REPLACING MULTIPLE CHOICE QUESTIONS WITH A MATRIX PUZZLE TO ASSESS STUDENT UNDERSTANDING IN ECONOMICS

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Outline

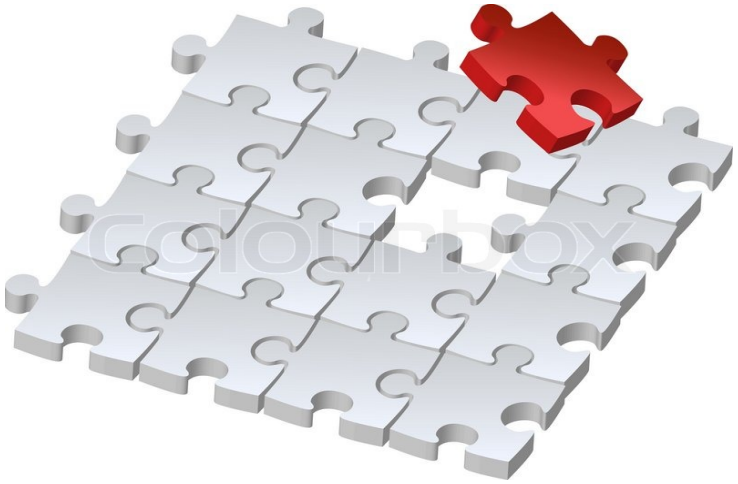
- A matrix puzzle as a concept assessment
- Supply and demand example
- Other examples of matrix puzzles
- Scores from a matrix puzzles
- Weighting a matrix puzzle

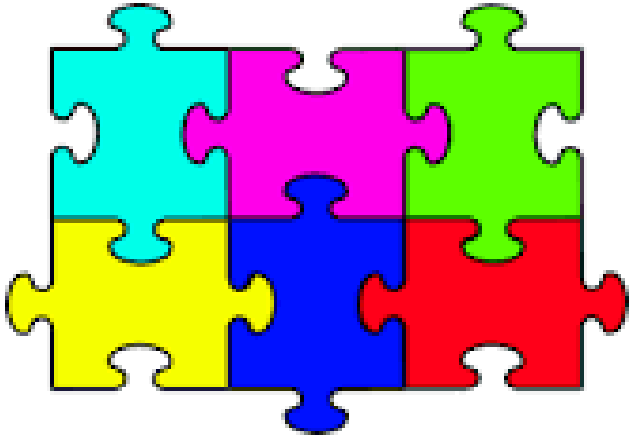
Innovations in Assessment

- **Multiple-choice items often used for testing in economics courses, especially with large classes**
- **Can we do better?**
  - **Can we develop something new, efficient, and innovative to check for student mastery of economic concepts**

Puzzles


GREEN
YELLOW
ORANGE
RED
WHITE
LIGHT BLUE
DARK BLUE
PURPLE
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 1 2 3 4 5 6 7 8 9





A Matrix Puzzle: Three Elements

- **Conditions:** the assumptions that limit the problem or situation that describes it
- **Outcomes (columns):** what happened that has to be explained.
- **Changes (rows):** what causes the outcomes. The causal explanation is based on economic analysis
- **Solving the puzzle:** supply the correct YES or NO response to each cell in the matrix

Concept Assessment: Supply and Demand (single shift)

Shift Effects on Price (P) and Quantity (Q)

Demand (D):

D↑ , but S stays same: P↑ Q↑

D↓ , but S stays same: P↓ Q↓

Supply (S):

D stays same, but S↑ : P↓ Q↑

D stays same, but S↓ : P↑ Q↓

Conditions: A competitive market for a homogeneous product (wheat) with many buyers and sellers.

Outcomes:

1. The price of the product increases.
2. The quantity of the product decreases.
3. The price of the product decreases and the quantity increases.

Changes: In the matrix below are four changes (A to D). In each cell, make a Y for Yes and an N for No if a change explains an outcome (1, 2, and 3). Fill in all cells.

		Outcomes		
	Changes	**1**	**2**	**3**
A	**Increase in demand**			
B	**Decrease in demand**			
C	**Increase in supply**			
D	**Decrease in supply**			

Answer Key for the Matrix Puzzle

Outcomes:

1. The price of the product increases. (cells A1 and D1)
2. The quantity of the product decreases. (cells B2 and D2)
3. The price of the product decreases and the quantity increases. (cell C3)

		Outcomes		
	Changes	**1**	**2**	**3**
A	**Increase in demand**	Y	N	N
B	**Decrease in demand**	N	Y	N
C	**Increase in supply**	N	N	Y
D	**Decrease in supply**	Y	Y	N

Advantages

- **Holistic or Integrated.** It is a holistic set more so than collection of MC items on the same concept.
- **Compact and Efficient.** It limits the reading load and the topic switching that are problems with a set of MC items.
- **Challenges understanding.** It probes for what is correct and incorrect—and can be used to give better feedback more than MC items.
- **Hard to solve the puzzle by guessing.** Answers to entire puzzle show if student does not know and was guessing.

Extensions

- **Easy to make it more challenging**
  - Add more outcomes (columns) or changes (rows)
- **Many possibilities for supply and demand**
  - Add other price and quantity combinations
  - Include single shifts and double shifts

Conditions: A competitive market for a homogeneous product (wheat) with many buyers and sellers.

Outcomes:

1. The price of the product increases.
2. The quantity of the product decreases.
3. The price of the product decreases and the quantity increases.
4. The price of the product decreases and it is uncertain what happens to quantity.
5. The quantity of the product increases and it is uncertain what prices.

Changes: In the table that follows, mark an Y for Yes or an N or no by each *change* that explains each outcome. Fill in all the cells with either a Y or an N.

		Outcomes				
	Change	**1**	**2**	**3**	**4**	**5**
A	**Increase in demand**	Y	N	N	N	N
B	**Decrease in demand**	N	Y	N	N	N
C	**Increase in supply**	N	N	Y	N	N
D	**Decrease in supply**	Y	Y	N	N	N
E	**Equal increase in demand and supply**	N	N	N	N	Y
F	**Equal decrease in demand and supply**	N	Y	N	N	N
G	**Equal increase in demand and decrease in supply**	Y		N	N	N
H	**Equal decrease in demand and increase in supply**	N	N	N	Y	N

Other Concept Applications

- Aggregate supply and demand
- Externalities
- Elasticities
- Money market
- Foreign exchange market
- Table or Graph Interpretations

Conditions: An economy is currently in full-employment equilibrium.

Outcomes:

1. Price level in the economy will increase in the short-run.
2. Real GDP will increase in the short-run.
3. Unemployment will increase in the short-run.
4. Real wages will increase in the short-run.

Changes: In the matrix below are four changes (A to D). In each cell, make a Y for Yes and an N for No if a change explains an outcome (1, 2, 3, & 4). Fill in all cells.

		Outcomes			
	Changes	**1**	**2**	**3**	**4**
A	**Money oil prices increase.**				
B	**Federal income taxes are decreased.**				
C	**Government spending is decreased.**				
D	**Workers correctly anticipate an increase in aggregate demand**				

Key

Conditions: An economy is currently in full-employment equilibrium.

Outcomes:

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		Outcomes			
	Changes	**1**	**2**	**3**	**4**
A	**Money oil prices increase.**	Y	N	Y	N
B	**Federal income taxes are decreased.**	Y	Y	N	Y
C	**Government spending is decreased.**	N	N	Y	N
D	**Workers correctly anticipate an increase in aggregate demand**	Y	N	N	N

Conditions: Certain economic activities generate an externality that results in an inefficient market for a good.

Outcomes:

1. The example is of a positive externality.
2. The example is of a negative externality.
3. The good or service is underproduced in the market.
4. The good or service is overproduced in the market.

Changes: In the matrix below are four changes (A to D). In each cell, make a Y for Yes and an N for No if a change explains an outcome (1, 2, 3, & 4). Fill in all cells.

		Outcomes			
	Changes	**1**	**2**	**3**	**4**
A	**Child receives a flu shot.**				
B	**Electricity is produced by burning coal**				
C	**Honey is produced by bees in hives near agricultural areas.**				
D	**A student buys a pizza at the student union.**				

Key

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		Outcomes			
	Changes	**1**	**2**	**3**	**4**
A	**Child receives a flu shot.**	Y	N	Y	N
B	**Electricity is produced by burning coal**	N	Y	N	Y
C	**Honey is produced by bees in hives near agricultural areas.**	Y	N	Y	N
D	**A student buys a pizza at the student union.**	N	N	N	N

Scores from A Matrix Puzzle

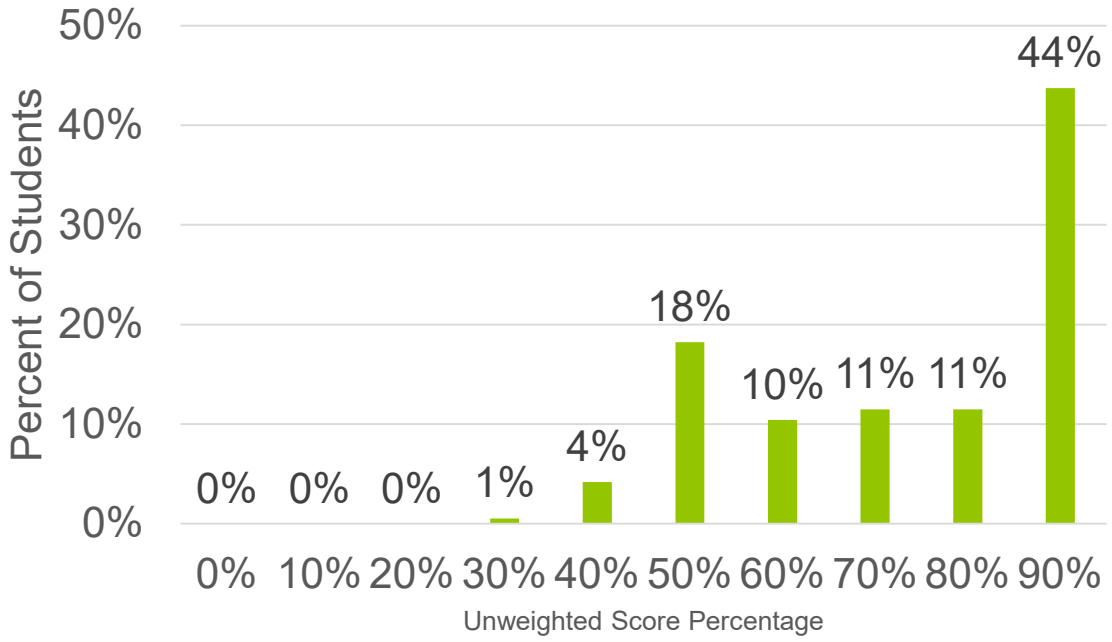
Class Results from a Supply and Demand Matrix Puzzle (n=192)

Outcomes:

1. The price of the product increases. (cells A1 and D1)
2. The quantity of the product decreases. (cells B2 and D3)
3. The price of the product decreases and the quantity increases. (cell C3)

	Changes	1	2	3	Avg
A	Increase in demand	71%	85%	95%	*84%*
B	Decrease in demand	82%	53%	91%	*75%*
C	Increase in supply	96%	86%	67%	*83%*
D	Decrease in supply	67%	68%	96%	*77%*
	Average	*79%*	*73%*	*88%*	*80%*

Unweighted Score Distribution



Individual Results for a Student—S&D Matrix

Key	1	2	3
A	Y	N	N
B	N	Y	N
C	N	N	Y
D	Y	Y	N

Student Heat Map	1	2	3
A	Correct	Correct	Correct
B	Correct	Correct	Incorrect
C	Correct	Incorrect	Correct
D	Correct	Incorrect	Correct

Should be No

Should be a Yes

Yes	1	2	3
A	Correct		
B		Correct	Incorrect
C		Incorrect	Correct
D	Correct		

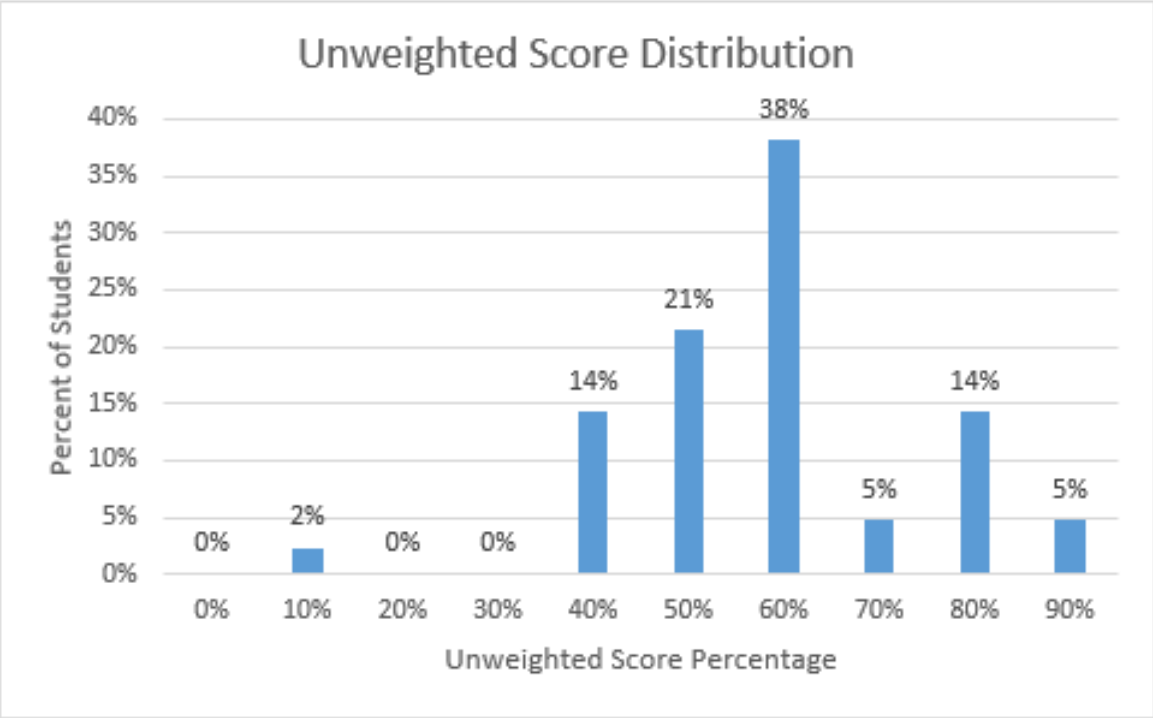
No	1	2	3
A		Correct	Correct
B	Correct		
C	Correct		
D		Incorrect	Correct

Scores from AD/AS Example

FIGURE 6: Macroeconomic Matrix Puzzle Results

	1	2	3	4	Average
Money oil prices increase.	88%	76%	67%	60%	73%
Federal income taxes are decreased.	50%	64%	86%	36%	59%
Government spending is decreased.	69%	86%	81%	36%	68%
Workers correctly anticipate an increase in aggregate demand.	81%	19%	81%	33%	54%
Average	72%	61%	79%	41%	63%

Scores from AD/AS Example

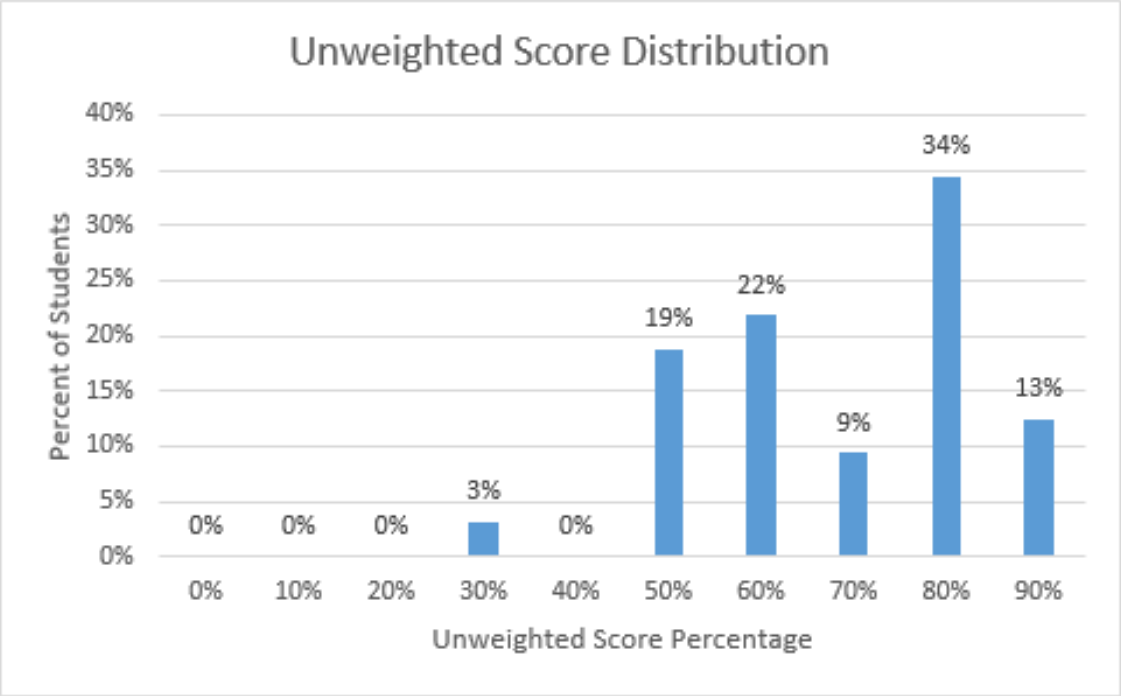


Scores from Externality Example

FIGURE 8: Externality Puzzle Results

	1	2	3	4	Average
1	88%	94%	53%	75%	77%
2	75%	81%	75%	72%	76%
3	91%	81%	66%	69%	77%
4	44%	81%	63%	78%	66%
Average	74%	84%	64%	73%	74%

Scores from Externality Example



Weighted Scores

- **Problem**
- number of yes and no cells are unequal
- can guess all no or all yes and get many items correct

Solution

- Limit maximum score for *all* no or *all* yes to 50% of cells (.5C).
- Limit sets weights: yes = [.5C / max yes]; no=[.5C / max no]

12-cell matrix puzzle

(correct: 5 yes and 7 no)

	1	2	3	Avg
A	71%	85%	95%	*84%*
B	82%	53%	91%	*75%*
C	96%	86%	67%	*83%*
D	67%	68%	96%	*77%*
	79%	*73%*	*88%*	*80%*

Equation: Score = [(6/5) x Yes score + (6/7) x No score]

Weights: 1.2 points for correct yes and 0.857 for correct no

40-cell matrix puzzle

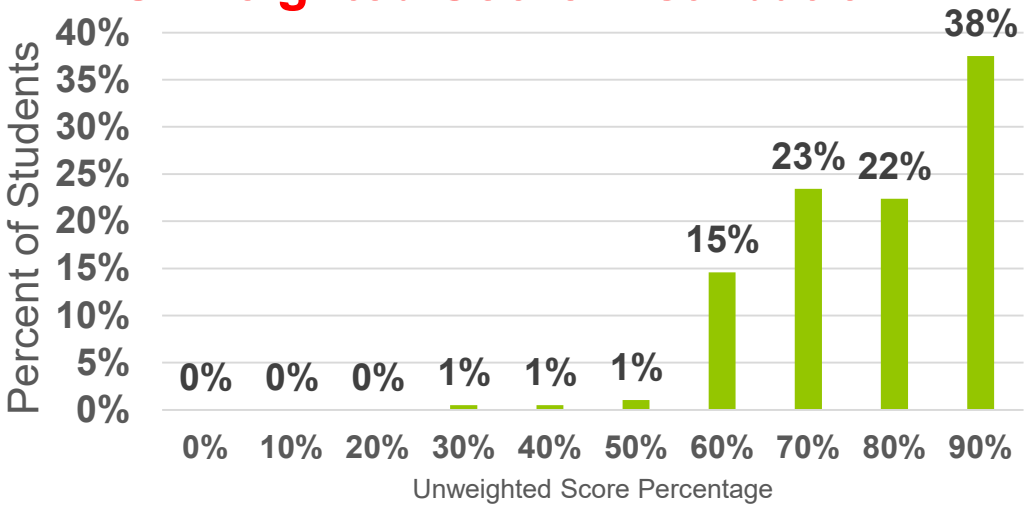
(correct: 9 yes and 31 no)

	1	2	3	4	5
A	71%	85%	95%	88%	92%
B	82%	53%	91%	82%	97%
C	96%	86%	67%	91%	69%
D	67%	68%	96%	95%	98%
E	92%	96%	84%	88%	63%
F	90%	49%	97%	83%	94%
G	57%	75%	95%	87%	92%
H	92%	95%	77%	49%	83%

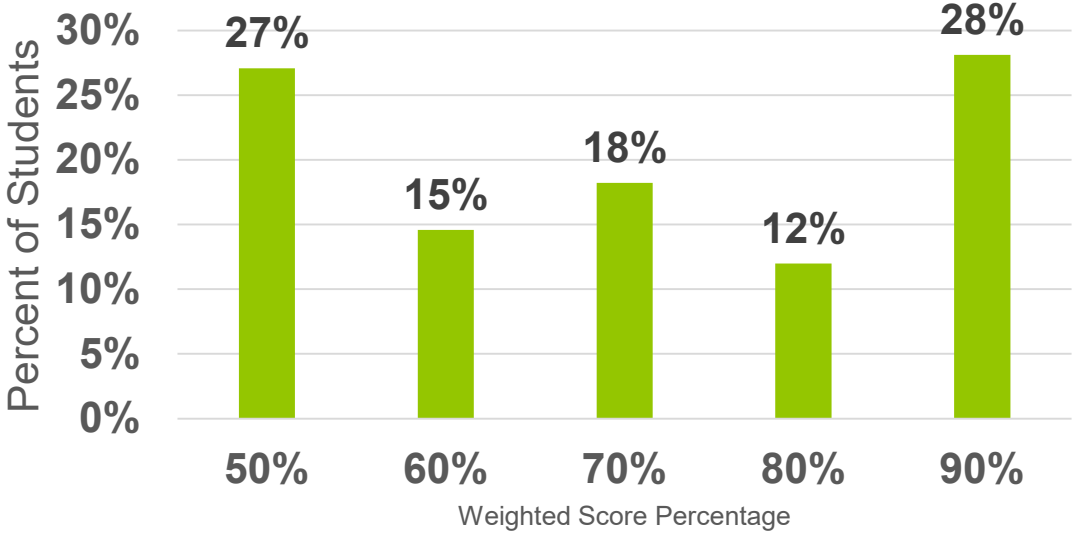
Equation: Score = [(20/9) x Yes score + (20/31) x No score]

Weights: 2.22 points for correct yes and 0.645 for correct no

Unweighted Score Distribution



Weighted Score Distribution



Thank You