Figure 1.9. INTRODUCTION: What is Statistics?

Program 1 in: *Against All Odds: Inside Statistics*

This program introduces the 26-part series and also attempts to answer the question posed in the title by showing how statistical methods are used to answer one or more questions in each of a variety of situations. The host of the series is Dr. Teresa M. Amabile who, when the series was made in the mid-1980s, taught statistics in the Department of Psychology at Brandeis University; her research was concerned with creativity and what motivates people to be creative.

The statistical matters shown in Program 1 involve both historical anecdotes and contemporary applications, to indicate the nature of statistics and its impact on our world; many of the applications are taken up in more detail in later programs. The following summary of the video's content uses three categorizations: statements about statistical methods (□), situations illustrating the application of statistical methods (⊙) and statistical matters that arise in these situations (– and ∗).

⊙ The effect of competitive rewards on creativity as expressed in children's collages.
- – A carefully planned *experiment* with *two groups* of children making collages at *separate* art parties.
  - ∗ Only *one* difference between the groups: what the children believe about the prize or reward.
- – *All* the collages are rated *independently* by *several* art experts who are *blind* to the children's groups.
- – A measure of the effect of the reward is the *difference* between the *average scores* for the two groups.
  - ∗ How can we be sure it was competition for the reward and not some *other* factor that caused any difference?
- – How *many* children need to be tested before the results become meaningful? *i.e.*, before we can conclude that there is a *real* difference between the two averages?
- – What degree of *confidence* can be placed in the investigation *answers*? How close to *certainty* can we hope to get?

□ Statistical methods offer a way of *finding things out*, and knowing something about statistics helps you make wiser decisions on public issues or in business, as well as in research.

Statistical methods enable their user(s) to move from *data* (for example, the collage judges' ratings, poll results, unemployment figures) to something much more interesting and powerful: clear *answers* to puzzling *questions*.

Statistics can be found just about everywhere: it's as popular as .... pizza.

⊙ Domino's Pizza's development of a deep-dish pan pizza, their first new menu item in almost 30 years.
- – A *sample survey* had found that, among *respondents*, 48% liked the traditional *thin* crust, 45% would prefer a *thick* crust, and 7% liked *both*.
- – Sensory evaluation by *trained* tasters of different doughs for the thick crust developed in a research kitchen.
  - ∗ *Repeatedly* obtaining qualitative assessments *and* numerical ratings with their statistical analyses.
- – Investigating the effects on pizza ratings of dough, amount of sauce, amount of cheese, baking time.
  - ∗ Use of a *precise script* to try to ensure comparability of results from *consumer* trials all over the U.S.
  - ∗ *Random* order of presentation of the two pizza types in a test of appearance and more *vs.* less cheese.
- – 100,000 *responses* from 150,000 survey questionnaires sent out by the market research department.
  - ∗ Development of a demographic *profile* of pan pizza customers involving matching with a national data base.
- – Development of a statement of *objectives* and a *strategy* to achieve these objectives in marketing the new pizza.
  - ∗ Using *sample surveys* to test consumer reactions to potential advertisements which continue to use the *noid*.
  - ∗ Testing the new advertisements *and* the new pizza in selected cities and *measuring the response*.
  - ∗ One example of *constantly evaluating the product*: telephone surveys within an hour of pizza delivery.
- – Statistical analysis can show if two things are *significantly different*; without statistics, one is only guessing.
  - ∗ Statistics help provide a basis on which to make an intelligent decision.
- – Domino's Pizza's policy is to *measure* everything it does: *it's no fun playing sports if you don't keep score.*

□ Statistics is a *science*, our guide to answering the question: *How do you know .....?*
Statistics is part of *all* the sciences – it is fundamental to the *scientific method*.

Statistical methods can turn *raw data* into *honest, verifyable arguments that resolve profound questions.*
They *harness numbers to help us make sense of the world*, and they provide a means of *taming uncertainty.*

Statistics is concerned with: *describing* data (including *existing* data) to provide clear, compact summaries;
producing data which are precisely tailored to answer *specific* questions;
obtaining answers from data, and quantifying how *certain* these answers are.

The following situations are concerned with using *existing* data to provide a *numerical picture*:

⊙ Lightning strikes in Colorado: based on data for ¾ million flashes collected in just a limited area of the state and using *histograms*, important information can be obtained about the *time* of the *first* flash.

⊙ The growth rate of a child with a growth hormone deficiency, compared on a chart with normal growth rates.

⊙ Manatee (vegetarian sea mammal) deaths in Florida: relationship to the number of power boat registrations.
- – These data led to the creation of coastal sanctuaries for manatees where power boats are off limits.

(*continued overleaf*)

⊙ Baseball players' salaries: how do they relate to, or *correlate with*, the numbers of home runs batters hit?

The following situations are concerned with *producing* (new) data that will provide answers with acceptable limitations:
We also encounter three familiar but often misunderstood words: *samples*, *experiments* and *probability*.

⊙ Pollution damage in Chesapeake Bay: data collection by means of sampling to monitor *trends* over time.
– Researchers follow a precise statistical *plan* for gathering and analysing random Bay-floor mud samples.

⊙ The efficacy of aspirin in reducing heart attacks: a *controlled experiment* (or *clinical trial*) involving more than 22,000 male doctors found 104 heart attacks in the treatment group compared with 189 in the control (*placebo*) group.

⊙ Frito Lay's manufacture of potato chips: the aim of quality control based on *sampling* is to maintain consistent standards to try to ensure that *each chip is the same as the one before*.

⊙ U.S. opinion polls typically use a *sample* of size about 1,500 drawn from a *population* of size around 240,000,000.
– Polls are *widely* used; *e.g.*, to gather data about politicians, products and problems.
– *Random selecting* of the sample of interview subjects from the population.
– The importance of the *wording* of the question(s).
– *Training* the interviewers; *e.g.*, never *suggest an answer to a question*.
– Purposes of polls include providing snapshots of public opinion and identifying significant *trends* over time.

⊙ The *Challenger* disaster: each joint in the casing of each booster rocket has a high probability (estimated as 0.977) of maintaining its integrity during a shuttle launch, but the probability of no malfunction in *all six* joints of the two boosters is appreciably *lower*.
– After the disaster, probability analysis was instrumental in the overhaul of the entire shuttle program.

⊙ Casino gambling: there is a reasonable probability an *individual* gambler will 'strike it rich', but the house does a profitable business *every day of the year*.

The following situations are concerned with the *interpretation* of (*i.e.*, obtaining *answers with acceptable limitations* from) data:
Major themes are: the *accuracy* of answers and the degree of *confidence* that can be placed in them;
making the *best use* of the information you have, gathering information you *don't* have.

⊙ Racial discrimination in the FBI:
– Statistical analysis showed that the status of Hispanic agents was *very unlikely to have arisen by chance alone*.
– A key issue was the *assumptions* that went into *the building of the picture that statistics painted for the judge*.

⊙ Duracell batteries: it can be shown that the present batteries have longer lives than those made a few years ago.
– Based on data from laboratory tests of batteries *sampled at random* from the production line, today's *AA* batteries, used under specified conditions, have an *average* lifetime of 7½ hours ± 20 minutes with 95% confidence.

⊙ The Salem witch hunts: data analysis shows that the witches and their accusers lived on *opposite* sides of the town; this sharp geographical division provides evidence that the motivation for the hunts was *political persecution*.

⊙ Did Shakespeare write a recently-discovered 'inferior' poem of uncertain authorship? A statistical analysis of the poem's vocabulary, compared with that of Shakespeare's *known* works, indicates that he *could* have written it.
– In this context, the statistical analysis (like a paternity test) *can only rule* out, *it can't rule* in.

⊙ Improving the welfare system for women: the Baltimore *experiment* with two groups of welfare recipients.
– One group went through the existing program, the other group, who also received remedial education, counselling, day care and job training in the *Options* program, found *more jobs and received better pay*.
– The data from this study provided the impetus for new legislation to reform the welfare system.

⊙ The effect of competitive rewards on creativity – Dr. Amabile's data suggest that:
– competitive rewards *undermine* creativity – creative work seems to be its own reward;
– to encourage creativity, people need to be taught the basic *skills* to enable them to accomplish the task at hand.

1 After you have viewed the video, go over the points given in this summary for each situation (⊙) and outline, where appropriate, both the *reasons* for the importance of the statistical matters and also the *answers* to the questions (– and ∗); *keep* a written copy of your work.
● At the *end* of the course, repeat the exercise; a comparison of what you write on the two occasions will indicate the growth over the term of your understanding of statistics.

2 With reference to the *Challenger* disaster mentioned above, estimate the probability *none* of the three joints fail in a booster.
● What *assumption(s)* underlie your calculation?
● Find an approximate value for the probability of booster failure during a shuttle launch (the shuttle has *two* boosters).

3 For casino gambling, briefly explain the 'paradox' of the individual having an appreciable probability of winning but the casino being almost certain of coming out ahead at the end of each day.