
V.D.1	Understands that scientists categorize things according to similarities and differences
V.E.1	Uses models to make predictions
V.E.2	Uses scale to relate models and structures
VIII.C.1	Understands the fundamental concepts of kinematics
VIII.C.2	Understands forces and Newton's Laws
VIII.C.3	Understands the concept of momentum
X.C.1	Recognizes variations in population sizes, including human population and extinction, and describe mechanisms and conditions that produce these variations
X.E.1	Describes the different uses for land
Social Studies:	
I.A.1	Uses the tools and concepts of geography appropriately and accurately
I.A.2	Analyzes the interaction between human communities and the environment
I.A.3	Analyzes how physical and cultural processes have shaped human communities over time
I.A.4	Evaluates the causes and effects of human migration patterns over time
I.A.5	Analyzes how various cultural regions have changed over time
I.A.6	Analyzes the relationship between geography and the development of human communities
I.B.2	Identifies and evaluates sources and patterns of change and continuity across time and place
IV.A.1	Identifies and analyzes the main idea(s) and point(s) of view in sources
IV.A.2	Situates an informational source in its appropriate contexts
IV.A.3	Evaluates sources from multiple perspectives
IV.A.6	Reads research data critically
IV.B.1	Uses established research methodologies

IV.B.3	Gathers, organizes, and displays the results of data and research
IV.B.4	Identifies and collects sources
IV.C.1	Understands/interprets presentations critically
V.A.1	Uses appropriate oral communication techniques depending on the context or nature of the interaction
V.A.2	Uses conventions of standard written English
V.B.1	Attributes ideas and information to source materials and authors

Cross-Disciplinary Standards:

I.A.1	Engages in scholarly inquiry and dialogue
I.C.1	Analyzes a situation to identify a problem to be solved
I.C.2	Develops and applies multiple strategies to solving a problem
I.C.3	Collects evidence and data systematically and directly related to solving a problem
I.D.1	Self-monitors learning needs and seeks assistance when needed
I.D.2	Uses study habits necessary to manage academic pursuits and requirements
I.D.3	Strives for accuracy and precision
I.D.4	Perseveres to complete and master tasks
I.E.1	Works independently
I.E.2	Works collaboratively
I.F.1	Attributes ideas and information to source materials and people
I.F.2	Evaluates sources for quality of content, validity, credibility, and relevance
II.A.3	Identifies the intended purpose and audience of the text
II.A.4	Identifies the key information and supporting details
II.A.5	Analyzes textual information critically
II.A.6	Annotates, summarizes, paraphrases, and outlines texts when appropriate
II.C.1	Understands which topics or questions are to be investigated
II.C.2	Explores a research topic
II.C.3	Refines research topic based on preliminary research and devises a timeline for completing work
II.C.4	Evaluates the validity and reliability of sources
II.C.5	Synthesizes and organizes information effectively
II.C.6	Designs and presents an effective product
II.C.7	Integrates source material
II.C.8	Presents final product
II.D.2	Uses statistical and probabilistic skills necessary for planning an investigation, and collecting, analyzing, and interpreting data
II.D.3	Presents analyzed data and communicates findings in a variety of formats
II.E.1	Uses technology to gather information
II.E.2	Uses technology to organize, manage, and analyze information

II.E.3	Uses technology to communicate and display findings in a clear and coherent manner
II.E.4	Uses technology appropriately