3.2 Designing Experiments

SUBJECTS, FACTORS, TREATMENTS

The individuals studied in an experiment are often called subjects, especially if they are people.
The explanatory variables in an experiment are often called factors.
A treatment is any specific experimental condition applied to the subjects. If an experiment has several factors, a treatment is a combination of a specific value (often called a level) of each of the factors.

EXAMPLE 3.11

Absorption of a drug

Researchers at a pharmaceutical company studying the absorption of a drug into the bloodstream inject the drug (the treatment) into 25 people (the subjects). The response variable is the concentration of the drug in a subject’s blood, measured 30 minutes after the injection. This experiment has a single factor with only one level. If three different doses of the drug are injected, there is still a single factor (the dosage of the drug), now with three levels. The three levels of the single factor are the treatments that the experiment compares.
FIGURE 3.3 The treatments in the experimental design of Example 3.12. Combinations of levels of the two factors form six treatments.

**EXAMPLE 3.12**

Effects of TV advertising

What are the effects of repeated exposure to an advertising message? The answer may depend both on the length of the ad and on how often it is repeated. An experiment investigates this question using undergraduate students as subjects. All subjects view a 40-minute television program that includes ads for a digital camera. Some subjects see a 30-second commercial; others, a 90-second version. The same commercial is repeated either 1, 3, or 5 times during the program. After viewing, all of the subjects answer questions about their recall of the ad, their attitude toward the camera, and their intention to purchase it. These are the response variables.\(^7\)

This experiment has two factors: length of the commercial, with 2 levels; and repetitions, with 3 levels. The 6 combinations of one level of each factor form 6 treatments. Figure 3.3 shows the layout of the treatments.

Examples 3.11 and 3.12 illustrate the advantages of experiments over observational studies. Experimentation allows us to study the effects of the specific treatments we are interested in. Moreover, we can control the environment of the subjects to hold constant the factors that are of no interest to us, such as the specific product advertised in Example 3.12. The ideal case is a laboratory experiment in which we control all lurking variables and so see only the effect of the treatments on the response. Like most ideals, such control is not always realized in practice.

Another advantage of experiments is that we can study the combined effects of several factors simultaneously. The interaction of several factors can produce effects that could not be predicted from looking at the effect of each factor alone. Perhaps longer commercials increase interest in a product, and more commercials also increase interest, but if we both make a commercial longer and show it more often, viewers get annoyed and their interest in the product drops. The two-factor experiment in Example 3.12 will help us find out.

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3.29 Sickle cell disease. Sickle cell disease is an inherited disorder of the red blood cells that in the United States affects mostly blacks. It can cause severe
3.2 Designing Experiments

Comparative experiments

Experiments in the laboratory often have a simple design: impose the treatment and see what happens. We can outline that design like this:

Subjects —— Treatment —— Response

In the laboratory, we try to avoid confounding by rigorously controlling the environment of the experiment so that nothing except the experimental treatment influences the response. Once we get out of the laboratory, however, there are almost always lurking variables waiting to confound us. When our subjects are people or animals rather than electrons or chemical compounds, confounding can happen even in the controlled environment of a laboratory or medical clinic. Here is an example that helps explain why careful experimental design is a key issue for pharmaceutical companies and other makers of medical products.
EXAMPLE 3.13

Gastric freezing to treat ulcers

“Gastric freezing” is a clever treatment for ulcers. The patient swallows a deflated balloon with tubes attached, then a refrigerated liquid is pumped through the balloon for an hour. The idea is that cooling the stomach will reduce its production of acid and so relieve ulcers. An experiment reported in the Journal of the American Medical Association showed that gastric freezing did reduce acid production and relieve ulcer pain. The treatment was widely used for several years. The design of the experiment was

Subjects → Gastric freezing → Observe pain relief

This experiment is poorly designed. The patients’ response may be due to the placebo effect. A placebo is a dummy treatment. Many patients respond favorably to any treatment, even a placebo, presumably because of trust in the doctor and expectations of a cure. This response to a dummy treatment is the placebo effect.

A later experiment divided ulcer patients into two groups. One group was treated by gastric freezing as before. The other group received a placebo treatment in which the liquid in the balloon was at body temperature rather than freezing. The results: 34% of the 82 patients in the treatment group improved, but so did 38% of the 78 patients in the placebo group. This and other properly designed experiments showed that gastric freezing was no better than a placebo, and its use was abandoned.16

The first gastric-freezing experiment was biased. It systematically favored gastric freezing because the placebo effect was confounded with the effect of the treatment. Fortunately, the remedy is simple. Experiments should compare treatments rather than attempt to assess a single treatment in isolation. When we compare the two groups of patients in the second gastric-freezing experiment, the placebo effect and other lurking variables operate on both groups. The only difference between the groups is the actual effect of gastric freezing. The group of patients who receive a sham treatment is called a control group, because it enables us to control the effects of lurking variables on the outcome.

Randomized comparative experiments

The design of an experiment first describes the response variables, the factors (explanatory variables), and the layout of the treatments, with comparison as the leading principle. The second aspect of design is the rule used to assign the subjects to the treatments. Comparison of the effects of several treatments is valid only when all treatments are applied to similar groups of subjects. If one corn variety is planted on more fertile ground, or if one cancer drug is given to less seriously ill patients, comparisons among treatments are biased. How can we assign individuals to treatments in a way that is fair to all the treatments?

Our answer is the same as in sampling: let impersonal chance make the assignment. The use of chance to divide subjects into groups is called randomization. Groups formed by randomization don’t depend on any
characteristic of the subjects or on the judgment of the experimenter. An experiment that uses both comparison and randomization is a randomized comparative experiment. Here is an example.

**EXAMPLE 3.14 Testing a breakfast food**

A food company assesses the nutritional quality of a new “instant breakfast” product by feeding it to newly weaned male white rats. The response variable is a rat’s weight gain over a 28-day period. A control group of rats eats a standard diet but otherwise receives exactly the same treatment as the experimental group.

This experiment has one factor (the diet) with two levels. The researchers use 30 rats for the experiment and so must divide them into two groups of 15. To do this in an unbiased fashion, put the cage numbers of the 30 rats in a hat, mix them up, and draw 15. These rats form the experimental group and the remaining 15 make up the control group. Each group is an SRS of the available rats. Figure 3.4 outlines the design of this experiment.

We can use software or the table of random digits to randomize. Label the rats 01 to 30. Enter Table B at (say) line 130. Run your finger along this line (and continue to lines 131 and 132 as needed) until 15 rats are chosen. They are the rats labeled

05 16 17 20 19 04 25 29 18 07 13 02 23 27 21

These rats form the experimental group; the remaining 15 are the control group.

**Completely randomized designs**

The design in Figure 3.4 combines comparison and randomization to arrive at the simplest statistical design for an experiment. This “flowchart” outline presents all the essentials: randomization, the sizes of the groups and which treatment they receive, and the response variable. There are, as we will see later, statistical reasons for generally using treatment groups that are about equal in size. We call designs like that in Figure 3.4 *completely randomized*.

**COMPLETELY RANDOMIZED DESIGN**

In a completely randomized experimental design, all the subjects are allocated at random among all the treatments.

**FIGURE 3.4** Outline of a randomized comparative experiment, for Example 3.14.
Completely randomized designs can compare any number of treatments. Here is an example that compares three treatments.

**Example 3.15**

Conserving energy

Many utility companies have introduced programs to encourage energy conservation among their customers. An electric company considers placing electronic indicators in households to show what the cost would be if the electricity use at that moment continued for a month. Will indicators reduce electricity use? Would cheaper methods work almost as well? The company decides to design an experiment.

One cheaper approach is to give customers a chart and information about monitoring their electricity use. The experiment compares these two approaches (indicator, chart) and also a control. The control group of customers receives information about energy conservation but no help in monitoring electricity use. The response variable is total electricity use in a year. The company finds 60 single-family residences in the same city willing to participate, so it assigns 20 residences at random to each of the 3 treatments. Figure 3.5 outlines the design.

To carry out the random assignment, label the 60 households 01 to 60. Enter Table B (or use software) to select an SRS of 20 to receive the indicators. Continue in Table B, selecting 20 more to receive charts. The remaining 20 form the control group.

Examples 3.14 and 3.15 describe completely randomized designs that compare levels of a single factor. In Example 3.14, the factor is the diet fed to the rats. In Example 3.15, it is the method used to encourage energy conservation. Completely randomized designs can have more than one factor. The advertising experiment of Example 3.12 has two factors: the length and the number of repetitions of a television commercial. Their combinations form the six treatments outlined in Figure 3.3 (page 190). A completely randomized design assigns subjects at random to these six treatments. Once the layout of treatments is set, the randomization needed for a completely randomized design is tedious but straightforward.

**Apply Your Knowledge**

3.32 Gastric freezing. Example 3.13 describes an experiment that helped end the use of gastric freezing to treat ulcers. The subjects were 160 ulcer patients.

(a) Use a diagram to outline the design of this experiment, following the information in Example 3.13. (Show the size of the groups, the treatment each group receives, and the response variable. Figures 3.4 and 3.5 are models to follow.)
3.33 Sealing food packages. Use a diagram to describe a completely randomized experimental design for the package liner experiment of Exercise 3.30. (Show the size of the groups, the treatment each group receives, and the response variable. Figures 3.4 and 3.5 are models to follow.) Use software or Table B, starting at line 120, to do the randomization required by your design.

3.34 Does child care help recruit employees? Will providing child care for employees make a company more attractive to women, even those who are unmarried? You are designing an experiment to answer this question. You prepare recruiting material for two fictitious companies, both in similar businesses in the same location. Company A’s brochure does not mention child care. There are two versions of Company B’s material, identical except that one describes the company’s on-site child-care facility. Your subjects are 40 unmarried women who are college seniors seeking employment. Each subject will read recruiting material for both companies and choose the one she would prefer to work for. You will give each version of Company B’s brochure to half the women. You expect that a higher percentage of those who read the description that includes child care will choose Company B.

(a) Outline an appropriate design for the experiment.

(b) The names of the subjects appear below. Use Table B, beginning at line 131, to do the randomization required by your design. List the subjects who will read the version that mentions child care.

Abrams Danielson Gutierrez Lippman Rosen
Adamson Durr Howard Martinez Sugiwara
Afifi Edwards Hwang McNeill Thompson
Brown Fluharty Iselin Morse Travers
Cansico Garcia Janle Ng Turing
Chen Gerson Kaplan Quinones Ullmann
Cortez Green Kim Rivera Williams
Curzakis Gupta Lattimore Roberts Wong

The logic of randomized comparative experiments

Randomized comparative experiments are designed to give good evidence that differences in the treatments actually cause the differences we see in the response. The logic is as follows:

- Random assignment of subjects forms groups that should be similar in all respects before the treatments are applied.
- Comparative design ensures that influences other than the experimental treatments operate equally on all groups.
- Therefore, differences in average response must be due either to the treatments or to the play of chance in the random assignment of subjects to the treatments.
PRINCIPLES OF EXPERIMENTAL DESIGN

1. **Control** the effects of lurking variables on the response, most simply by comparing two or more treatments.
2. **Randomize**—use impersonal chance to assign subjects to treatments.
3. **Replicate** each treatment on enough subjects to reduce chance variation in the results.

We hope to see a difference in the responses so large that it is unlikely to happen just because of chance variation. We can use the laws of probability, which give a mathematical description of chance behavior, to learn if the treatment effects are larger than we would expect to see if only chance were operating. If they are, we call them **statistically significant**.

STATISTICAL SIGNIFICANCE

An observed effect so large that it would rarely occur by chance is called **statistically significant**.

If we observe statistically significant differences among the groups in a comparative randomized experiment, we have good evidence that the treatments actually caused these differences. You will often see the phrase “statistically significant” in reports of investigations in many fields of study. The great advantage of randomized comparative experiments is that they can produce data that give good evidence for a cause-and-effect relationship between the explanatory and response variables. We know that in general a strong association does not imply causation. A statistically significant association in data from a well-designed experiment does imply causation.

APPLY YOUR KNOWLEDGE

Conserving energy. Example 3.15 describes an experiment to learn whether providing households with electronic indicators or charts will reduce their electricity consumption. An executive of the electric company objects to...
including a control group. He says, “It would be simpler to just compare electricity use last year (before the indicator or chart was provided) with consumption in the same period this year. If households use less electricity this year, the indicator or chart must be working.” Explain clearly why this design is inferior to that in Example 3.15.

3.36 Exercise and heart attacks. Does regular exercise reduce the risk of a heart attack? Here are two ways to study this question. Explain clearly why the second design will produce more trustworthy data.
1. A researcher finds 2000 men over 40 who exercise regularly and have not had heart attacks. She matches each with a similar man who does not exercise regularly, and she follows both groups for 5 years.
2. Another researcher finds 4000 men over 40 who have not had heart attacks and are willing to participate in a study. She assigns 2000 of the men to a regular program of supervised exercise. The other 2000 continue their usual habits. The researcher follows both groups for 5 years.

3.37 Statistical significance. The financial aid office of a university asks a sample of students about their employment and earnings. The report says that “for academic year earnings, a significant difference was found between the sexes, with men earning more on the average. No significant difference was found between the earnings of black and white students.” Explain the meaning of “a significant difference” and “no significant difference” in plain language.

Cautions about experimentation

The logic of a randomized comparative experiment depends on our ability to treat all the subjects identically in every way except for the actual treatments being compared. Good experiments therefore require careful attention to details. For example, the subjects in both groups of the second gastric freezing experiment (Example 3.13, page 192) all got the same medical attention over the several years of the study. The researchers paid attention to such details as ensuring that the tube in the mouth of each subject was cold, whether or not the fluid in the balloon was refrigerated. Moreover, the study was double-blind—neither the subjects themselves nor the medical personnel who worked with them knew which treatment any subject had received. The double-blind method avoids unconscious bias by, for example, a doctor who doesn’t think that “just a placebo” can benefit a patient.

The most serious potential weakness of experiments is lack of realism. The subjects or treatments or setting of an experiment may not realistically duplicate the conditions we really want to study. Here are two examples.

EXAMPLE 3.16 Response to advertising

The study of television advertising in Example 3.12 showed a 40-minute videotape to students who knew an experiment was going on. We can’t be sure that the results apply to everyday television viewers. The student subjects described their reactions but did not actually decide whether to buy the camera. Many experiments in marketing and decision making use as subjects students who know they are taking part in an experiment. That’s not a realistic setting.
EXAMPLE 3.17
Center brake lights

Do those high center brake lights, required on all cars sold in the United States since 1986, really reduce rear-end collisions? Randomized comparative experiments with fleets of rental and business cars, done before the lights were required, showed that the third brake light reduced rear-end collisions by as much as 50%. Alas, requiring the third light in all cars led to only a 5% drop.

What happened? Most cars did not have the extra brake light when the experiments were carried out, so it caught the eye of following drivers. Now that almost all cars have the third light, they no longer capture attention.

Lack of realism can limit our ability to apply the conclusions of an experiment to the settings of greatest interest. Most experimenters want to generalize their conclusions to some setting wider than that of the actual experiment. Statistical analysis of the original experiment cannot tell us how far the results will generalize. Nonetheless, the randomized comparative experiment, because of its ability to give convincing evidence for causation, is one of the most important ideas in statistics.

3.38 Does meditation reduce anxiety? Some companies employ consultants to train their managers in meditation in the hope that this practice will relieve stress and make the managers more effective on the job. An experiment that claimed to show that meditation reduces anxiety proceeded as follows.

The experimenter interviewed the subjects and rated their level of anxiety. Then the subjects were randomly assigned to two groups. The experimenter taught one group how to meditate and they meditated daily for a month. The other group was simply told to relax more. At the end of the month, the experimenter interviewed all the subjects again and rated their anxiety level. The meditation group now had less anxiety. Psychologists said that the results were suspect because the ratings were not blind. Explain what this means and how lack of blindness could bias the reported results.

3.39 Frustration and teamwork. A psychologist wants to study the effects of failure and frustration on the relationships among members of a work team. She forms a team of students, brings them to the psychology laboratory, and has them play a game that requires teamwork. The game is rigged so that they lose regularly. The psychologist observes the students through a one-way window and notes the changes in their behavior during an evening of game playing. Why is it doubtful that the findings of this study tell us much about the effect of working for months developing a new product that never works right and is finally abandoned by your company?

Matched pairs designs

Completely randomized designs are the simplest statistical designs for experiments. They illustrate clearly the principles of control, randomization, and replication of treatments on a number of subjects. However, completely randomized designs are often inferior to more elaborate statistical designs. In particular, matching the subjects in various ways can produce more precise results than simple randomization.
3.2 Designing Experiments

One common design that combines matching with randomization is the matched pairs design. A matched pairs design compares just two treatments. Choose pairs of subjects that are as closely matched as possible. Assign one of the treatments to each subject in a pair by tossing a coin or reading odd and even digits from Table B. Sometimes each “pair” in a matched pairs design consists of just one subject, who gets both treatments one after the other. Each subject serves as his or her own control. The order of the treatments can influence the subject’s response, so we randomize the order for each subject, again by a coin toss.

**Block designs**

Matched pairs designs apply the principles of comparison of treatments, randomization, and replication. However, the randomization is not complete—we do not randomly assign all the subjects at once to the two treatments. Instead, we only randomize within each matched pair. This allows matching to reduce the effect of variation among the subjects. Matched pairs are an example of block designs.

A block is a group of subjects that are known before the experiment to be similar in some way expected to affect the response to the treatments. In a block design, the random assignment of individuals to treatments is carried out separately within each block.

A block design combines the idea of creating equivalent treatment groups by matching with the principle of forming treatment groups at random. Blocks are another form of control. They control the effects of some outside variables by bringing those variables into the experiment to form the blocks. The following is a typical example of a block design.

**EXAMPLE 3.18 Coke versus Pepsi**

Pepsi wanted to demonstrate that Coke drinkers prefer Pepsi when they taste both colas blind. The subjects, all people who said they were Coke drinkers, tasted both colas from glasses without brand markings and said which they liked better. This is a matched pairs design in which each subject compares the two colas. Because responses may depend on which cola is tasted first, the order of tasting should be chosen at random for each subject.

When more than half the Coke drinkers chose Pepsi, Coke claimed that the experiment was biased. The Pepsi glasses were marked M and the Coke glasses were marked Q. Aha, said Coke, this just shows that people like the letter M better than the letter Q. A careful experiment would in fact take care to avoid any distinction other than the actual treatments.
EXAMPLE 3.19 Men, women, and advertising

Women and men respond differently to advertising. An experiment to compare the effectiveness of three television commercials for the same product will want to look separately at the reactions of men and women, as well as assess the overall response to the ads.

A completely randomized design considers all subjects, both men and women, as a single pool. The randomization assigns subjects to three treatment groups without regard to their sex. This ignores the differences between men and women. A better design considers women and men separately. Randomly assign the women to three groups, one to view each commercial. Then separately assign the men at random to three groups. Figure 3.6 outlines this improved design.

A block is a group of subjects formed before an experiment starts. We reserve the word “treatment” for a condition that we impose on the subjects. We don’t speak of 6 treatments in Example 3.19 even though we can compare the responses of 6 groups of subjects formed by the 2 blocks (men, women) and the 3 commercials. Block designs are similar to stratified samples. Blocks and strata both group similar individuals together. We use two different names only because the idea developed separately for sampling and experiments. The advantages of block designs are the same as the advantages of stratified samples. Blocks allow us to draw separate conclusions about each block—for example, about men and women in the advertising study in Example 3.19. Blocking also allows more precise overall conclusions because the systematic differences between men and women can be removed when we study the overall effects of the three commercials.

The idea of blocking is an important additional principle of statistical design of experiments. A wise experimenter will form blocks based on the most important unavoidable sources of variability among the experimental

![FIGURE 3.6 Outline of a block design, for Example 3.19. The blocks consist of male and female subjects. The treatments are three television commercials](image-url)
subjects. Randomization will then average out the effects of the remaining variation and allow an unbiased comparison of the treatments.

Like the design of samples, the design of complex experiments is a job for experts. Now that we have seen a bit of what is involved, we will usually just act as if most experiments were completely randomized.

3.40 Does charting help investors? Some investment advisors believe that charts of past trends in the prices of securities can help predict future prices. Most economists disagree. In an experiment to examine the effects of using charts, business students trade (hypothetically) a foreign currency at computer screens. There are 20 student subjects available, named for convenience A, B, C, . . . , T. Their goal is to make as much money as possible, and the best performances are rewarded with small prizes. The student traders have the price history of the foreign currency in dollars in their computers. They may or may not also have software that highlights trends. Describe two designs for this experiment, a completely randomized design and a matched pairs design in which each student serves as his or her own control. In both cases, carry out the randomization required by the design.

3.41 Comparing weight-loss treatments. Twenty overweight females have agreed to participate in a study of the effectiveness of 4 weight-loss treatments: A, B, C, and D. The company researcher first calculates how overweight each subject is by comparing the subject’s actual weight with her “ideal” weight. The subjects and their excess weights in pounds are

<table>
<thead>
<tr>
<th>Name</th>
<th>Excess Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birnbaum</td>
<td>35</td>
</tr>
<tr>
<td>Hernandez</td>
<td>25</td>
</tr>
<tr>
<td>Moses</td>
<td>25</td>
</tr>
<tr>
<td>Smith</td>
<td>29</td>
</tr>
<tr>
<td>Brown</td>
<td>34</td>
</tr>
<tr>
<td>Jackson</td>
<td>33</td>
</tr>
<tr>
<td>Nevesky</td>
<td>39</td>
</tr>
<tr>
<td>Stall</td>
<td>33</td>
</tr>
<tr>
<td>Brunk</td>
<td>30</td>
</tr>
<tr>
<td>Kendall</td>
<td>28</td>
</tr>
<tr>
<td>Obrach</td>
<td>30</td>
</tr>
<tr>
<td>Tran</td>
<td>35</td>
</tr>
<tr>
<td>Cruz</td>
<td>34</td>
</tr>
<tr>
<td>Loren</td>
<td>32</td>
</tr>
<tr>
<td>Rodriguez</td>
<td>30</td>
</tr>
<tr>
<td>Wilansky</td>
<td>42</td>
</tr>
<tr>
<td>Deng</td>
<td>24</td>
</tr>
<tr>
<td>Mann</td>
<td>28</td>
</tr>
<tr>
<td>Santiago</td>
<td>27</td>
</tr>
<tr>
<td>Williams</td>
<td>22</td>
</tr>
</tbody>
</table>

The response variable is the weight lost after 8 weeks of treatment. Because a subject’s excess weight will influence the response, a block design is appropriate.

(a) Arrange the subjects in order of increasing excess weight. Form 5 blocks of 4 subjects each by grouping the 4 least overweight, then the next 4, and so on.

(b) Use Table B to randomly assign the 4 subjects in each block to the 4 weight-loss treatments. Be sure to explain exactly how you used the table.

Section 3.2 Summary

- In an experiment, we impose one or more treatments on the subjects. Each treatment is a combination of levels of the explanatory variables, which we call factors.
- The design of an experiment describes the choice of treatments and the manner in which the subjects are assigned to the treatments.
The basic principles of statistical design of experiments are control, randomization, and replication.

The simplest form of control is comparison. Experiments should compare two or more treatments in order to avoid confounding of the effect of a treatment with other influences, such as lurking variables.

Randomization uses chance to assign subjects to the treatments. Randomization creates treatment groups that are similar (except for chance variation) before the treatments are applied. Randomization and comparison together prevent bias, or systematic favoritism, in experiments.

You can carry out randomization by giving numerical labels to the subjects and using a table of random digits to choose treatment groups.

Replication of each treatment on many subjects reduces the role of chance variation and makes the experiment more sensitive to differences among the treatments.

Good experiments require attention to detail as well as good statistical design. Many behavioral and medical experiments are double-blind. Lack of realism in an experiment can prevent us from generalizing its results.

In addition to comparison, a second form of control is to restrict randomization by forming blocks of subjects that are similar in some way that is important to the response. Randomization is then carried out separately within each block.

Matched pairs are a common form of blocking for comparing just two treatments. In some matched pairs designs, each subject receives both treatments in a random order. In others, the subjects are matched in pairs as closely as possible, and one subject in each pair receives each treatment.

**Section 3.2 Exercises**

3.42 Public housing. A study of the effect of living in public housing on the income and other variables in poverty-level households was carried out as follows. The researchers obtained a list of all applicants for public housing during the previous year. Some applicants had been accepted, while others had been turned down by the housing authority. Both groups were interviewed and compared. Is this study an experiment or an observational study? Why? What are the explanatory and response variables? Why will confounding make it difficult to see the effect of the explanatory variable on the response variables?

3.43 Effects of price promotions. A researcher studying the effect of price promotions on consumers’ expectations makes up a history of the store price of a hypothetical brand of laundry detergent for the past year. Students in a marketing course view the price history on a computer. Some students see a steady price, while others see regular promotions that temporarily cut the price. Then the students are asked what price they would expect to pay for the detergent. Is this study an experiment? Why? What are the explanatory and response variables?