Olivia Anacleto
EDCI 300
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Investigation One: Small Number
Good Copy Notes/ Reflection

My first step to solving the problem was to understand what the question was asking and to use various problem-solving skills (as outline in the problem-solving document) to explore multiple approaches for solving the question.

Step 1: What is a low floor, high ceiling question? *In order to fully understand what I needed to do for the task, I needed to understand the type of question and what was expected of me when solving it.

A low floor, high ceiling question means:
- There are lots of possibilities when approaching the question.
- The process to solve the question is more important than the answer itself.
- This question allows for differentiation, meaning that learners can approach the question as they please. Some may choose to challenge themselves with complex math solutions, while others may take a more creative or imaginative way to solve the question.

(Wisconsin Mathematics Council, Inc., 2017)

Step 2: What question(s) am I trying to solve?

Question 1: Why did Small Number think that the posts used to build the roof were about 5m long each?
- What problem-solving steps could Small Number have used to reach this statement?

Question 2: Small Number: "I wonder how our ancestors knew how many posts they needed to build the roof? Grandfather: "Our ancestors had their ways."
- What was grandfather referring to during this part of the story?

Step 3: Make it simpler (problem-solving approach): I needed to break down the question and consider what information the question provided me (which could help with my understanding of how to solve it).

After breaking down the question, I made note of these details to help with my problem-solving process:
- Grandfather estimated the hole to the outside was at least **3m** above the floor
- Grandfather estimated that the pit house was not very big, maybe **8m** across
- Small Number estimated **hundreds** of poles were used to build the roof
- Small Number estimated the poles were **5m** long

I also drew a few diagrams to help me visualize the pit house. Here are the diagrams (copied from my rough copy notes) that I found most useful during the solving process.
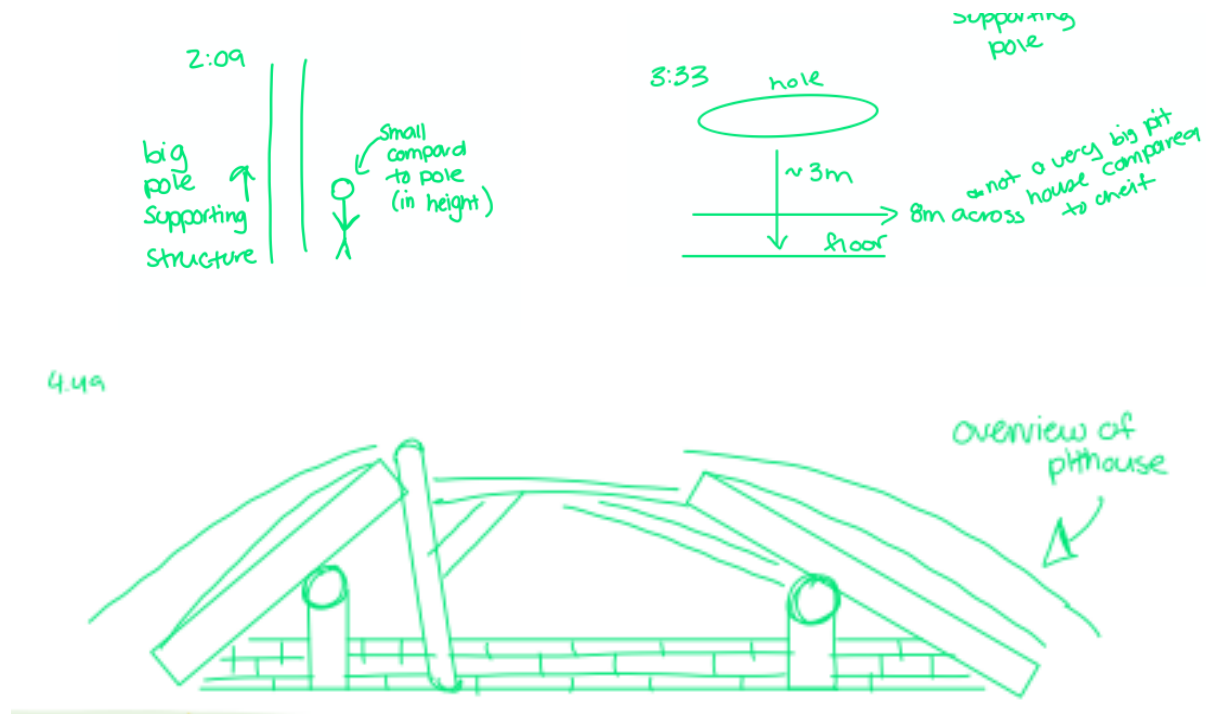
Step 4: My next step to approaching the questions was to address any misconceptions/ any details I was confused about. I found that I struggled when considering how tall 5m actually is (for Question 1). So, I found an image to help me clearly visualize something that is 5m tall/ long.
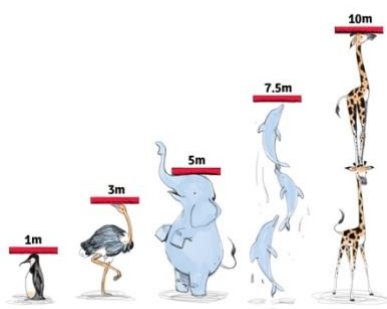
I found this image which really helped clear up my misunderstandings about how long/ tall 5m is. This image was an awesome tool to help me clearly visualize the size!

(Swim England Diving, 2021)

Step 5: I approached the question and re-visited it multiple times. By using the incubation method (setting a problem aside to revisit over a span of time), I was able to consider various approaches to the question and document a variety of potential answers. After considering numerous possibilities, I determined the most logical/ realistic answer.

Question 1: Why did Small Number think that the posts used to build the roof were about 5m long each?

Here is all the process I considered. I used the problem-solving document to help me decide on various approaches to use:

- **Estimation**: The video stated that Grandfather's measurements that he explained were all estimates. They were Grandfather's best guess from looking at the space and using his existing knowledge of pit houses. Since Grandfather is knowledgeable about the pit house building process (as it seems from the video), I can assume that his estimates are based on his prior knowledge and are near accurate. After considering Grandfather's estimates, Small Number could have estimated the length of the posts by comparing it to the other measurements. This would not result in an exact or very accurate answer; however, it would provide an educated guess as to why he thought the posts were 5m long.

- **Comparison:** Another method I considered for this question was by using comparison. Small Number could have compared the length of the posts for the roof to his height. This strategy may have been difficult, as Small Number stands vertically, and the posts on the roof lay horizontally or on a diagonal. However, I do think this is a potential scenario in which Small Number could have determined the length of the poles. While figuring out how much taller the pole would be compared to Small Number, I used an equation and determined that it would be about 3 times his height (supposing he is around 5ft tall).

  · lets say Small Number is 5ft tall

  $1m = 3.28\ ft$

  $\dfrac{5m}{3.28ft} = \sim 1.5m$ ← Small numbers height is about 1.5m ∴ the pole is a little more than 3 x his height

- **Equation-based Approach**: Another potential method to solve this problem is using an equation. When I looked at the diagram I drew, I noticed that I could create a triangular shape using the height to the roof, the width of the floor, and the slanted poles on the roof. The height of the triangle would be 3m tall, the base would be 4m long (8m – estimated width of pit house – divided by 2), and to figure out the hypotenuse, I thought of using Pythagoreans Theorem. I have included the equation and the process to solve the answer below:

Day 4: Attempt 2 (q.1)
- images/diagrams look like a triangle ← Pythagorean Theorem
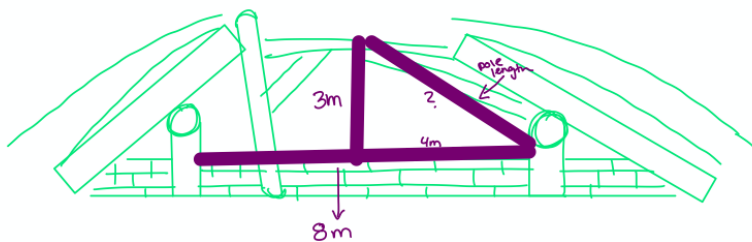
$a^2 + b^2 = c^2$
$3^2 + 4^2 = c^2$
$9 + 16 = c^2$
$\sqrt{25} = \sqrt{c^2}$
$5 = c$
↳ 5m long

a more Mathematical approach

After considering this approach, I do not think it was very realistic for Small Number to use Pythagoreans Theorem to determine the length of the posts. Small Number most likely did not have a calculator or pen/ paper, and we do not know Small Number's age (as this process may be too complex for him). However, using this method helped me recognize that the height of the pit house is 3m, half of the length is 4m, and he guessed the length of the poles was 5m. If Small Number compared each of these measurements, he would be able to see that half the length of the pit house is a little bigger than the height, and the length of the poles is a little bigger than half the length of the pit house. While this is not an exact way of determining the length of the poles, I do think it is a reasonable/ realistic approach.

- **Existing Knowledge and Imagination:** The final approach I considered for why Small Number thought the posts were 5m long each was by using his existing knowledge and imagination. If Small Number used his existing knowledge of something else that was 5m long or tall, he could have imagined that the posts were around that same size. For example, Small Number may have compared the length of the posts to the height of a totem pole. Totem poles are an important aspect of Indigenous culture. Thus, it is possible that Small Number sees totem poles regularly and may be familiar with the height of some of them. A more imaginative way to determine the length might be by comparing it to the size of a giraffe. In the image I found to help me understand how tall 5m is, it showed that a giraffe is about 5m tall. This is a more creative and imaginative comparison; however, it is still a potential option. Another comparison by using existing knowledge may have been thinking of a meter stick and estimating that the length of the posts looks as though they were five meter sticks long.

After considering each of these approaches, I think Small Number most likely determined the length of the posts by comparison. I think he used Grandfather's estimates, examined the other measurements of the pit house that he was aware of, and compared it to the size of other things he was familiar with (i.e., totem pole). I do not think Small Number used a formula to determine an exact measurement, as it did not seem like he had a calculator or the proper tools to complete a math equation at that moment. I think his prior knowledge, comparison to other aspects of the pit house, and his Grandfather's logical estimates helped Small Number complete some mental math and make an educated guess about the length of the posts.

Question 2: Small Number: "I wonder how our ancestors knew how many posts they needed to build the roof?" Grandfather: "Our ancestors had their ways." – What was Grandfather referring to?

For this question, I focused on the problem-solving strategy of existing knowledge. From the video, it seems that the Grandfather knows a lot about their ancestors' history. When he states that their "ancestors had their ways," I think this goes along with the fact that they have been building pit houses for generations, and after years of practice, they had a specific process they followed while building. This does not necessarily mean they followed a specific mathematical approach, but rather their generational knowledge assisted them in the pit house building process. While thinking about this, I considered different factors that may have been considered during the building process:

- **Community Members:** The video emphasizes the importance of community to Indigenous peoples. It explains that lots of people contributed to building the pit house, and after the building process there would be a celebration as well. With so many people building the pit house, I assume there would have been lots of insight from very knowledgeable members of the community. Their community members had generations of practice, lots of insight, and a lot of knowledge regarding their traditional practices. This would have made the building process smoother.

- **Comparison to Previous Work:** Another factor their ancestors may have considered while deciding how many posts they needed to build the roof was by comparing it to previous pit houses. If they wanted to build a pit house of similar size to one they built in the past, they may have been able to replicate the same number of posts they used for the new project.

- **Trial and Error:** At the beginning stages of pit house building, I think there would have been a lot of trial and error. Indigenous peoples most likely would have estimated the number of posts they needed to build the roof. If they needed more posts, they would have gotten more. If they had too many, they may have been used for another project. After generations of practice, they would have seen what works and what did not work. This knowledge would have been passed down to future generations so they can make logical estimates of how many posts they needed.

- **Support of the Roof:** The final thing I took into consideration when answering this question is the support needed to hold up the roof. When building the pit houses, their ancestors would have most likely considered that few posts meant little support, whereas more posts meant more support. With this in mind, they would be able to make logical decisions about the exact number of posts they needed to effectively support the pit house (along with trial and error, generational knowledge, and community insight).
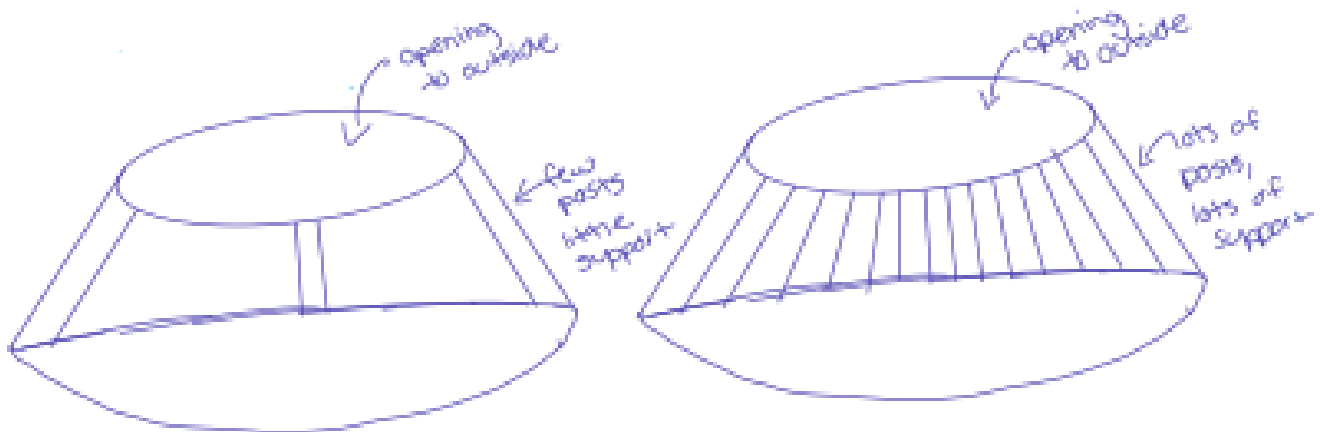
*Note: Incorporation of Indigenous Education

I really liked how this math question incorporated Indigenous teachings in the learning process. After working on the math problem for multiple days, I felt as though I learned a lot of information about pit houses and Indigenous practices. Incorporating math questions like these is a great way to weave Indigenous storytelling, relationships, languages, practices, and teachings into a math lesson!

I was looking at the First Peoples Principles of Learning poster and I found that various principles aligned with the processes I considered while working on this problem. There is one principle that stood out to me the most when thinking about this problem. I have included it below:

"Learning involves generational roles and responsibilities" (First Nations Education Steering Committee, n.d.)

This principle stands out to me because I found that the concept of generational responsibilities was a consistent theme while working on this problem. Small Number learned about pit houses, the building process, and knowledge about what they are used for from his Grandfather. Generational knowledge was passed down to inform Small Number about an important aspect of his heritage. Similarly, while building the pit houses, I assume that generational knowledge was a major aspect. The generations preceding had the responsibility to inform their children about the pit house building process, so they knew exactly how to build the pit houses and what materials/ how many of the materials they needed. Learning from their ancestors is an important aspect of Indigenous practices. This is clear both from this specific First Peoples Principle of Learning, but also from the information included in this mathematical problem. Being able to connect my learning process to the First Peoples Principals of Learning is another incredible aspect of this math problem and I think it is an extremely effective way to weave Indigenous teaching practices into a math lesson.

Reflection

I found the process of completing this problem really useful as a future teacher. I found that the type of question itself – low floor, high ceiling – was really helpful to learn about. Previously, I was not aware of these types of questions and was focused on the fact that the purpose of math was to reach a specific answer. However, this investigation has proved that math is not solely about the answer, but about the process instead. I look forward to using this knowledge to share that there are various ways to approach a problem and potentially, various answers as well. By completing questions similar to this investigation, students can see that the process to reach a mathematical answer can be personalized in order to make sense to them. This is really important to emphasize in a math classroom and I hope to use questions like these in the future to transition my students' thinking about math problems.

Something else I really enjoyed about the investigation process was the incubation effect. I did not complete the question in one sitting. Instead, I returned to it over multiple days and from that, I was able to consider various approaches to the problem. Each time I revisited the question, I deepened my understanding and discovered more solutions. The idea of returning to a question multiple times to really understand the process is something else I look forward to sharing with my future students.

Overall, I really enjoyed the process of completing this investigation and I look forward to introducing questions similar to this to my future students!

References

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