Traffic
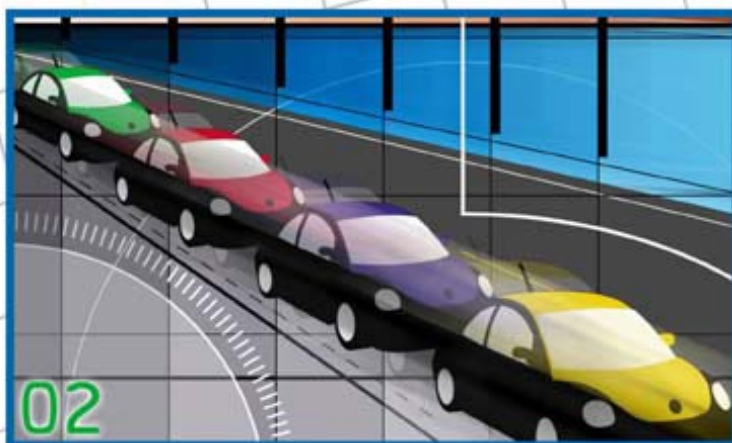
on the Information Superhighway

02

Unit 2

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Introduction and Overview

Introduction

    Traffic on the Information Superhighway is a two-part integrated mathematics unit that focuses on data collection and statistical analysis. The unit, which is suitable for students in grades 6–8, is aligned with the National Council of Teachers of Mathematics (NCTM) (2000) *Principles and Standards for School Mathematics*. It is based on a specific Internet site that provides data on traffic flow in a large city. The data available at the site is updated continuously, providing students with an opportunity to collect, organize, and represent data, to pose researchable questions, to make hypotheses, to draw conclusions, and to communicate to others what they have learned.

    Traffic on the Information Superhighway is divided into two parts, *Unit One* and *Unit Two*. The two parts are complementary although not dependent on each other. In *Traffic: Unit One* students become familiar with the Internet site and topic, choose and create appropriate graphs representing traffic data, and analyze and compare data sets using measures of center and spread. In *Traffic: Unit Two* (this unit) students pose research questions, design and implement an investigation, and create, share, and evaluate results. The last section of *Unit Two* gives students an opportunity to find a new real-time data site on the Internet and to create their own investigations using the data at that site.

OVERVIEW: Traffic Unit Two

    Traffic: Unit Two is divided into four sections, each of which is divided into several lessons. Lessons may take more than one class period depending on students' familiarity with the Internet, spreadsheets, data collection, and data analysis. *Unit Two* should take approximately two weeks to complete. The unit could also be used in an ongoing way throughout the school year. As content topics arise in the curriculum, teachers could implement the components aligned with them.

    The introductory lesson (Lesson 0), *Looking at Traffic Flow*, in *Traffic: Unit Two* allows students to become familiar with the Internet site and the type of data it contains. Students discuss the meaning of the items in the data table at the traffic site and how the data might be useful. If students have completed *Traffic: Unit One*, this introductory lesson may be omitted.

In the first section, *A Test Drive*, the students become familiar with the Internet site, learn the type of data it contains, and decide how the data might be useful to answer research questions. Students also design their own investigation based on the traffic site. In the first lesson, *Looking at the Map*, students explore the Internet site to see what information is available and analyze data to answer research questions that are presented. In the second lesson, *Where Should We Go?*, students pose potential research questions, evaluate the quality of research questions, and develop criteria for good research questions. In *Choosing a Destination*, the third lesson, students choose a question for their own investigation and develop their research plan.

The second section, *Driving Down the Road*, involves the implementation of student research plans. The first lesson, *Speeding Along*, is the data collection phase of the investigation. The second lesson, *Looking At the Road*, centers on the use of a spreadsheet for organizing data. Students input data, look at the data in a variety of formats, and draw conclusions from patterns in the data.

The third section, *Sharing Our Trip*, allows students to present their research study and its results to an audience (their class or a small group of their peers). The first lesson, *Making Our Own Map*, focuses on the process of creating a research presentation, including deciding what data and information to present and how to present it. The second lesson, *Sharing Where We Have Been*, is the actual presentation of the research projects. Students may evaluate their peers' research and presentations in the latter part of the second lesson.

The fourth section, *Finding a New Road*, encourages students to apply the research process independently to a different situation. In this section students find a new dynamic Internet site, pose a research question, develop a research plan, and conduct an investigation to answer their question.

Before beginning *Traffic: Unit Two,* students should have a basic knowledge of graphs, variables, and measures of center and spread. *Traffic: Unit One* can be used to introduce students to these topics but it is not a prerequisite for *Unit Two* if students have sufficient background in graphs and measures of center and spread. Specifically, students should be able to choose and create appropriate graphs and to calculate measures of center to describe data sets. Students should also be able to compare data representations and data sets by comparing centers, spreads, and graphical representations. Students should have experience using a spreadsheet program to create graphs and to calculate measures of center and spread.

The following chart provides time-allocation estimates for the lessons. Time spent on the computer is in addition to class time listed. The time needed will vary depending on student familiarity with the Internet, spreadsheets, and the research process. Lessons may take more than one class day.

Unit Time Allocations

Lesson	Mathematical Description	Class Time (minutes)	Computer Time (minutes)	Total
Lesson 0 Looking At the Map	Introduction to traffic site; analyzing data and answering posed research questions	20	30	50

Section 1 - Exploring Traffic Flow: Developing a research question and research plan

Lesson	Mathematical Description	Class Time (minutes)	Computer Time (minutes)	Total
Lesson 1 Where Should We Go?	Pose and evaluate research questions	50	0	50
Lesson 2 Choosing A Destination	Choose a research question and develop a research plan	50	0	50

Section 2 - Driving Down the Road: Collecting and analyzing data

Lesson	Mathematical Description	Class Time (minutes)	Computer Time (minutes)	Total
Lesson 3 Speeding Along	Collect data	0	will vary	will vary
Lesson 4 Looking At the Road	Organize, analyze, and evaluate data; draw conclusions	20	30	50

Section 3 - Sharing Our Trip: Presenting Results

Lesson	Mathematical Description	Class Time (minutes)	Computer Time (minutes)	Total
Lesson 5 Making Our Own Map	Create presentation of results	50	access	50
Lesson 6 Sharing Where We Have Been	Share results; evaluate self and peers	50	access	50

Section 4 - Finding a New Road: Finding a new dynamic Internet site and conducting an investigation.

Unit Goals by Lesson

	Lesson						
	1	2	3	4	5	6	7
Use Internet sources and a spreadsheet program to assist in gathering, analyzing, organizing, and presenting data.	✓			✓	✓	✓	
Choose, create, and utilize various graphical representations of data appropriately and effectively.	✓		✓		✓	✓	
Interpret graphical representations of data.	✓	✓			✓		
Compute, describe, and interpret mean, median, and mode as measures of the center of a data set; know which measure is best to use in particular situations; and understand how each does and does not represent the data.	✓		✓		✓		
Analyze associations among variables by comparing the centers, spreads, and graphical representations of related data sets.	✓				✓		
Design experiments and describe potential sources of bias in research designs and data collection.	✓	✓	✓				
Formulate conclusions and make recommendations based on data analysis.	✓				✓		
Use data to answer questions posed, understand the limitations of those questions and answers, and pose new questions that arise from the data.	✓	✓	✓		✓		
Organize and consolidate mathematical thinking to facilitate communication with others.	✓	✓	✓	✓	✓	✓	✓
Express mathematical ideas coherently and clearly to peers and teachers.	✓	✓	✓	✓	✓	✓	✓
Extend their mathematical knowledge by considering the thinking, ideas, and strategies of others.	✓	✓	✓		✓		✓

Guidelines for Teaching Traffic: Unit Two

Unit Structure

The unit is divided into four sections, each of which is divided into two or three lessons (see chart on page ix). Some lessons may take more than one class period depending on the students' familiarity with the Internet, spreadsheets, data collection, and analysis.

The following information is provided for each lesson: materials needed (PREPARING FOR THE TRIP), student objectives (DESTINATION), lesson launch (STARTING THE ENGINE), task sequence (DRIVING DOWN THE ROAD), assessment ideas (CHECKING THE OIL), and lesson closure (PARKING THE CAR). Also included are lesson suggestions, questions for discussion, definitions of mathematical terms, potential areas for review and extension (REST STOP), and suggestions for homework. A brief description of the lesson (LESSON OVERVIEW) is also provided for easy reference.

As students work on the unit, they will be required to collect data, answer questions, and record their thoughts and conclusions. For each lesson, student guide (SG) sheets are provided as a place for students to record their work. Prior to the lesson, the teacher should photocopy these sheets (or an adaptation of them) for each student to use.

Material is provided for a variety of student achievement levels and emphasis. Teachers should choose material and assign homework that is appropriate for their students and their curriculum.

Assessment

Assessment of student learning is embedded in the unit, and should be an integral part of ongoing classroom activity. It is essential that during the teaching of the lessons a variety of assessment techniques be used to gain an understanding of each student's knowledge of and ability to use mathematics and technology. Each lesson has a list of questions for homework, discussion, and/or quizzes. Teachers do not need to assign all of the questions. The goal is to provide enough questions to allow for flexibility and teacher choice. If teacher assessment shows that students lack knowledge in a particular area, classroom discussion can be enriched by using questions from the suggested list. Note that some questions have more than one correct answer. Several of the more difficult questions can be used as extension or enrichment for advanced students.

Lesson I

Looking at the Map

OVERVIEW (Brief Description of the Lesson)
This lesson provides an introduction to doing research and allows students to prepare to conduct their own research project (Lessons II–VII). Given a data set, the student analyzes data by creating graphs and finding measures of center. Then the student uses the analysis to answer posed research questions.

PREPARING FOR THE TRIP (Materials)
- student guide (SG-1): "Looking at the Map" for each student
- computers with spreadsheet program for student use
- overhead transparency (or handout) of Summary Data for Analysis

DESTINATION (Student Objectives)
The student will
- find, describe, and interpret mean, median, and mode as measures of center of a data set.
- interpret graphical representations of data.
- analyze associations among variables by comparing the centers, spreads, and graphical representations of related data sets.
- use data to answer the questions that were posed, understand the limitations of those answers, and pose new questions that arise from the data.

STARTING THE ENGINE (Lesson Launch)
Begin by discussing the notion of research, how one does research, how research answers given questions (research questions), and the role of research in society. Present Summary Data for Analysis (on page 17), which contains a data table from the traffic site, a related graph, and the measures of center and spread. Ask students to explain what the table, graph, and statistics tell about the data and to give specific examples of questions for which the information would be helpful. The discussion should help students understand how to use data to answer a research question.

> **Teaching Tip**
> You might want to give examples from the newspaper about research other people are doing.

Questions to foster discussion:
- What can be said about the speed on Interstate 35W?
- What variables do the data compare?
- Do the data help answer the question, "How does the time of day affect traffic speed on Interstate 35W?"
- Do the data help answer the question, "How does the day of the week affect traffic speed on Interstate 35W?"
- What do the means tell you about the data that the graph does not?
- How do the measures of center and spread relate to the graph?
- How could this information be helpful?

Definitions

Research – careful, critical inquiry or examination that seeks facts related to specific questions; a diligent investigation to find out something; a prolonged, intensive, purposeful search.

Research questions – questions that may be answered by collecting information (data).

DRIVING DOWN THE ROAD (Task Sequence)
In pairs, small groups, or individually, students should work through the student guide. The guide presents data and a research question and asks students to analyze the data and answer the research question. Students should be allowed to use spreadsheets to create graphs, and to calculate measures of center and spread.

> **Teaching Tip**
>
> After students have completed the student guide, and if time permits, students can share their summary paragraphs. One possibility would be to pair the groups and have each group present its findings to another group.

CHECKING THE OIL (Assessing Ideas)
Sources of information on student progress and understanding are:
- observation of groups
- responses to student guide
- questions from the "Homework, Assessment, or Discussion" section

PARKING THE CAR (Lesson Closure)
Review ways to analyze data and answer research questions with emphasis on the following points:
- graphs and measures of center and spread are powerful tools in analyzing data
- non-obvious factors can limit and/or influence the data
- convincing arguments use data to support conclusions

The next lesson asks students to write their own research questions. Have students think about the following questions before the next lesson:
- What research question might you want to answer related to the traffic Internet site?
- What makes a good research question?

Assign homework.

SUGGESTIONS FOR HOMEWORK, ASSESSMENT, OR DISCUSSION
Teachers can assign one or more of the following:

1. Answer one or both of the questions in "Parking the Car."

2. Use the following data to answer the questions listed below.

Sensor	Number of cars on Tuesday	Number of cars on Friday
a	4320	4710
b	5280	5720
c	6480	5920
d	4560	5970
e	7320	6150
f	7680	6430
g	4680	5750
h	4920	6010
i	3960	2700
j	2760	3160

	Tuesday	Friday
Mean	5196	5252
Median	4800	5835
Mode	no mode	no mode
Range	4920	3730

a) What variables do the data compare?

b) How might this information be helpful? Who might be interested in this information?

c) Do the data help answer the question, "How does the day of the week affect traffic speed on Interstate 494?"

d) Do the data help answer the question, "How does the day of the week affect the number of cars on Interstate 494?"

e) Analyze the data and write a thorough response to the research question, "How does the day of the week affect the number of cars on Interstate 494?" In your response be sure to include your reasons and the data that support your claims.

f) What non-obvious factors might have influenced the data in the table?

g) What other research questions might the data help to answer?

3. Jered is interested in answering the question, "How does the number of accidents on a highway affect the traffic speed?" What type of data should he collect to answer his question?

4. An amusement park manager is interested in answering the research question, "Which is the most popular ride in the park?" She collects the following data:

Ride	Number of Passengers in 1 hour
merry-go-round	157
Ferris wheel	189
roller coaster	246
water-log ride	234
tornado	251
bumper cars	208
twister	227
fun house	174

a) What variables do the data compare?

b) To answer the question do you need to graph the data, and/or compute the measures of center and spread?

 c) Use the data to answer the research question. Be sure to include your reasons and the data that support your claims.

 d) What non-obvious factors might have influenced the data? How might they affect the data and your responses to parts b and c?

 e) What would be the advantage of gathering another set of the data?

 f) What other questions do the data answer?

5. The numbers of visitors each month for Sunny Beach Resort and Animal World are shown below along with the summary statistics. Four students used the data to answer the question, "Which vacation place is busier?" Their conclusions are shown below.

Month	Visitors to Beach Resort	Visitors to Animal World
Jan	45,200	41,000
Feb	42,350	39,850
Mar	43,600	42,400
Apr	31,000	36,250
May	33,200	24,800
Jun	25,800	29,800
Jul	26,950	33,000
Aug	21,400	26,700
Sep	19,650	21,450
Oct	20,700	20,500
Nov	33,680	29,900
Dec	44,850	43,200
Total	388,380	388,850

	Resort	Animal
mean	32,365	32,404
median	32,100	31,450
max	45,200	43,200
min	19,650	20,500
range	25,550	22,700

Student conclusions:

Brian: I know that generally Sunny Beach Resort had more visitors than Animal World because the busiest month for Sunny Beach Resort was busier than the busiest month for Animal Kingdom.

Christa: Overall, I think Animal World was busier because they had more total visitors than Sunny Beach Resort.

Kate: I can say that Sunny Beach Resort had more visitors than Animal World because for 7 out of the 12 months Sunny Beach Resort had more visitors than Animal World.

Casey: I think they were both equally busy because one had a higher mean and the other had a higher median.

 a) Which of the arguments is most convincing? Why?

 b) Both Christa and Kate looked at the number of visitors. Both make correct statements. Why did they reach different conclusions?

 c) Which vacation place do you think is busier? Why?

Summary Data for Analysis

Average Speed on Interstate 35W at 1 PM and 4 PM
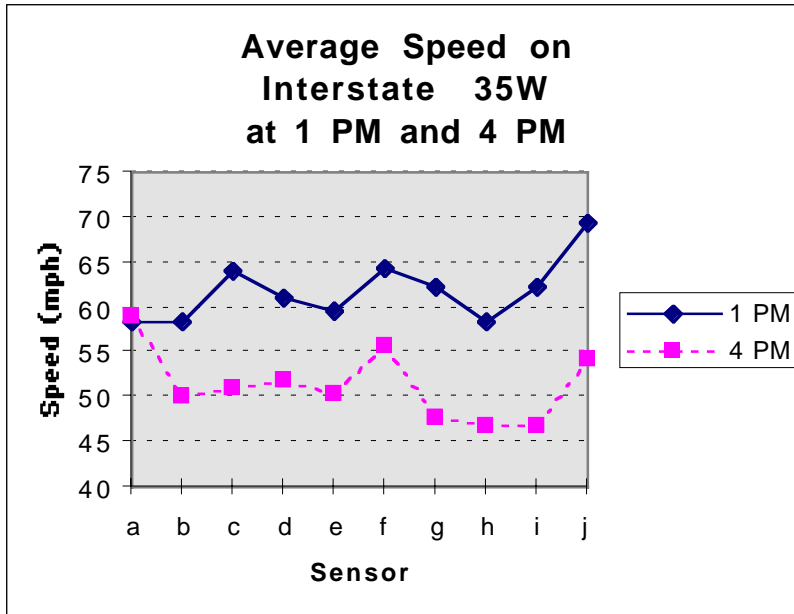
Sensor	1 p.m. Average Speed (mph)	4 p.m. Average Speed (mph)
a	58.5	59.1
b	58.4	50.1
c	64.1	51.1
d	61.0	52.0
e	59.5	50.4
f	64.2	55.6
g	62.3	47.7
h	58.5	46.9
i	62.3	46.7
j	69.4	54.3

	1 p.m.	4 p.m.
Mean	61.8 mph	51.4 mph
Median	61.7 mph	50.8 mph
Mode	58.5 mph	no mode
Range	11.0 mph	12.4 mph