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ABSTRACT

The two-part activity outlined in this paper reveals to undergraduate students that assumptions made in theory building remain unquestioned until one steps outside the initial realm of expectations, and that theories adopted have a demonstrable impact on behaviors. Part I defines a theory, describes the roles of assumptions and knowledge in theories, and provides a test to reveal that biases are involved whenever tests are made or taken. The test demonstrates that knowledge is needed to make useful theories and that sometimes the knowledge is based on assumptions that turn out not to be useful. Part II shows how a theory which is not perfect may be better than no theory at all, even if such a model leads to predictable and consistent errors. For example, when human behavior is predicted, it is useful to be right even if the theory is right for the wrong reasons. Further, even if there are gaps in the model, on the whole it may lead to better predictions than random guesses. Part II shows this by presenting a memory task twice. The first time students simply try to memorize a set of numbers in 20 seconds, while the second time they are guided by information that will lead to a "theory"; that is, they use a mnemonic device to aid their recall. (JDD)

Knowing, Assuming, and Theorizing:

Activities to Teach about Theory

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Students often assume that theories are highly abstract and without noticeable consequences. Undergraduates at all levels seem to have difficulty conceptualizing how theorizing takes place and why anybody would choose to generate a theory.

Theory building occurs within a context of assumptions that are so "obvious" that they are hidden from their holders, or the assumptions are simply assumed to be correct. The theorist proceeds on the basis of these assumptions. Considering the rationale for building a theory in the first place, without some kind of mental model, it is often very difficult to accommodate all the facts or information that one receives.

The two-part activity outlined here reveals to students that assumptions remain unquestioned until we step outside our initial realm of expectations and that the theories we adopt have a demonstrable impact on our behaviors. The lesson requires about 15 minutes, depending on the nature of the discussion allowed.

Part I: The roles of assumptions and knowledge in theories

A theory is nothing more than a formalized mental model of some aspect of our world. To establish either a theory or a mental model, you need knowledge. In most instances, your knowledge reflects your assumptions and experience. Consequently, your limited knowledge and your view of the world can lead to conclusions that are not warranted. Fortunately, sometimes when your assumptions are called into question, your mental model of the world can then be modified to be more useful.

The following test is designed to reveal that whenever we make or take tests, our biases precede us. Each of the questions below involve answers that are "correct" only when certain assumptions are made. In addition, other questions also require that students have knowledge for a correct answer; these questions are designed to show that you must have a certain level of knowledge before you can approach a task with any degree of confidence that you are acting reasonably. In all cases, students might select correct answers for the wrong reason, bolstering a theory that might arise from questionable assumptions.

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Directions: Read each question to the class and encourage students to provide the correct answer to each question. After they take the test, assess their answers so they can be aware of their assumptions, some of which are so ingrained that they are totally unaware that these assumptions might be unwarranted.

1. Is the sun closer to the earth, farther from the earth during the winter, or is the distance the same in the summer and winter?

2. Is it possible for a football game that is actually played to end with a 1-0 score? (Note: "Football" in this question does NOT mean "soccer.")

3. Whose face appears on the penny?

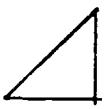
4. Who stole the greatest number of bases in a single season in professional baseball?

5. Who hit more home runs in a career than any other professional baseball player?

6. What is the minimum voting age in a national election?

7. On what month, day, and year will the next century begin?

8. Can you transform the item below into a perfect square, using just one straight line?



Answer and Rationale for Item

1. The answer depends on your hemisphere. For Americans in the northern hemisphere, the earth is closest to the sun in the winter; for Americans in the southern hemisphere, the earth is closest to the sun in the summer. This is the reason that the 1956 summer Olympics were in December: they were held in Australia.

The sun is at one focal point in the earth's elliptical orbit; the earth just happens to be closer to the sun in the winter. This question calls into the assumption that anybody taking this test lives north of the equator. In addition,
the adequacy of a person's answer depends on knowledge of the path of the earth around the sun. In any case, students can learn about assumptions whether or not they are correct. An important point is that you can be right but for the wrong reasons. Sometimes this happens in the development of theories.

2. A football game can end in a score of 1-0. In Canadian football, when a punter kicks the ball out of the back of the end zone, the team is awarded one point. When a team forfeits a game, the score is also 1-0, but it can be questioned whether the game ever began. Thus, in

one sense, a student could answer that a 1-0 score is legitimate, providing a correct answer for the wrong reason.

Most students will have answered that a football game cannot end with a 1-0 score. After this question, though, they will become more aware that the U.S. is not the only country in the world and that what might be "correct" here is not "correct" everywhere.

3. It depends on the country minting the coin. In the U.S., it will be Abraham Lincoln, although some students may be aware of the old Indian-head pennies. In Canada, the queen of England appears on the penny.

Students will begin to question some of their basic assumptions on every subsequent question. Even so, other assumptions will be so deeply held, that students will not think to challenge them.

4. Virtually nobody will get this answer correct because the record holder is a woman. Her name is Sophie Kurys; she played for the Racine Belles in the Women's Professional Baseball League. In 1946, she stole 202 bases.

Students often tend not to take this answer seriously because they do not think that it is "real" professional baseball. The instructor can use this opportunity to illustrate that this attitude pervades athletics; for instance, there is the varsity basketball team and there is the women's varsity basketball team. The male version is the default value and any other form is merely derivative.

In this test question, the assumption that students initially hold is that the record holder is a man. In this case, the assumption is so deep that, before the students know the correct answer, they will examine the possibility that the person is not an American, that the league is not the American or National League, then they will be baffled because they cannot think of another category of player for whom the answer might possibly be true. Part of the reason for this blockage knowledge-based: They are unaware of a women's league.

5. Students will generally not know the answer to this question, but will be savvy enough at this point to know that the answer might not be an American baseball player. The person is Sadduharo O, a Japanese player who hit over 800 home runs in his career.

6. The students' original answer will be 18, the minimum age in the United States. During the discussion, they will not know that they should not assume that the answer involves American law. The correct answer (as far as I can ascertain) is 16. In Canada, military personnel 16 years of age may vote in national elections.

7. The next century will begin, according to our Western calendar, on January 1, 2001. The reason is that there is no year call "zero." As a result, the end of the first decade was the year 10; the end of the second was the year 20. By extension, the end of the first century ended with a zero, that is, the year 100. Each decade and each century ends with a zero; the beginning of each new decade and century begins with a one.

There are other, non-Western calendars, such as the Jewish calendar, the Chinese calendar, and undoubtedly many others. It is our bias to assume that this question requires an answer based on our own calendar.

8. The assumption for this question is that one will draw a line to produce a box that is

square. In reality, by extending the line on the right side down, the triangle becomes the number four, which is the perfect square of two.

The important points to this exercise are that you need knowledge to make useful theories and that sometimes your knowledge is based on assumptions that turn out not to be useful. The second part of this demonstration of theory shows how a theory which is not perfect may be better than no theory at all, even if such a model leads to predictable and consistent errors. When we try to predict human behavior, for example, it is useful to be right, even if you are right for the wrong reasons. Further, even if there are gaps in your model, on the whole it may led to better predictions than random guesses.

Part II: Demonstrating the utility of theories

In this part of the activity, students are given a difficult memory task twice. The first time they simply try to memorize a set of numbers after about 20 seconds of study; their second attempt is guided by information that will lead to a "theory;" that is, they use a mnemonic device to aid their recall.

Numbers to be remembered:

1 4 9 1 6 2 5 3 6 4 9 6 4 1 0 0 1 2 1 1 4 4

This set of numbers is too large to be easily memorized without some mnemonic aid. After the first try, students should be given a cue such as "Squares of integers" or some similar cue. Some students will note that this string of numbers can be chunked as a group of squares of numbers, starting with the number one.

With this knowledge, they will quickly develop the "theory" that these numbers represent the square of the first twelve integers. Consequently, they will recall all the numbers in the list.

The catch here is that, whereas the number 81 (i.e., 9^2), does not appear on the list in proper sequence, students with the theory will recall it. This illustrates the point that mental models, like theories, are useful in that they can enhance organization of information, but they can also contributed to error. The advantage of a mental model or theory is that, even though it may not be perfect, the result is enhanced performance. Without the theory, students will not necessarily recall numbers that were not on the list, but they will also have lower levels of recall.

The point here is that mental models are useful even if they are not perfect. They allow us to deal with large amounts of information more easily, even if they sometimes lead to error. The theory is useful when the advantages outweigh the disadvantages.

The implications of theories

Normally, we think that when theories are based on questionable assumptions, we conclude that there are no real implications involved. One example to the contrary involves intelligence testing. IQ tests were devised so that the scores for men and for women were equal. The assumption is that there are no basic differences in intelligence between women and men. On the other hand, racial minorities score lower on current IQ tests than to whites.

In this latter case, no assumption was made about equality across groups. In both examples, we have no knowledge about the "truth" of difference or equality across groups. Nonetheless, test construction proceeded on the assumption of no differences between sexes but a real difference across racial groups. Consequently, there have been some very demonstrable consequences of the assumptions of our theories of intelligence.