HOW MUCH? A MATHEMATICS PLAYLET

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This playlet depicts how man from the earliest times passed through certain steps in the development of ways to answer the question, "How much?" This development begins with early cave man's ingenious invention of measure to the latest coordinated efforts of present day civilization to devise the most effective system of weights and measures.

Scene I. Early Man Devises His First Unit of Measure [Narrator reads, giving plenty of time for the characters to act. Cardboard with the title of the scene may be placed on the stage.]

Narrator: The first scene take place somewhere in very early times. Cavemen Ug and Og meet. Ug shows Og his new spear and tells Og how he used it to kill four tigers. [Ug and Og should be about the same size. They meet and exchange grunts. Ug carries a spear which should be about nine feet long. Ug lifts his spear up and balances it as if he was ready to throw it at a tiger, calling Og's attention to it with grunts and gestures. Ug then slaps himself on chest boastfully as he tells—in grunts—of the four tigers killed.] Og shows interest in the length of Ug's spear since his arms are about the same length as Ug's. Og wants to use it to kill tigers since he needs some tiger skins. [Og grunts and gestures as he starts to walk away with the spear.] Ug doesn't want to let Og borrow the spear and suggests that he go into the woods, cut down a small tree, and make himself a spear the same length as his spear. [Ug grasps Og's arm and grunts and points to the woods.] Ug tells him that he must be going and can't let Og take the spear into the woods to hunt for a sapling.

Narrator: Og tries to see if he can mark off on his body the length of the spear but finds that it is longer than his height or his reach. [Og looks at spear, stands it by himself and tries to reach the top, and picks it up and tries to reach the length with both arms outstretched.] Ug calls Og's attention to a grape vine hanging in a nearby tree and suggests to Og that he cut off a length of the grape vine equal to that of the spear and carry this length with him. [Ug grunts, points into a tree and at spear.] Og can't reach the vine. [Og jumps.] He has a problem now. Let's see how he solves it. [Og is puzzled. He scratches

his head. While holding his arms in front of his face, he gets an idea.] Og gets an idea. He will use his forearm, seeing how many times this length is contained in the length of the spear. He picks up a pebble each time he places his forearm down. There goes Og into the woods with his pebbles and, of course, with his forearms, which are certainly convenient.

Narrator: This length of the forearm was called the cubit and was used for thousands of years. We have heard it said that "necessity is the mother of invention." Prior to this time all measuring was done by the process of fitting. Since Ug would not let Og borrow his spear in order to cut a sapling the same length, it was necessary for Og to devise another way of getting a sapling the desired length. This way is that of applying an arbitrary length—called a unit—to the length to be "measured."

Scene II. The Need for Standardization

Narrator: Most of our units of measurement of length are based upon measurement of parts of the body. The hand [Shows width of palm of hand], the span [Shows fingers outstretched on a hand], the cubit, the yard [Indicates distance from nose to tip of fingers on outstretched arm], and the fathom were all in common use. The fathom is the distance from tip of fingers to tip of fingers on outstretched arms and comes from a word meaning "to embrace."

Narrator: Each man of course carried his units around with him at all times. But since people's body measurements differ widely, disputes were quite frequent. Let us look in on an open market operated by Nol and Sud in early times. Ahab comes in to buy rope.

[Nol should have a *very* short fathom while Ahab and Sud should have *very* long arms. Sud might have a crude abacus with pebbles placed in grooves on a board.]

Nol: Come in, Ahab. What can we do for you?

Ahab: Nol, I want some good strong rope. What do you have?

Nol: We have some of the finest rope. [Hands ball of rope to Ahab.]

Ahab: [After testing rope] How many fathoms of this rope will you trade me for a fat young lamb?

Nol: We will trade you 10 fathoms for a lamb.

Ahab: I guess that's fair enough.

[Nol measures off 10 fathoms, using his short forearms. Ahab looks skeptically at the length of rope and measures on his extra long arm, finding the measure to be only 8 of his fathoms.]

Ahab: Now look here, Nol. When I said 10 fathoms, I meant 10 of my fathoms. There are only 8.

Sud: Ahab, Nol has been measuring and selling rope here for some time. If you are not satisfied with this rope, then let's call our chief in and let him measure the rope.

Ahab: Call in the chief.

[Nol brings in the chief.]

Nol: Chief, will you measure this rope? Ahab thinks he is not being given full measure.

Chief: Let me settle the dispute. [He measures.] There are 9 fathoms here. What's the dispute, Ahab?

Ahab: I was supposed to get 10 fathoms, but I measured only 8 of them.

Chief: Let's look at these arms. [Compares Ahab's and Nol's fathoms.] Ah! No wonder there is a dispute. But Sud's arms are long. Nol, why don't you let Sud measure the rope? He has much longer arms than you?

Sud: I go out and buy the rope and Nol sells it! [Group laughs.]

Chief: This matter will require a royal decree. I don't want to be called every time Nol wants to measure rope, so I will measure off a royal fathom. [Proceeds to do so.] This will henceforth be a fathom among all people of our tribe. Peace unto you.

[Chief leaves. Nol measures off 10 fathoms with the standard. Ahab leaves. Nol hangs the standard up in view.]

Narrator: Thus one tribe made steps toward standardization of its units of measure. At first the lengths of a unit of measurement varied greatly also from tribe to tribe. However, the desire to trade between groups of people caused people to see the value of further standardization. As groups joined together one length for a unit displaced several lengths which several groups separately used.

Scene III. Some Familiar Units

Narrator: In Scene III you will witness three instances illustrating the early use of units of measurement.

Narrator: From I Samuel 17:4 we read, "And there went out a champion out of the Philistines named Goliath of Gath, whose height was six cubits and a span." [If possible,

have a tall boy walk in on stilts. Let someone mark off his height onto a pole, and putting the pole in a horizontal position, proceed to show that his height is as described.] One cubit, two cubits . . . 6 cubits and 1 span over. [Narrator counts as the pole is being measured.]

Narrator: From Genesis 6:15 we find the dimensions of Noah's Ark. The length was 300 cubits. Since the length of the Hebrew forearm was about $1\frac{1}{2}$ feet, the Ark was about 450 feet long or about $1\frac{1}{2}$ times the length of a football field between goal lines. The width of the Ark was 50 cubits or $\frac{1}{4}$ the length of a football field. The height of the Ark was 30 cubits.

[A group of soldiers assemble and start marching with one person counting the paces: "unus, duo, tres, quattuor, quinque, sex, septem, octo, novem, decem, undecim, duodecim, tredecim, quattuordecim. . . ."]

Narrator: We have just now seen a group of Roman soldiers counting the number of paces or double steps from Rome. The Roman unit of measurement of distances was a mille passuum, which meant a thousand paces. Our word "mile" comes from "mille." Since a double step is about 5 of our feet, the Roman mile was about 5000 feet.

Narrator: We are going to be interrupted. These two men are disputing the length of a rod. [Two men, each with a pole, one being 17 feet long and the other about 14 feet long, appear on stage, compare poles, and gesticulate as if in argument.] But I believe this other gentleman will help them settle their dispute.

Town Crier: [Enters and reads loudly from official document] Hear ye! The King decrees: If two men dispute the length of a rod, the two shall stay the first sixteen men who leave the church, be they thick or be they thin, and take the length from the toe of the first to the heel of the last. That shall be the proper rod. [He departs.]

Narrator: Here comes a group out of a church building now. The two in argument proceed to line up sixteen of them and mark the distance on a pole. They have settled their argument. [All leave.]

Scene IV. Establishment of the Metric System

Narrator: The fourth scene deals with the establishment of the metric system of measurement by France. Let us look in on a meeting of the Academy of Science of Paris

on March 19, 1791. You will notice 5 scientists who are members of a committee reporting to the larger assembly

First Scientist: [Addressing larger assembly] Distinguished members of the Academy of Science, our committee has been studying the possibility of bringing some order out of the chaos of our weights and measures. We predict succeeding generations will look back upon this meeting as a memorable one if we can make some decisions that simplify our system. We shall now be brought up to date on what decisions were reached last Fall.

Second Scientist: Fellow members of the Academy, let us first glance at the chaotic systems used in France and England. [He reads from the following cards:]

France
12 pouets = 1 lignes
12 lignes = 1 pouce
12 pouce = 1 pied
6 pieds = 1 toise

England	
3 barley-corns	= 1 inch
12 inches	= 1 foot
3 feet	= 1 yard
$5\frac{1}{2}$ yards	= 1 perch (rod)
40 perches	= 1 furlong

We all realize how inconvenient it is to work with these units when we are required to multiply or divide by that number *12,* which we borrowed from the *Romans!* And the English system is much worse than ours. We have not yet decided upon a unit of length but whatever it is the decision has been reached that we will subdivide it into 10, 100, and 1000 parts and also define units which are 10, 100, and 1000 times our basic one. The Royal Society of London has been urged to cooperate with us in this revolutionary undertaking. Some of you have cautioned me that we cannot expect the people of France to discard a system which they have lived with all of their lives. But may I remind you that because of the Revolution it will be possible to gain public consideration for radical ideas in science as well as in government! [Group applauds.]

First Scientist: Messieurs, our problem today is to decide upon the unit of measures. What proposals do we have?

Third Scientist: [Showing a string about 40″ long with a weight on one end.] I have in my hand a seconds pendulum—meaning that it requires one second for it to make one swing. You will agree that its length is a convenient unit to use. I submit this as the meter and suggest that we proceed

to determine its value with great, great accuracy at sea level at 45° latitude. [Groups talk among themselves with the majority giving nods of disapproval.]

Fourth Scientist: Messieurs, may I propose that we base our unit upon the measurement of the earth's equator. [Groups chat again with sentiment about equally divided.]

Fifth Scientist: As you well know, the length of a seconds pendulum will vary slightly as we vary our distance from the center of the earth. [Several heads shake approvingly of point made.] And also the measurement of the earth's equator will be extremely difficult. [Looks at globe.] The land masses of South America, Africa, and Borneo traversed by the equator are regions unexplored and inhabited by wild animals and savages. Certainly we must reject this proposal also.

I would, however, like to make a third proposal. Let us base our meter upon the distance from the equator to the North Pole. Here is Barcelona, Spain. And here on the same meridian is Dunkerque, France. This is the greatest meridinal distance available for measurement in all Europe. You may recall that Monsieur Lacaille in 1740 surveyed this distance. From his recorded data we can compute the total distance from the equator to the North Pole. One ten-millionth of this distance would provide us with a tentative standard until we re-survey the distance with the greatest accuracy possible. [The whole assembly rises applauding. Group exits.]

Narrator: The Academy of Science of Paris adopted the proposal to base the system of measurement on the length of the earth's quadrant. The French surveyors set to work on the vast labor of measuring the distance from Barcelona to Dunkerque. After a few years they completed the task and arrived at a unit of length which is a little more than our yard. This unit was called a meter [displays meter bar] after the French word for "measure." Other countries joined France so that today 75% of the civilized world uses this metric system. It is used today for international events—Olympic races, baggage weight allowance for air flights to other countries, etc. Even though the metric system is not used widely for trade in this country, it is *the official unit of measurement.* Our meter bar is kept in the Bureau of Standards in Washington, D. C. Sacred relics of these standard meter bars are also kept in an underground shrine at Sèvres near Paris.

In September 1953 a ten-nation advisory committee met in Sèvres, France and recommended that these hallowed meter bars be abandoned. The measurement of the earth's quadrant was in error! In 1954 a full-dress international conference will make a decision. Proposals will be made to define the meter in terms of wave lengths of light. Germany wants to use light given off by a krypton isotope; Russia wants to use cadmium 114; the United States scientists prefer mercury 198. We shall see.

OVERSEAS BATTLES COMING TO WHITE HOUSE TV SCREEN

The President in the White House and high military officials in the Pentagon will be able some day to watch on television the actual progress of battles as they occur in far-off corners of the earth.

This was indicated during a demonstration here of combat television that has been developed by the U. S. Army Signal Corps and the Radio Corporation of America. All combat TV needs today to bring battle progress into the strategic command centers and the nation's capital is a method of carrying TV signals across the ocean and the electronics industry is working on that. Thus, large scale invasions or A-bomb or H-bomb strikes may be watched during the instant they are happening. As a result of what appears on the TV screen in the Pentagon or the White House, plans can be changed and new orders sent to the front.

A distinguished audience including Gen. Matthew Ridgway, Army Chief of Staff, and Brig. Gen. David Sarnoff, chairman of the Board of R.C.A., watched the demonstration of combat TV here. They were guests of the Second Army. The Third Armored Cavalry Regiment staged a river crossing and hill assault under mock combat conditions to demonstrate how commanders could use TV. Seven hand-carried TV cameras, one mounted in an Army plane and another on an amphibious assault craft, actually went into battle with the troops. They brought to the battle commander's post instant pictures of what was going on. These allowed him to redirect his troops and order additional artillery fire as needed. He interviewed a captured "prisoner" through the medium of TV and thus gathered valuable information about the "enemy."

The equipment used in the demonstration was part of the Signal Corps Interim Tactical TV System devised for use on the battlefield.

POLAROID RADIATION DETECTOR

Edwin H. Land, inventor of the one-minute Polaroid-Land camera, added another patient to his files. It covers a mouth-held device which tells the user how much atomic radiation he has absorbed.

Designed for use in experimental laboratories, the device consists of a photographic film sensitive to X-rays, radium, uranium and other natural or artificial radioactive materials, particularly deadly gamma radiation, beta radiation and neutron radiation.

This film is carried in a badge. When the user wants to know the degree of radiation he has absorbed, he slips it into his mouth, crushes a capsule sandwiched in the circular film packet, permits the developer to work on the film and then examines the film for his answer. Holding the film in his mouth while it is being developed eliminates the effect of varying laboratory temperatures. The film thus will always be developed at body temperature.

Mr. Land assigned patent No. 2,687,478 to the Polaroid Corporation.