WAMC Lesson Plan

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Lesson Title: Monopoly Regression
Date: 6-25-19
Text: Financial Algebra   STEM Correlation: Math/Technology
 Lesson Length: 50min + 15min

Big Idea (Cluster): Interpreting Categorical and Quantitative Data (S-ID)
Linear Regression (2-2 Old Book)
Could pair with 1-5, 7-1, 8-4, 9-3 for regression support and practice in the new book

Mathematics K–12 Learning Standards:
Interpreting Categorical and Quantitative Data (S-ID)
Summarize, represent, and interpret data on two categorical and
quantitative variables
5. Summarize categorical data for two categories in two-way frequency
tables. Interpret relative frequencies in the context of the data
(including joint, marginal, and conditional relative frequencies).
Recognize possible associations and trends in the data.
6. Represent data on two quantitative variables on a scatter plot, and
describe how the variables are related.
a. Fit a function to the data; use functions fitted to data to solve
problems in the context of the data. *Use given functions or choose*
a function suggested by the context. Emphasize linear, quadratic, and
exponential models.
b. Informally assess the fit of a function by plotting and analyzing
residuals.
c. Fit a linear function for a scatter plot that suggests a linear
association.
Interpret linear models
7. Interpret the slope (rate of change) and the intercept (constant term)
of a linear model in the context of the data.
8. Compute (using technology) and interpret the correlation coefficient
of a linear fit.
9. Distinguish between correlation and causation.

Washington English Language Arts Standards (Common Core State Standards) -
Science and Technology Literacy Standards (Grades 11-12):
RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse
formats and media (e.g., quantitative data, video, multimedia) in order to address a question
or solve a problem.

Educational Technology:
3.d Students build knowledge by actively exploring real-world issues and problems,
developing ideas and theories and pursuing answers and solutions

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Mathematical Practice(s):
Practice 1: Make sense of problems and persevere in solving them.
Practice 2: Reason abstractly and quantitatively.
Practice 4: Model with mathematics.
Practice 5: Use appropriate tools strategically.

Practice 6: Attend to precision.
Practice 7: Look for and make use of structure.
Practice 8: Look for and express regularity in repeated reasoning.

Content Objectives: Understand the concepts of scatterplots, regression, predictions, accuracy, applications to business/real estate/etc	Language Objectives (ELL): Adapt and support as needed, translation tools as needed, etc.
Vocabulary: Scatterplot, variables, association, centroid, regression equation, slope, y-intercept, residual, correlation coefficient, coefficient of determination	Connections to Prior Learning: Students will have experience graphing scatterplots and understanding the components of a line (y-intercept and slope)
Questions to Develop Mathematical Thinking: - How do you think location and price are connected with real estate? - How do you know your prediction is reasonable? - Explain the meaning of the value for the slope and y-intercept	Common Misconceptions: - All distributions are "neat and tidy" - All predictions are perfectly accurate - That every regression line goes through the origin

Assessment (Formative and Summative):

- Multiple "thumb check" (up if we are understanding or have reached a particular landmark in the lesson; sideways if we are needing more help or time; thumbs down if we think we are in the wrong class)
- Exit ticket (Fast FIVE)
  1. Is all data "neat and tidy"? 2. Explain how the correlation (pattern) relates to the slope. 3. Rate your understanding of regression and predictions. 4. Rate how YOU functioned in your team and how your team functioned together. 5. How would you change this activity to improve your understanding?
- Quiz (see below)

Materials:

- Graphing Calculator or Desmos
- Worksheet
- Monopoly gameboards or images of monopoly gameboards
- Graph paper (poster size is ideal but not necessary)

Instruction Plan:

Introduction: Do you think location has an impact on the cost of a property? Let's use monopoly to see if we can use location to predict the sale price of a property. Working in groups we will explore the concepts of scatterplots, regression, predictions, and more!
Explore: Students will explore the concept of making predictions with the use of a scatterplot and regression model as well as the quality evaluation of their model.
When I observe students: They are conversing, debating the best ways to create a prediction line, working through the mathematical processes as they make predictions and evaluate the quality of predictions. Hopefully conversing using proper mathematical

language!

Questions to Develop Mathematical Thinking as you observe:

How do you think location and price are connected with real estate?

Explain the meaning of the value for the slope and y-intercept

How do you know your prediction is reasonable?

Answers:

Yes, the proximity to certain land marks might raise or lower the price of a property.

Slope: connects the price to the number of spaces from go as a prediction value; y-intercept: at zero spaces from go, we predict an initial base cost

Reasonable prediction: connect back to the scatterplot, equation, correlation coefficient, coefficient of determination, residuals, etc

Summarize: Students will be asked to predict the "typical" cost of a property on a monopoly board, connecting that to the concept that location "drives" the price of a property. Students will create a scatterplot (property price vs number of spaces from go). Using this scatterplot, they will create a regression line (depending on the class and their experience—this can be done by hand, using desmos, graphing calculator, etc). Interpretation of slope, y-intercept, correlation coefficient, coefficient of determination, residuals, etc. Students need to be prepared to do mini tutorials (sharing what they learned in a low-risk situation with the support of their group) on different topics address the following day

Extensions:

Can be used to develop a lab where students do research regarding pricing of properties in their community. Where do prices seem highest? Lowest? Is there a particular land mark from which we can compare prices and distance from said landmark? Can a prediction equation be created after researching this information? Will the data indicate a linear or non-linear relationship?

Career Application(s):

- Business, Real Estate, Marketing, Actuarial Science

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)
☐ Global Awareness ☒ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☐ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☐ Think Creatively
☐ Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☐ Make Judgments and Decisions
☒ Solve Problems
Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☐ Access and Evaluate Information
☐ Use and manage Information
Media Literacy
☐ Analyze Media
☐ Create Media Products
Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☐ Adapt to Change
☐ Be Flexible
Initiative and Self-Direction
☐ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners
Social and Cross-Cultural
☒ Interact Effectively with Others
☐ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☐ Produce Results
Leadership and Responsibility
☐ Guide and Lead Others
☒ Be Responsible to Others

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Regression Assessment:

Name: Date: Period:

A certain psychologist counsels people who are getting divorced. A random sample of six of her patients provided the following data where

       x=number of years of courtship (dating) before marriage
       y=number of years of marriage before divorce

X	3	0.5	2	1.5	5
Y	9	6	14	10	20

1. Construct a scatterplot of these points.
Label, title, scale!

2. Calculate the regression line. Write the equation and plot this line on your graph.

LSRL: _____

Interpret the y-intercept in context:

Interpret the slope in context:

3. Show how the residual for the first data point in the table is calculated and interpret this value (in context) with respect to how well the line predicted the point.

4. Interpret in context
    a. Correlation coefficient (r)

    b. Coefficient of determination (r^2)

5. Comment on the quality of your regression line/equation with respect to questions 3 and 4.

KEY:

2. y-hat=5.36 + 2.68x
y-intercept: I predict five years of marriage when 0 years of courtship occur
slope: I predict an increase of approximately 2.68 years of marriage for every one additional year of courtship

3. x=3
5.36 + 2.68(3)
Predicted value: 13.4
Actual observed value: 9

Residual: 9-13.4 = -4.4
The line over predicts the actual value, thus the negative residual

4. The r value correlation coefficient is 0.85. This indicates a strong positive linear relationship between years of marriage and courtship.

5. The coefficient of determination value (r^2) is relatively high at 0.72, indicating the line is a relatively good fit for the data. The regression line accounts for 72% of the variability in predicting years of marriage from years of courtship

6. With a high r and r squared, plus a linear pattern, the line is likely a good fit for the data. A residual plot shows there is not a strong pattern, indicated the points are randomly scattered around the regression line.
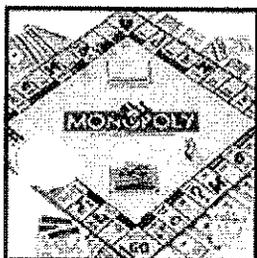
Name:

Period:

Investigating Monopoly – Is There an Association Between Spaces From Go and Property Cost?

_____/25 points

1. Construct a scatterplot of (Spaces From Go, Cost). 2 points
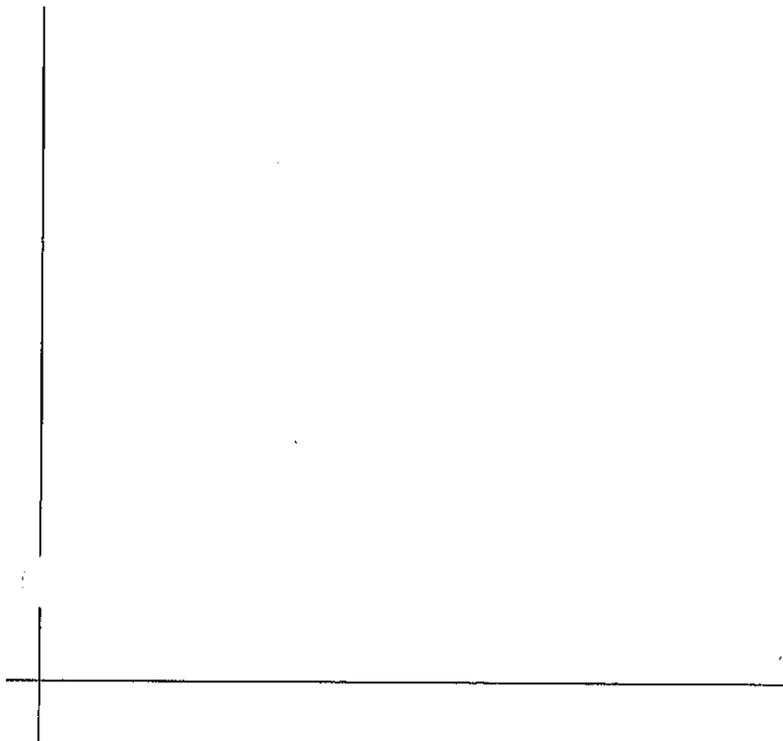
Property	Spaces from GO	Cost
Mediterranean Avenue	1	60
Baltic Avenue	3	60
Reading Railroad	5	200
Oriental Avenue	6	100
Vermont Avenue	8	100
Connecticut Avenue	9	120
St. Charles Place	11	140
Electric Company	12	150
States Avenue	13	140
Virginia Avenue	14	160
Penn Railroad	15	200
St. James Place	16	180
Tennessee Avenue	18	180
New York Avenue	19	200
Kentucky Avenue	21	220
Indiana Avenue	23	220
Illinois Avenue	24	240
B & O Railroad	25	200
Atlantic Avenue	26	260
Ventnor Avenue	27	260
Water Works	28	150
Marvin Gardens	29	280
Pacific Avenue	31	300
Nth Carolina Avenue	32	300
Pennsylvania Avenue	34	320
Short Line Railroad	35	200
Park Place	37	350
Boardwalk	39	400

2. Describe the association between the two variables? (Direction, form, strength, context). 4 points

3. What is the regression equation? Write it both as = a +bx and with the contextual variable names. 2 points

4. Compute the value of the centroid $(\bar{X}, \bar{Y})$ and label it on the plot. 2 points

5. Show how the regression line goes through the centroid. (Plug $\bar{X}$ into the equation.) 1 point

6. Find and interpret meaning of the slope of the regression line in the context of the problem. 3 points

7. Find and interpret the y-intercept of the regression line in the context of the problem. 3 points

8. Calculate the value of the residual for Waterworks (Space 28). Show your work. 3 points

9. What is the value of the correlation coefficient? Give two reasons why this numerical value makes sense. 2 points.

10. What is the value of the coefficient of determination? In context, what it tell you about the association between the two variables? 3 points

Regression Feedback/Open ended Assessment

1. Describe two quantitative variable for which you are interested in exploring their potential relationship. Identify the explanatory and response variable
2. Explain the contextual meaning of the (a) y-intercept and (b) slope of the variables of interest from #1
3. What kind of correlation would you predict for these variables? Sketch a quick (seriously quick!) scatterplot. What would you predict for the correlation coefficient?
4. Will all of the points in the scatterplot lie on a regression line? Why/why not?
5. Explain the concept of a positive and negative residual in the context of your variables defined in #1.