

## **2003 AP® STATISTICS FREE-RESPONSE QUESTIONS**

4. Because of concerns about employee stress, a large company is conducting a study to compare two programs (tai chi or yoga) that may help employees reduce their stress levels. Tai chi is a 1,200-year-old practice, originating in China, that consists of slow, fluid movements. Yoga is a practice, originating in India, that consists of breathing exercises and movements designed to stretch and relax muscles. The company has assembled a group of volunteer employees to participate in the study during the first half of their lunch hour each day for a 10-week period. Each volunteer will be assigned at random to one of the two programs. Volunteers will have their stress levels measured just before beginning the program and 10 weeks later at the completion of it.
- (a) A group of volunteers who work together ask to be assigned to the same program so that they can participate in that program together. Give an example of a problem that might arise if this is permitted. Explain to this volunteer group why random assignment to the two programs will address this problem.
- (b) Someone proposes that a control group be included in the design as well. The stress level would be measured for each volunteer assigned to the control group at the start of the study and again 10 weeks later. What additional information, if any, would this provide about the effectiveness of the two programs?
- (c) Is it reasonable to generalize the findings of this study to all employees of this company? Explain.

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5. A random sample of 200 students was selected from a large college in the United States. Each selected student was asked to give his or her opinion about the following statement.

“The most important quality of a person who aspires to be the President of the United States is a knowledge of foreign affairs.”

Each response was recorded in one of five categories. The gender of each selected student was noted. The data are summarized in the table below.

		Response Category				
		Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
		Male	Female			
	Strongly Disagree	10	20	15	25	25
	Somewhat Disagree	15	25	25	25	15
	Neither Agree nor Disagree	15				
	Somewhat Agree					
	Strongly Agree					

Is there sufficient evidence to indicate that the response is dependent on gender? Provide statistical evidence to support your conclusion.

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**Question 4**

**Solution**

**Part (a):**

For example, a deadline in the department where the group of volunteers works has been moved back, lowering the stress levels of those working in the department. If the volunteers from this department were all in the same treatment group, this change in stress level could mistakenly be attributed to the treatment.

Without random assignment of volunteers to the two programs, it is possible that the two treatment groups could differ in some way that affects the outcome of the experiment. Randomization "evens out" the possible effects of potentially confounding variables.

**Part (b):**

Without the control group, the company could compare the two treatments, but would not be able to say whether the observed reduction in stress was attributable to participation in the programs. For example, a change in the work environment during this period might have reduced the stress level of all employees. The addition of a control group would enable the company to assess the magnitude of the mean reduction attributable to each treatment, as opposed to just determining if the two programs differ.

**Part (c):**

It is not reasonable to generalize the findings of this study to all employees, because

- the participants in this experiment were volunteers and volunteers may not be representative of the population
- OR
- the participants were not randomly selected from the company employees.

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**Question 4 (cont'd)**

**Scoring**

Each component is scored as either essentially correct (E), partially correct (P), or incorrect (I).

**Part (a)** has two components: the example, and the randomization.

- The example is scored as essentially correct (E) if it contains each of the elements in the table below:

Elements	Sample statements
1. Identify a plausible example of a problem	“Because a deadline has been moved back...”
2. Relate the identified problem to the change in stress level (the response)	“...lowering the stress levels of those working in the department. This <u>change in stress level</u> ...”
3. ...and state that the identified problem effects can not be distinguished from the difference in treatment effects	“...could mistakenly be attributed to the treatment.” (Note: A construction such as “can’t tell the difference” is OK here.)

The example is scored as partially correct (P) if the response contains 2 of the 3 components.

- The randomization is scored as essentially correct (E) if the student gives a reason for the necessity of random assignment. Possibilities include:

clearly stating in context that randomization is relied upon to create comparable groups

clearly stating in context that randomization controls for the effects of potentially confounding variables or reduces bias. (Both “Avoiding” bias and “Eliminating” bias are incorrect (I). )

The randomization is scored as partially correct (P) if the statement about randomization is not in context or is poorly communicated.

Note: Constructions such as “split up” and “divided into” can be interpreted to indicate randomization.

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**Question 4 (cont'd)**

**Part (b)** is scored as essentially correct (E) if the student

1. indicates that a control group does provide additional information  
AND
2. explains that the control group allows the company to determine if either or both treatments are effective in reducing stress

OR

explains that the control group provides a baseline for comparison

Part (b) is scored as partially correct (P) if the student indicates there is additional information, even if the student's explanation is incorrect.

Note: Stating that the "passage of time" reduces stress is not sufficient; the student must specify that there is a confounding variable that operates through time.

**Part (c)** is scored as essentially correct (E) if it

1. indicates that it is not reasonable to generalize to all employees  
AND
2. gives an explanation that the participants were not randomly selected from the company employees

OR

gives an explanation tied to the use of volunteers

Note: Simply using the word "volunteer" in the explanation is not sufficient.

Part (c) is scored as partially correct (P) if the student explicitly says that it is not reasonable to generalize to all employees, even if the student's explanation is incorrect.

Part (c) is scored as incorrect (I) if the student indicates that it is reasonable to generalize to all employees.