Game Theory–Strategies and Payoffs

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SUBJECT(S): Personal Finance

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

☰ OVERVIEW:

In this lesson, students will learn about game theory. In particular, students will think about the standard prisoner's dilemma as it relates to routine business decisions. Students will compare and contrast one-time games and repeated games, looking at the incentives for cooperation in both. After reading the Knowledge@Wharton article,"Forecasting in Conflicts: How to Predict What Your Opponent Will Do," students will think about game theory in personal decision making by playing a short game.

☰ NBEA STANDARD(S):

- Personal Finance, I. Personal Decision Making
- Personal Finance, VIII. Protecting Against Risk

☰ RELATED ARTICLES:

- "Jeremy Siegel: Why Investors Shouldn't Panic Over Stock Market Volatility"
- "5 Takeaways from Today's Board Game Revival"

Objectives/Purposes:

The purpose of this lesson is for students to understand game theory:

- Students will be able to explain the term *game theory.*
- Students will understand the difference between repeated games and one-time games.
- Students will be able to explain game theory as an abstraction of everyday decision making in the business world.

Knowledge@Wharton Article: "Forecasting in Conflicts: How to Predict What Your Opponent Will Do"

Other Resources/Materials:

For Teachers:

- Internet Access
- Printer/Copier
- Access to Chalkboard/Whiteboard
- Chart Paper
- Markers

Activity:

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

1. Introduction (5 mins):

Introduce this lesson by asking for two volunteers. Have the two students come to the front of the classroom, one standing on the left, one standing on the right. Ask the class if they have ever heard of the term *prisoner's dilemma.* Regardless of the students' answers, tell them that we are going to do a short demonstration of what the prisoner's dilemma means. For this demonstration, we will pretend that our two volunteers are budding artists. During their free time at school, they decided to use their artistic talents to spray-paint graffiti on the side of the building. Eventually one of the teachers found the graffiti and started asking other students who was responsible. Now both volunteers have been caught, and they are currently standing in front of the principal. If the principal believes you are responsible, you will both get suspended. In order to keep you from lying, she interviews each of you separately. Now you each have a choice. You can admit to the crime. You can give up your partner. Or you can say nothing. Depending on your choice, you face different outcomes:

	Person B stays silent	Person B confesses
Person A stays silent	You each get detention	Person A: one-week suspensionPerson B: goes free
Person A confesses	Person A: goes freePerson B: 1 week suspension	You each get a two-day suspension

After the volunteers answer, ask the students what was going through their mind. The class should realize that the outcome of this "game," depends on what *BOTH* students do. So, the prisoner's dilemma is all about trust. If both "prisoners" can completely trust their partners, it is in their best interest for both to stay silent. However, if you cannot trust your partner, you answer accordingly.

2. Definitions (5-10 mins):

Once the demonstration is over, spend a bit of time explaining *game theory* to the class. The prisoner's dilemma is a subset of game theory more broadly.

In economics, game theory is a way of modeling real life decisions. Ask students to think about the prisoner's dilemma as a model. Is it accurate? What does it capture and what does it leave out? It is important for students to realize that game theory is about *abstraction.* We don't pay attention to every real-life detail; rather, we focus on specific salient things.

Game theory has several parts: There are (1) players, (2) strategies, (3) rules, and (4) payoffs. Ask students to find each of these parts within the earlier prisoner's dilemma demonstration in the class. The players are the two student volunteers. The payoffs are the suspensions and detentions. The rules say *how* those payoffs occur. And the strategies are what the players used to make their decisions.

Next, ask students to think about game theory in business. How might game theory work in the real world?

A great example is to have students think about two competing companies (e.g. Coca-Cola and Pepsi-Cola). Draw a blank prisoner's dilemma table on the board. For this example, the decision is not to "stay silent" or "confess," — instead, the decision is to "lower prices" or keep them the same. See below:

		Coca-Cola	

Pepsi-Cola		Lower Prices	Keep Current Prices
	Lower Prices	Both companies earn $5 million	Coca-Cola: $3 millionPepsi-Cola: $15 million
	Keep Prices	Coca-Cola: $15 millionPepsi-Cola: $3 million	Both companies earn $10 million

Use this example to get students thinking about the difference between a one-time game and a repeated game. If Pepsi decides to have a surprise sale, what will Coca-Cola do in response? Again, students can think about the earlier prisoner's dilemma. Would the two student volunteers' strategies have changed if they were going to play the game over and over again?

3. Guided Reading (5-10 mins):

Have students read through the article "Forecasting in Conflicts: How to Predict What Your Opponent Will Do." As students read, ask them to consider, "What is the value of role play?" Next, ask students, "How does role play relate to game theory?" Get students to start thinking about role play and modeling as decision-making strategies. The more time you have to "try out" a strategy, the better informed you will be before making your decision.

After students finish reading, have them briefly summarize the article. Relate the author's advice on forecasting to the students' earlier prisoner dilemma game.

4. Exploration Activities (15-20 mins):

Next, have the students play a short game to demonstrate the relationship between game theory and cooperation.

Before playing this game, create two small groups (e.g. two groups of 6). Have each group play through the game.

Set-up: Each group must pair off. Do not assign pairs. Have students create them using their own strategies/decision-making. Once you have three pairs, the teacher can organize them 1 through 3. Have group one come to the front of the class.

For this game, you will ask each pair three multiple-choice questions. The content of the questions is up to the instructor's discretion. (Sample questions included below). Each team starts with 100 points. After the instructor reads out a question, the pair has 15 seconds to agree on an answer. If students do not agree, they earn 0 points. If students select the correct answer, they win 100 points. After the three questions are finished, the students must then make a decision. Provide each student with an index card or small piece of paper. Both team members must write down "keep" or "share." If both partners write down "share," then they split the points. If both write down "keep," they get no points. If one writes "keep" and one writes "share," the person who wrote "keep" earns all the points.

Have each of the three groups play through the game. Keep track of how many teams cooperate and how many do not.

Now, bring the second group of six students up to play the game. This game will be identical; *however,* after every question, students must decide "keep" or "share." Moreover, in this second game, do not tell students how many rounds they will play. They might only get asked one question. They might get asked 10 questions. But, after each question, they must decide: "share" or "keep."

After both groups play through the game, spend some time discussing the differences. What was different about group one (one-time game) and group two (repeated game). Was the second group more likely to cooperate? Why was this the case?

5. Closing (1-10 mins):

With the remaining time, briefly summarize the main concepts of the lesson. Economists use game theory to model complex decisions through abstraction. In one-time games, there is often a large incentive to defect. However, as games are repeated, players are more likely to cooperate and work together.

Practice Outside of the Classroom:

Outside of the classroom, ask students to research Robert Axelrod and his *prisoner's dilemma* game. As students report back, the instructor can talk in depth about repeated games and winning strategy. In his research, Axelrod found that some strategies are better than others. As it turns out, it is not smart to be too nice or too mean. Instead, the winning strategy is "tit-for-tat"— when your partner defects, you defect. When your partner cooperates, you cooperate.

What Worked and What I Would Do Differently:

Because my students had pre-existing relationships, they were extremely nice to one another. During our games, almost everyone was happy to cooperate, knowing that their friends would have their backs. Almost no one turned against his or her partner. If this happens in your class, encourage students to think about how their behavior would differ if they were playing against strangers, against someone they would never see again. Use these examples to think about the role of trust in game theory.

Sample Questions:

1. Which of the following is a primary cause of inflation?

    1. Increases in technology
    2. More competition in the marketplace
    3. An increase in money supply
    4. An increase in unemployment

2. IBM has just discovered a new technology for making laptop computers more quickly and efficiently. How will this affect supply and demand?

    1. The demand curve will shift inward
    2. The demand curve will shift outward
    3. The supply curve will shift inward
    4. The supply curve will shift outward

3. A monopoly is most likely to benefit:

    1. Consumers
    2. Competitors
    3. The monopoly itself
    4. None of the above

4. According to the *law of demand,* when the price of a product increases:

    1. Demand increases
    2. Demand decreases

3. Supply decreases
4. None of the above

5. When the price of Coca-cola increases, people tend to buy more Pepsi-cola. This is because the two are:

1. Complements
2. Substitutes
3. Inelastic
4. None of the above

6. In economics, the term *opportunity cost* refers to:

1. The cost of a product
2. The utility of a product
3. The value of the next best alternative
4. None of the above

7. According to the *law of supply*, when the price of a product decreases:

1. Demand decreases
2. Supply increases
3. Demand shifts outward
4. None of the above

8. In economics, *scarcity* refers to the fact that:

1. Resources are limited
2. Individuals face mutually-exclusive choices
3. People must make trade-offs
4. All of the above

9. Which of the following is an *elastic* product?

1. Salt

2. Gasoline

3. Electricity

4. Coffee

10. The term *equilibrium price* refers to:

   1. The current price of a good or service

   2. The cheapest price of a good or service

   3. The price at which supply and demand are equal

   4. Both a. and b.

11. If the current price of a product is *less than* equilibrium, which of the following is true?

   1. Supply = Demand

   2. Supply > Demand

   3. Supply < Demand

   4. None of the above

12. The term *marginal cost* refers to:

   1. The average cost of producing a product

   2. The cost of producing one additional product

   3. The selling-price of one additional product

   4. The average selling-price of a product

13. According to economists, the term *utility* refers to:

   1. The price of an item

   2. The price you pay for an item

   3. The value an item brings you

   4. Both b. and c.

14. If there is a supply surplus (if supply is greater than demand) what will happen to price?

   1. Nothing. The price will stay the same

2. The price will increase

3. The price will decrease

4. None of the above

15. Which of the following are complementary goods?

1. Sandals and coats
2. Ice cream and pencils
3. Bottled water and soda
4. Hamburgers and ketchup

16. Yesterday a huge hurricane tore through orange trees in Florida. What is likely to happen to the supply and demand for orange juice?

1. Supply increases
2. Supply decreases
3. Demand increases
4. Demand decreases

17. Which of the following are substitute goods?

1. Notebooks and pens
2. Sports cars and delivery vans
3. CDs and mp3s
4. Bottled water and ice

18. If the demand for a product shifts *inward*, what will happen to the equilibrium price?

1. Nothing. It stays the same
2. The price will increase
3. The price will decrease
4. None of the above

19. Game theory includes which of the following:

1. Players
2. Strategies
3. Payoffs
4. All of the above

20. Economics is:

1. The study of choice under scarcity
2. Fun
3. Confusing
4. All of the above