AP Statistics Assignment - Experimental Design

Each situation on the following pages has a conjecture, an experiment setup, and a description of the participants. If the problem is assigned to you, you will outline (or write a paragraph) describing the experiment using:

- a) a completely randomized model
- b) a blocking (using the given blocking criteria)
- c) a matched pairs model (either by similar groups or subjects acting as their own control)

In all cases, you will assume that you already have the experimental units (subjects if they are people).

d) How you will test your conjecture must be explained in several sentences. Anything not clear in your diagram must also be explained.

e) A possible problem with the experiment or a lurking variable.

Example:

**The conjecture:** You believe that self-checkouts in supermarkets are faster.

**The experiment setup:** There are two types of supermarket checkouts available. One is a self-checkout and the other has a cashier.

**The participants:** 200 people, 100 men and 100 women with different order sizes.

![Randomized Experiment Diagram]

![Blocking by Gender Diagram]
Matched Pairs

100 pairs of similar orders

Random allocation
For each pair

Gp 1
100

Cashier

Compare times

Gp 2
100

Self

or

100
pairs
of similar
orders

Random allocation
For each pair

Gp 1
100

Regular cashier

Self-checkout

Compare times

Gp 2
100

Self-checkout

Regular cashier

similar groups

d) Compare checkout times could be done in a variety of ways. One way is find the mean checkout time for the number of people in the line. (you could also find the median checkout time).

e) You have to define what is meant by checkout time. Is bagging included? Some cashiers bag as they go.

How about payment? Is that included? Some people pay by cash and take time to dig out the money. Sometimes there are slowups in the credit card system).

Suppose someone is not used to the self-checkout and gets confused. Should we count that?

Note – you only need give one potential problem. Don’t give more than one as I did here.
1. **The conjecture**: People will use less water in showers if they can’t control how hot the water gets.

**The experiment setup**: There are two types of showers. One allows water to get as hot as they like. The other allows hot water (120° F. which is usually hot enough for most people).

**The participants**: 100 people who just exercised. 50 are men, 50 are women.

a. Completely randomized:

b. Blocking (gender)
c. Matched pairs (own control)

d) how you will test your conjecture.

e) Potential problem, lurking variable, something to be decided beforehand.
2. **The conjecture**: People who are given unsweetened iced tea will put more sugar in it than the amount in pre-sweetened tea.

**The experiment setup**: There are two types of iced teas available. One is pre-sweetened with a spoonful of sugar per cup while the other has no sugar in it. People can add as much sugar as they want to both.

**The participants**: 120 people who like iced tea. There are 80 men and 40 women.

a. Completely randomized:

b. Blocking (gender)
c. Matched pairs (own control)

d) how you will test your conjecture.

e) Potential problem, lurking variable, something to be decided beforehand.
3. **The conjecture**: Pets who are fed 3 times a day will actually gain less weight than pets who are fed exactly the same amount of food either once a day.

**The experiment setup**: Pets are given a can (6 ounces) of wet food a day. They can either get a full can or a third of a can three times a day. The experiment lasts a month.

**The participants**: 300 pets, 180 dogs and 120 cats of various sizes.

a. Completely randomized:

b. Blocking (type of animal)
c. Matched pairs (similar groups)

d) how you will test your conjecture.

e) Potential problem, lurking variable, something to be decided beforehand.
4. **The conjecture**: Cold water washing is the best for keeping shirts the original color.

**The experiment setup**: Shirts are washed 20 times. There is a choice of hot water, warm water, and cold water.

**The participants**: 48 shirts of various colors, 36 of which come from Old Navy (less expensive) and 12 come from LL Beans (more expensive)

a. Completely randomized:

b. Blocking (price of shirt)
c. Matched pairs (similar groups based on color of shirt – only test cold water vs. warm water).


d) how you will test your conjecture.


e) Potential problem, lurking variable, something to be decided beforehand.
5. **The conjecture**: Goldberg’s SAT Services does a better job in raising SAT math scores than Princeton Review.

**The experiment setup**: 11th grade students take the PSAT’s and have 3 months of tutoring using either Goldberg’s, Princeton Review or none at all. They then take the SAT’s.

**The participants**: 60 students, 39 of whom have math PSAT’s below a score 50 of points and 21 who have math PSAT scores 50 or above.

a. Completely randomized:

b. Blocking (PSAT score)
c. Matched pairs (you decide the type – only test Goldberg’s vs. Princeton)

d) how you will test your conjecture.

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6. **The conjecture**: Freschetta Frozen Pizza, available in the supermarket, claims that people who eat it think it is from a pizza shop (store bought).

**The experiment setup**: Eaters have both pizzas available, all the same type (plain).

**The participants**: 96 pizza lovers, 50 of whom never eat frozen pizza.

a. Completely randomized:

b. Blocking (based on whether they eat frozen pizza)
c. Matched pairs (you decide)

d) how you will test your conjecture.

e) Potential problem, lurking variable, something to be decided beforehand.
7. **The conjecture**: Listening to talk radio while driving in heavy traffic reduces blood pressure.

   **The experiment setup**: Drivers are exposed to 30 minutes of driving in heavy traffic while listening to talk radio, music, and nothing at all.

   **The participants**: 45 drivers, 30 of whom are over 25 years old.

a. Completely randomized:

b. Blocking (age)
c. Matched pairs (you decide – only test talk radio and music)

d) how you will test your conjecture.

e) Potential problem, lurking variable, something to be decided beforehand.
AP Statistics Assignment - Experimental Design – Solutions

Each situation on the following pages has a conjecture, an experiment setup, and a description of the participants. If the problem is assigned to you, you will outline (or write a paragraph) describing the experiment using:

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d) How you will test your conjecture must be explained in several sentences. Anything not clear in your diagram must also be explained.

e) A possible problem with the experiment or a lurking variable.

Example:

The conjecture: You believe that self-checkouts in supermarkets are faster.

The experiment setup: There are two types of supermarket checkouts available. One is a self-checkout and the other has a cashier.

The participants: 200 people, 100 men and 100 women with different order sizes.
d) Compare checkout times could be done in a variety of ways. One way is find the mean checkout time for the number of people in the line. (you could also find the median checkout time).

e) You have to define what is meant by checkout time. Is bagging included? Some cashiers bag as they go. How about payment? Is that included? Some people pay by cash and take time to dig out the money. Sometimes there are slowups in the credit card system.

Suppose someone is not used to the self-checkout and gets confused. Should we count that?

Note – you only need give one potential problem. Don’t give more than one as I did here.
1. **The conjecture**: People will use less water in showers if they can’t control how hot the water gets.

**The experiment setup**: There are two types of showers. One allows water to get as hot as they like. The other allows hot water (120°F. which is usually hot enough for most people).

**The participants**: 100 people who just exercised. 50 are men, 50 are women.

a. Completely randomized:

b. Blocking (gender)
c. Matched pairs (own control)

![Diagram showing matched pairs experiment]

- Group 1: Controlled Shower
- Group 2: Uncontrolled Shower
- Compare Average Shower Length
- Random Allocation


d) how you will test your conjecture.

[Will take the amount of water used in each group and find the mean amount. Possibly eliminate outliers first.]

e) Potential problem, lurking variable, something to be decided beforehand.

[Some people let the water run first/ It needs to be decided what constitutes the length of the shower. The type of soap available should be the same and preferably, the shower itself should be the same.]
2. **The conjecture**: People who are given unsweetened iced tea will put more sugar in it than the amount in pre-sweetened tea.

**The experiment setup**: There are two types of iced teas available. One is pre-sweetened with a spoonful of sugar per cup while the other has no sugar in it. People can add as much sugar as they want to both.

**The participants**: 120 people who like iced tea. There are 80 men and 40 women.

a. Completely randomized:

![Diagram](image1)

b. Blocking (gender)

![Diagram](image2)
c. Matched pairs (own control)

We need a way to measure the amount of sugar. We don’t want people to know that they are in an experiment so it is best to use sugar packets and have someone observe how many packets they used.

d) how you will test your conjecture.

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e) Potential problem, lurking variable, something to be decided beforehand.

The type of tea should be determined beforehand – lemon in the tea might make a difference. Whether people actually finish the tea could be a problem – someone might put too much sugar in it and find it not their taste.
3. **The conjecture**: Pets who are fed 3 times a day will actually gain less weight than pets who are fed exactly the same amount of food either once a day.

**The experiment setup**: Pets are given a can (6 ounces) of wet food a day. They can either get a full can or a third of a can three times a day. The experiment lasts a month.

**The participants**: 300 pets, 180 dogs and 120 cats of various sizes.

a. Completely randomized:

```
Weigh Animals  Random Allocation  Group 1 150 pets  Feed 3 times daily
```

b. Blocking (type of animal)

```
Weigh Animals
```

```
Group 1 180 dogs
```

```
Group 2 120 cats
```

```
Feed 3 times daily (90)
```

```
Feed once daily (90)
```

```
Feed 3 times daily (60)
```

```
Feed once daily (60)
```

```
Compare Average weight change
```

```
Compare Average weight change
```

```
Compare Average weight change
```

```
Compare Average weight change
```
c. Matched pairs (similar groups)

- Similar pairs of dogs and cats (size and age)
- Random Allocation for each pair
- Group 1: 150 pets, Feed 3 times daily
- Group 2: 150 pets, Feed once daily
- Compare Average weight change

Will weigh the animals before and after the experiment, and find the average amount of weight change in each group after eliminating outliers.

d) how you will test your conjecture.

Will weigh the animals before and after the experiment, and find the average amount of weight change in each group after eliminating outliers.

e) Potential problem, lurking variable, something to be decided beforehand.

Animals might get sick and not eat, throwing off the calculations. Animals might also eat table scraps and that needs to be monitored.
4. **The conjecture:** Cold water washing is the best for keeping shirts the original color.

**The experiment setup:** Shirts are washed 20 times. There is a choice of hot water, warm water, and cold water.

**The participants:** 48 shirts of various colors, 36 of which come from Old Navy (less expensive) and 12 come from LL Beans (more expensive)

a. Completely randomized:

```
Keep identical shirt out of expt. — Random Allocation — Group 1 — Group 2 — Group 3
16 shirts — 16 shirts — 16 shirts
Cold wash 20 times — Warm wash 20 times — Hot wash 20 times
```

b. Blocking (price of shirt)

```
Keep identical shirt out of expt. — Old Navy — Beans
12 shirts — 12 shirts — 4 shirts
Group 1 — Group 2 — Group 3
Cold wash 20 times — Warm wash 20 times — Hot wash 20 times
Compare color change to original — Compare color change to original — Compare color change to original
```
c. Matched pairs (similar groups based on color of shirt – only test cold water vs. warm water).

![Diagram](image)

d) how you will test your conjecture.

<table>
<thead>
<tr>
<th>Keep identical shirt out of experiment</th>
<th>Divide into similar color shirts</th>
<th>Random Allocation</th>
<th>Compare color change to original</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 24 shirts</td>
<td>Cold wash 20 times</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2 24 shirts</td>
<td>Warm wash 20 times</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We need a device to compare colors. We should have an identical shirt that is not washed and then compare the washed shirt to it. But there needs to be a way to quantify that.

e) Potential problem, lurking variable, something to be decided beforehand.

Different washers wash more effectively. The detergent needs to be the same. Some shirts naturally fade in hot water washing.
5. **The conjecture**: Goldberg’s SAT Services does a better job in raising SAT math scores than Princeton Review.

**The experiment setup**: 11th grade students take the PSAT’s and have 3 months of tutoring using Goldberg’s, Princeton Review or none at all. They then take the SAT’s.

**The participants**: 60 students, 39 of whom have math PSAT’s below a score of 50 points and 21 who have math PSAT scores 50 or above.

a. Completely randomized:

![Diagram](image)

b. Blocking (PSAT score)

![Diagram](image)
c. Matched pairs (you decide the type – only test Goldberg’s vs. Princeton)

<table>
<thead>
<tr>
<th>30 students</th>
<th>Take</th>
<th></th>
<th>Take</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldberg</td>
<td>SAT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Divide into similar students: race, gender, grades, PSAT’s

Random Allocation

30 students

Princeton

Take SAT

Compare change in score

d) how you will test your conjecture.

Compare the PSAT’s to the SAT’s and measure the change in score. Average that for each group, eliminating the outliers, high and low.

e) Potential problem, lurking variable, something to be decided beforehand.

Students come from different schools and are taught differently. Also, the teachers in Goldberg’s and Princeton might be different. Students might spend different amounts of time in practice.
6. **The conjecture**: Freschetta Frozen Pizza, available in the supermarket, claims that people who eat it think it is from a pizza shop (store bought).

**The experiment setup**: Eaters have both pizzas available, all the same type (plain).

**The participants**: 96 pizza lovers, 50 of whom never eat frozen pizza.

a. Completely randomized:

![Diagram of completely randomized experiment setup]

b. Blocking (based on whether they eat frozen pizza)

![Diagram of blocking experiment setup]
c. Matched pairs (you decide)

We need a score card to quantify preference. In the matched pairs, it is easy as a comparison of one to another is made but in the blocking or randomized, we need to score such things as taste, crust, cheese consistency, etc.

d) how you will test your conjecture.

How hot the pizza is, thin or thick crust, and the fact that Pizza shop pizzas vary as well.
7. **The conjecture:** Listening to talk radio while driving in heavy traffic reduces blood pressure.

**The experiment setup:** Drivers are exposed to 30 minutes of driving in heavy traffic while listening to talk radio, music, and nothing at all.

**The participants:** 45 drivers, 30 of whom are over 25 years old.

a. Completely randomized:

b. Blocking (age)
c. Matched pairs (you decide – only test talk radio and music)

![Diagram of matched pairs experiment]

d) how you will test your conjecture.

| Compare blood pressure change from after to before. Average them. |

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e) Potential problem, lurking variable, something to be decided beforehand.

| People’s starting blood pressure vary. It is also difficult to recreate the same traffic conditions from test to test. |