

The Power of Two

Cast

Narrator

King

Queen

Clever Girl

Servant

Granary master

Mathematician 1

Mathematician 2

Mathematician 3

Narrator: Long, long ago and far, far away in a kingdom that no longer exists, there lived a clever young girl. From the time she was very young, she had shown great talent. She invented toys for her little brother; she invented timesaving gadgets for her mother and father; and she invented machines to help the citizens of her city. For she had learned the GREAT-SECRET-OF-LIFE, the joy of being helpful. Soon, the king heard about this wonderful child and summoned her to his palace to work for him. One day, she showed the king a new game called “checkers”.

Scene I – The Palace

King: I am pleased. Checkers is a great game. You have served me well. Name your reward.

Clever Girl: Your Majesty, I ask that as I have shared my talent with you, you share your great supply of rice with the starving people of our country.

King: Never. Name something else.

Clever Girl: Very well, if you will not help the poor of this land, let me. Here is the reward I wish. Give me one grain of rice today. Place it on the first square of your checkerboard; tomorrow, double it. Give me two grains of rice tomorrow for the second square. The next day double that and give me four grains of rice; then eight grains of rice. For each square of your checkerboard, give me twice the number of grains before it, and I will give it to the poor.

King: How many grains will that be altogether – 1, 2, 4, 8, 16, 32, ___?

Queen: Ask the clever girl.

King: There are 8 rows of 8 squares on the checkerboard. If I multiply 8 x 8, I get 64.

Queen: Ask the clever girl.

King: Do you think it would be more than a pound?

Queen: Why don't you ask the clever girl?

King: Your request is granted. Go feed all the hungry of my kingdom on a few grains of rice. Servant, go to the granary master and get the rice to deliver to the clever girl today.

Servant: Yes, Your Majesty.

Clever Girl: Thank you, Your Majesty..

Scene II – Granary.....Clever Girl's House

Narrator: Day one

Gr Mst: Here is your first delivery, 1 grain of rice. Ha Ha Ha

Servant: Yes, master. Here is your delivery.

Clever Girl: Thank you.

Narrator: Day two

Gr Mst: Here is your delivery, 2 grains of rice. Ha Ha Ha

Servant: Yes, master. Here is your delivery.

Clever Girl: Thank you.

Narrator: Day three

Gr Mst: Here is your delivery, 4 grains of rice. Ha Ha Ha

Servant: Yes, master. Here is your delivery.

Clever Girl: Thank you.

Narrator: Day four

Gr Mst: Here is your delivery, 8 grains of rice.

Servant: Yes, master. Here is your delivery. Ha Ha Ha

Clever Girl: Thank you.

Narrator: And so it continued. On day five, the servant delivered 16 grains of rice. On day six, 32 grains of rice. On day seven, 64 grains of rice. On day eight, 128 grains of rice. On day nine, the servant delivered 256 grains of rice. The granary master stopped laughing on day ten.

Gr Mst: . . . 510, 511, 512. I am getting very tired of counting this rice each day. (Waves the servant out the door.) There must be an easier way. I know! I'll call the royal mathematicians. They are always helpful. ROYAL MATHEMATICIANS!

Math 1,2,3: At your service, Granary Master

Gr. Mst: Excellent. I have a mathematical problem for you. Each day I must make a delivery of rice to the Clever Girl. Each day I must double the amount of the day before.

Math 1: Let's see what you do. Observation is a most important step to solving problems.

Gr Mst: . . . 1,020, 1,021, 1,022, 1,023 and 1,024. Phew! So you can see it is taking me longer and longer each day to count the grains of rice. Soon, I fear, I will spend my whole day counting rice and my royal bookkeeping will suffer.

Math 1,2,3: Yes, there is definitely a serious problem.

Math 1: We may need more help.

Math 2: You are right. Shall we call in our apprentice mathematicians?

Math 1&3: Yes, the sooner the better.

Math 2: Let me go get them. Are any of you apprentice mathematicians? Raise your hands high. Good. Are you willing to help us?

Audience: Yes.

Math 2: We have lots of help. No problem is too difficult now.

Math 1: Does anyone have any facts?

Math 3: I do. It took the granary master 1 hour to count 1,024 grains of rice.

Math 2: How many grains does he need to count tomorrow? What do we get if we double 1, 024?

Audience: 2,048

Math 2: You're right.

Math 3: That does seem like a lot of counting. And what about the next day?

Math 2: How many grains of rice will he need to count the next day? What do we get if we double 2,048?

Audience: 4,096

Math 2: You're right.

Math 3: If it takes 1 hour to count today's rice, it will take twice as long or 2 hours to count the next day's rice. How long will it take the next day?

Audience: 4 hours.

Math 2: You're right.

Math 3: That seems like a lot of counting. And what about the next day?

Audience: 8 hours

Math 2: You're right.

Math 3: I cannot believe it!

Gr Mst: Oh, dear. What is the matter?

Math 3: According to my calculations, by the end of the week you will have to spend every waking moment counting grains of rice.

Gr Mst: Oh No!

Math 3: And that is not the worst of it. The next day, you will not even have enough hours in one day to count the rice for the day!

Math 2: Can that be? Let us ask our apprentice mathematicians to check your work. Can you help? If you can, say yes.

Audience: Yes

Math 2: On Tuesday it will take approximately 1 hour. On Wednesday it will take. . .

Audience: 2 hours

Math 2: On Thursday it will take. . .

Audience: 4 hours

Math 2: On Friday, it will take. . .

Audience: 8 hours

Math 2: On Saturday, it will take. . .

Audience: 16 hours

Math 2: On Sunday, it will take. . .

Audience: 32 hours

Math 2: Is that more than 1 day?

Audience: Yes

Gr Mst: Help! Help!

Math 1,2,3: Think, Think, Think

Math 2: Any ideas?

Audience: Use a scoop.

Math 2: Use a scoop. Brilliant!

Math 1 & 3: Use a scoop. Fantastic!

Gr Mst: How do I use a scoop?

Math 3: 1,024 grains of rice fit in 1 scoop. Instead of counting grains of rice, you can count scoops. Tomorrow, send two scoops. The next day send 4 scoops.

Gr Mst: One million thanks, no 2 millions thanks, no 4 million thanks, no 8 million. . .

Math 1: Enough, enough.

Math 2 & 3: Our pleasure.

Scene IV – GranaryClever Girl’s House

Gr Mst: Here is today’s delivery, 1,024 grains of rice equals 1 scoop.

Servant: Yes, Master. . . Here is your delivery.

Clever Girl: Thank you.

Narrator: Day twelve.

Gr Mst: Help me count today’s delivery.

Gr Mst & Audience: 1, 2

Gr Mst: That was surely an easier way to count 2,048 grains of rice. Here is today’s delivery, 2 scoops.

Servant: Yes, Master. . . Here is your delivery.

Clever Girl: Thank you

Narrator: Day thirteen.

Gr Mst: Help me count today’s delivery.

Gr Mst & Audience: 1, 2, 3, 4.

Gr Mst: That was surely an easy way to count 4,096 grains of rice. Here is today’s delivery, 4 scoops.

Servant: Yes, Master. Here is your delivery.

Clever Girl: Thank you

Narrator: And so it continued. On day fourteen, the servant delivered 8 scoops or 8,192 grains of rice. On day fifteen, the servant delivered 16 scoops or 16,384 grains of rice. It was at this point that the granary master had a great insight.

Scene V – Granary

Gr Mst: Oh dear! I am beginning to see that same pattern again. ROYAL MATHEMATICIANS. Thank you for coming.

Math 1,2,3: It is our pleasure to serve you.

Math 1: Is the scoop not working?

Gr Mst: It is working perfectly.

Math 2: Then what is the problem?

Gr Mst: I cannot put my finger on it exactly. Every time I count the scoops, I have the strangest feeling that I have done this before.

Math 3: Really? Tell us how you have counted.

Gr Mst: 1 scoop, then 2 scoops, then 4 scoops. I was elated. It was so easy to count. On the day that I counted 8 scoops, I began to have an uneasy feeling. The next day I counted 16 scoops, and the feeling got worse. That is why I sent for you.

Math 1: Good thinking.

Math 2: Let's get some help from our apprentice mathematicians.

Math 3: Great idea.

Gr Mst: Today is day sixteen, and we must deliver 32 scoops.

Math 2: You are right. There is a pattern here. It is the same one we had with the grains of rice.

Math 3: Yes, by the end of twenty-one days or the 3rd week, you will have the same counting problem as before.

Gr Mst: No! No! No! I don't want to lose my job. Help!

Math 1,2,3: Think, think, think.

Math 2: Apprentice Mathematicians, do you have any ideas?

Audience: Weigh the rice.

Math 1: Weigh the rice, weigh the rice – of course.

Math 2: Brilliant

Math 3: Stupendous

Gr Mst: I am saved! Hoo-ray for the mathematicians.

Narrator: And so the granary master thought his problems were solved. Weighing took almost no time at all. It took only a matter of seconds to change the weight on the balance. Awaiting him, only weeks away, was a far more serious problem. The royal mathematicians were summoned again.

Scene VI– Granary

Math 1,2,3: At your service. How can we help? Is your balance broken?

Gr Mst: It is the end of the world as we know it.

Math 1: Calm down.

Math 2: It cannot be so serious a problem.

Math 3: We can always find a solution. You must describe the problem.

Gr Mst: Soon, the king will be out of rice.

Math 1,2,3: Impossible

Gr Mst: No, it is not. I delivered, 1 pound, then 2 pounds, then 4 pounds, then 8 pounds, then 16 pounds, then 32 pounds, then 64 pounds, then 128 pounds, then 256 pounds, then 512 pounds, and then 1,024 pounds. Have you heard this pattern before?

Math 1,2,3: Yes, yes.

Math 1: But what's the problem. You said the scales were working. Surely, it shouldn't take you very much time to weigh it.

Gr Mst: Weighing is not the problem. It has been 4 weeks or twenty-eight days. I thought I could use the idea of patterns to help me prepare for the next few weeks. Let me show you what is going to happen in another 10 days – on day thirty-eight. I need the apprentice mathematicians to read the numbers. I never learned to read such large numbers. Day twenty-nine.

Audience: 8,192 pounds

Gr Mst: Day thirty

Audience: 16,384 pounds

Gr Mst: Day thirty-one

Audience: 32,768 pounds

Gr Mst: Day thirty-two

Audience: 65,536 pounds

Gr Mst: Are you following?

Math 1,2,3: Yes.

Gr Mst: I was happy to reach day thirty-two. Half way there. 65,000 pounds of rice – a lot but manageable, I thought. Half way there. Perhaps the total would be double that or 130,000 pounds, a lot of rice but enough in the central storage to make the delivery.

Math 1,2,3: Seems reasonable.

Gr Mst: It only took me another minute to realize we were bordering on certain disaster.

Math 1,2,3: No!

Gr Mst: Are you ready to continue?

Audience: Yes

Gr Mst: Day thirty-three

Audience: 131,072 pounds

Gr Mst: Day thirty-four

Audience: 262,144 pounds

Gr Mst: Day thirty-five

Audience: 524,288 pounds

Gr Mst: Day thirty-six

Audience: 1,048,576 pounds

Gr Mst: That is all the rice in the country. I could keep this up but you get the picture. There is not enough rice in the whole world to complete the king's bargain with the clever girl.

Math 1: I have checked your work, and you have calculated perfectly.

Math 2: But the problem is not calculation. It simply helps us see the magnitude of the problem.

Math 1: Call the king.

Gr Mst: He is still about the country, collecting taxes.

Narrator: they alerted the army. They alerted the navy, but no one could find the king to inform him of his disastrous bargain. The king, had decided to go into the tiniest villages to collect taxes. Meanwhile, the clever young girl was distributing the rice to the poorest in the city. She hired the city poor to take more rice out to the country. By the time the King returned, he had not one grain of rice left anywhere in his royal granary. He ordered the clever young girl to his palace.

Scene VII – The Palace

King: I have no rice left to keep my bargain.

Clever Girl: Are you hungry?

King: Yes

Clever Girl: Now you know how your subjects have felt.

King: What am I to do?

Clever Girl: You are rich.

King: I cannot eat gold or jewels or land.

Clever Girl: Then trade your gold and jewels and land. Your subjects have plenty of rice which they will gladly sell you.

King: I am ruined. What am I to do?

Clever Girl: You are not ruined. You may have lost your rice, but you still have the greatest gift.

King: And what is that?

Clever Girl: Your wits, your brains, your intelligence! Use your talents well and you will become the wealthiest man in the world again. This wealth is open to each one of us whether we are born rich or poor.

Narrator: I began this tale with long, long ago and far, far away in a kingdom that no longer exists. The kingdom ceased that very day and a republic took its place. There is no gun or statue in the town centers. Rather, the citizens of each village, town, and city erected a marble table with an inlaid checkerboard. Each year, on the anniversary of the founding of this republic, all the citizens gather round to reenact this special story. Each citizen wants to pass on to the children the importance and the value of their intelligence.

Instructional Materials to Support *The Power of Two*

Math web site MathFLIX.luc.edu

http://mathflix.luc.edu/NCTM_cat/Connections/Everyday/nctm-connections-everyday-math-videos.html

A Grain of Rice <http://www.amazon.com/Grain-Rice-Helena-Clare-Pittman/dp/044041301X>

Grade 3-8 An original story set on the grounds and in the palace of the Emperor of China during the 15th Century. Pong Lo, the son of a farmer, kneels in the Emperor's court to ask for his majesty's daughter's hand in marriage. Employed as a storeroom worker, Pong Lo sets about to prove that he is "wise and quick and more than a little clever, and would make... as fine a prince as China has ever seen." From School Library Journal

One Grain of Rice: A Mathematical Folktale <http://www.amazon.com/One-Grain-Rice-Mathematical-Folktale/dp/059093998X>

Grade 1-4. A resourceful village girl outsmarts a greedy raja, turning a reward of one grain of rice into a feast for a hungry nation. From School Library Journal

The King's Chessboard <http://www.amazon.com/Kings-Chessboard-Picture-Puffins/dp/0140548807>

Grade 2-6 The king of the title is an Indian potentate who receives a service from a wise man and insists on repaying the favor. The wise man finally requests the familiar mathematical puzzle of the chessboard, on whose first square is placed a single grain of rice, on whose second square is placed two grains, four on the third square, and so on. The king, who is too proud to admit that he can't calculate the sum total of the gift, foolishly grants the wish, at least until it becomes clear that it will wipe out his stock. Finally, in spite of his pride, he takes back his repayment, justly embarrassed because of his stupidity and the wise man's obvious generosity in not wanting a repayment in the first place. From School Library Journal

COUNTDOWN.luc.edu

Literature	Everyday	Algebra
<ul style="list-style-type: none"> ♦ Using "The King's Chessboard" ♦ Extending "The King's Chessboard": Part 1 ♦ Extending "The King's Chessboard": Part 2 ♦ Countdown Activity: Using "The King's Chessboard" ♦ "The King's Chessboard" Computer Spreadsheet ♦ "The King's Chessboard" Computer Graphics 	<ul style="list-style-type: none"> • 2ⁿ Intro • 2ⁿ and Probability • 2ⁿ At the Store • 2ⁿ In Literature • 2ⁿ In Music • 2ⁿ In the Kitchen • 2ⁿ Using a Ruler • 2ⁿ Using Hexagrams • 2ⁿ Using Magic Tricks • 2ⁿ With Games • Napier's Ancestors on the Computer • Napier's Ancestors: Computer Graphics 	<ul style="list-style-type: none"> ♦ Geometric Sequence: Whole Number ♦ Geometric Sequence: Fractions ♦ Exponential Relationships ♦ Exponential Relationships Continued ♦ Exponential Relationships on the Computer ♦ Comparing Linear and Exponential Sequences: Computer