FOSS ® MEASUREMENT
TEACHER PREPARATION VIDEO TRANSCRIPT

<Larry Lowery Introduction to FOSS Program>
Lowery: Hello. Welcome to the Full Option Science System. This program was funded by the National Science Foundation. Its goal was to develop materials that would involve youngsters with both the processes and the content of science.

The program is developed with the Lawrence Hall of Science, with scientists, science educators and teachers working together as a team to develop the materials. The materials are tested in the hands of teachers and children in classrooms. It takes about two years to turn out a module.

Each module begins with firsthand experiences. This is done because it has been found that firsthand experiences are the best way for youngsters to learn about the concepts of science. As the module progresses, children are introduced to abstractions and reading materials. The sequence from firsthand experiences through reading materials is deliberate because it has been found that youngsters, when they have some experience before they read, learn and understand more from the reading. Authors of reading materials can then take youngsters to greater abstractions.

Trust the materials that you are getting acquainted with. They have been well-tested. We have found that they work extremely well in the hands of all teachers and are effective for youngsters in learning about science.

<Larry Lowery Introduction to Measurement>
For people to exchange scientific ideas, a standard measurement system must be used. The world agreed upon standard is the metric system. This system is introduced to youngsters in this module.

It has been found that students learn the metric system more easily when the units are not compared to English standard units. Thus, each metric concept in this model has its own frame of reference. Students will measure lengths and distances. They will measure mass of objects, fluid volumes and temperatures, all in metric units.

<Linda De Lucchi Introduction to Module>
Narrator/Linda De Lucchi: Hi. I'm Linda De Lucchi from the Lawrence Hall of Science. And I'm here to help you get started with the Measurement module. We suggest that you use this module early in the third grade.

The module consists of four investigations, each designed to introduce one aspect of metric measurement: Length, mass, volume and temperature. Each of the investigations follows a three-part learning sequence.

In the first part, the students through a discrepant event, realize the need for a standard and then we introduce the unit and the tools to measure. Then they gain practice using the unit and using the tools and they begin to develop a metric frame of reference. And finally, we give them a

chance to apply their skills by solving a problem involving metric measurement.

Most of the equipment that you will need to teach the module comes in these two boxes. Everything that you see here is included in the kit. Be sure to read the Materials section in the Teacher Guide to become familiar with the materials and to know which items are permanent and which ones are consumable.

You will need to provide scissors, crayons, tape, ice, a stopwatch or a watch with a secondhand and an apple or orange.

Before you begin teaching the module, it's very important that you read the Teacher Guide thoroughly. The first thing you will find is the module overview, which points out the national standards addressed in this module as well as information about how to make best use of the Teacher Guide. It also includes valuable background information specially written for teachers who have not had extensive science training.

Next you'll find the Materials folio. If you're the first teacher using a new kit, you'll want to turn to the section that describes first-time prep. If the kit has been used before, check the section with directions for each classroom use. Both of these sections will give you helpful hints that will save you lots of preparation time later.

The next portfolios are the investigation folios. Each takes one or two weeks to complete. These are the heart of the program.

The first page is an overview. The next two pages provide a matrix which summarizes the investigation and helps you plan for assessment and extension activities. Then you'll find background information specific to this investigation followed by a Teaching Children About section, which gives you some insight into research about how children think and learn.

Then for each part of the investigation, there will be a Materials list, a Getting Ready section and step-by-step instructions for how to proceed through the investigation.
At the end of the folio, you'll find Interdisciplinary Extensions. You can do some of these extensions with the whole class or individual students may choose to do some of them as projects at the end of the module.

Next are the investigation duplication masters. Each master is labeled with a number so it will be easy to find when you need it. The first master is the letter home to parents. It familiarizes parents with the goals of the module and suggests home experiences to enrich the module. Shortly before beginning the module, duplicate this letter and send it home with the students.

The next tab is the Assessment folio. It's important to read this folio before you begin teaching. It describes a system for assessing students' progress throughout the investigations and also gives you ideas for end-of-the-module testing and portfolio assembly.

The next tab is the assessment duplication masters. Here you'll find the masters for the assessment charts and for the end-of-the-module assessments.

The Science Stories folio provides background information and recommends when to read the

FOSS stories and when to do follow-up activities. We suggest that you read the Science Stories during a reading period rather than during science time, especially if you only teach science a few times a week.

The next folio is the Resource folio. In it you'll find lists of trade books, videos, computer software and other resources that will enrich the program. The final tab introduces you to the FOSS website. The website contains simulations for each module, allows students to e-mail or write to scientists as well as other FOSS students across the country. It provides opportunities for teachers to talk with other FOSS teachers. Be sure to check the FOSS website to see the many features available there.

<Investigation 1, Part 1>

Narrator: In this part of the investigation, the students discover the need for a standard unit when measuring length. For all of the investigations, you will need to set up a Materials Station, a table where the getters come and get the equipment.

For this part you will need from the kit the meter tapes and straws. Be sure to cut three centimeters off half of the straws so that you end up with two different lengths. And don't put the straws out on the Materials Station because you don't want the students to know there are two separate lengths.

You will need to supply tape, crayons, and scissors. Duplicate Student Sheet No. 2, Paper Meter Tape. The accuracy of the meter tape will depend on the precision of your copy machine. Make one tape and compare it with the meter tape from the kit to make sure that the student-made tapes will be accurate. You may have to adjust the copy machine up or down a few percent.

Duplicate the Assessment Chart for Investigation 1 to record students' progress as they are working. On two large sheets of paper, prepare the Word Bank and the Content/Inquiry chart for the entire module.

Now let's join a third grade class as they start the module.

Teacher: Okay, boys and girls. This morning we're going to start our science unit about measurement. But before I can start teaching you about measurement, I need to know what you already know about measurement.

Student: I measured inside of my desk before.

Teacher: You measured the inside of your desk. What did you use to measure the inside of your desk?

Student: These long things.

Teacher: What kind of long things.

Student: Tape measure.

Teacher: A tape measure.

Narrator: The teacher continues to ask other questions to engage students' thinking and then poses the challenge.

Teacher: We're going to be doing some measuring today. And what we'll be using to measure is straws. We're going to have everybody measure their desks, how long and how wide they are. The length and the width of their desks.

Narrator: The teacher passes out the straws giving half of the groups the longer straws and half of the groups the shorter straws. The students measure the length and the width of their desks with the straws.

Student: Three and a half this way and four and a half this way.

Narrator: When all of the students have completed their measurements, the reporters write their results on the chart on the board.

Teacher: Very good. Four and a half. And how wide was it?

Student: Two and a half.

Teacher: Two and a half straws wide. Would you show us how long and how wide your straws measured your desk.

Narrator: With all of the results on the board something seems to be peculiar.

Teacher: The back two tables, the red and the blue, you said your desks were four and a half straws long. But the green and yellow group said they were five straws long. It seems to me the desks are all the same size. Do you think the desks are different sizes?

Class: Yes.

Teacher: So what's the problem here? Why can't we measure this correctly?
Vanessa, what do you think the problem is?

Student: I think the straws are kind of short and long.

Teacher: You think so? Let me have one of your straws and let me have one of these straws. Let me see. Look, Vanessa was right. The straws are different lengths.

Narrator: The students discuss how to fix this situation and decide they need a standard unit. You introduce the meter as the standard unit and distribute a meter tape to each group. They look at the meter tape and realize it's a very long unit. Too long to measure some things like a pencil.

Teacher: So we need to divide the meter into smaller sections. And meters are divided into 100 sections. And these little tiny sections are called a centimeter.

Narrator: To help the students learn to use the meter tape, the teacher asks the students to point to several numbers on the tape.

Teacher: Very good. No. 77.

Narrator: Next have the students measure the straw with the meter tape. Remind the students to be careful to place the 0 edge of the tape on the end of the straw. Make sure that it's clear to the students that the 0 edge is under the metal tip.

Teacher: Okay. Boys and girls, I would like you to try measuring your desks with the meter tape now and see if we can come up with an agreement about the size.

Narrator: The teacher watches to be sure that they start with the 0 edge of the tape at the edge of the desk. This time the results are still not perfect. But they are more consistent.

Teacher: And how wide?

Narrator: In Part 2, the students will have a lot more practice estimating the length of objects and measuring them with the meter tape. You may want to continue Part 1 on another day. This is where each student will get to make a meter tape of their own.

Teacher: We are going to be using this paper right here called the Paper Meter Tape. And what you're going to do is cut on the dotted lines. Only on the dotted lines. When you cut on the dotted lines, you're going to end up with four long strips of paper that you're going to tape together end to end. And if you look at your Paper Meter Tapes forms that are on your desk, you'll see that the top numbers go from 0 to 19. And then it just says 2. It just says 2 on the end. That's kind of strange. What should come after 19? Raise your hand. Vanessa?

Student: After 19 should be 20.

Teacher: It only says 19 and then 2.

Student: But the next strip has the 0.

Teacher: That's because the next strip has the 0. So when you cut this strip off, don't cut the solid line. You're only cutting the dotted lines. Remember? You're going to cut this one off. And then you're going to tape these two together when they are all cut apart so the 2 and the 0 line up.

Boys and girls I have Kimberly's tape here that she's got started taped together. You can see all the little ovals are lined up and now it says 18, 19 --

Student: 20.

Teacher: -- 20, 21. Down here it says on this end 38, 39, 4 -- what do we need to tape on the end there?
Samantha?

Student: There's another piece of paper. And it has a 0. And then it will be 40 and then will go on 41, 42, 43, 44 and so on.

Teacher: Very good.

Narrator: The students color every 10 centimeters a different color being sure they can still read the numbers.

Student: 100.

Student: Done.

Narrator: As students offer vocabulary words, add them to the Word Bank. Add concept statements and any student questions to the Content/Inquiry chart. This is a good time to check the Science Stories folio for reading opportunities for the entire investigation.

<Investigation 1, Part 2>

Narrator: In this part, students get practice estimating and measuring using meters and centimeters. From the kit you will need meter tapes. You will need to provide Paper Meter Tapes made during the last session.

Children at this age usually don't realize the reason for estimating. They think it's a test and they want to get the exact measurement. So start this session with a discussion about the reasons for estimating and how to make a good estimate.

Teacher: We're going to talk about what you would do if you needed to know how long something was but you didn't have your meter tape with you. What would you do? If you were looking at something and said, "Gosh, I wonder how long that is," you could guess. You could guess. But you know what they call it if you make a really good guess? Michelle.

Student: Estimate.

Teacher: Estimating, that's right. An estimate is a very good guess, not a wild --

Narrator: The teacher explains that when making an estimate, you base it on something you already know. For instance, if you know that a centimeter is about the width of your pinky finger, you can estimate how many centimeters long something is by using your pinky.

Teacher: You are going to write an object. You are going to write something down that you're going to guess. You're going to estimate how long it is.

Narrator: Using the sheet How Long Is It, students list five items they want to measure. They estimate the length of each item and then measure to check each estimate.

Teacher: Okay. Michelle thinks 6.
How long do you think it is, Vanessa? How long do you think it is? What would be your estimate?

Student: I think 7.

Teacher: You think 7.

Student: I think 6.

Narrator: Students will be trying to improve their ability to estimate.

Student: I think it's about 16.

Narrator: When they've completed their estimates, the students use their meter tapes to measure each object and then they record the length they measured.

Student: 16.

Teacher: 16 and you guessed 14. So write down 16 here. Close.

Student: Mine is a 10.

Student: I did a 10.

Narrator: A way for you to check your students' abilities is to list three more objects for them to estimate and then measure. Collect the student sheets and check their work.

To wrap up this session, students come up with words to add to the Word Bank. The most important thing for your students to get from this experience is that their ability to estimate improves with practice.

<Investigation 1, Part 3>

Narrator: In Part 3, students practice making measurements by measuring parts of their body and comparing the lengths and distances. You don't need any materials from the kit. But you'll need to provide the Paper Meter Tapes that the students made, a three by five index card or piece of paper for each student and transparent tape.

Duplicate the student sheet called Making Comparisons and the student sheet called Response Sheet - Linear Measurement. You'll need to have available the Assessment Chart for Investigation 1.

Begin this part by asking the students to measure their partner's height in centimeters using the Paper Meter Tapes.

Student: I'm supposed to make me.

Narrator: Since the students are all over one meter tall, accurate measuring is a challenge. The teacher assesses the techniques students use but doesn't offer guidance at this point.

Student: Hold that there.

Student: Okay.

Student: Okay. Let go of this one.

Student: What is this?

Student: 141.

Narrator: After the students have recorded their heights, they line up in order by the number on their cards. They quickly become aware that there are mistakes.

Teacher: 120. 121? 121.

Student: I'm taller than Christy and I'm 141 and she's 142. I'm taller than her.

Teacher: What do we see is the problem here? What's going on? You guys are supposed to be in order from the shortest to the tallest. What happened? Anybody have an idea? Samantha, what happened?

Student: Well, I notice that it's -- the meter is not long enough for us. And some people counted wrong for the centimeters to get it right. So people ended up being shorter than they were or taller than they really are.

Teacher: So maybe we found out this isn't the best way to measure people, is it?

Narrator: Lead a class discussion on how they can improve their measurements. If the students don't suggest it, you suggest taping two meter tapes to the wall.

Teacher: Do you think we might get a little bit more accurate measurement that way?

Class: Yeah.

Teacher: And then you could stand up against it and we can see how tall you are that way.

Class: Yeah.

Teacher: Let's try it that way.

Student: 136.

Student: 100? Oh, 100.

Student: See here.

Student: Oh, okay. That's why I'm thinking I'm just 38.

Narrator: The students continue to measure other body parts, including head and arm span. When students compare their arm span to their height, they may be surprised to find that the

lengths are just about the same. This is a good time to use the response sheet Linear Measurement to assess students' progress.

Ask students for words to add to the Word Bank and statements to add to the Content/Inquiry chart. This part gives students experience applying their measurement techniques and making comparison results. Before leaving this investigation, be sure to consider the math problem of the week and other interdisciplinary activities described at the end of the folio.

<Investigation 2, Part 1>
Narrator: In Weight Watching, the students are introduced to the concept of mass. They use a balance and mass pieces to weigh a variety of common items. From the kit you will need balances, plastic cups and mass sets in bags, each with 20, 10, 5 and 1 gram pieces. These you'll need to assemble ahead of time if the kit is new.

You'll need to place 25 jumbo paper clips in cups for half your groups, 50 regular paper clips in cups for the other half of the groups. You'll also need the plastic chips, wood squares and washers. Duplicate the Student Sheet No. 6, Steps For Weighing An Object, and the Assessment Chart for Investigation 2.

Let me introduce you to the FOSS balance. The balance has three parts: The base, the beam and the pointer. When the kit arrives new, the pointers will be in this small plastic bag. To insert the pointer, put the rounded end into the beam so that the flat edge hangs down in front of the raised line on the base. Place a cup on the two edges of the beam and then zero the balance by moving the plastic slider to one side or the other until balance is achieved. Check to make sure that the pointer lines up with the line on the base.

In this investigation, students are introduced to the concept of mass. Mass is the amount of matter in an object. This book has a greater mass than this pencil. In our everyday language, we equate those two terms, mass and weight, with how heavy an object is. And that's where we leave it for third grade students.

We don't try to distinguish between mass and weight. But we do for you, the teacher. And that description is in the Teacher Guide. So in FOSS, students weigh objects to determine their mass and report that in grams.

Begin this investigation with a discussion about mass.

Teacher: Today we're going to find out how heavy things are. And the way we're going to do that is to start off by using the objects in this cup. We have a few things in here. This is a little metal washer --

Narrator: The teacher sets the challenge for the students. Place a plastic chip and a washer and wooden square in order from heaviest to lightest.

Teacher: Which one is the lightest?

Student: This one. And this is the heaviest -- this is the lightest. This is the second lightest. And this is the heaviest.

Student: The heaviest.

Student: Yeah, the heaviest.

Narrator: As each group completes the task, the reporters list the results on the board. But the groups don't report the same results. The teacher leads a discussion to resolve this problem.

Teacher: We have a good idea of what's the heaviest and what's the lightest. But how can we find out for sure? What would be a way we can find out for sure?
Samantha?

Student: If we have -- like you know the stuff you have in grocery stores to weigh them. You can use one of those if we had them.

Teacher: Very good. What are those things called, the things they have in grocery stores?

Student: I can't remember.

Teacher: Does somebody else know? What are the things they have in the produce department in the grocery stores? What is that called?

Student: A scale.

Teacher: A scale. They do have scales in a grocery store. We're going to be using a tool today that's not a scale but similar to a scale.

Narrator: After the teacher demonstrates how to set up and zero the balance, the students do the same.

Student: I'll stop it. Come on, stop.

Student: Almost there.

Student: I'm just trying to move this thing. Oh, it's hard. Oh.

Student: No.

Student: All right. Your turn, Jabar.

Narrator: The students compare the objects using the balance.

Student: No.

Student: It's this thing.

Narrator: Now the students know the order of the objects from heaviest to lightest. But they don't know how much each object weighs. The teacher introduces paper clips as a measurement

unit. And the students weigh the washer using the paper clips.

Student: Yes, it is. The washer is in there.

Student: Well, I think we have a little too much of this.

Student: That looks just right.

Student: Yes.

Student: It is.

Student: Yes.

Student: So let's take them out and count them.

Student: Count them.

Student: Okay. I'll count these.

Narrator: The students may need to do this more than once.

Student: Oh, man. Now we have to do it again.

Student: One, two, three, four --

Narrator: The reporters record the mass of the washers on the class chart and again find a discrepancy. When the teacher asks why, a student suggests the clips may not be the same.

Teacher: This is Group No. 1's paper clip. This is Group No. 2's paper clip.

Student: See.

Teacher: What happened here? Let's see Group No. 3's paper clip. Oh, you have big ones, don't you? You have big paper clips. What about No. 4? What does your paper clip look like? And you guys have small paper clips.

Narrator: When the students realize the need for the standard, introduce the gram. Have the students weigh the objects in grams and record the results on scratch paper.

<Investigation 2, Part 2>

Narrator: In this part, students practice weighing a number of objects to determine their mass. From the kit you will need the balances, plastic cups, the mass sets, the container of gravel, and the small zip bags. You'll need to provide permanent markers to label the zip bags, transparent tape, and an apple or orange.

Duplicate Student Sheet No. 7 called How Heavy Is It and Student Sheet No. 8 called Response Sheet - Weight Watching. Also get out the Assessment Chart for Investigation No. 2.

This session begins with a review of the metric unit for measuring mass, the gram, and a review of how to use the balance. The students practice estimating and weighing a variety of objects and record the results on their student sheets. When the students have completed their measurements, the teacher poses a new challenge.

Teacher: We're going to see if we can weigh this apple using our balance and our gram pieces. So let's see how much it weighs. Let's see. Let's put some fives in there and see.

Student: All the fives.

Teacher: It's still not moving. I'll put some more fives in there. Well, it didn't move. We'll pour all the blues in and see if it we can get it to -- uh-oh. That didn't work. We didn't have enough gram pieces. How are we going to weigh this apple?

Narrator: After the students have shared their ideas, the teacher suggests they use cups of gravel in small zip bags to make and label a 100 gram mass piece to add to their mass sets. These students are counting out 50 grams and will use them to measure 50 grams of gravel twice.

Student: Why don't you take two yellows?

Teacher: I'm going to give you another tool. I'm going to give you some gravel and little plastic bags. And with the gravel and plastic bags and your gram pieces, you're going to figure out how to weigh this apple using these tools.

Student: A little more.

Student: Okay. That's good.

Student: Is it straight?

Student: It's straight.

Student: Yes.

Student: Okay. Get the bag.

Student: Put it in here.

Student: Put it in here.

Student: 150.

Teacher: Are you guys ready to weigh the apple?

Student: Yes.

Teacher: Let's see if it will do it.

Student: That's 100.

Student: Stop, stop, stop.

Student: It's perfect.

Narrator: The whole class will need ten 100 gram bags of gravel. Have a few groups make extra gravel bags so that you end up with ten 100 bags of gravel to make the kilogram weight.

Before the session ends, you might have the students complete the response sheet Weight Watching. In this part students have discovered a limitation with their tools in weighing heavy objects and have come up with a way to solve this problem by constructing 100 gram mass pieces.

<Investigation 2, Part 3>

Narrator: In Part 3, students have an opportunity to apply their skills by determining the amount of water a sponge will hold. From the kit you will need balances, plastic cups, mass sets, small sponges, half liter containers and a pitcher of water. Duplicate Student Sheet No. 9 called Soaking Sponges and get out the Investigation Chart for Investigation 2.

Start this session with a discussion of sponges. How much water can a sponge pick up? Two times its weight? Four times its weight? Find out what the students think. Then ask them to design a plan to find out and check those plans before they begin the investigation.

Ask them to estimate and record what they think the weight of the dry sponge is and how much water it can pick up. Most groups will plan to weigh the dry sponge first.

Student: The sponge is pretty heavy. I never knew a sponge was heavy.

Student: Yeah; yeah.

Student: Yeah.

Narrator: The getters bring a one half liter container of water to their groups and the students soak the sponge.

Student: One, two, three, four, five, six, seven, eight, nine, ten. Okay. Christine, put the grams in.

Narrator: The students record the weight of the dry sponge and the soaked sponge and calculate the difference. Most students are surprised to find out that a sponge can pick up eight to ten times its weight in water.

There are a number of extensions for this investigation in the Teacher Guide. In this part, students are using their measurement skills to solve the problems.

<Investigation 3, Part 1>

Narrator: In Take Me To Your Liter, students explore volume and capacity using a variety of measuring tools. From the kit you will need the basins, liter container, half liter container, cups, 100 milliliter beakers, the liter beaker and the one milliliter spoon.

You'll need the two pitchers for water and the small and large vials. Don't put the vials out on the materials table because you don't want the students to know there are two sizes of vials. You need to provide the water and the paper towels in case of a spill.

Duplicate the Assessment Chart for Investigation 3. Keep this chart with you so you can make notes about student progress. Assessment for this part is informal teacher assessment.

In this part, the students discover the need for standard unit to accurately measure capacity. You challenge them to find out the capacity of this cup. How much water will it hold when it's filled all the way up to the rim?

You distribute a vial to each group. Half the groups get this small vial. The other half get this large vial. But you don't let the students know that you're distributing two different vials. Each group measures the capacity of the cup with their vial.

Teacher: How many did it take?

Student: It took us nine vials to fill up the cup.

Teacher: Okay.

Student: Seven and a half vials to fill up the cup.

Student: 14 vials.

Student: Seven vials.

Student: 12 vials.

Teacher: 12 vials. Okay.

Narrator: The teacher asks the students how they could get such varied answers.

Teacher: Why do you think that is?

Student: Maybe some vials are smaller and some are bigger.

Teacher: That's absolutely correct.

Narrator: When the teacher holds up two vials, the students confirm they are different sizes.

Teacher: We realize that the vials are not all the same size. So how can people measure the capacity or how much water is in a container if our vials are different sizes?

Narrator: When the students agree that a standard unit of measure is needed, the teacher introduces the liter.

Teacher: Well, what we do have is we have what's called the liter. It's the metric standard for measuring volume. Volume refers to the amount of space that's taken up inside of something.

Narrator: Explain to the students that the liter is a large volume. But it's been subdivided into 1,000 parts called milliliters. This spoon holds one milliliter. Ask the students how many spoonfuls of water it would take to fill this beaker up to the one liter mark.

Introduce the 100 milliliter beaker and demonstrate how to use it. Once the beaker is full of water, place it flat on the table and move your eye level down to observe the water line.

Teacher: I'm going to have the starters fill their 100 milliliter beaker up to where you see the 100 milliliter line is. It's not at the top, but it's just below the top.

Narrator: When the water is measured perfectly, the teacher asks how many 100 milliliter beakers will it take to fill the one liter beaker. The getters pour the water from the small beakers into the one liter beaker, counting as they work.

Teacher: Delvon. Erica. Kayla is next. Mario.

Narrator: When all of the groups have taken their turn, the one liter beaker will still not be full. The class will find that it takes ten 100 milliliter beakers to fill the one liter container. This way they confirm that there are 1,000 milliliters in one liter.

In this part, the students have been introduced to the metric unit for measuring volume, the liter, and to the subdivision of the liter, the milliliter. They confirmed that it takes 1,000 milliliters to make a liter. Be sure to check the Science Stories folio at this point for reading opportunities to enhance this investigation.

<Investigation 3, Part 2>

Narrator: In this part, students continue investigating capacity and volume. From the kit you will need the basins, the liter containers, the syringes, the graduated cylinders and two pitchers for water. You'll also need eight plastic cups. You'll need to prepare these by marking each one with four lines. A, B, C and D.

You'll need to provide a variety of containers and paper towels in case of a spill. Duplicate Student Sheet No. 10 called Measuring Volume and Sheet No. 11 called Response Sheet - Volume. You will also need the Assessment Chart for Investigation 3.

To begin this session, hold up the cup of water that you filled up to the level C. Tell the students there's a volume of water in the cup and it's their job to find out what that volume is. Each student in the group practices measuring 50 milliliters of water with the syringe.

Student: Wow, that comes out fast.

Student: We'll take turns. So next.

Narrator: The starter fills the cup to the first mark.

Student: Okay. Is that enough?

Student: Yeah, that's enough.

Narrator: And the group estimates the volume of water in the cup. The students measure the actual volume by pouring the water into the graduated cylinder.

Student: Dante, pour that in.

Student: It is 44.

Student: 44.

Narrator: They record the measurement and calculate the difference between their estimate and the actual volume.

Student: 44.

Narrator: Each student takes a turn filling the cup to the next higher mark. At each level students first make estimates of volume and then measure actual volumes to see if their estimates improve as they go.

To conclude this part, students practice estimating capacity and measuring capacity using a variety of containers. In this part, the students have been introduced to two new tools for measuring fluid volume: The syringe and the graduated cylinder. And they've used these tools to measure the capacity of a variety of containers.

<Investigation 3, Part 3>

Narrator: In this part, students are challenged to solve a problem dealing with capacity. From the kit you will need the basins, the half liter containers, the syringes, the graduated cylinders and two pitchers for water.

You will need to provide 355 milliliter soda cans, water, and paper towels in case of a spill. Duplicate Student Sheet No. 12 called Soda Can Volume and have the Assessment Chart for Investigation 3 available.

Set the challenge by telling the students that you opened a can of soda and noticed that it wasn't filled to capacity. You were wondering if the soda company was really giving you your money's worth of soda.

The can says 355 milliliters. But you don't know if that's the volume of the soda or the capacity of the can. Ask the students to help you solve your problem.

The teacher asks the students to work in their groups and to think of a plan to find out if the soda

company is giving accurate information on the cans.

Student: So let's start off. Okay.

Student: I have an idea.

Student: Okay. What's your idea?

Student: We take the can. We pour the water in there carefully and then measure.

Student: Yeah. We can do that.

Narrator: The recorder writes the plan.

Student: Put the water in the can.

Narrator: The students fill the can with water and then use the syringe and graduated cylinder to measure the capacity.

Student: Oh, they are watching me.

Student: And once it's full, we're going to dump it into here and see how many times we can do it. That's 150. That's 50. Okay. Stop.

Narrator: The students discover that the capacity of the can is actually 370 milliliters. Then they put the 355 milliliters of water into the can to see how that looks.

Student: 250.

Narrator: When the students observe what 355 milliliters looks like in the can, they see that the can is not full. After the groups have finished their measurements, call the class together and ask the reporters to share their observations. They will have found out that 355 milliliters is the volume of soda and not the capacity of the can.

Ask the students why they think the soda company doesn't fill the cans all the way up. This sets the stage for a good writing opportunity. The students can write to the customer service division of the soda company and ask them why they include free airspace in each can of soda.

Before leaving Investigation 3, check the math problem of the week and the interdisciplinary activities at the back of the folio.

<Investigation 4, Part 1>

Narrator: In The Third Degree, students measure temperature in degrees Celsius using thermometers. From the kit you will need pitchers for water, half liter containers, the straws for stirring, the syringes and the thermometers. You'll also need sticky labels for labeling the cups. Each group will need three cups labeled A, B and C.

Just before starting the activity, put 100 milliliters of room temperature water in Cups A and C.

Put 100 milliliters of ice cold water in Cup B. The basins are optional. You will need to provide room temperature water, ice water, hot water and paper towels just in case of a spill. Duplicate Student Sheet No. 13, Measuring Temperature, and duplicate the Assessment Chart for Investigation 4.

Begin this session with a class discussion of temperature. Then challenge the students to put three cups of water in order from warmest to coldest. Each group has three cups of water labeled A, B and C. Each student puts one finger in each cup only once.

Student: Cold.

Narrator: Then they put the cups in order from warmest to coldest.

Student: I think it should go like that. C, A, B.

Narrator: When each group has agreed on the order ask, the reporters to list the order on the board. Not all of the groups will agree which cup is warmer, A or C. Give them a thermometer to help them solve the dilemma.

Teacher: The thermometer has a thin glass tube like a straw. And inside it is filled with alcohol. How many of you see the red alcohol in my thermometer? Fantastic.

Now, when you use a thermometer by dipping the bulb which is the round part filled with alcohol at the bottom into the liquid, if it is warm, it heats up the alcohol which makes the alcohol expand and push up the glass tube. To check to see how many degrees Celsius your water is, you would look at the top of the red column of alcohol. And whatever number is at the top tells you the temperature in degrees Celsius that that particular liquid is that you dipped the bulb into.

Narrator: Getters get a thermometer for their groups and now students can measure the exact temperature of each cup.

Student: Okay. Go.

Student: What does it say, Dicarlo?

Student: 19.

Student: Almost to 10.

Student: 20.

Narrator: The students record their measurements on their student sheets. The students may be surprised that Cups A and C are actually the same temperature. This provides an excellent opportunity to discuss why they weren't able to detect that when they tested with their fingers. The teacher distributes 100 milliliters of hot water to each group.

Student: This is going high.

Student: It's high.

Student: Look at that.

Student: It's about 50.

Student: Wait. It keeps going.

Student: It's at 56.

Narrator: The students record the temperature of the hot water.

Student: It's 10.

Student: Yeah, it's exactly 10 it seems. We could say -- yeah.

Narrator: The students record the temperature of the cold water. After discussing what the students have found, the teacher asks what they think will happen if they mix equal parts of the hot and the cold water.

Teacher: Let's estimate and guess what the new temperature would be.
Aaron?

Student: I think 35.

Teacher: 35 degrees Celsius after mixing the two, hot and cold water, together.
What do you think, Lanisha?

Student: 33.

Teacher: 33 degrees Celsius.

Narrator: The students place 50 milliliters of hot water and 50 milliliters of cold water in a cup. They stir the water with a straw. They measure the temperature of their mixture and record the results.

In this part, the students have been introduced to the limitations of the human body to detect temperature and they've extended their senses using a Celsius thermometer.

<Investigation 4, Part 2>

Narrator: In this part, the students will investigate the effect ice has on the temperature of water. From the kit you will need cups, the half liter containers, the straws for stirring, the syringes, the thermometers, the two pitchers and the basins. The basins are optional. You'll need to provide room temperature water, ice cubes, a stopwatch or a clock with a secondhand and paper towels.

Duplicate three student sheets: No. 14 called Response Sheet - Temperature; No. 15, Cold Water Data; and No. 16, Graphing Cold Water. Have the Assessment Chart for Investigation 4

available.

This session begins with a class discussion of what happens to water when you add ice to it. The students know that it gets colder. But they don't know how cold it gets or how fast it gets cold. So they are going to monitor temperature change in ice water over time.

Teacher: Make sure to put the bulb of the thermometer submerged into the water.
On your chart next to the 0 you will write the starting temperature in degrees Celsius in the temperature column. Great. Boys and girls, are you ready?

Class: Yes.

Teacher: Let's begin. Go.

Narrator: At the signal, students put two ice cubes in the water and begin to stir with the straw. When one minute is up --

Teacher: Boys and girls, that's one minute. Please take the temperature of your ice water and write it down on your charts.

Student: 10.

Student: 10.

Student: It's about what? 10.

Student: 8.

Student: 7.

Narrator: The students continue to stir, take readings every minute, and record their readings. This continues for ten minutes. At the end of ten minutes, there is no question that the temperature has decreased significantly.

Some students may need help recording temperatures below 0. The students will transfer their information from the Cold Water Data sheet to the graph on the Graphing Cold Water sheet. Most students will need guidance plotting the points on this graph.

In this part, the students have gained more experience with the Celsius thermometer and they've observed and recorded temperature change over time. They've also refined their ability to estimate the temperature of water by feeling it.

<Investigation 4, Part 3>
Narrator: The FOSS Field Day is the last part of the Measurement module. The students have an opportunity to apply all the skills they've learned over the last few weeks. This part will take three class sessions. In the first session, the students plan the events. In the next two sessions, the students have a chance to compete on one day and then to officiate on the next.

Plan to hold these events outdoors or in a large multi-purpose room. The students will need access to all of the measurement kit items. In addition, you need to provide poster board, marking pens, masking tape and other items students request for the field day events. Duplicate the student sheet called Metric Field Day Chart.

This part begins with a review of the metric measuring units that the students used: Length, mass, temperature and volume. To plan the field day, each group designs a contest for the other students to participate in. Four examples are described in the Teacher Guide and these are the ones that you'll see here.

The students write the directions for their events.

Student: Go.

Narrator: This is Grab For Treasure. The competitors grab one handful of jewels and place them in a cup. The officials use the mass pieces to weigh them. The competitors get three turns and the one with the greatest total wins.

Student: Ready?

Narrator: Water Transfer.

Student: Stop.

Student: Okay.

Student: Christine.

Narrator: The Paper Plane Toss.

Student: Could it be? It might be? I mean . . .

Student: Let me see.

Student: That's 10.

Narrator: The Syringe Squirt.

Student: 7 and a half.

Student: 7 meters.

Student: 41.

Narrator: The FOSS Field Day provides a motivating way for your students to demonstrate their ability to use metric measurement. And this brings us to the end of the FOSS Measurement module.

Although you may have gotten a lot out of this video, there are still many more details that you need to read about in the Teacher Guide. Be sure to look at the Science Stories folio, the Resources folio and the Website folio and have your students post their field day results on the FOSS website.