What to Expect–Decision-making and Expected Value

SUBMITTED BY: Michael Ryan Moore, University of Pennsylvania, GSE

SUBJECT(S): Economics, Personal Finance

GRADE LEVEL(S): 9, 10, 11, 12

OVERVIEW:

This lesson extends the concepts of opportunity cost and risk by introducing students to expected value. Using the article "Using Scenario Planning as a Weapon Against Uncertainty?" students will think about managing uncertainty in the decision-making process. In particular, students will think about strategic "scenario planning," and weighing the value of multiple outcomes.

NBEA STANDARD(S):

- Economics, I. Allocation of Resources
- Personal Finance, I. Personal Decision Making

RELATED ARTICLES:

- "Three Critical Steps to Help You Choose a College"
- "Career Insight: Author Collin Williams Jr. on What It Takes To Be a Collegiate Athlete"

Common Core Standard(s):

Mathematics (N-Q), "Reason quantitatively and use units to solve problems."

Objectives/Purposes: The purpose of this lesson is to introduce students to thinking about risk assessment and risk management.

- Students will be able to define *expected value.*
- Students will be able to calculate *expected value.*
- Students will be able to use expected value to make a decision in the face of uncertainty.

Knowledge@Wharton Article: "Using Scenario Planning as a Weapon Against Uncertainty"

Other Resources/Materials:

For Teachers:

- Internet Access (Outside of the Classroom)
- Printer/Copier
- Access to Chalkboard/Whiteboard
- Chart Paper
- Markers
- Worksheet (linked below)

Activity:

The lesson is divided into five parts: (1) Introduction, (2) Guided Reading, (3) Class Discussion, (4) Exploration Activity, and finally (5) Closing

1. Introduction (15-20 mins)

For this lesson, students will build on prior knowledge of opportunity costs and risk. By definition, an opportunity cost of one decision is the value of the next best alternative. For example, if I choose to attend college full-time, the opportunity cost of that decision is the salary I could be making by spending that time working instead. Risk refers to the fact that we don't always know the value of certain decisions. It is difficult to accurately determine the utility, or value, of attending school full-time as compared to working full-time. There are numerous, random events that could change the value of either decision.

Today, students will think about measuring opportunity costs and risk through *expected value*. Building on the previous lesson on risk, ask students several hypothetical questions about a coin toss:

- Game 1: If the coin lands heads, you win $1. If the coin lands tails, you lose $1.
- Game 2: If the coin lands heads, you win $2. If the coin lands tails, you lose $1.

Ask students about these games. For example, if you played game 1 over and over again, how much money would you earn? If you played game 2 over and over again, how much money would you earn? Write students' guesses down on the board.

Next, have students break into pairs. Give each pair a coin. One person will flip the coin, and the other person will keep track of heads and tails. Have each group play the game 15-20 times. With each flip, have the group keep track of total money won or lost.

Have the pairs report the outcome of their individual game to the class. Ask students to reflect on what they see. Why do different pairs have different total winnings? Next, look at the average winnings across the class. How close is the average to the original guesses that students' made before playing the game?

Next, ask students to think of a more complicated game with two coins:

- If both coins land on heads, you win $3
- If both coins land on tails, you win $3
- If one coin lands on heads, and the other lands on tails, you lose $4

Would students play this game? Why or why not? If someone played this game over and over again, how much money would they expect to make?

Depending on student answers, you may want them to play out this game as well. However, if students seem to grasp the concepts, you can continue with the lesson.

Introduce students to the concept of *expected value.* The expected value of a decision is the sum of each outcome times its probability. For example, we had a game where heads earned you a dollar and tails lost you a dollar. What are all the possible outcomes? There are two: earn a dollar, lose a dollar. What is the probability of each occurring? 50%. So the expected value of the game is 50%*$1 + 50%*(-$1) or 0.

2. Guided Reading (5-10 mins)

After this short introduction, students should read through the first two sections of the article "Using Scenario Planning as a Weapon Against Uncertainty?" As they read, ask students to think about what "scenario planning" means, and how scenario planning is or is not related to the concept of "expected value."

3. Class Discussion (1-5 mins)

Once students have finished, ask them to briefly summarize the article. Encourage students to make connections between "scenario planning," and expected value. In both cases we are trying to think about potential future outcomes and their payoffs. When we have an idea of all the outcomes, and their respective value, we can make smarter decisions.

4. Exploration Activity (5-10 mins)

Have the students break into small groups. With the remaining time, ask students to work on the Worksheet.

5. Closing (1-5 mins)

Remind students of key takeaways: although we often make choices that we think will maximize our utility, we aren't always sure what the outcome will be. By calculating an expected value, we can incorporate risk and uncertainty into our calculations about utility and value.

Tying It All Together:

Assessment & Extension

This lesson can easily be extended by incorporating a greater amount of probability and statistics. The coin toss game can be expanded to include dice, or other chance-based outcomes with more complicated solutions.

What Worked and What I Would Do Differently:

This lesson is math-intensive. Moreover, the coin-toss examples in this lesson can be somewhat divisive. This lesson is better suited to students who have some background in probability and calculating expected value. If students do not have this background, it helps to paint broader strokes. In other words, instead of looking at subtle differences in risk, look at extremely large differences. Even without the math background, students have an intuitive understanding of the difference in risk.