CBA1 Mathematical Investigation: Dublin Zoo

Should Dublin Zoo invest in a cheetah enclosure?

A report and CBA by

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The Problem

Dublin Zoo is thinking about getting a cheetah enclosure for 2 cheetahs. Based on these factors:

- What are the minimum enclosure requirements? How much does the perimeter cost to build?
- How much food do 2 cheetahs need in 365 days? How much does it cost?
- Would people be interested in seeing this attraction? Would the zoo make a profit?
- Is it healthy for the cheetahs to be in captivity?

Should the zoo invest into a cheetah enclosure?

I chose this problem because it includes a topic I'm interested in, which is animals. It also has lots of maths involved which is a bonus to the investigation.

Poses concise problem statement

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Assumptions

- There is enough space in the zoo for the enclosure because the investigation would be pointless otherwise.
- Two cheetahs are available because there would be no reason to invest in an enclosure otherwise.
- As the cheetah is the fastest land animal, the cheetah will need exercise and will need at least the minimum space requirements.
- The cheetahs are the average weight and healthy as this will be important when calculating the annual food consumption cost.
- There is an unlimited budget because if the zoo couldn't afford the enclosure then they wouldn't suggest it in the first place.
- I'm assuming the cheetahs are both a year old because since cheetahs mature at 3 years old, I won't have to include anything on cheetah cubs.

Clarifies and simplifies the problem by making justified assumptions in most cases

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Steps I took

1. Research background information on the cheetah that will be needed to calculate food and enclosure costs.

2. Research what the minimum area requirements are (and what possible dimensions) and calculate the cost based on materials used because this will be needed when calculating the total cost.

3. Find out how much cheetahs eat and calculate how much it would cost for 365 days (keeping in mind there are two cheetahs) because this will be needed in calculating the total cost.

4. Carry out a survey on whether people would be more inclined to visit Dublin Zoo to see the cheetah. Would the zoo make a profit? This will be important to see if the zoo will receive income for their investment and not just expenditure.

5. Research whether cheetahs are usually healthy in captivity as this will affect my over-all conclusion.

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Breaks the problem down into manageable steps.

6. State whether Dublin Zoo should invest into a cheetah enclosure based on these factors to answer the original question of my investigation.

7. Add charts, graphs and tables to represent calculations, so that the information is displayed in a visual way.

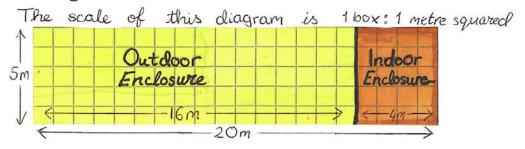Breaks the problem down into manageable steps.

Enclosure

After much research I have concluded that there is not much previous research done before. But, the "ministerstvo zemedelství Ceske Republiky" has said on their website that the minimum area for two cheetahs is 100m². 80m² being outdoor enclosure and 20m² being indoor enclosure.

The dimensions will be 5m x 20m for the whole enclosure because rectangular enclosures are recommended for cheetahs. The indoor enclosure is 4m x 5m. the perimeter will be 5m+5m+20m+20m= 50m for the whole enclosure. The indoor enclosure's perimeter will be 5m+5m+4m+4m= 18m.

If a window of 4m will be on display for the public's viewing of the indoor enclosure it would look like this:

The scale of this diagram is 1 box: 1 metre squared

Outdoor Enclosure

Indoor Enclosure

5m

16m

20m

4m

The indoor enclosure takes up 4m+5m+4m = 13m of the outer perimeter, the rest is 16m+16m+5m = 37m. 37m+ 13m =50m which means I must have 50m x 3.7m

Visual representations are used

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= 185m² of glass. (According to cats.org, fences should be dug in around the perimeter and cheetahs have been known to jump 2.4m high. But solid walls should be a minimum of 3.7m high.)

According to window24.ie triple-glazed windows (which will keep cheetahs warm) costs around €450 – €620 per square metre. Let's say, it's €500 because that's a nice number and it's close to the average of €535. €500 x 185m² = €92,500 for the whole perimeter.

The perimeter of the enclosure	50m
The minimum height requirement of the walls	3.7m
How many square metres of glass we would need	185m²
How much triple glazed windows cost	About €500 per metre squared
How much the 185m2 of the glass would cost	€92,500

I will not include the cost of the indoor enclosure as it's difficult to research, but you and Dublin Zoo should be made aware of it.
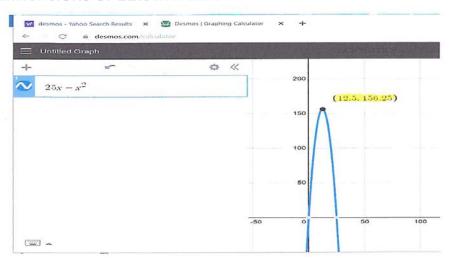
Uses simplifying assumptions.

Suitable mathematical procedures are followed and accurate mathematical language is used.

Ok, I went off on a bit of a tangent but....

After further calculations I have deducted that I can make a bigger area using the same perimeter. Using quadratic functions, I have made a formula that works for my perimeter of 50m every time. The formula I made which is 25x-x2, can be used if the perimeter equals 50m. I put the formula into Desmos (the mathematical graphing website) and it showed me that the biggest area I could have is 156.25m² using the dimensions of 12.5m x 12.5m.

Desmos showing me the biggest area I can have, after I typed in my formula
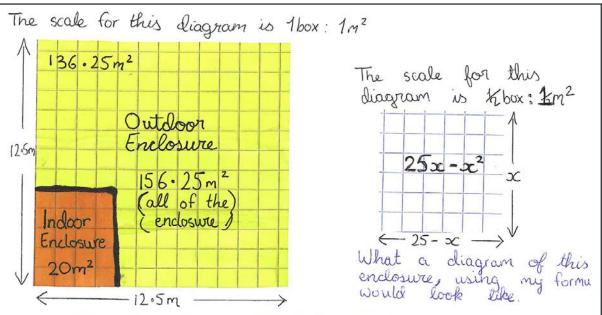
Solutions/ observations are generalised

Mathematical procedures are followed and a justifed answer is achieved

Symbolic notation used to consolidate mathematical thinking and justify decisions and solutions

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The scale for this diagram is 1 box : 1m²

136.25m²

Outdoor Enclosure

156.25m² (all of the) (enclosure)

12.5m

Indoor Enclosure 20m²

12.5m

What the enclosure will look like with the new dimensions

The scale for this diagram is 1 box : 1m²

$25x - x^2$

x

$25 - x$

What a diagram of this enclosure, using my formula would look like.

I have concluded that I will use these dimensions as it will provide the cheetahs more space and will not affect the cost of the perimeter. I will keep the indoor enclosure the same size of 20m2. Which means that my outdoor enclosure area will be 156.25m² − 20m² = 136.25 m².

Conjectures relationship between variables

Visual representations are used

Checks reasonableness of solution

Uses formal mathematical language to communicate ideas

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Food cost for 365 days

Cheetahs eat an average of 2.8kg of meat per day. In zoos they are fed horse meat, beef, chicken and rabbit.

If there will be 2 cheetahs, then it will be about 5.6kg a day. Which means that 5.6kg x 365 = 2044kg per year. According to Bordbia.ie, the average beef prices in Ireland this year is €3.45 per kg. which means that if we only fed the cheetahs beef then it would cost 2044kg x €3.45 = 7,051.80 euro.

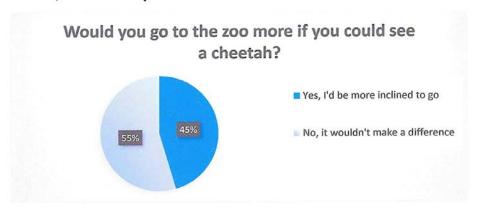Here is a table showing the information:

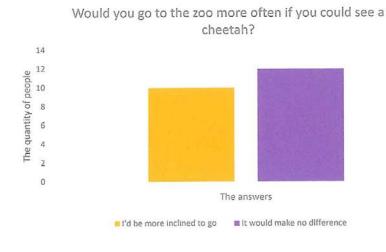|	
Average food per day for 1 cheetah	2.8 kilograms
Average food per day for 2 cheetahs	5.6 kilograms
Average food for two cheetahs per year	2044 kilograms per year
Average cost for beef this year, according to borbia.ie	€3.45
The cost of beef per year for the 2 cheetahs	€7,051.80

Simplifying assumptions are used.

Survey results

I carried out an online survey. The question was "would you go to the zoo more if you could see a cheetah?" 22 people replied, 10 said that they would be more inclined to go. 12 said that it wouldn't make a difference. (10 x 100) divided by 22 = 45%. (12 x 100) divided by 22 = 55%. Even though less would visit more often, it's still a profit!

Would you go to the zoo more if you could see a cheetah?

55%   45%

- Yes, I'd be more inclined to go
- No, it wouldn't make a difference

Would you go to the zoo more often if you could see a cheetah?

The quantity of people

The answers

- I'd be more inclined to go
- It would make no difference

Visual representations are used.

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Captivity: healthy or not?

Despite improvements in conditions in zoos, cheetahs still suffer from a lot of unusual diseases that are rarely found in other captive cats. E.g. gastritis, various kidney ailments, liver abnormalities, fibrosis of the heart muscle and a lot of ill- defined neurological disorders.

-theconversation.com

In the San Diego Zoo, cheetahs are often too nervous or shy to breed. This is because they're actually very anxious animals. They get emotional support dogs in zoos.

-meowingtons.com

If the precautions are taken and their habitat and the diet are up to their natural standard, then yes, I think they can be healthy in captivity. I think that having cheetahs in zoos can be brilliant because just an estimated 7,100 remain in the wild.

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Variable & Constants

Variables:

- The width and length of my enclosure
- The answers to the survey

Constants:

- My enclosure perimeter of 50 metres
- The quantity of cheetahs (2)
- The age of the cheetahs (1)
- The material used to make the enclosure (triple-glazed glass)
- The food the cheetahs consume (beef)

Identifies relevant variables

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Generalising the approach into everyday life

I think that some parts of my project are used in everyday life.

I know that architects might use quadratic functions like I did in this investigation. They probably use them to find out what dimensions can be used to make the biggest area for a building without changing the perimeter.

Engineers, scientists and mathematicians use quadratic functions from time to time as well.

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Conclusions

All the costs added together would make a total of:

7,051.80 – the food cost

+92,500.00 – the glass cost

€99,551.80 – the total cost

The important thing to remember is that this excludes the actual costs of the cheetahs, the interior design of the enclosure, the indoor enclosure, cost of the other meats a cheetah needs in their diet, veterinary procedures, the builders' salaries to build the enclosure and water costs (although cheetahs receive most water in their food).

I think that if Dublin Zoo can afford it and has enough space then they should invest into a cheetah enclosure to help conserve this species whose numbers are rapidly declining.

Comments on the reasonableness of the solution and makes a concrete connection to the original question.

Uses everyday familar language to communicate ideas

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Revisiting & Commenting on the process and solution

The assumptions:

I think that some of my assumptions are unreasonable. Meaning that they probably wouldn't be true in real life. I made these assumptions to make the investigation easier to calculate. These include:

- That there is enough space in the zoo
- That there Dublin Zoo has an unlimited budget
- That the cheetahs are both 1 years old

The steps:

Overall, I think that my steps were very precise. Every step I took was necessary in my investigation. Except for some extra information I researched at the start. I would spend less time on the research next time. But if I had more time and were to improve my steps then I would add more factors to my investigation. E.g. how much would the interior design of the enclosure cost, how much do cheetahs cost?

Strengths and Weaknesses of the solution

Strengths: the main strength of my solution is that it's correct because I was very concise in my investigation. I was also very thorough and if I saw any small mistakes, I immediately

Attempts to identify strengths and weaknesses in the solution strategy

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corrected them. Another strength is that I listed all the factors that it doesn't include. This may seem like a weakness but is actually a strength because I am making my solution more realistic. Realistically, in zoos there would be many more factors included in the cost.

Weaknesses: the main weakness of my solution is that even if I counted the total cost for my factors, it's still not the TOTAL cost of taking care of cheetahs. If I had more time, then I would go into more depth in my investigation.

Any changes?

I only made one change during this investigation. It was using quadratic functions to see if I could make a bigger area but still use the same perimeter. Other than this, I made no changes to my investigation.

Does the answer make sense?

The answer makes sense. I included food consumption cost and the cost for the perimeter for their enclosure and it's already almost 100 thousand euro. Looking after a cheetah is not cheap. In fact, looking after any wild animal is not cheap. That is because they're wild and we spend a lot of money to try and make their captive situation as realistic to their natural habitat.

Revisits strategy to iterate the process

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Appendix

I did some extra research while doing this investigation. Some facts ended up being use and others not so much. But it was interesting.

Cheetahs bodies grow between 1.1m and 1.4m long, plus a tail measuring 65cm and 80cm. -natgeokids.com

Weight: ranges from 34kg to 54kg, males are slightly heavier. -natgeokids.com

Speed: can reach up to 112km/h in just 3 seconds, quicker than any sports car accelerates. -natgeokids.com

A cheetah chase is usually limited to 200m to 300m and lasts less than a minute. -natgeokids.com

An estimated 7,100 remain in Africa (some live in Asia). – nationalgeographic.com

Cheetahs in captivity almost all suffer from anxiety-related conditions. In zoos, they get support dogs. -meowingtons.com

Diet: they eat gazelles, wildebeest calves, impalas and other small hooved animals. They eat an average of 6.2 pounds (2.8kg) of meat a day. In zoos, they are fed horse meat, beef, chicken and rabbit. – kidzfeed.com

San Diego Zoo had 2 five-acre enclosures for 10 cheetahs. – zoo.sandiegozoo.org

There are 4 subspecies of cheetah: the Asiatic cheetah, Northwest African cheetah, Northeast African cheetah, Southwest African cheetah. -bigcatswildcats.com

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Overall judgement: ≋ Above expectations

≣ Exceptional   ≋ Above expectations   ≊ In line with expectations   ⌣ Yet to meet expectations