## The Housekeeper and the Professor by Yoko Ogawa



## Algebra 2 or Pre-Calculus Novel Study

## Curriculum created by Joel Bezaire, University School of Nashville http://www.pre-algebra.info

All rights reserved by the author, please do not re-distribute or edit this curriculum except for your own personal/classroom use.

As we read through each day's passage, be sure to answer (in bullet points) the questions in the "Reflection" section. You may continue any reflections for homework, but be sure to reflect on the passage while we're reading it so that the content is freshest in your mind. Questions in the "Assignment" section are for homework. Assignments will sometimes deal with passages we have just read, but they might be questions foreshadowing passages we are about to read as well. Since Assignments are for homework, you should use complete sentences when answering Assignment questions. Please use the back of each page if you need any extra room to write. We will read one chapter per day in this novel study.

## Chapter One

## Reflection:

1. What do you think the Professor meant when he said, "...even those we can't see" (page 1)?
2. "How exactly can a man live with only 80 minutes of memory (page 6)?" Think about this question and list some of the enormous challenges that would be associated with this type of memory.

## Assignment:

1. The Professor talks about "amicable numbers" and gives the example of 220 and 284. In the $9^{\text {th }}$ century, Arab mathematician Thabit ibn Qurra derived a formula that could generate some pairs of amicable numbers in some instances. That formula says the following:

If the following three numbers ( $\mathrm{p}, \mathrm{q}$, and r ) are all prime when n is an integer and $n>1$...

$$
\begin{gathered}
p=3\left(2^{n-1}\right)-1 \\
q=3\left(2^{n}\right)-1 \\
r=9\left(2^{2 n-1}\right)-1
\end{gathered}
$$

...then the following pair of numbers are amicable numbers:
$2^{n}(p)(q)$ and $2^{r}$
a) When $\mathrm{n}=2$ this generates the Professor's amicable numbers. Show how by plugging in for $n$.
b) The next time this works is when $\mathrm{n}=4$. Find the amicable numbers created in this instance. If you really want to challenge yourself, prove that these two numbers you generated are amicable the same way the Housekeeper did in the story (this part is optional)

## Chapter Two

## Reflection:

1. The professor's nickname for the son is "Root" because of the way his head is shaped (like a radical: $\sqrt{ }$ ). Imagine you had to pick a mathematical name for yourself, based on either a physical trait or a personality trait. What would it be and why?
2. The Professor has Root solve a problem about socks and handkerchiefs, and Root solves this problem intuitively. Set up a system of equations and use elimination to solve the system. What advantages does this technique have over the method that Root used to solve the problem? Does Root's method have any advantages over using a system of equations?

## Assignment:

1. The Housekeeper describes what she discovered about the number 28 at the very beginning of Chapter 2. There is a number smaller than 28 that has this same property. Can you discover it? Brainstorm some ideas about why this property might be important and list them below.
2. Root was given a problem to solve (sum of all numbers up to 10). Use the formula derived by Karl Gauss to find the answer. (Look this up on the internet if you've forgotten it).

## Chapter Three

## Reflection:

1. The professor makes some surprising claims about perfect, abundant and deficient numbers. List some of the properties of those numbers below. Which one is most surprising to you? How do these properties play into the Professor's claims that number theory is the "Queen of Mathematics" (page 43).
2. Think of some numbers that are important to you (favorite number, house number, locker number, etc.) Are they perfect, deficient, or abundant? Are they special cases of any of those numbers? Do they have any other unique properties that you can discover?

## Application:

1. Why do you think it was so important to the Professor that Root find a way to sum the integers from 1 to 10 without using the addition operation? What was important about Root's process of discovering the alternate method?

## Chapter Four

## Reflection:

1. List the first (smallest) four pairs of twin primes:
2. Another type of prime number pairing is called sexy primes (seriously). These are primes that differ by 6. List all the sexy prime pairings up to 100 (you can use the Professor and Root's list of primes on page 62 to help you). Are there more twin prime pairs or sexy prime pairs between 1 and 100? Why do you think this is? Do you think this would continue to be true as we listed twin primes and sexy primes on towards infinity?

## Application:

1. The Professor was explaining how triangular numbers are related to Gauss' formula for finding the sum of integers up to $n$ (before he started crying). Give a full explanation in your own words below.

## Chapter Five

## Reflection:

1. The Professor claims that 5 and 6 are the smallest pair of consecutive whole numbers where the prime factors of one number add up to the other number (he gives 714 and 715 as an example). What assumption is the Professor making in order for 5 and 6 to be true that he didn't have to use in order for 714 and 715 to be true?

## Assignment:

1. It is starting to become clear why the professor is such a huge baseball fan, even though this chapter contains the account of the first game he's ever attended. Use the text (anywhere in the first five chapters) to give evidence as to why the professor enjoys baseball so much.
2. Find another pair of numbers that fits the criteria for the Reflection question above. What makes this a difficult question? Is there a strategy that could make this search more efficient than just guessing and checking?

## Chapter Six

## Reflection:

1. Notice that nobody in this story is given a name. "The Housekeeper", "The Professor", "The Widow" - even "Root" is simply a nickname given by The Professor. Why do you think this is? What point is the author trying to make by not giving any of the characters a proper name?
2. What do you think the widow's real concern was regarding the Housekeeper and the Professor's relationship? Do you think she told the truth about why the Housekeeper was fired?

## Assignment:

1. The absence of the professor is striking in this chapter, particularly when a new number is introduced (" $58^{\text {th }}$ no-hitter in Major League history, page $\qquad$ ). What might the professor said about the number 58 that could have sparked an interesting conversation about number theory? Is there special category of number to which 58 belongs, or does it have a particular relationship with other numbers that makes it "special"?

## Chapter Seven

## Reflection:

1. "I remembered something the Professor had said...(page 114)". How does the quote and the following conversation about the non-utilitarian uses of mathematics strike you? Do you agree or disagree?
2. Without researching the equation, brainstorm some ideas why the equation $e^{\pi i}+1=0$ might be important and meaningful to the Professor, and why that equation might have changed the Widow's mind regarding the Housekeeper.

## Application:

1. On page 121, the Professor talks about Mersenne primes. Mersenne was a French mathematician who discovered that many prime numbers are one less than a power of two. Any prime number that fits this description is known as a Mersenne Prime. As mathematicians continue to search for large prime numbers, they generally search for Mersenne Primes. The currently largest-known prime number was found in 2008 and it is a Mersenne Prime $\left(2^{43112609}-1\right)$. This is the $48^{\text {th }}$ Mersenne Prime, and the number would take thousands of pages of printer paper to print using 12-point font (it's over 10 million digits long). Below are values of $p$ that result in values less than 100. Determine if the evaluation of $2^{p}-1$ results in a prime number or not.

| $\mathbf{p}$ | $\mathbf{2}^{\boldsymbol{p}}-\mathbf{1}$ | Mersenne Prime? <br> (Yes or No) |
| :---: | :---: | :---: |
| $\mathbf{1}$ |  |  |
| $\mathbf{2}$ |  |  |
| $\mathbf{3}$ |  |  |
| $\mathbf{4}$ |  |  |
| $\mathbf{5}$ |  |  |
| 6 |  |  |

Why do you think mathematicians focus on finding Mersenne Primes when searching for "next-largest" prime numbers?

## Chapter Eight

## Reflection:

1. Why do you think the Professor was so engrossed in watching the Housekeeper cook her sautéed pork/salad/omelet dinner?
2. On page 136 , the professor's " 80 minute tape" fails for the first time. Why might this prove to be an important development?

## Application:

1. The Professor gives the Housekeeper a discourse on the value of 0 (zero). Below list 10 things that would be much more difficult or impossible without zero. Why do you think zero was not "created" earlier in the history of mathematics?

## Chapter Nine

## Reflection:

1. "I simply peeked in God's notebook and copied down a bit of what I saw... (page 153)". What did the Professor mean by this quote? How does he view mathematics, why does he love it so much, and why isn't he overly proud of his mathematical accomplishments?
2. Here is a brief biography/summary of Enatsu's career in the Japanese Major Leagues:
http://www.baseball-reference.com/bullpen/Yutaka_Enatsu Read through it. A lot of what the Professor, the Housekeeper, and Root discussed in included in this biography but one important life detail was left out of the novel. Why do you think this was not included in our story?

## Application:

1. Google the "Ax-Cochen Theorem". You don't need to understand the mathematics of this theorem to see the implications to this story. Explain the relationship of this theorem to this story, explain why the author doesn't include this theorem in the novel, and explain the implications of the Ax-Cochen theorem to the Professor's work.

## Chapter Ten

## Reflection:

1. The Housekeeper marks the passage of time in the novel by references to the Hanshin Tigers baseball team. Games won and lost, score at the time of a certain event occurring. Why do you think this is? Why is the author using this device to mark the passage of time?
2. What is the significance of the final paragraph of this chapter? Does it recall an earlier incident in the novel? Explain.

## Assignment:

1. The chapters are getting shorter and shorter as we approach the end of the book. Do you think this is a deliberate choice by the author, or just a coincidence? What might the author be trying to get us to feel as we approach the end of this book?

## Chapter Eleven

## Reflection:

1. What is the significance of the Housekeeper finding out that Fermat's Last Theorem had finally been solved? Why does she mention the Japanese mathematicians (Taniyama and Shimura) and their role in the proof?
2. Why might Euler's formula $\left(e^{\pi i}+1=0\right)$ take on a whole new meaning for the housekeeper here in the final chapter of the book?

## Application:

1. On pages 179-180, The Professor tells Root about Fermat Primes, named after the French mathematician Pierre de Fermat (the Professor doesn't name them as Fermat Primes, but those are the types of primes he is discussing). Fermat said that when a prime number can be written as the sum of $4 n$ and 1 ( $n$ is a counting number), then it can also be written as the sum of two perfect square numbers. On the next page, l've included a chart of all prime numbers less than 100. Not all of them are Fermat Primes, but some of them are. Find which ones are Fermat Primes, and express those numbers as the sum of two perfect square numbers.

| Prime Number | n | $4 n+1$ | Sum of two Perfect Squares |
| :---: | :---: | :---: | :---: |
| 2 |  | Not a Fermat Prime |  |
| 3 |  | Not a Fermat Prime |  |
| 5 | 1 | $4(1)+1$ | $1+4$ |
| 7 |  | Not a Fermat Prime |  |
| 11 |  | Not a Fermat Prime |  |
| 13 |  |  |  |
| 17 |  |  |  |
| 19 |  |  |  |
| 23 |  |  |  |
| 29 |  |  |  |
| 31 |  |  |  |
| 37 |  |  |  |
| 41 |  |  |  |
| 43 |  |  |  |
| 47 |  |  |  |
| 53 |  |  |  |
| 59 |  |  |  |
| 61 |  |  |  |
| 67 |  |  |  |
| 71 |  |  |  |
| 73 |  |  |  |
| 79 |  |  |  |
| 83 |  |  |  |
| 89 |  |  |  |
| 97 |  |  |  |

