ART JOHNSON

Now & Then

Community Planning through Data Analysis

Now . . . A NEW HOUSING DEVELOPMENT IS BEING BUILT ON THE outskirts of town. Is the closest elementary school large enough to accommodate the expected influx of new students? Members of local and regional planning commissions consider such questions and help communities adapt to growth and change. Andrew Singelakis is the head of the Regional Planning Commission in south-central New Hampshire. He uses mathematics to help towns and cities in his part of the state plan and evaluate community services, from bus routes and new schools to traffic lights and tollbooths. To help communities plan for the future, Andrew uses mathematics to analyze data from the past and present. He also relies on a reasonable sense of both current trends and human nature.

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How did Andrew get started in this career? He was an indifferent student in high school. "I took the required curriculum for college-intending students. That meant four years of mathematics, from algebra to precalculus. I wasn't really interested in mathematics; I took those courses because I had to. I never thought I would use much of it after I graduated, so I never applied myself at all in mathematics. I wish I had known then how much mathematics and statistics I would use in my career. If I had, I would have taken more math in high school." Andrew always had an interest in analyzing data and its applications, however. "I remember reading the Top 40 list of hit records and tracking songs by various artists to see whether I could predict the next week's list. I also tried to predict how long it would take a recording to make number 1 or how long a particular song would stay on the list."

As an undergraduate at the University of New Hampshire, Andrew focused on psychology and sociology, enrolling in only the required mathematics courses that would improve his data-analysis and surveying techniques. A graduate degree in social planning and statistics enabled Andrew to use what he had learned to help committees with both long- and short-term planning projects.

Prepared by ART JOHNSON, *johnsonart@aol.com, who teaches at Nashua Senior High School, Nashua, NH 03062. He is interested in the history of mathematics and in geometry and is involved in research about proportional reasoning and similarity.*

Andrew's first position was with the planning office of a small community in upper New York State. His first job demonstrated the importance of statistics and mathematics to social planning in a way that none of his course work had predicted. "When I began that first job, I arrived just as a heated debate was going on about a proposed sludge plant. No one really wanted the plant, but it seemed inevitable, and several potential sites had been selected for it. A cursory glance at these sites did not turn up any real reason for objecting to any of them. I decided to do a bit more research and bring some mathematics into the analysis of the sites. As it turned out, each of the sites was situated within one mile of a significant minority population. When that fact became known in the community, opposition to the plant exploded." Andrew's findings helped to rally opposition to the sludge plant and supplied the opponents with data to sustain their position. The sludge plant was never built.

According to Andrew, "The whole incident helped convince me that mathematics has to be a critical component of any community planning. It also convinced me that I wanted to use data and data analysis to help people make informed decisions about the future of their community."

Several members of the Regional Planning Commission work on various projects, each bringing his or her particular skill to the job. For example, one member of the office has an interest in, and a talent for, designing effective bus routes for both school and public transportation. Many times the data and statistical analysis for the commission are provided by other agencies. The planning commission then helps local communities interpret the agency's findings and make decisions for the future of the community. Andrew explains, "We don't actually gather data, like the census. The data are collected by state and federal agencies. We use their data to help communities plan for the future. Once the 2000 census is completed, we will certainly use those data and the data from the 1980 and 1990 censuses to try to determine the trends in population growth, use of infrastructure, and school-population changes, among many other programs. In fact, one of the best ways to look to the future is to use past trends and data and compare them with present situations."

Andrew believes that his role is to present findings, try to identify trends, and offer advice. Community members must make their own decisions after hearing from the planning commission. "Their final decision depends on trends, analysis of the data, and the human factor. You can never predict for certain what trends will persist and how they might impact a community, just as it is difficult to account for human nature in community decisions.

"I will stay with community planning. I am having great fun and am happy to help communities plan for the future."

Teacher Notes

THE STUDENT ACTIVITY PAGES CONTAIN WORLD population data for your students to use to predict future population figures and Consumer Price Index data to track changes in the costs of the goods. As an extension, you might assign students the task of gathering data about your community, then use that data to predict future figures and trends.

Answers for Student Activity 1

1. In the year 2000, the world population will be approximately 6 billion; in the year 2010, approximately 7 billion.

2. The population growth rate is increasing slightly.

3. a. The world population would increase by 259 200 in one day; approximately 1.8 million in one week; and approximately 7.8 million in one month, on the basis of a 30-day month.
   b. The world population would be approximately 6 200 000 000.

4. Some factors that affect population growth include war, disease, scientific advances, and cultural changes.

5. The most common “other name” for 2510 million is 2 billion, 510 million.

Answers for Student Activity 2

THE ANSWERS WILL VARY DEPENDING ON HOW students draw their graphs. The answers for this activity were found by estimation methods. The regression line equation feature of the graphing calculator can also be used to obtain lines of best fit and is another estimation tool. However, graphing calculators are not required. A carefully drawn graph will yield very similar results. Students may need help in scaling and labeling their graphs appropriately. See **figure 1.** Not all problems require a lot of calculation. For instance, for problems 5 through 7, good approximations can be obtained by simple estimation techniques.

1. The 1960–1975 data lead to an estimate that is too low. Note that in 1980 the CPI starts to rise sharply.

2. Yes. From 1960 to 1980, the CPI increased $52. From 1980 to 1995, the CPI rose $70. By using a graphing calculator to graph the two sets of data from 1960–1975 and 1980–1995, the regression line feature can be used to generate two lines of best fit with slopes 1.5 and 4.66, respectively, which confirm students’ observations of their own graphs.

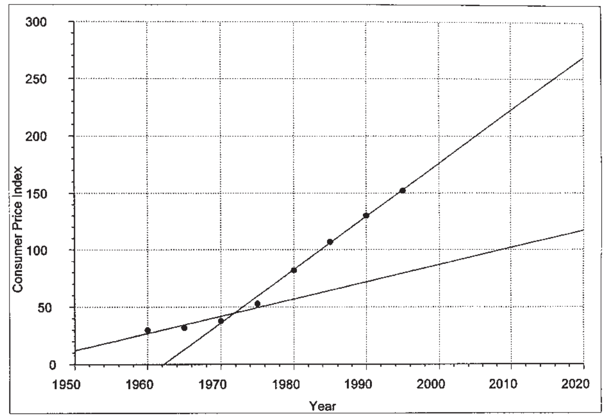

Fig. 1 Lines of best fit for CPI obtained using a graphing calculator

3. The CPI will be somewhere between 173 and 176, depending on the method used. Students can observe that the change per five-year period is as follows: 2, 6, 15, 29, 25, 23, 22. Therefore, the next five-year-period change should be about 21; 152 + 21 = 173. The graphing calculator gives an estimate of 176.

4. Using the second line (1980–1995), we get the CPI doubling in about the year 2005.

5. In 1995, the CPI was 152 and the cost of a CD was about $15.00, or about one-tenth of the CPI. If CDs continue to cost roughly one-tenth of the current CPI, then CDs this year should cost a little more than $17.00, or between $17.30 and $17.60.

6. Students can calculate the CD cost to be $12.83 in 1990, or they can use the estimation technique in the previous answer. By using this technique, the cost of a CD in 1990 would be one-tenth of the CPI, which was 130, or $13.00.

7. A soda that cost $0.10 in 1960 was 1/300 of the CPI of 30. Sodas today would cost about 1/300 of 173, or about $0.57. Sodas are more expensive than other things in the CPI.

Bibliography

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Student Activity 1: Predicting Population Figures

NAME ______________________________

For many people, the year 2000 will be an important year in history. One important event will be the census of the United States. The government conducts a census to find out how many people are living in the country. The data from a census are then used to plan new schools, hospitals, and roads. Most countries conduct a census every ten years. The data from previous population counts can be used to estimate the figures for the next census.

The following data are for the population of the world.

Year	Population (in millions)
1950	2510
1960	3030
1970	3680
1980	4480
1990	5290

Use these data to make a line graph; put the year on the horizontal axis and the population in millions on the vertical axis. Use the resulting graph to answer the following questions.

1. Predict the world population in the years 2000 and 2010.

2. Is the population-growth rate increasing or decreasing? Explain.

3. One population expert claims that every two seconds, nine babies are born and three people die. Assuming that this information is accurate, answer the following:

a. By how much will the world population increase in one day? In one week? In one month?
b. On the basis of the 1990 population and your answer in part (a), what will the world's population be on 1 January 2000?

4. What factors can affect population growth?

5. What is another name for 2510 million?

Student Activity 2: Predicting Prices

NAME ________________________________

Many of you may have heard a parent or grandparent say something like, “When I was your age, we could buy pop for ten cents.” But how much do things cost today compared with how much they cost in the past? The United States government keeps track of rising prices by computing the Consumer Price Index (CPI). The CPI is the cost of a selection of common goods and services, such as food, housing, transportation, and so on, related to the cost in other years. In 1982, the CPI was set at $100, meaning that goods that cost $82 in 1980 cost $100 in 1982. Goods that cost $100 in 1982 cost $130 in 1990. Make a graph of the data with the year on the horizontal axis and the CPI on the vertical axis. Use your graph to answer the following questions.

Year	Consumer Price Index
1960	30
1965	32
1970	38
1975	53
1980	82
1985	107
1990	130
1995	152

1. Graph the data from the years 1960 through 1975, and use the graph to predict the CPI for 1980. Compare your prediction with the actual CPI for 1980. How close was your prediction to the actual CPI? Was it too high or too low?

2. Graph the remaining data. Did prices increase faster from 1980 to 1995 than they did from 1960 to 1980?

3. What do you predict the CPI will be for this year?

4. Predict in what year the CPI will be double what it was for 1982.

5. Predict what a CD that cost $15 in 1995 will cost this year.

6. On the basis of the past CPI, what would a CD that cost $15 in 1995 have cost in 1990?

7. If a small bottle of soda cost 10 cents in 1960, predict its price today on the basis of the CPI. Is soda more or less expensive than it was in 1960? Explain.

John Graunt: The Founder of Statistics

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. . . & Then

IT SEEMS THAT OUR everyday lives are increasingly affected by data, such as inflation rates, the Consumer Price Index, interest rates, and monetary exchange rates. This influence was not always so keenly felt. In fact, the use of statistical data began only about 350 years ago. Before that, people attempted to encapsulate societal trends with numerical data; however, the data were not used to make inferences about the present or future. Englishman John Graunt (1620–1674) was the first to use data to make inferences.

Graunt was born to a middle class couple in London. He attended school until he was sixteen, then quit to take up his father's trade, haberdashery, in which he probably made and sold women's wear. Graunt had an active mind as a young man and taught himself French and Latin by studying early in the morning before opening his shop. He married and had a son who moved to Persia and a daughter who became a nun. Despite his lack of formal education beyond basic schooling, Graunt was held in high regard by the English gentry and was considered an outstanding conversationalist.

Nothing in Graunt's life suggested the groundbreaking work that he was to do with statistical data. Even Graunt himself was unsure about how he got started examining the records of births and deaths for the city of London. Once engaged, he found that the records contained a wealth of information, and he was able to compile statistical data about births and deaths for the city of London for 1592 to 1661. In fact, the word *statistics* comes from the word *state,* reflecting that early studies were of information about the state.

According to Graunt, for most people, the Bills of Mortality—records of births and deaths—provided grist for social conversation. Graunt sought to find some value in these data beyond morbid interest in causes of death, and so began the field of statistics. He was sure that the information in the Bills of Mortality could be used to verify a number of commonly held notions about the city of London, not the least of which was its estimated population of 2 million. By comparing the number of deaths with the number of baptisms, Graunt was able to make various inferences. For example, he determined that the population of London could not possibly be 2 million because that number would require far more baptisms than were recorded. He fixed London's population at 384 000, a figure that is close to what present-day historians claim for London in the mid-seventeenth century.

Graunt made a number of other inferences, including that within two years of a plague outbreak, the population could fully recover; one-third of all deaths were of children younger than five years old; the native population of London was decreasing, so immigration could expand the city's population growth; rickets was rapidly increasing among the citizens of London; the population of England and Wales was 6.5 million; and the population of London was growing four times faster than the general population of England and Wales. Graunt published his observations in 1662, followed by several updates in succeeding years. These publications were well received, and Graunt became highly esteemed by the upper classes. In 1665, he was nominated by King Charles II for membership in the Royal Society; Graunt was the only tradesman ever admitted to the Society. He died of jaundice in 1674.

Graunt's legacy is to be known as the founder of statistics, an honor that is all the more impressive when one remembers his lack of formal training. Despite this deficiency, he was able to educate an entire nation about the population of London and to begin a completely new field of mathematics—quite an achievement for a humble shopkeeper.

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