Monopoly™ Part 3

Teachers Teaching with Technology™
Professional Development from Texas Instruments

Teacher Notes and Answers

7   8   **9   10   11**   12

TI-Nspire™   Activity   Student   120 min

Investigation

Part 1 of this investigation explored the change in property prices as a player advanced around the board. Part 2 explored the return on investment; which properties paid the best rent in comparison to their purchase price?

A little more investigation combined with some data collection is required to build a robust strategy for the game of Monopoly.

Teacher Notes:

The questions in this part of the investigation are much more open ended. The idea is that parts 1 & 2 of the investigation provide significant scaffolding on which students can build their understanding, data collection and evidence, calculator skills and reporting.
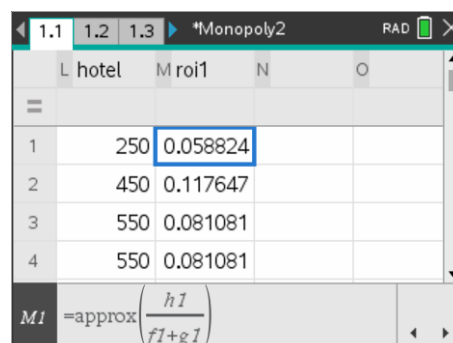
Instructions

Open your TI-Nspire document from Part 2 and navigate to the spreadsheet application. The spreadsheet should already contain the Property names, where they are on the board, mortgage value, rent and return on investment columns.

In this section of the investigation you will need to record:

- Property group cost
- House price
- Rental (for each additional house)
- Rental (for each hotel)

The image shown (above right) illustrates how the spreadsheet can be used to calculate the "Return On Investment" for ONE house on a particular property group. "ROI1" divides the rental return by the cost of purchasing the entire property group and placing ONE house on the specific property.

In building a winning strategy, whilst remaining within the rules, it must be noted that "You cannot build more than one house on any property of a colour-group until you have built one house on every property of that colour-group".[1]

[1]Source: https://www.hasbro.com/common/instruct/Monopoly_Vintage.pdf [Hasbro is the manufacturer of Monopoly!]

Question: 1.

Investigate which properties (groups) provide the best return on investment for a single house.

Answer: Student responses will vary; however they must support their answers with graphs and data, justifying their selection for best property.

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Question: 2.

Investigate which properties (groups) provide the best return on investment when a house is placed on each property within the group.

Answer: This question addresses the difference between property groups where only two properties exist within the group compared to three.

Example:

The graph shown opposite represents ROI for a single house attached to each property. The ROI is calculated by adding the total cost of acquiring all properties in the group and the cost of a single house on the given site.

At this point Whitechapel Road in the first property group is a standout, so too the final property group, Park Lane and Mayfair.

Things change when a player puts a single house on all the properties within the group. The rules state that houses must be added evenly to a group.

The second graph shows that if houses are developed evenly across all in the group, a slightly bigger discrepancy exists between the groups that only have two properties and those that have three. Clearly a group that contains three properties requires the additional investment, however, this also provides 50% more opportunities to return some rent over the 'double' groups.

At this point students may choose to 'average' the return across a group and perhaps even include the probability that an opponent lands on the property group (assuming all squares are equally likely).

Students can justify either of these two selections. If a player can only afford one house on a single property, the first graph is more applicable, in which case it is evident which property the player should put their house.

Students should also notice that the return on investment for the orange, red, yellow and green groups are all quite similar. A small difference in probability with regards to landing on the given squares could make all the difference!
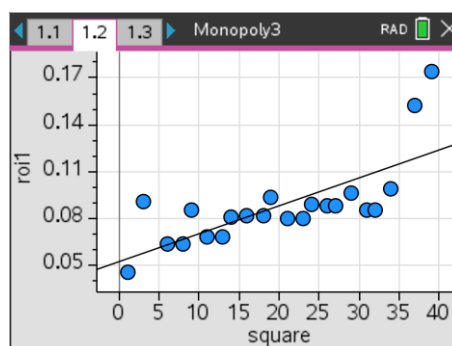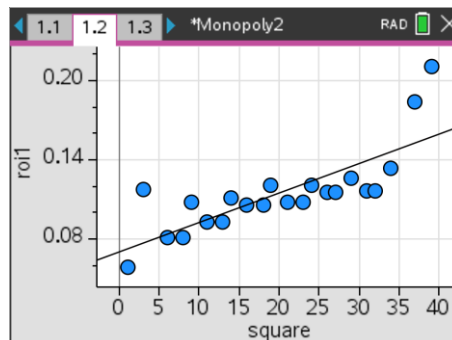
Question: 3.

Investigate each property group as additional houses are added.

Answer: In this section, it is assumed that houses are distributed evenly across the property group, as per the rules.

Each additional house within a group costs the same, however the return on investment changes due to the cost of additional houses for all the properties in the group. The relatively *busy* graph shown opposite displays all the property groups with the addition of houses (up to 4).

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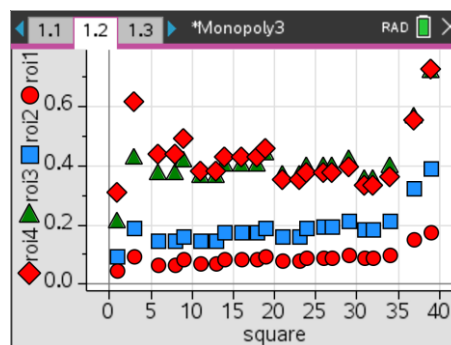
Consider the first property (Old Kent Road). Each additional house appears to increase the ROI by approximately the same amount each time. The partner property (Whitechapel Road) provides a greater spread for its ROI, with the most sizeable jump when the third house is added.

Most of the property groups show a much bigger increase in ROI when the third house is added to the property group, some show a drop in the ROI when the fourth house is added.

To understand what is happening, consider the first property group. The table below shows the rental returns and total cost for the development.

Property	Rent	1 House	2 Houses	3 Houses	4 Houses	Hotel
Old Kent	$2 ($4)	$10	$30	$90	$160	$250
Whitechapel	$4 ($8)	$20	$60	$180	$320	$450
Total Cost:	$120	$220	$320	$420	$520	$620

The graph shown here is a comparison between the return on investment for Old Kent Road and Whitechapel as additional houses are added.

Whitechapel:

The first house adds only $12 to the doubled rent. The second house adds a further $40, but the third house adds $120 and the fourth $140, whilst the last (hotel) adds $130.
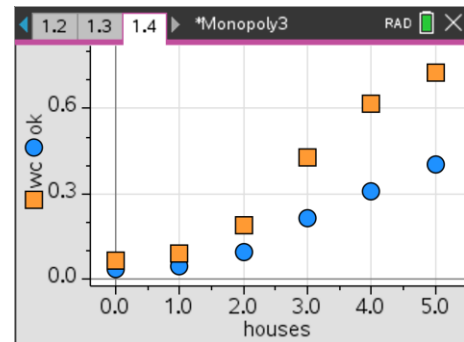
The ROI is calculated on the total investment. For example, purchasing both properties and adding three houses on each costs a total of $420. If an opponent lands on Whitechapel the player receives $180 in rent, which represents: 180/420 ≈ 43% return on the overall investment.

What about the fourth house and/or the hotel? The ROI climbs to approximately 62% (fourth) and almost 73% for the hotel.

We can compare this to the Green property group. The *busy* graph shows that the return on investment drops from three houses to four!

This is evidence that each property group holds a different strategy.

A better comparison can be drawn across properties that have the same house/hotel costs.

The graph shown here compares The Angel Islington and Old Kent Road, both property groups have house prices of $50.00. The return on investment for the light blue group is superior across the entire development, however, students still need to consider overall costs. While the light blue group has a better dollar for dollar return (ROI), the entire group plus houses costs a lot more to develop.
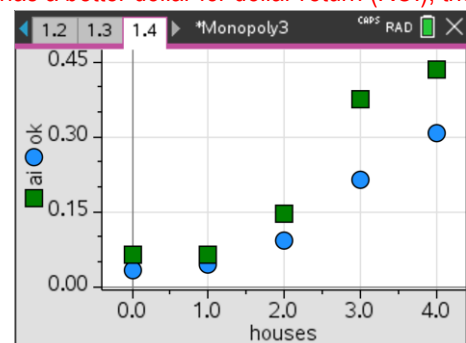

Example: One house across reach group:

First Group = $240
Second Group = $470
Two houses across reach group:
First Group = $340
Second Group = $620

This level of exploration should lead students into consideration of a budget, hence the next question prompt.

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Question: 4.

Imagine you could choose whichever property group(s) you like, but you have a budget!
Explore different budgets such as: $1000, $2000 and $3000 and determine the best groups and capital improvements.

Answer: This part of the investigation can be enormous with so many possible variations, particularly as the budget increases. Students should also 'define' their calculation of 'average return'. In this case, the 'average rate of return' refers to a 1/40 chance that a player lands on a given square in any given roll.

Sample Budget: $620

Option 1:

Purchase the first property group and place hotels on each for a rental return of $250 and $450 respectively. Assuming all squares are equally likely the 'average' return for this property group would be $17.50.

Option 2:

Purchase second property group and place 2 houses on each, generating rental returns of $90, $90 and $100 and an expected return (3 possible squares to land upon) of just $7.

Option 3:

Purchase the third or fourth property group, however that would leave insufficient funds to do any capital improvements. This option provides an expected return of just $2.64.

Conclusion:

On a $620 budget, purchase the first set of properties and add hotels. This conclusion of course does not consider the option of buying the first and second property groups as it leaves an insignificant budget for any capital improvements on the properties.

Sample Budget: $1,000

Option 1:

Purchase the second property group and 4 houses on each ($920) This would generate rental returns of: $400, $400 and $450. This produces an expected return of $31.25.

As a comparison, albeit slightly over budget ($1,040) buy the third property group and 2 houses on each for rental returns of $150, $150 and $180. This however produces a lower expected return of $12.00

Comment: We know from previous questions that expected returns jump significantly when the third house is added to the property group.

Option 2:

Purchase the first property group and hotels on each ($620) leaving just enough money to purchase the second property group (with no capital improvement). This would generate rental returns of: $250 and $450 on the first group and $12, $16 and $18 on the second for an expected return of $18.65. Not surprisingly this option is lower than purchasing the second property group with capital improvements.

Sample Budget: $2,000

Option 1:

Purchase the first and second property groups and place hotels on each ($1690) This would generate rental returns of: $250, $450, $550, $550 and $600. This produces an expected return of $60.00. Note there is still a significant budget left over!

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Option 2:

Purchase the first three property groups and place 3 houses on the first two groups and two houses on the third. ($1980) This would produce rental returns: $90, $180, $270, $270, $300, $150, $150 and $180. The expected return for this option is: $33.00. It should not be surprising to students that this return is lower than option 1, based on the explorations completed in Question 2.

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