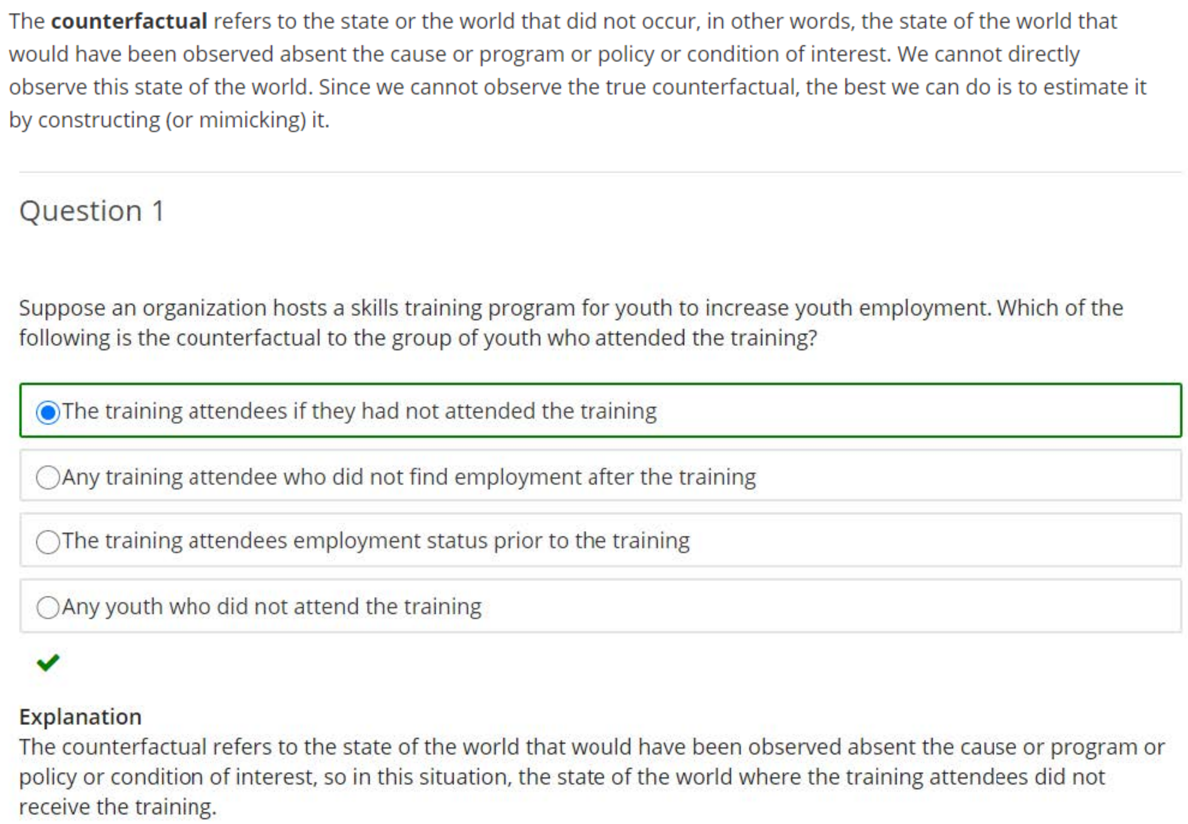
Causality (18 Questions)



The **counterfactual** refers to the state or the world that did not occur, in other words, the state of the world that would have been observed absent the cause or program or policy or condition of interest. We cannot directly observe this state of the world. Since we cannot observe the true counterfactual, the best we can do is to estimate it by constructing (or mimicking) it.

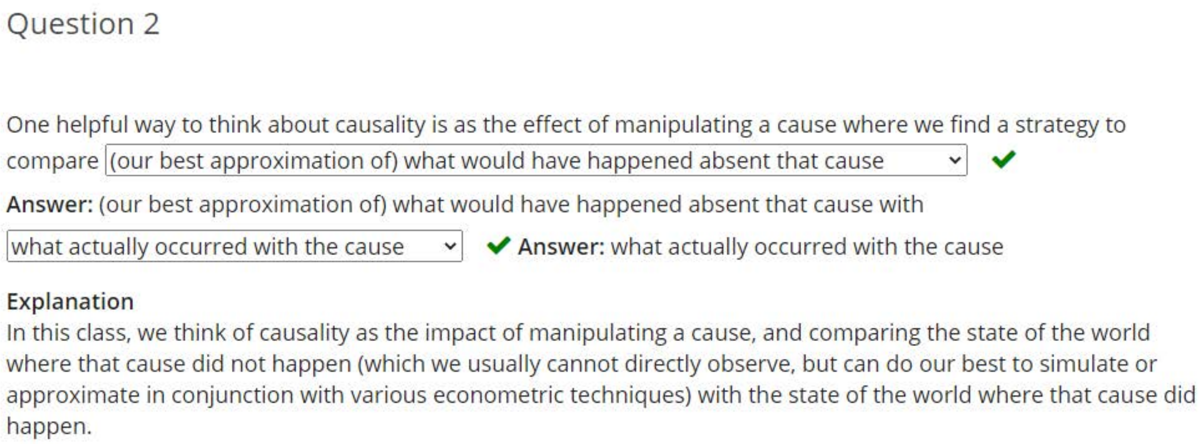
Question 1

Suppose an organization hosts a skills training program for youth to increase youth employment. Which of the following is the counterfactual to the group of youth who attended the training?

- ● The training attendees if they had not attended the training
- ○ Any training attendee who did not find employment after the training
- ○ The training attendees employment status prior to the training
- ○ Any youth who did not attend the training

✓

Explanation
The counterfactual refers to the state of the world that would have been observed absent the cause or program or policy or condition of interest, so in this situation, the state of the world where the training attendees did not receive the training.



Question 2

One helpful way to think about causality is as the effect of manipulating a cause where we find a strategy to compare (our best approximation of) what would have happened absent that cause ✓

Answer: (our best approximation of) what would have happened absent that cause with

what actually occurred with the cause ✓ **Answer:** what actually occurred with the cause

Explanation
In this class, we think of causality as the impact of manipulating a cause, and comparing the state of the world where that cause did not happen (which we usually cannot directly observe, but can do our best to simulate or approximate in conjunction with various econometric techniques) with the state of the world where that cause did happen.

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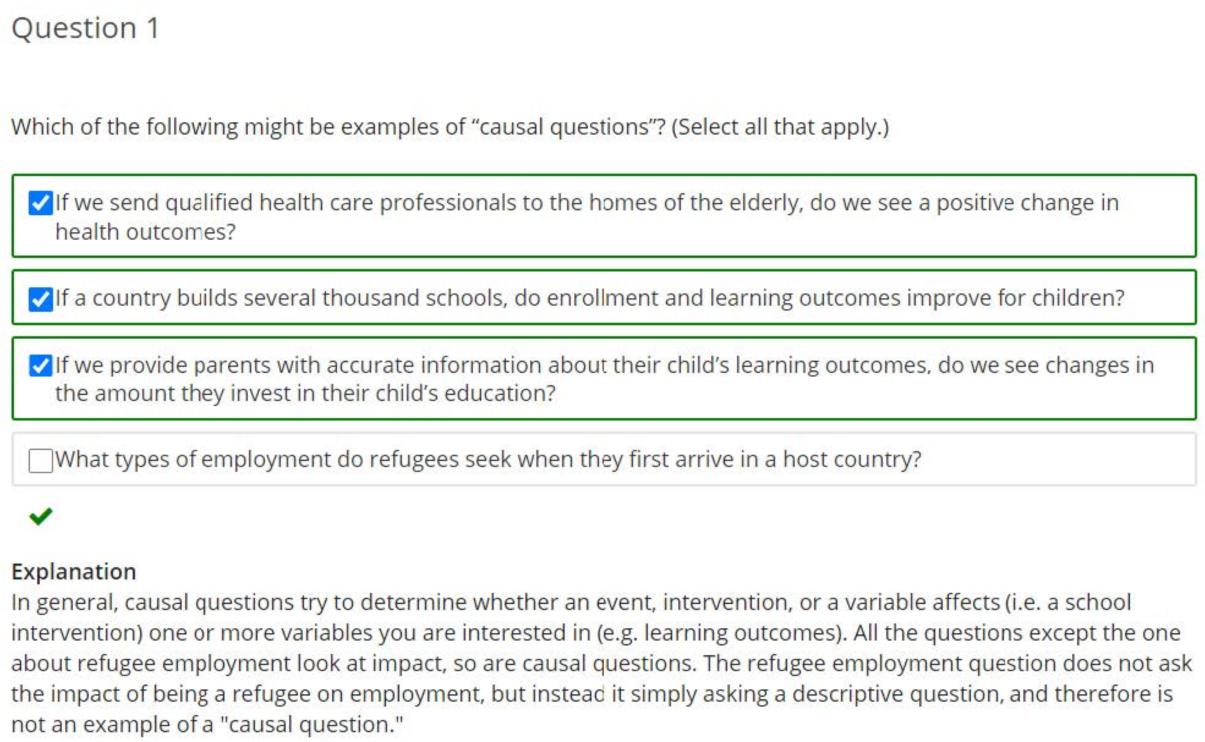


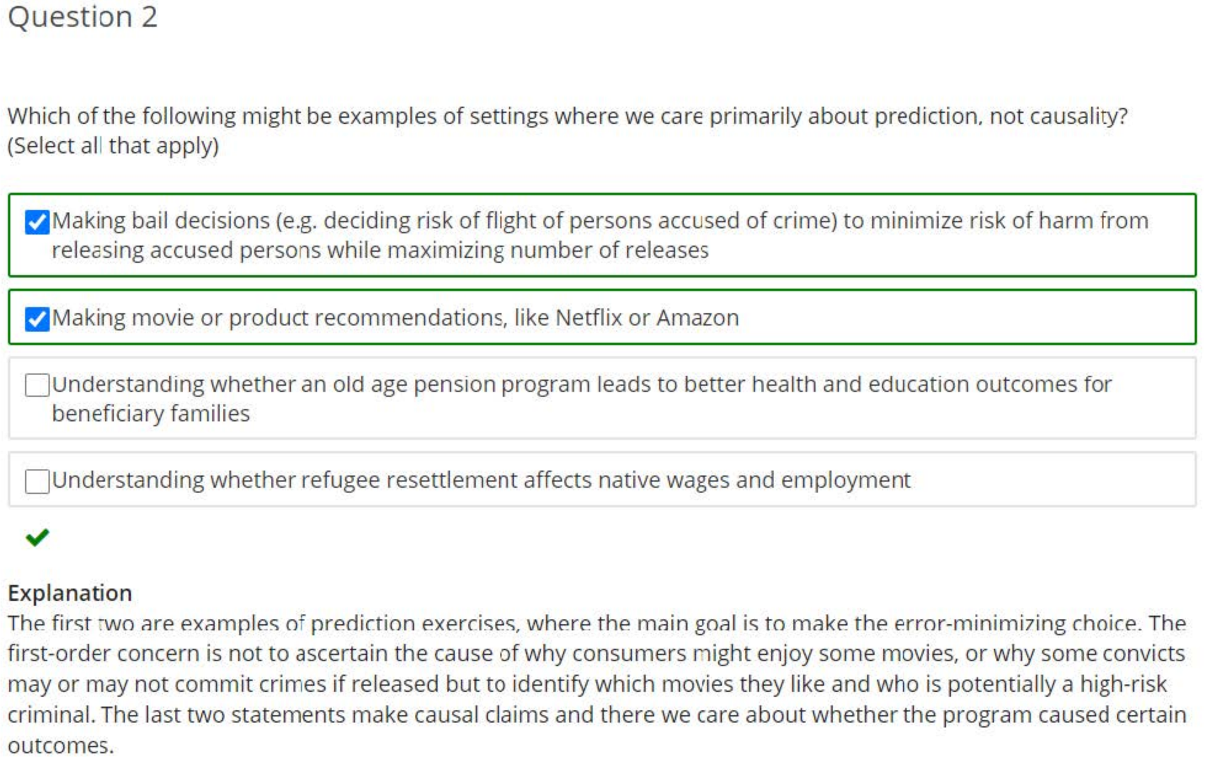
Question 1

Which of the following might be examples of “causal questions”? (Select all that apply.)

- ☑ If we send qualified health care professionals to the homes of the elderly, do we see a positive change in health outcomes?
- ☑ If a country builds several thousand schools, do enrollment and learning outcomes improve for children?
- ☑ If we provide parents with accurate information about their child’s learning outcomes, do we see changes in the amount they invest in their child’s education?
- ☐ What types of employment do refugees seek when they first arrive in a host country?

✓

Explanation
In general, causal questions try to determine whether an event, intervention, or a variable affects (i.e. a school intervention) one or more variables you are interested in (e.g. learning outcomes). All the questions except the one about refugee employment look at impact, so are causal questions. The refugee employment question does not ask the impact of being a refugee on employment, but instead it simply asking a descriptive question, and therefore is not an example of a "causal question."



Question 2

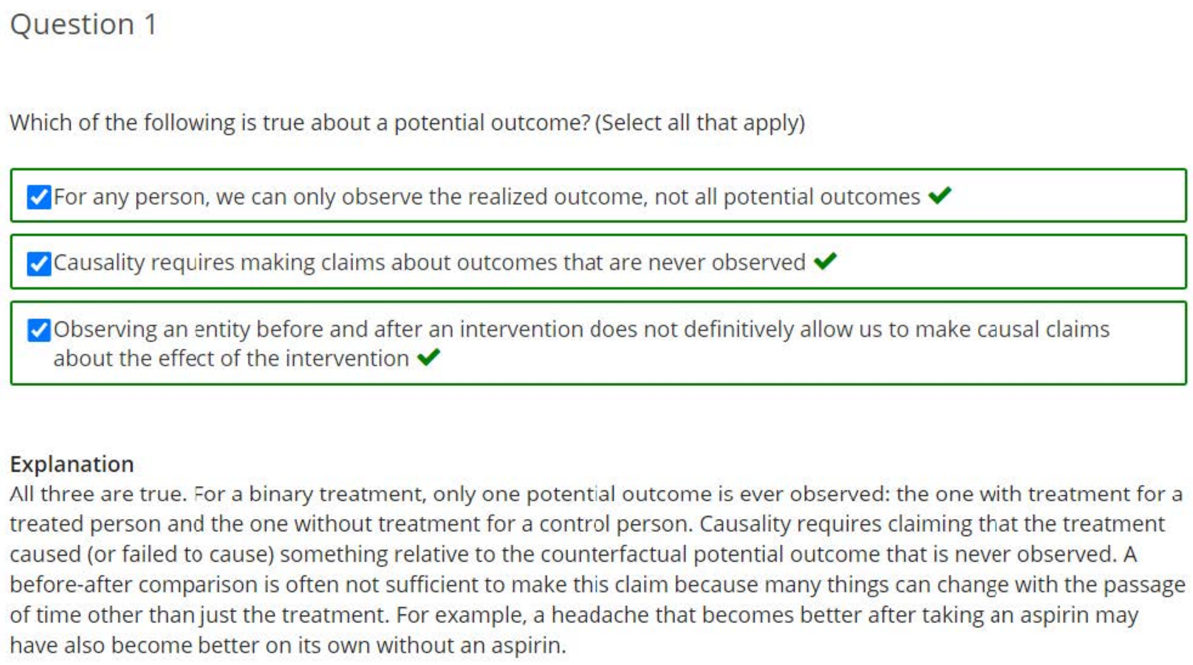
Which of the following might be examples of settings where we care primarily about prediction, not causality? (Select all that apply)

- ☑ Making bail decisions (e.g. deciding risk of flight of persons accused of crime) to minimize risk of harm from releasing accused persons while maximizing number of releases
- ☑ Making movie or product recommendations, like Netflix or Amazon
- ☐ Understanding whether an old age pension program leads to better health and education outcomes for beneficiary families
- ☐ Understanding whether refugee resettlement affects native wages and employment

✓

Explanation
The first two are examples of prediction exercises, where the main goal is to make the error-minimizing choice. The first-order concern is not to ascertain the cause of why consumers might enjoy some movies, or why some convicts may or may not commit crimes if released but to identify which movies they like and who is potentially a high-risk criminal. The last two statements make causal claims and there we care about whether the program caused certain outcomes.

Causality (18 Questions)



Question 1

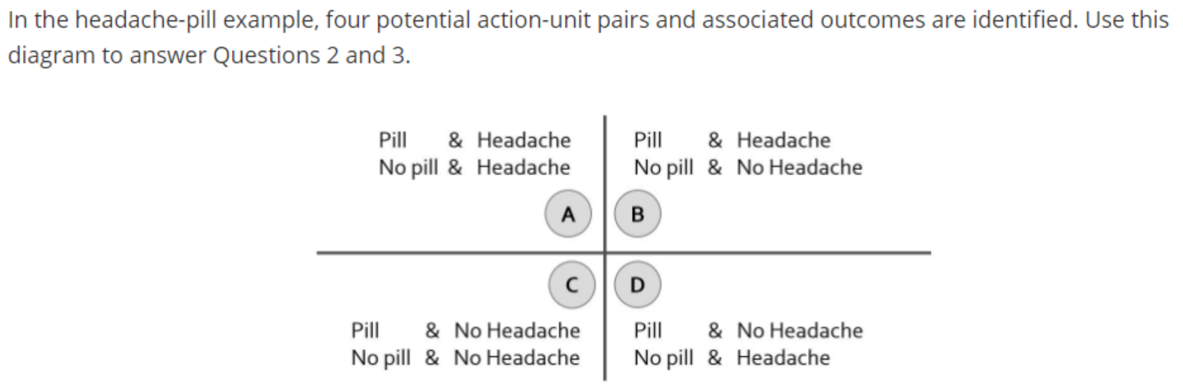
Which of the following is true about a potential outcome? (Select all that apply)

☑ For any person, we can only observe the realized outcome, not all potential outcomes ✓

☑ Causality requires making claims about outcomes that are never observed ✓

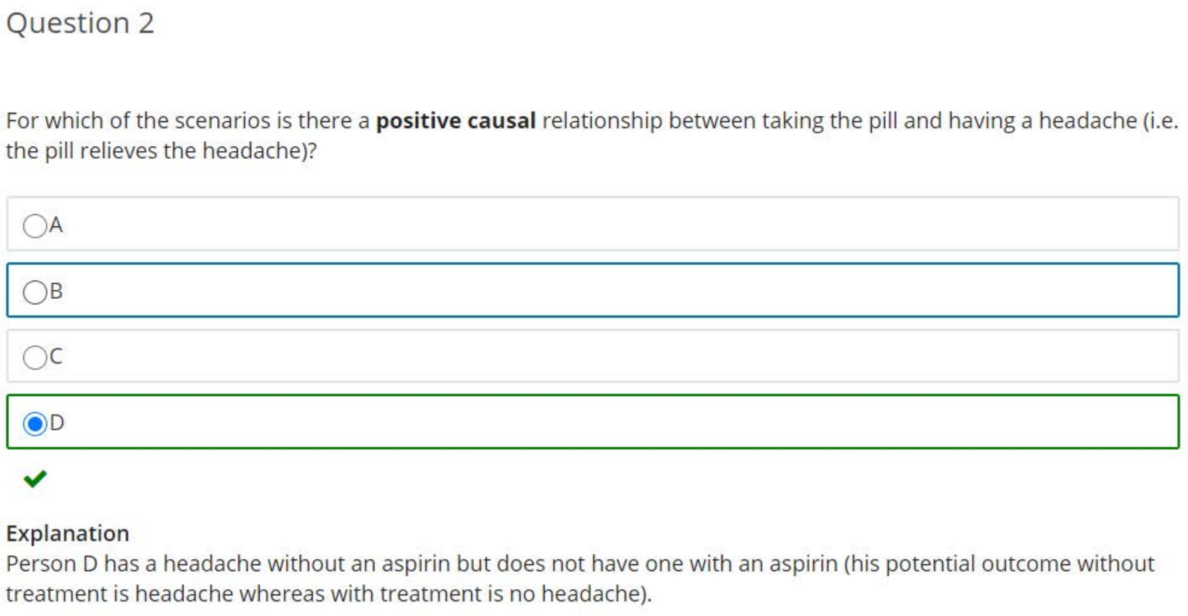
☑ Observing an entity before and after an intervention does not definitively allow us to make causal claims about the effect of the intervention ✓

Explanation
All three are true. For a binary treatment, only one potential outcome is ever observed: the one with treatment for a treated person and the one without treatment for a control person. Causality requires claiming that the treatment caused (or failed to cause) something relative to the counterfactual potential outcome that is never observed. A before-after comparison is often not sufficient to make this claim because many things can change with the passage of time other than just the treatment. For example, a headache that becomes better after taking an aspirin may have also become better on its own without an aspirin.



In the headache-pill example, four potential action-unit pairs and associated outcomes are identified. Use this diagram to answer Questions 2 and 3.

Pill & Headache No pill & Headache A	Pill & Headache No pill & No Headache B
C Pill & No Headache No pill & No Headache	D Pill & No Headache No pill & Headache



Question 2

For which of the scenarios is there a **positive causal** relationship between taking the pill and having a headache (i.e. the pill relieves the headache)?

○ A

○ B

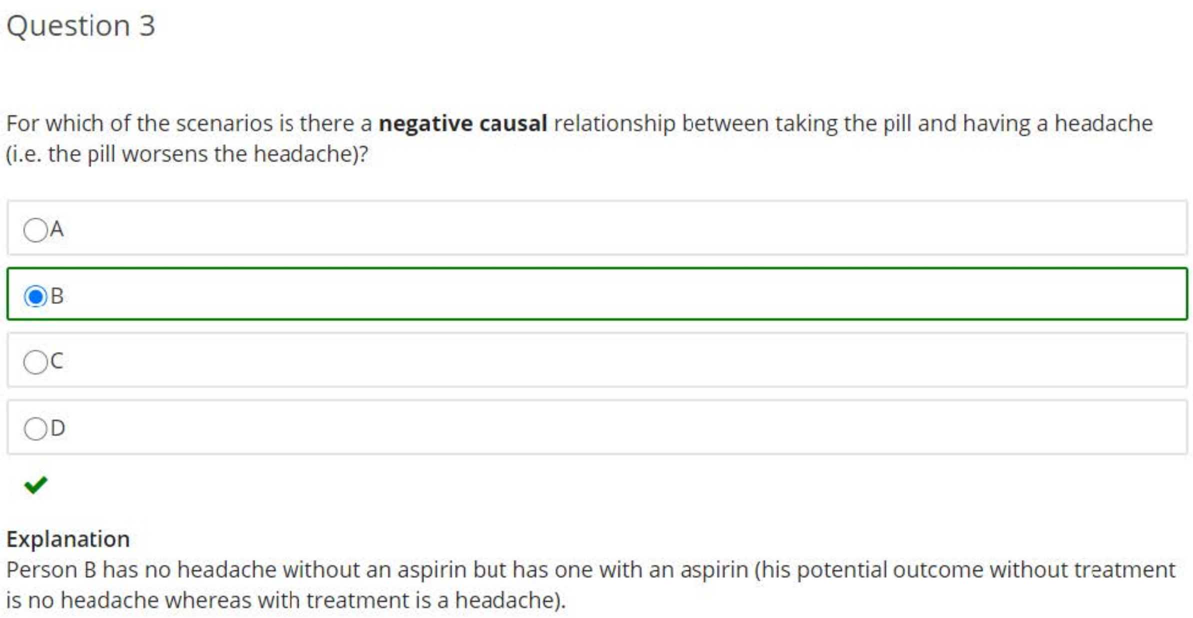
○ C

● D

✓

Explanation
Person D has a headache without an aspirin but does not have one with an aspirin (his potential outcome without treatment is headache whereas with treatment is no headache).

Causality (18 Questions)



Question 3

For which of the scenarios is there a **negative causal** relationship between taking the pill and having a headache (i.e. the pill worsens the headache)?

○A

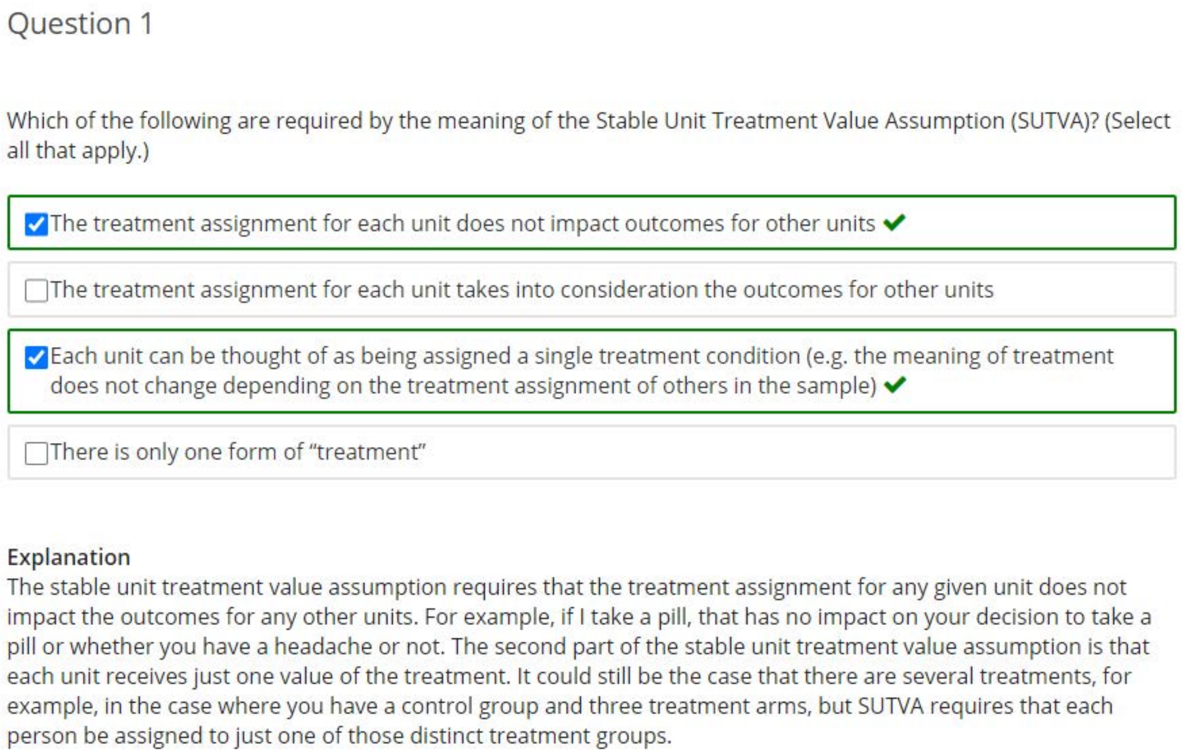
●B

○C

○D

✓

Explanation
Person B has no headache without an aspirin but has one with an aspirin (his potential outcome without treatment is no headache whereas with treatment is a headache).



Question 1

Which of the following are required by the meaning of the Stable Unit Treatment Value Assumption (SUTVA)? (Select all that apply.)

☑The treatment assignment for each unit does not impact outcomes for other units ✓

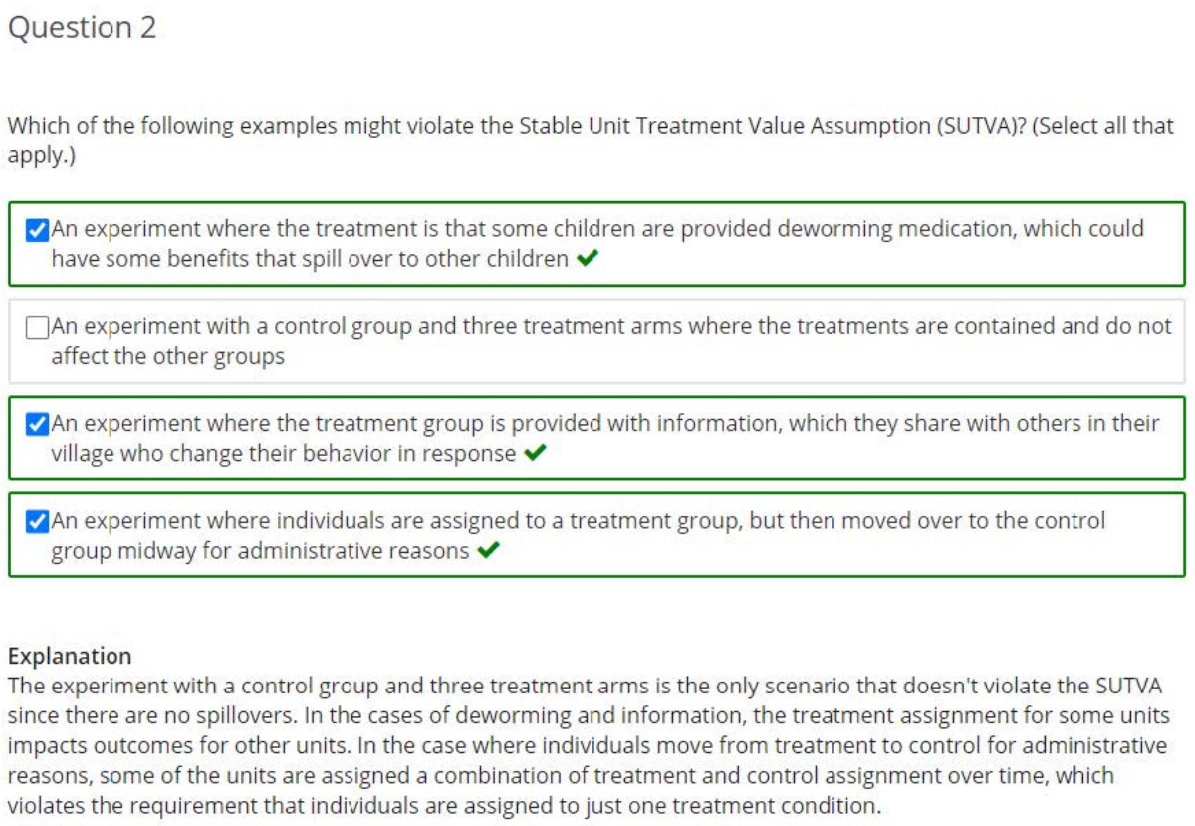
☐The treatment assignment for each unit takes into consideration the outcomes for other units

☑Each unit can be thought of as being assigned a single treatment condition (e.g. the meaning of treatment does not change depending on the treatment assignment of others in the sample) ✓

☐There is only one form of "treatment"

Explanation
The stable unit treatment value assumption requires that the treatment assignment for any given unit does not impact the outcomes for any other units. For example, if I take a pill, that has no impact on your decision to take a pill or whether you have a headache or not. The second part of the stable unit treatment value assumption is that each unit receives just one value of the treatment. It could still be the case that there are several treatments, for example, in the case where you have a control group and three treatment arms, but SUTVA requires that each person be assigned to just one of those distinct treatment groups.

Causality (18 Questions)



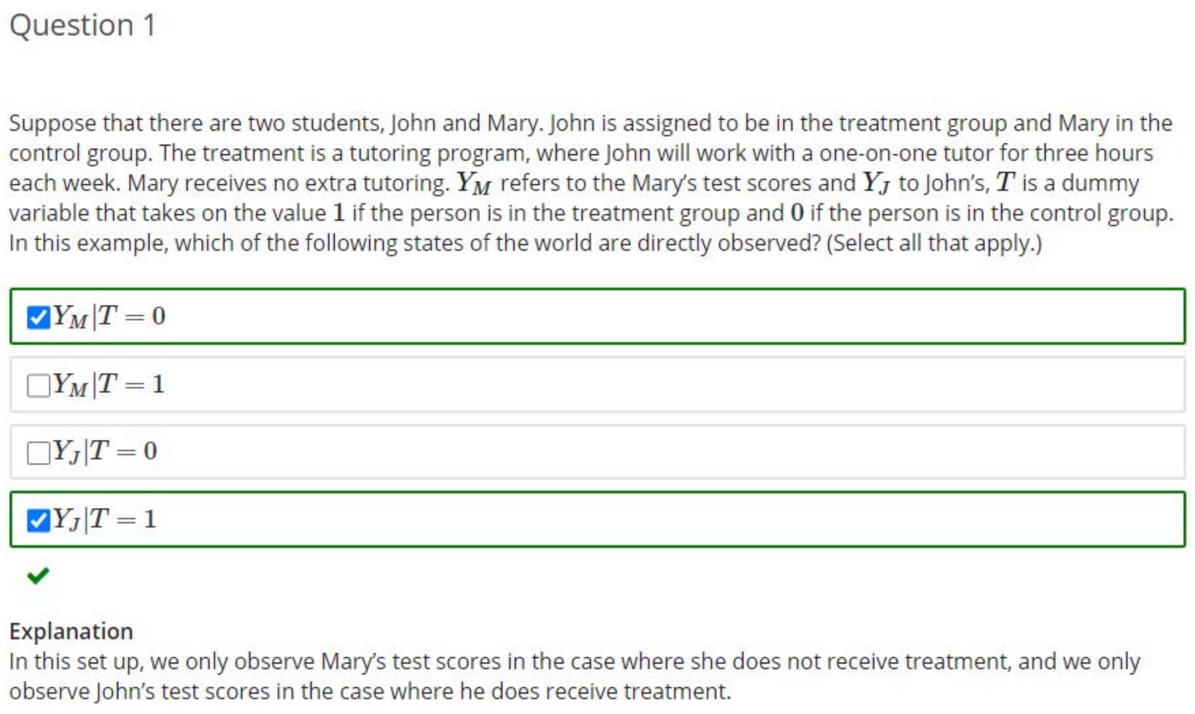
Question 2

Which of the following examples might violate the Stable Unit Treatment Value Assumption (SUTVA)? (Select all that apply.)

- ☑ An experiment where the treatment is that some children are provided deworming medication, which could have some benefits that spill over to other children ✓
- ☐ An experiment with a control group and three treatment arms where the treatments are contained and do not affect the other groups
- ☑ An experiment where the treatment group is provided with information, which they share with others in their village who change their behavior in response ✓
- ☑ An experiment where individuals are assigned to a treatment group, but then moved over to the control group midway for administrative reasons ✓

Explanation

The experiment with a control group and three treatment arms is the only scenario that doesn't violate the SUTVA since there are no spillovers. In the cases of deworming and information, the treatment assignment for some units impacts outcomes for other units. In the case where individuals move from treatment to control for administrative reasons, some of the units are assigned a combination of treatment and control assignment over time, which violates the requirement that individuals are assigned to just one treatment condition.



Question 1

Suppose that there are two students, John and Mary. John is assigned to be in the treatment group and Mary in the control group. The treatment is a tutoring program, where John will work with a one-on-one tutor for three hours each week. Mary receives no extra tutoring. Y_M refers to the Mary's test scores and Y_J to John's, T is a dummy variable that takes on the value 1 if the person is in the treatment group and 0 if the person is in the control group. In this example, which of the following states of the world are directly observed? (Select all that apply.)

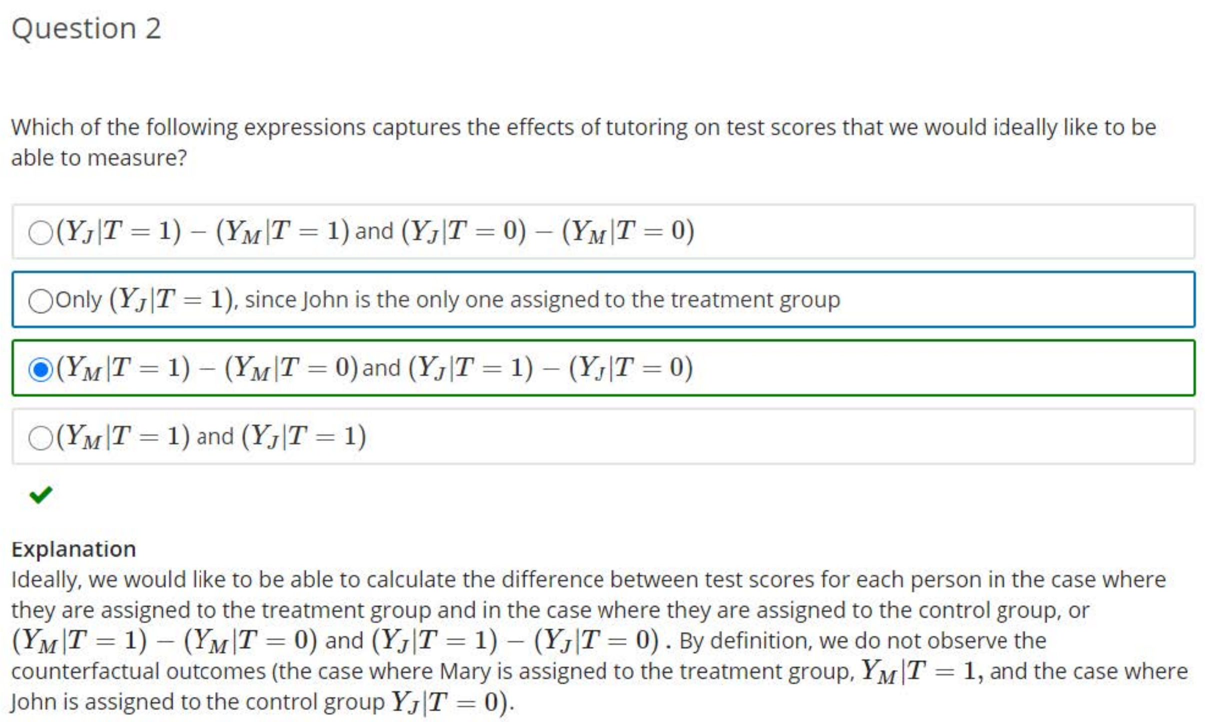
- ☑ $Y_M|T=0$
- ☐ $Y_M|T=1$
- ☐ $Y_J|T=0$
- ☑ $Y_J|T=1$

✓

Explanation

In this set up, we only observe Mary's test scores in the case where she does not receive treatment, and we only observe John's test scores in the case where he does receive treatment.

Causality (18 Questions)



Question 2

Which of the following expressions captures the effects of tutoring on test scores that we would ideally like to be able to measure?

○ $(Y_J|T=1)-(Y_M|T=1)$ and $(Y_J|T=0)-(Y_M|T=0)$

○ Only $(Y_J|T=1)$, since John is the only one assigned to the treatment group

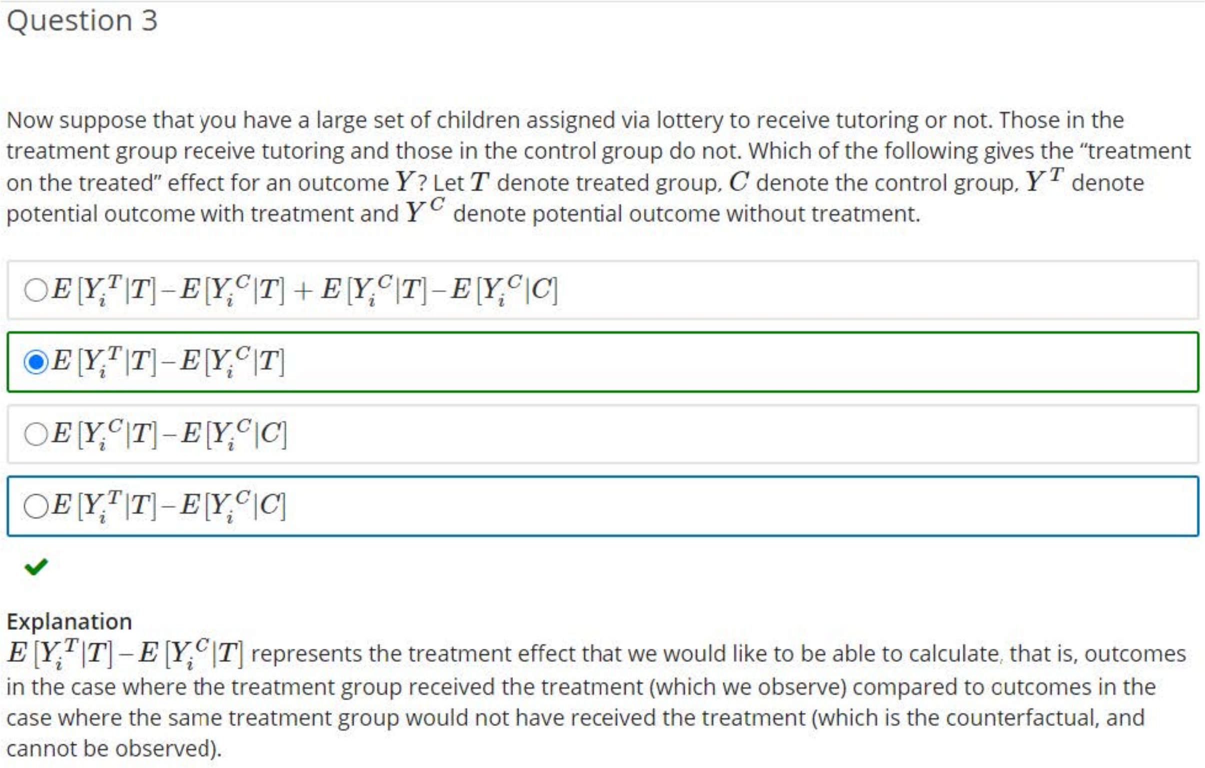
● $(Y_M|T=1)-(Y_M|T=0)$ and $(Y_J|T=1)-(Y_J|T=0)$

○ $(Y_M|T=1)$ and $(Y_J|T=1)$

✓

Explanation

Ideally, we would like to be able to calculate the difference between test scores for each person in the case where they are assigned to the treatment group and in the case where they are assigned to the control group, or $(Y_M|T=1)-(Y_M|T=0)$ and $(Y_J|T=1)-(Y_J|T=0)$. By definition, we do not observe the counterfactual outcomes (the case where Mary is assigned to the treatment group, $Y_M|T=1$, and the case where John is assigned to the control group $Y_J|T=0$).



Question 3

Now suppose that you have a large set of children assigned via lottery to receive tutoring or not. Those in the treatment group receive tutoring and those in the control group do not. Which of the following gives the "treatment on the treated" effect for an outcome Y? Let T denote treated group, C denote the control group, Y^T denote potential outcome with treatment and Y^C denote potential outcome without treatment.

○ $E\left[Y_i^T|T\right]-E\left[Y_i^C|T\right]+E\left[Y_i^C|T\right]-E\left[Y_i^C|C\right]$

● $E\left[Y_i^T|T\right]-E\left[Y_i^C|T\right]$

○ $E\left[Y_i^C|T\right]-E\left[Y_i^C|C\right]$

○ $E\left[Y_i^T|T\right]-E\left[Y_i^C|C\right]$

✓

Explanation

$E\left[Y_i^T|T\right]-E\left[Y_i^C|T\right]$ represents the treatment effect that we would like to be able to calculate, that is, outcomes in the case where the treatment group received the treatment (which we observe) compared to outcomes in the case where the same treatment group would not have received the treatment (which is the counterfactual, and cannot be observed).

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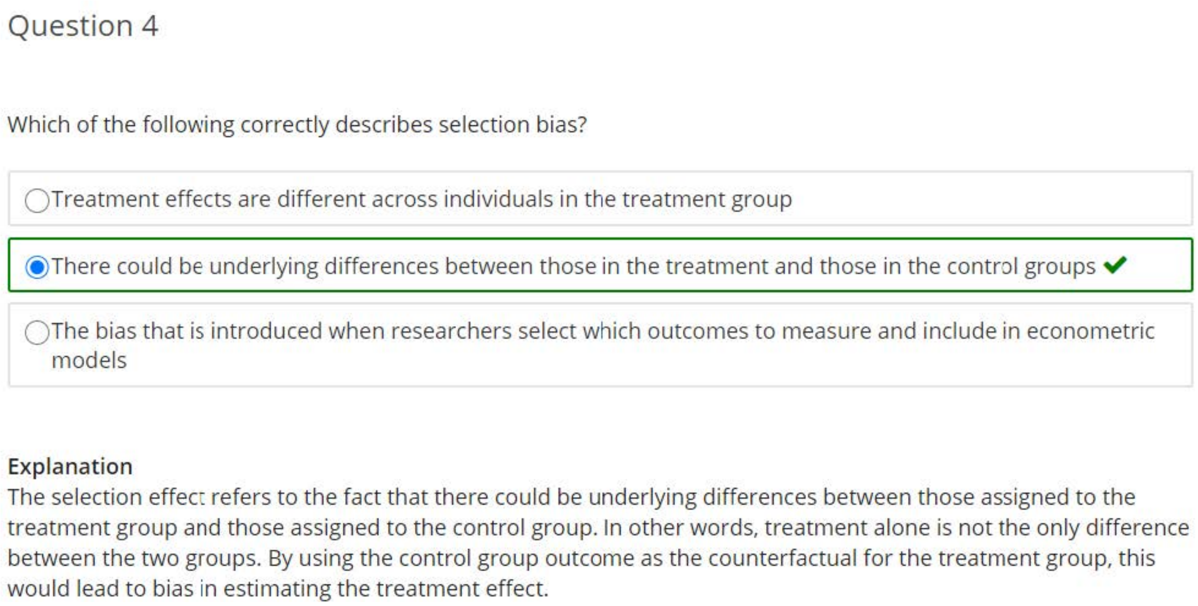


Question 4

Which of the following correctly describes selection bias?

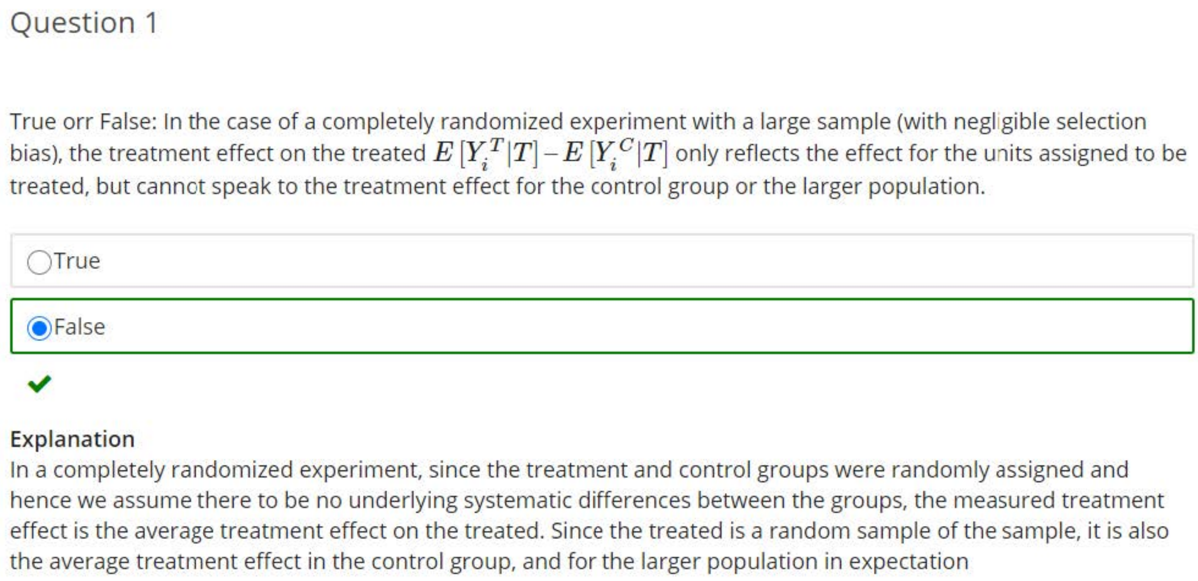
○ Treatment effects are different across individuals in the treatment group

● There could be underlying differences between those in the treatment and those in the control groups ✓

○ The bias that is introduced when researchers select which outcomes to measure and include in econometric models

Explanation

The selection effect refers to the fact that there could be underlying differences between those assigned to the treatment group and those assigned to the control group. In other words, treatment alone is not the only difference between the two groups. By using the control group outcome as the counterfactual for the treatment group, this would lead to bias in estimating the treatment effect.



Question 1

True orr False: In the case of a completely randomized experiment with a large sample (with negligible selection bias), the treatment effect on the treated $E[Y_i^T|T] - E[Y_i^C|T]$ only reflects the effect for the units assigned to be treated, but cannot speak to the treatment effect for the control group or the larger population.

○ True

● False

✓

Explanation

In a completely randomized experiment, since the treatment and control groups were randomly assigned and hence we assume there to be no underlying systematic differences between the groups, the measured treatment effect is the average treatment effect on the treated. Since the treated is a random sample of the sample, it is also the average treatment effect in the control group, and for the larger population in expectation

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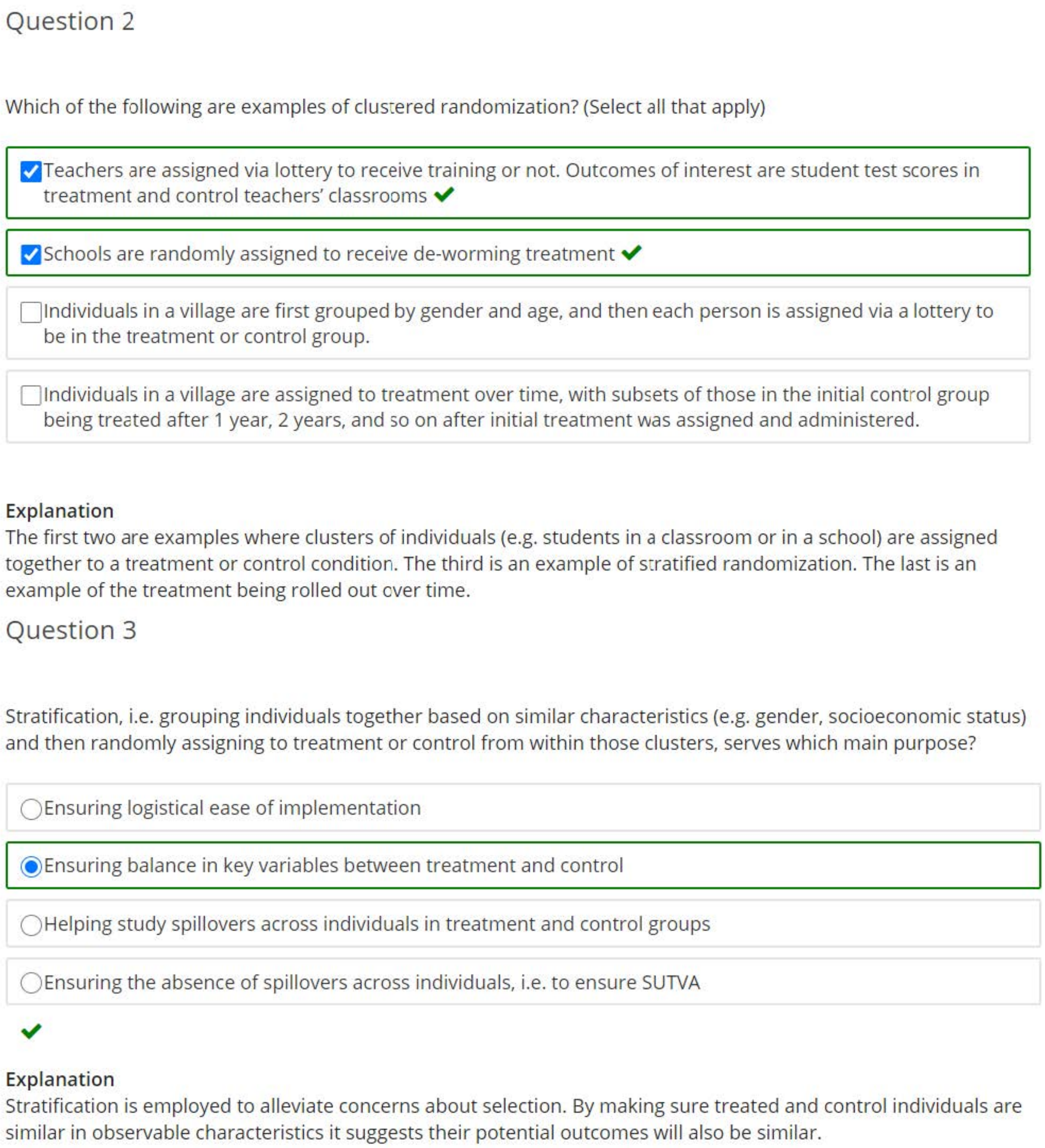

Question 2

Which of the following are examples of clustered randomization? (Select all that apply)

- ☑ Teachers are assigned via lottery to receive training or not. Outcomes of interest are student test scores in treatment and control teachers' classrooms ✓
- ☑ Schools are randomly assigned to receive de-worming treatment ✓
- ☐ Individuals in a village are first grouped by gender and age, and then each person is assigned via a lottery to be in the treatment or control group.
- ☐ Individuals in a village are assigned to treatment over time, with subsets of those in the initial control group being treated after 1 year, 2 years, and so on after initial treatment was assigned and administered.

Explanation
The first two are examples where clusters of individuals (e.g. students in a classroom or in a school) are assigned together to a treatment or control condition. The third is an example of stratified randomization. The last is an example of the treatment being rolled out over time.

Question 3

Stratification, i.e. grouping individuals together based on similar characteristics (e.g. gender, socioeconomic status) and then randomly assigning to treatment or control from within those clusters, serves which main purpose?

- ○ Ensuring logistical ease of implementation
- ● Ensuring balance in key variables between treatment and control
- ○ Helping study spillovers across individuals in treatment and control groups
- ○ Ensuring the absence of spillovers across individuals, i.e. to ensure SUTVA

✓

Explanation
Stratification is employed to alleviate concerns about selection. By making sure treated and control individuals are similar in observable characteristics it suggests their potential outcomes will also be similar.

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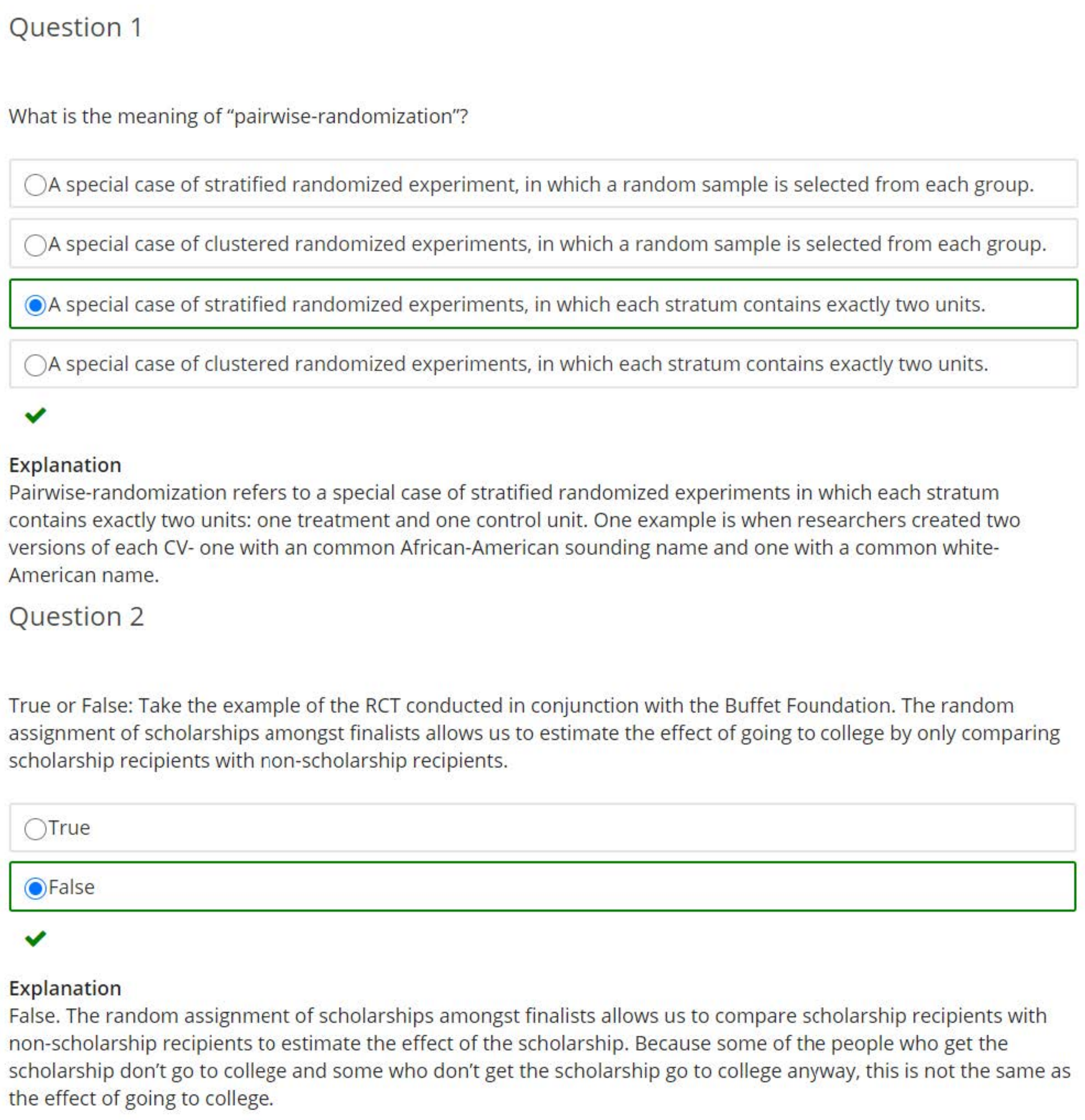

Question 1

What is the meaning of “pairwise-randomization”?

○ A special case of stratified randomized experiment, in which a random sample is selected from each group.

○ A special case of clustered randomized experiments, in which a random sample is selected from each group.

● A special case of stratified randomized experiments, in which each stratum contains exactly two units.

○ A special case of clustered randomized experiments, in which each stratum contains exactly two units.

✓

Explanation
Pairwise-randomization refers to a special case of stratified randomized experiments in which each stratum contains exactly two units: one treatment and one control unit. One example is when researchers created two versions of each CV- one with an common African-American sounding name and one with a common white-American name.

Question 2

True or False: Take the example of the RCT conducted in conjunction with the Buffet Foundation. The random assignment of scholarships amongst finalists allows us to estimate the effect of going to college by only comparing scholarship recipients with non-scholarship recipients.

○ True

● False

✓

Explanation
False. The random assignment of scholarships amongst finalists allows us to compare scholarship recipients with non-scholarship recipients to estimate the effect of the scholarship. Because some of the people who get the scholarship don’t go to college and some who don’t get the scholarship go to college anyway, this is not the same as the effect of going to college.