The Teacher-to-Teacher initiative was created by the U.S. Department of Education to provide the latest strategies and research on educational practices that work in the classroom. This series features teachers from across the country presenting techniques that can be used with students of all ages. This series is just one way the Department of Education is helping teachers get the support they need so “No Child is Left Behind.” (MUSIC) Hi, I’m Shannon C’de Baca. I’m from Council Bluffs Community Schools. I teach at Thomas Jefferson High School in Iowa. We’re going to do density of solids. You’ll see us move into kind of an onramp, backtrack to do the treasure hunt activity. We’ll do a little bit with densitometers. And then we’ll wrap it all up with dancing raisins and a lot of fun. This was a good group. I hope you enjoy density (MUSIC). Welcome, I appreciate you guys coming out on the end of the afternoon, and I promise that your time will be worthwhile. We’ll have some fun. We’ll learn some great stuff. The title of the presentation is Taking the Dense out of Density. But it’s basically a standards unpacking unit that teaches you how to take a concept – any concept in your curriculum – and move it from a series of activities to something that the kids take away good content from, so that you get a chance to say “Okay, I’ve got a concept that I want to teach in my class. Can I use this as a template to make sure that my kids, without stressing me and turning my hair as gray as C’de Baca’s, without making me eat and gain weight like C’de Baca, without making me have heart attacks, can I get the kids from point A to point B, from knowing very little about a subject to have a master level experience to where they can apply the particular content in new and different ways. And that’s the goal. And so we are giving you some activities. You know that there is no science and no elementary science that doesn’t exist without toys, so we’ll use some toys. We’re going to start with the concept of density, only because it’s one of those very difficult concepts to teach grade 2 through even grade 12. Now at the elementary level, particularly at the primary, we’re looking at just differences mainly. We’re not going to do the numeric, the data gathering, the quantitative stuff about density, we’ll do qualitative – it’s heavier than, is lighter than, and we’ll segue. We’ll move them slowly into the concept of density, building a foundation that allows them to construct accurate knowledge, because the biggest thing that drives people crazy is at the secondary level, and I work with secondary people mostly, is when a kid comes in and they’ve constructed this really beautiful world of incorrect knowledge. And we try to tinker with that. But trying to tell somebody that – like the seasons we were talking about this morning, trying to explain to someone that the summer season is not caused by the sun being closer to the earth and giving more heat. It’s such a pervasive misconception that even when they interview Harvard students as they’re graduating from Harvard they did this shedding light on science program they will say “Well it’s because the sun is closer to earth at that time.” Or have you ever seen those Leno Jaywalks? When he asks people, when asks them science pay attention because some of those things are really frightening. But we want to get kids not only to come out of this and say I like science, I like school, I like you, but we want them to say I am competent in science, that I can tackle problems twice my size. So we’re going to go back and we’re going to unpack a little about the density of solids. We’re going to do an activity that I love called Pencil Hydrometers, okay. We’re also going to do a couple of other activities that I just love that some of them are kind of gross and some of them are kind of fun. Now this particular unit on density stemmed from an activity where a kid said – you know how you're teaching your heart out and you're up front and you're giving kids all kinds of great stuff and the kids say "I've got to go to the bathroom," you know "Why did my uncle's hair fall out?" They come up with off-the-wall stuff. This kid that I didn't think was even paying attention raised his hand and he said "Why do fish float when they die?" And I teach chemistry, and I'm going "What?" And he goes "My uncle and I were out fishing," and I go "Okay I got that part," and he goes "Well we were using a little explosive." I don't even want to know this part. But he says "And you know we would set that off, it would blow up and some of the fish in that particular region would float to the top." And I thinking you fish differently that we do. And it got us off on a tangent that was very valuable because we were getting ready to do physical and chemical properties of matter. And so I said "You know, I've gotta go back and ask you what you know about density." And so I asked them and from their elementary school instruction they had a variety of theories about density and about sixty percent of them were constructions that teachers had taught with all their heart and soul, but the kids had constructed their own little world as adults often will do when you talk to parents sometimes it happens, when you talk to your children that happens – they construct their own little world. You said "I can't go to the mall tonight," but you didn't say "if I go this afternoon and it extends into night I think that's probably legal." Okay, so getting understanding is tough. Communication is tough. And so I went back and started teaching the kids and I found that I wanted to back clear into elementary school with them and see what they knew and what they learned and take it from there. And so this series of lessons for elementary stems from that. It also stems from my experiences teaching 4th grade, which my hair was dark – it was gray by the end. Some of my first years were in the elementary level and I loved it. I mean those were the best years and unfortunately if you have a certification in science and your district can't find chemistry or physics teachers, you get bumped up. And I love teaching high school kids – their sense of humor is my sense of humor. However elementary holds my heart because I love staring at a group of kids and having them go Wow! And the wow factor is a little bit more apparent in elementary than it is in secondary. In secondary you have to get to wow a little bit more – I've got to get through some politics first in order to get to the wow, but the elementary kids you can wow them with a plastic fish. So we'll start with a plastic fish. Now I'm gonna tell you up front when we were in Denver I got these plastic fish at the little place that sells all of these old trinkets I think in Omaha, Nebraska. And they sell them by the gross and whatever. And I said "Do you have any plastic fish?" And he goes "Oh yeah we got plastic fish." So he found these little cute plastic fish and I'll give you some fish in a minute. They sink. So the whole point of the plastic fish was to do the activity where the fish float, but I'm going to tell you right off hand, these fish sink. And so what it is about this fish that makes it sink is different from most fish. Most fish will sink all things being equal. There are scales. What else does a fish have that would be heavier than water? Bones, yeah. Fins that are cartilage or something. Fish guts. Okay. All that stuff would cause a fish to sink. So a fish likes to be able to open up some sort of fish valve and be able to have gasses come into the fish to change the density. Really dead fish float because of a chemical reaction called decomposition, but a submarine works in the same way. And so you can use the analysis of a submarine to explain to kids, fish. And it gets back to density to tell you – and I wouldn't use this with very young kids. A submarine sinks and becomes neutrally buoyant because it has these two tubes – these ballast tubes are generally filled with water. And a submarine is made of what? Metal, which is usually more dense than water. You're going down in a large metal tube, and so the submarine would normally sink. So they take compressed air and they force the water out of these tubes until they've got enough air, like a life jacket, on both sides of this submarine in order to make it neutrally buoyant in order to give it enough lift, because of the gas, the whole submarine calculated in terms of its mass relative to the mass of water and that submarine will lift up. And if you want the submarine to go down you just open up a valve and let some of the gas out and the submarine will go back down. And so you can continue to do that until you run out of compressed air, which no submarine really wants to do for obvious reasons. So we're going to take a look at the density of solids. From point A to point B – and I like to teach things three-deep. I explain this in the secondary workshop. Three-deep means I give the kids an activity that's kind of fun. I give them a model that they can get their hands on, whether it's a model that they can manipulate or a model that's drawn on an overhead or on a piece of chart paper or on a chalk board and then I also give them another opportunity to demonstrate their understanding in some sort of activity. And that's called three-deep. And I test them three-deep. Three-deep means you explain it to another person, you explain it to me generally in writing or orally if I was working with primary kids I'd say "Now, tell me what you're doing here. Tell me what you're seeing." Listening for cues to the construction of knowledge that they have and then I might do some sort of form of assessment that allows them to see if they really have it. And with upper level kids it's different than with lower level kids. I like a lot of oral give and take where I can talk to the kids and listen to conversation. So to give you a background in density so that you have more background than then kids most of you know density pretty well. I'm going to cover that and then we're gonna go back and we're gonna to do pencil hydrometers from a teacher's prospective. I explain to the kids that density is kind of interesting because let's use a Volkswagen. The record is held by the University of Texas and it's like, I don't know, 30 people in a Volkswagen. They're obviously not people my size. And we could not do that in Iowa. I think the record in Iowa, corn-fed, lots of beef, is 6. California it's 136 – no I'm kidding. Hollywood it would be 900. But a Volkswagen – kids know what a Beetle is or they'll know what a small car is. You can call it a Yugo or whatever – a very small Ford – what are they Focus or whatever? But if you had a car that had 42 people packed into it, it would be heavier than a car that only had 12. Okay and the kids will obviously say "12 you-people or 12 me-people?" That kid's out! So density depends on how much matter is packed into a single space. Now at your table there is a thing that has some film canisters in it. Take that out, will you? What I want you to do is to line those up from the heaviest to the lightest - heaviest to the lightest. I want everybody at your table heft those just a little bit. I don't know about those two. This one's heavier than this one. This one I think is next. Yes, yep, yep, check. Ok Stan, Come on around. Ok, I agree. Now you want to verify even further, and you got a chance to do it, because the film canisters have the same volume. And volume is a unit of space. My volume is much greater than say Linda's volume. Okay. But the film canisters we've controlled the variable and the variable we've controlled was volume. Yeah. Open them up and see if there are more pennies – I used pennies for this experiment – in each one of those. And you can check even 1 and 4 to make sure, or you can check the other ones as well. Now an interesting note for teachers, and this is on your GEMs website as well if you've attended the GEMs session. If you type in density and you do a search on the GEMs site you'll see several activities involving pennies. Pennies changed in 1982. Anybody know what happened to them? Now pennies now are a very thin coating of copper cause someone brilliant at the Treasury Department was probably sitting around over coffee and said "You know, Sally, a penny has more copper in it than a penny. So we may be losing money on these things." In their infinite wisdom they said "Well let's make them out of something else." They thought about plastic I'm sure or some kind of polymer. They thought about other types of metals – aluminum – and do you remember doing the war years? Don't raise your hands because we can tell. We can tell who remembers this. During the war years they made them out of steel when copper was in short supply – that's the big WWII. So they didn't want to go back there, because the copper penny has a certain Americana to it. So they didn't want to change the look of the penny, so they said "Can we do anything else?" And they came up – material science came up with a solid core of the penny made of zinc, which is a cheaper metal, and the outer surface of the penny is copper. It's a little more expensive to make because you've gotta kinda dip them like a chocolate I think. But it made a penny that makes a different ring when you drop it on the floor. If you drop a pre-1982 penny on the floor and a 1996 penny on the floor the ring will be different because the two densities of the metal are different. And so one of the things that you can do with elementary kids in the upper – 4^{th}, 5^{th}, 6^{th} – is you can take some pennies that were pre-1982 and pennies that were post-1982 and ask the kids to hypothesize about the differences. And with younger kids you can do the same and different kind of activity with film canisters. You're still teaching them to control one of the variables – volume. But you're getting them to use their tactual senses to examine something that's fairly complex and fairly difficult to teach to that level of kids, which is mass. Anyway, so these pennies – if you know a chemistry teacher – send them all to Joseph and me. If they notch the edge of a penny, a fairly strong acid will eat away the zinc. You could put this in a little beaker of acid and the inner core – the zinc core – will be removed from the penny and you'll end up with this absolutely paper thin copper penny. They are absolutely amazing and if you can get a couple of those for your little science kit to show kids it's a really powerful thing. So kids get the idea that there's a difference in pennies if you want to do this penny. But in this activity here they get an idea that there's a difference in terms of the amount of stuff that is stuffed into one of these film canisters and you've controlled an important variable. Now if you get across the point that density depends on how much matter there is packed in a unit of volume you've gotten through the unit of solid density – no problem – you're there, okay? Now you want them to look at some other things and it becomes a little bit more problematic because sometimes you know you have to back up to get onto an on-ramp. You have to backtrack through the city to get back up to speed. When I take kids through this one of the things that they're not very good at is observing. Have you guys noticed that? If you say "Give me five good observations about what you're looking at" what will they come up with? Blue, looks like a fish, has eyes, has those finny things, tastes nasty – oh that's 4^{th} grade – no that would be 2^{nd} grade wouldn't it? So here's what I want you to do. This is called a treasure hunt and this is primary. It leads up to density or it comes in to the point where you say "Boy I've got this incongruence going here, I've got this little – the kids are not making good observations, they're not understanding what I'm saying – I want to focus them and I want to redirect them." There are treasure bags at each table. Treasure bags are things that you just gather from whatever drawer you can find and inside these treasure bags there are a variety of objects – round, round and round – I don't think there are any square things. There are things that look like other things. Here's the rules of the game. Treasure hunt game means you can take one object out of there. You don't want the people around your table to see which object you've removed. Then you are to look at that object in your hand carefully and you are to make 5 observations that you think will describe that to another person. You may use color, but you can't use "it looks like a butterfly". You can use "it looks like it's made of wood". You can use "it looks like a rock'. You can use "it's smooth", its texture, any of those, but you can't say "it looks like a butterfly". So do that now – take an object out. Yeah and then after you've got your observations made put it back in there clandestinely, on the sly, and then we're going to have one of your partners try to identify that from your five observations. It's a good reason to take all of that junk out of your junk drawer and put it into zip locks. The surface is smooth. It has a circle or a ring on the back of it. You notice how your eyes dart over certain things every time she tells you something? The middle of it has sort of a rectangular shape. And the ends of it sort of have the top part of a heart shape. Sort of a top heart shape. Now do not feel bad if you do not get if they don't get it…(discussion) What were the clues that led you directly to the object? The best clues. Texture of the material it was made out of. Like wood, or stone. Let me hear her clues Concave, had a circular edge to it. As they struggle to explain something and they need better words that are connected to descriptions – like convex – then the vocabulary becomes extremely important and it's very apparent when a kid doesn't understand what convex or concave or one of those words mean at the 6th grade level because you'll see these kind of flashes of panic go across their faces, because it's one of their 5 clues. You can make it okay for the kid to ask the meaning of a word from someone else and they're learning a vocab word. I almost guarantee you that you won't forget – I may teach convex and concave in my classes, but if they do it and they learn it from a peer while they are trying to guess an object they will remember it more effectively than if I stand up in front of the class and give them what convex and concave is because it's tactile, it's real – awesome explanation – very well done. Did he explain it? Will you forget it? Maybe. Now Joseph – you had an interesting – because of Joseph's vision it was a very unique experience because if you're working with kids that have vision impairments of any kind – that have limited vision – then their tactile senses – it's not that they're super-people – they don't turn into automatically have the super-Spiderman sense of touch, but it's that they have to use different methodologies to explain. We rely on color. We rely on material sense – like it is wood, it is a stone. But when you are relying only on the tactile sense it becomes much more difficult. That's what primary kids are doing because their language development is not there yet. So where this might be a fairly easy task for us, although some would argue in this room, at this table in fact, this is a very difficult task for primary kids and when they get it done you know how you want to give kids a real sense of success where they say "I did that, I feel pretty good about it too." This is something significant for primary kids through the 2nd grade – even through the 4th, 5th or 6th grade. We have 6th graders in our district who will say "When are we going to do treasure boxes again?" because they want to get better at it and it brings up a little competitive edge in some cases, which you want to minimize, but it's something that they can hang onto and something they can feel good about. And under the table, very clandestinish, sneaking in vocabulary words. And you know what's interesting is that sometimes your special education students will significantly outperform your regular ed kids. Because they are used to having to go through some motions to explain things in a different way. They come from left field or right field, where a lot of kids will come right down the center and be very factual and matter-of-fact and expect that this person is going to understand exactly what I am saying. Special ed students do not have that expectation at all times. They'll say "I don't know that you're going to understand what I'm going to say to you, so I'm going to explain it a little bit more clearly or a little bit deeper or I'm going to use a metaphor. They'll use light, they'll use analogies, they'll use the most incredibly creative ways of describing objects that you'll ever see. And you'll see other kids – regular ed kids – say whoa – you know, like that was brilliant. And it was. You're just smart in a different way. This is one of my favorite activities and you can use this at primary, you can use it at middle, intermediate, junior high, high school. One of the favorite things that my high school kids do is categorizing. Periodic table comes into chemistry, right? It's one of our least favorite things when we're taking chemistry, but it's one of the chemistry teacher's favorite tools. If this activity goes on prior to and the categorize things prior to they understand things a lot better. We were talking at one of these tables about the elimination factor. Sometimes it's very difficult. We have a tendency to look at things – like here's a good case in point. You send your 12-year-old son. You say "I want you to go to the garage and get me the hammer." And if you don't have a well-organized toolbox, your 12-year-old son will go out there and say in a loud voice "I can't find it." Where it's probably sitting right there. But it's in the middle of some tools and it's not like they're standing up doing a little hammer dance saying "here I am". They're not used to eliminating information, whether it's in reading that's not important, or whether it's in summarizing and finding the key point of a reading passage – they can't do that. They can't eliminate unnecessary information. In science we have to. We have to learn how to eliminate unnecessary information so we can focus in on what's important – whether it's curriculum, whether it's scientific investigation – so this does that. Because how successful would you be – these guys were going green and we were talking about there were only how many green things – three green things. If they eliminated everything that wasn't green and just had the green stuff sitting in front of them – how easy would that have been? Would you then use that technique later on? Could there be some transferred learning when you try to talk about reading you could say "I want you to eliminate stuff that's not important – just like we did in the treasure hunt." Okay, I can do that! There's a hook. There's a cognitive, conscious hook in their brain that's like – can you remember, sometimes when you remember people's faces or names, you have to give some association with that – like Linda – you would probably remember her because of her unforgetable hair – you would probably remember that. I remember her because of some other horrible… (laughter) You'll remember somebody based on somebody they look like. And kids sometime remember based on something they did. Very memorable. Those are hooks that you use to cognitively associate things. We don't do enough of building in that on what you've done in elementary. If I died and went to heaven, my died and went to heaven wish would be that we could articulate some of these activities so that when the kids come into my classroom if they would have had elementary teachers I would know what the elementary teachers had done and they'd say "C'de Baca just sit and listen and I'll show you what I'm doing with my kids" and I could do some of the same things so the kids aren't relearning things in a different language, relearning things in a different pattern. I could save myself all kinds of agony and we don't do that enough. This is an activity that could articulate that way. Alright so what does this teach kids about density? Well it teaches them to start looking at physical properties because you are describing things how? Smooth – what else? Color, texture, shape, utility (good one), now there's a link, heft – there's a link directly to density when you start saying it's hollow. And some kids might say "What do you mean, hollow?" in particular primary levels. Well, it doesn't have anything on the inside. That's where those film canisters come into play. If you go to Walgreen's or Osco or Walmart or any one of those places that develop film and you say "I'd like you to save me some film canisters", they will save you lots. They'll give you more, and they're wonderful for science. But I'm going to warn you, tell them if you're going on summer vacation. At the end of summer vacation last year I forgot to tell the Walgreen's folks that I didn't need film canisters anymore. And I had this message about four times on my answering machine that said come get your film canisters. And each time it got a little angrier. So I went there and I thought how many film canisters could there be. In the back there were six lawn and garbage leaf bags full of film canisters. So I filled up the back of my van and went to local elementary schools dropping them off and I told the principal "Don't ask me what these are for, but your elementary teachers are going to want them." And it was kind of like "If you'll leave, okay – I'll take a bag if you'll leave." So you can get these for free. It's a really easy thing to do. And since you're controlling the aspects of the variable of volume, then you can put anything in it in terms of mass. Pennies work great because they're cheap, they're easy to find, and they can count them and see how many pennies are in there. But know that there's a difference in the terms of the pennies that we talked about before. Okay, we've got density of the solids down. We've got the ability to describe on the right track. I might go back to something like treasure things to say. I need you to describe things better. Your ability to describe things, say at 4th, 5th or 6th grade level, needs to be a little bit stronger, so let's go back and do something so that you're describing things with more detail. Hollow, heft, smooth, shiny, cold, warm – you're using the range of descriptions, you're using your senses better. And now let's take a look at density from another aspect. At the 6th grade and 5th grade level I would probably do the density and film canisters quantitatively, using numbers. I would bring out a scale and have them weigh them. Have them notice that you can calculate the volume of the cylinder by submerging it in water in like a graduated cylinder, or a beaker that has some graduated markings on the side. You can fill it up to a certain level, pop that little film canister down into it. I would probably fill the film canisters with pennies so that it actually sank. And you record how much the level of water goes up. That difference is the volume of the film canister – easy way to get volume. Or you can look it up on the web. Once you've got the volume of the film canister you can figure out the mass of this film canister with the pennies in it. And 1 and 4 are going to be significantly different, right? Then you can figure out the density. Density is mass divided by volume. So you can do it qualitatively by just looking at the heft, or quantitatively where you're actually measuring. You can take pennies out and say – this is a cool thing and we've got a hand-out on it later on – how much does one penny weigh? What's the volume of one penny? And this is in your hand-out too. What's the mass of one penny? Okay, what's the volume of 12 pennies? And what's the mass of 12 pennies? And if it truly density, the relationship will be linear on a graph. That's a 4th, 5th and 6th grade concept. And it becomes a really good way to teach them graphing. Joseph? [Joseph:] "You used the word weigh a while ago and now you're using the word mass. What is the difference?" Well, mass is a quantity of substance. And weight is effected by gravity. So right now I weigh a little over 125 pounds. I'm in the ballpark – I've got an error factor of 75 something percent, but okay. If I go to the moon – the moon has less gravity. Have you ever watched astronauts walk on the moon? Okay they kind of bounce and lilt. I'm less – I am JLo on the moon. Okay, maybe not. But I'm certainly not Rosanne. I'm lighter on the moon in terms of my weight, but the amount of C'de Baca that there is never changed. There's a certain amount to me. Five pennies is five pennies is five pennies, but if you weigh five pennies on a scale – here on earth it's dependent on gravity it's going to have a certain weight. The mass – I could weigh the mass anywhere. And mass is measured in a scale. And the scale is a little bit different – or balance, excuse me. If I took and I put five pennies on this side of this balance and I put a certain weight on here – this would be dependent – how much this went up or went down would be dependent on what I put on this end, right? And it would be the same, whether I had it on the moon, on Jupiter, stay away from the U planets, on Venus, Mars, Earth – it would be the same no matter where I was, because this weight and this way I'm comparing apples and apples. That's mass. When I'm thinking about weight I'm dependent on the pull of gravity, okay? Now, that get's us to another aspect of density… (MUSIC)

(MUSIC) Runners, and this is more for your information in upper elementary than it is for primary, but runners, like you have more of a runner's build than I do. I don't know why, I'm just guessing here, but if we went on a cruise ship, and the cruise ship went down, she's shark food. Okay, even bottom feeder food. I am a life raft for half of my floor. adipose or fat tissue is lighter, is less dense rather, than lean muscle tissue. And so, it's one of the reasons why some of the runners have a difficulty swimming. Your triathlon is no easy piece of work for somebody that's a die-hard runner, 'cause their more lean muscle tissue, they get into that water and they don't bob to the top like a cork like I would because of the difference in density. If you'll go to the, if you join the Air Force or the Army, they take a weight measurement of you. They get you completely naked and take your weight – and it's a job I want. But – alright, next – you're 175 pounds – if they want to also get an indication of your fitness and that is body fat composition. So what they'll do – they put you in this tank – claustrophobics need not apply – that's filled with water, and its got these calibrations and you're submerged in the water, you exhale as much air out of your lungs as you can, and then all of a sudden the level of the water raises an equal amount to your – based on your volume. And if you're fluffy – like me – your volume is going to go up more than if you are lean. So now they've got my volume and they've got my mass and they can calculate my density. And there are some really good human anatomy tables that can tell you what percentage your body fat is. And any good fitness trainer will explain to you your level of fitness based on body fat, as opposed to based on how large or small you are – or you think you are. And it's good to tell kids that, because you've got a lot of kids that are extremely thin that have a high percentage of body fat. And kids that are a little bit stockier or a little bit heavier that have a pretty good fitness level because their body fat composition, the percent of body fat, is lower. It's a real good way to integrate physical education or integrate some health concepts into it and it's something that kids don't understand and it's based on density. Back to density. Is there a difference in gravity and weight based on where you are on the planet Earth, and that's a really good question. And the differences are minor, but they're enough to throw some things off – yeah. So, I'd like to go from the concrete, which is solid density, to more abstract to more abstract. And so if I was going in phases of matter I'd go from the concrete, which was solid density, to liquid and then to gasses. And gasses are really tough at the 6th grade level because the kids are going to take that all kinds of places, which you know I'm a kid, I will. So lets go to liquids first and for liquids we're going to use a very highly technical piece of equipment called a pre-form Anybody know what these are? Alright. These are awesome. Free science equipment once again – these are called pre-forms. When they make soda bottles or water bottles – not your water bottles, but these were at one time, these are going to be made into, were before I stop them in their developmental stage, were going to be made into 2-litre pop bottles. They take these pre-forms and they make out of plastic and they come just like this. They put them in a mold, they heat them up and they inject air into them until they fill the mold and this becomes a 2-litre pop bottle. If you contact your bottling company, you may be able to sweet-talk them into sending you a case of these pre-forms. 'Cause if they're any way damaged – like if water gets on them, or one falls off the truck, or they get any dirt on them, they don't use them. Generally the bottling company in your area will probably be happy to give you some of these. And they're wonderful because you can put stuff in them and you can seal them off. Now they're tough to see through if you really need to see things distinctly. So we're going to be making a small modification in this particular activity, but these work great. And what I want you to do is with your partner there – or partners – I want you to put enough water in here to where it's up above this little rim here that looks like a little collar. Okay, just about that yellow thing there would be great. Find some water and put it in there. If you spill water – it's okay. Just water is okay. You're going to make it messier in a minute – very good. Alright – now – the next thing I want you to do is to cap it off and put that aside for a second. These are called pencil densitometers. And I want you to take one of those lovely golf pencils. And I want you to do what we call in science, calibrate the pencil. Now to calibrate the pencil we have to have some even markings along the side, and so with those little metric little rulers we've got there, would you mark off in half centimeter marks all the way up the pencil, from the point of the pencil all the way to the end. Place the densitometer in it. And I want you – I would probably put it point up – try it point up. And then I want you to count the number of markings that are above the surface of the water. We're not going to change the pencil – we've already got that calibrated – that took so much work on our part. What other variable could we change? What's that? Change the amount of water – I could put it in a taller cylinder – I could do that. What else could I do? Change the temperature? Don't have a hotplate, but that's a wonderful one to do. 'Cause temperature changes density. What else? Well it was different, the way the pencil went in. I could change the way the pencil went in – okay what else? Very good. Alright. I'm going to credit you with it – it's okay – it's a right one. Alright, if we change the liquid we're changing – there's a relationship between the density of the pencil and the density of this liquid. And so I'm looking at kind of at – this is water – so what if I changed this to something different? And so on your table there are some little vials with a white powder named sugar – that's a white crystalline substance known as sugar. You get the one from the 60's. I don't know why it says 60's on it. There's another one right there. What I want you to do is dissolve as much of that sugar as you can in your container without it overflowing. You may have to empty out a little water into one of the glasses. And then I want you to shake it up. And now you have a sugar-water mixture as opposed to pure water. You could always add more water. Now for those of you that really like clean elementary rooms – sugar is cheaper, but salt is cleaner. Salt will not make your kids sticky. And then you want to dissolve it. For our purposes here they don't all have to be dissolved but I would have kids dissolve it. I would probably even have kids put one tablespoon in one, two tablespoons in another, three tablespoons in another – particularly at the 5th and 6th grade level. Now insert the pencil in it again and note if there's a difference. Ahhh. Let's gather some data. What change did you notice in terms of numeric value, in terms of how many marks were out of the water, between trial one with pure water and trial two with sugar water? How about this table back here? "The pencil did not go down near as far" Okay, did you take a reading? Do you know how many marks it went down? "A mark-and-a-half." A mark-and-a-half – alright. Okay, so did you guys go up two centimeter or one centimeter? "One centimeter" One centimeter. So one centimeter, one centimeter, a-centimeter-and-a-half, about a centimeter-and-a-half. Your results are going to be pretty consistent with kids. It'll go up about a centimeter-and-a-half and you can vary the amount of sugar, but you're not going to get a whole lot of difference until you get a whole bunch of sugar in there – 'til it almost gets to be syrup. But it's interesting for the kids to know that if I change the density of the liquid then something's going to float higher. Now that's gets into buoyancy and buoyancy is kind of a real sticky concept. The only thing I stick with this is in terms of density and I'm comparing the density of one object to the density of the other. With the theory being – if it more dense than water it will sink – if it is less dense than water it will float – if it's the same density of water it's going to settle somewhere in the middle and I can compare it based on how much it floats. Like, for example, if I am swimming in salt water I am going to float at a certain level. If I'm swimming in fresh water it's different than salt water. And the saltier the water the greater degree of float. In forensics, when they test a piece of glass and they want to know the density of a tiny sliver of glass that they might need to solve a case, they have a set of reference liquids that they know the density of. And they'll put that tiny sliver of glass that's too small for them to measure in these different liquids. So they can take it out of the liquid and put it in another liquid and when they find a liquid that it floats right in the middle of, what do they know? The density of the glass. And the glass from your glasses is a different density than the glass from the window pane, and it's different from the glass in your headlights, and it's different from the glass that might be in the watch face that you're wearing. I mean different glasses have different densities. And sometimes that can match up, 'cause you can't match up a sliver with where the glass came from, but you certainly could if you could test the density of the different glasses that you think it might match. And so it's a real good application at the 6^{th} and 5^{th} grade level to forensic science that kids are kind of hot on. In terms of fruit juices, fruit juices are measured now with a much more high-tech instrument that does some refractive index measuring. But they used to use a densitometer. Winemakers used it for years which was to measure the amount of sugar. You use it when you do your anti-freeze in your car if you leave in the northern climates. This will mean nothing to you from Southern California, but in Minnesota in the winter it's really important that you know how much anti-freeze you have in your car so they draw out a little liquid out of your coolant system and they have this tiny little BB in this u-shaped tube and it will float at a certain level. Well it's somewhere between the density of anti-freeze and water – this little BB is. And where it floats will tell you how much anti-freeze – percentage-wise – and how much water is in your system and will tell them whether or not they have to add anti-freeze or whether or not they can add water. And it's a really good way to test how much cold your car will withstand before it will not start, or because things will freeze up and in Minnesota I'm firmly convinced that there are human beings that are still frozen somewhere in Minnesota, 'cause it gets that cold up there. Winemakers or people that make fruit juices can use a densitometer – looks like a big turkey-baster. Same process and it will tell you how much sugar because you made this liquid more dense by adding sugar. Because then you made it sugar-water, which is obviously more dense. On the GEMs site there is a really good activity with potatoes. If you clue into density, they called (inaudible), I think they're from McKrell There's one where you can take pure water and then sugar water and then you put a potato in one and in water it's going to sink and in the sugar water it will float. But if you make a mixture where the bottom is sugar water and the top is plain water the potato will be right in the middle of the liquid. It's a really good activity. You can do the same thing with different colors of liquid. You can take a couple of glasses – like six glasses. In glass number one you put pure water. In glass number two you put some salt – well, better yet, start with a glass of pure water and add tons of salt to it. Color that one color. Take out part of that before you color it and put it in the next glass and fill that glass up with half again as much water, so that you have kind of a serial dilution going on. This one is really salty, this one is less salty, less salty, less salty, less salty. Then what you can do is you can take a clear piece of aquarium tubing, or a long tube like a one-liter pop bottle or something. If you add the liquids very slowly, the layers of salt will layer with the most dense salt water being on the bottom, the next dense and the next dense. You can make a whole rainbow of salt water and it's a good way to talk about liquid density. You know? Questions at this point. Now liquid density is really complicated. And at the lower levels I would just be talking about similarities and differences. I probably would not do this with lower elementary kids, but I might do the salt water one and talk about what do you see? Not explain what's going on – the phenomenon – but explain the observation that one layer will – one liquid will layer on top of another one and I might relate that to salad dressing. In your refrigerator you have some salad dressings – particularly Italian salad dressing. If you have salad dressing what floats on top? The oil floats on top. If you ask kids in high school what's more dense – oil or water. Kids will think oil is denser because it's thicker, but it floats, so it must be less dense. So we have to realize one of those seasonal misconceptions. But at the elementary school if you're saying "Take a look at some salad dressing, you don't have to explain the phenomenon to them. You've introduced the phenomenon a little bit in a way that you don't have to explain a thing or connect it to the word density, but later on they'll have that idea that "Oh, wait – the salad dressing oil floats." And so when it's introduced later on it comes perfectly okay. "(inaudible)… testing the different milks. The whole milk, the 2% milk and the 1% milk and the skim milk and of course he predicted that skim milk would be less dense because, you know, it 's had all these things taken out of it. The outcome of his project was not true and then when he went back and remembered that the oil floated – that fat floats to the top – it turned out to be the whole milk was the least dense." Fattier, yeah. He did great. "Because he was a mathematician, he did his all with measurements. He didn't put them in…He found the volume and found the density – he was a real math guy." But that's well within the range of… You teach kids density. Now that particular type of experiment is well within the range of kids in terms of helping them through the measurements – not primary – but certainly 4th, 5th and 6th grade when they measure the volume and they can measure the mass they can say "Well why does this milk come out with a lower number than this milk." And teaching them what's in milk is kind of important. I mean there's a nutritional value there. We did a milk experiment that's kind of fun. It's in the hand-outs under 5 that's called the exploding colors of milk could be a good follow-up to that. Coins – and I put these fake, plastic coins only because I thought they were kind of cute on your table. They're identical copies of – okay not very good I don't think – I'm looking at the Liberty head of this quarter and I don't think – is it George Washington on the quarter? It looks a little more like Martha, but. It says – stamped across the top – copy – like I'm not going to know that this is not a real coin. Maybe in some countries I wouldn't. There are coins across the world that have different densities. In China there are some coins that actually will float. And so if you have any parents or any friends that travel, if they'll bring you back some different coins of the world it's really interesting for the kids to see the different densities of the coinage because it’s a good connection into some other ranges of social studies and things like that. So we’ve got the pencil hydrometers made, we know that there’s a connection to real life and forensic science, we know that there’s a real life connection to that in terms of fruit juices and the sugar in fruit juices and it’s a way that they measure things and antifreeze – cars. Good science involves accurate measurements and so far we done things kind of qualitatively. We’ve been looking at characteristics of things and the only measurement we did was making some half centimeter marks. Well it’s a good idea particularly in the transition from 4th to 5th to 6th that we get kids to start thinking quantitatively and saying “Can you measure this more accurately? Can you create a densitometer that will really accurately measure liquids?” And here’s one good challenge to do to say “Look, I’ve taken a container here and I’ve mixed some sugar and some water in here. I want you to tell me within a tablespoon how much sugar and how much water I put in here. Design an experiment to do that.” Talk them through some experiments that might be similar and then let them go with it. And I guarantee you it’ll be a struggle for them, but it will be an effective struggle in terms of they’re starting to think “Well I’ve got to measure something, and I’ve got to prove it to her, so we might have to start actually counting these. Maybe we’ll have to go down to half of half a centimeter – a quarter of a centimeter – maybe we might have to use something besides pencils. What else will float?” It’s a real good challenge. It’s a great take-home challenge for like the holidays, when you want to be really friendly with the parents and you give something for the kids to work on that’s going to keep them busy, they will erect a statute in your honor in the family living room if that kid is busy and engaged. So you teach them to measure carefully and accurately. Now we haven’t done that yet, but that is important and it gets to be important in terms of the middle grades. You want them to accurately describe things and that you want to get them better and better at describing things all throughout their school experience. Now you want to start getting them better at measuring things and that’s introduced here. These little things can actually measure the density of liquids, but even more importantly you can measure volume and you can measure mass and if you have trouble coming up with materials and equipment, always ask scales. This is a terrible reference, but if you talk to your police department – every police department in the United States busts somebody that’s selling some sort of medication under the counter. And those drug busts usually they have some sort of sale. So the police departments will have scales of all shapes and sizes highly accurate in some cases that go unclaimed because generally drug dealers don’t go back to the police station and say “I think you have my scale.” That doesn’t happen that often – I’m not sure why. But some of the scales are worth $300-$400 and some of them are much cheaper than that. But if you contact the police department and you say “if you bust a crack-house – no – if you have a drug bust, or you have a seizure that involves some sort of measuring device like a scale. I am a teacher – not a drug dealer – but my kids would love to have that so they could practice some of their measurements so that they might become – no, wait – so that they can become scientists later on.” And sometimes you might have to do a little talking to do it, but if they have them, once they’re released, it’s a great way for them not to destroy that material, but to give it to the school and so you could get a scale that would do that. Exactly – from something bad comes something good. Different super balls and different plastics have different densities too and they use it based on water and I've got a range of super balls here for you guys to take a look at anyways – to just see some of the differences in the textures and some of the differences – you can tell sometimes in the bounces of things – this one actually looks like either a glob of really old gum. Yeah, this one would go all over the place. This either looks like a specimen sample or a rock or something – I'm not sure what it was. But plastics have different density and so when they grind up plastic – pass those around to people that say "I'll toss these to you" – when they grind up plastics into tiny little pieces, some of the plastics that are recyclable will float. And they'll skim those off and they'll use those for a certain application and those that sink go to a whole other hopper and they're used to make park benches and some other things – high density polyethylene, recycled plastic – but it's a real good application of density. It's how they separate things sometimes - classify too. Another good application of density involves gasses. No, you guys can play with those. It's like being back in junior high – it kind of feels comfortable. The mass connection of this – while I've completely lost half of you with the super balls, which is good – is that you can graph this. Now on this graph on the overhead for those of you who might not be able to see it – mass is on the vertical axis, okay? And on the horizontal axis across the bottom is volume. And those units – mass is usually measured in grams and one gram is about the mass of a paper clip. And the volume called one centimeter, or one cubic centimeter, or one milliliter – I explain it to kids as if I was able to cut off – kids remember things if they're gross, if they're larger than life – okay so I say I'm going to slice off the top of your little finger – speaking just metaphorically here – I'm going to slice off the top of your little finger and that top of your little finger represents about a cubic centimeter, about a milliliter. They'll understand that – that's a good point of reference. So if I had something that had a volume of two and a mass of two, it would have a density of one. Mass divided by volume is density. Probably introduced about the 5th grade level. But the graph that you get when you graph mass and volume – particularly of something like a penny, those groups of pennies, as the mass goes up and the volume goes up, you'll get a line that looks straight across. Where the density doesn't change. This is where the density is actually going up. I'm measuring increasing volume, but I'm also measuring increasing mass. Now watch what happens. I've got two divided by two, if that was that dot point there that would be one. Three divided by three is going to be one. That's where the density remains the same. I stated that wrong before. If I had a glass where the density was flat-lined across – I see some graphs from kids. What they'll graph is they'll graph number of pennies versus density. And so if you've got number of pennies across the horizontal axis and across the vertical axis you've got the density, the density doesn't change irregardless of how many pennies you've got and so they get this flat graph and they say "I don't understand why your graph looks like that and my graph looks like this." Well it's flat-lined. And I say "Well, what changed?" "Well, I changed the number of pennies." "Well would the density change if you change the number of pennies? Look at your graph and see." And they eventually get to the understanding, well no it doesn't. Density is a quantity or a descriptive powerful characteristic that doesn't change irregardless of how much you have. If I have this much gold it has a density of about 19 point something grams per cubic centimeter. And if I have this much gold it has the same density. So if density doesn't change, irregardless of how much stuff you have, it becomes really valuable. 'Cause no matter how big or how small a piece of matter you have if you can identify its density, you could probably identify the material that it is. And so the fact that density doesn't change, it's better even if kids do come up with one of those flat lined graphs. If they graph the number of pennies versus the density of pennies and they come up with a flat line, that was a much better way for me to show kids density doesn't change than when I did the mass connections accurate graph like this. Because when kids see that they think "Well density changes. Density goes up. We use this all the time in science classes and I couldn't figure out why my kids kept thinking that density goes up. And one kid finally said "the graph goes up". I went "what graph goes up" and they go "mass versus volume" and I go "well it does, but does density go up?" Does density go up? No. And so because of the mistaken one I kept that on an overhead. I plopped that on the overhead and its number of pennies versus the density and it's a flat-lined graph. Kids get that. Sometimes even when we do accurate graphing we promote misconceptions of science and so we have to be real careful because you'll look at that you'll think "density goes up, right?" Okay. Now let's go on to – lower elementary. I don't want to leave you guys out on this. Floaters and sinkers are really important – really good. Take a big clear bucket – one of those Tupperware things – what do you put in it. An orange. What does an orange do? Float. What happens if you take the life jacket or the skin off an orange? Sinks. Okay, what does an apple do? How many of you have bobbed for apples? What does an apple do? If an apple sinks somebody's given you something really bad. And one of the reasons we use bobbing for apples is because apples do float. Apples are less dense than water and so you could stick your head barely in the water and if you have a large enough mouth you can grasp the apple in your mouth. It would be easier to actually grab the apple under water, but you would probably drown in the process and that's such a downer during a Halloween party. Uncle Joe got the apple, but he's at the hospital right now receiving some oxygen treatments. If you try different fruits, your tropical fruits that have a lot more sugar will probably do what? Float or sink? Probably sink. You could put a kiwi in and a kiwi goes down like a stone. Bananas are interesting – depending upon whether you leave the skin on or not. Different fruits that have thicker skins – like bananas and oranges – do different things. Apples will float. You can put stuff in there. What's another mutation of this? I know somebody in here has done this. Nope. That's a good one though, that's….Diet Coke versus regular or Diet Pepsi versus regular. Have you guys never done this? Ah! What's in regular Pepsi that's not in Diet Pepsi? Sugar. And so if you take two cans of soda – and the cheaper the better – but a regular and a diet and you put them in water – the regular soda will sink to the bottom and the diet one will float to the top because of the difference in density based on the sugar and the liquid. So if you're ever at a party and the ice has melted down and you're searching for those diet pops that they never buy enough of – all you have to do is skim the surface of the cooler and you'll find the diet pops. If there's nothing floating on the top you're out of luck. If you have to go to the bottom of the cooler it's going to be regular pop. But it's a great way to explain to kids and kids will want to try all kinds of different pops. They'll want to try High V and Safeway and Albertsons and let them. Let them bring in any kind of pop they want. They'll want to try Welch's grape juice. But the key is if has a aspartame or a sugar substitute in it, it's generally going to float. We've found a few rare exceptions but not many – usually in the fruit juice stuff. It's interesting too if you're going to measure the density and you get a really high sugar concentration of some of those sport drinks, some of those sport drinks are sugar and sugar. And when they do a density calculation on that and they can figure out – they can compare it to if you had pure water, what would the density of pure water versus water with a tablespoon of sugar? They can actually do a pretty good job of ramping up to try to figure out about how much sugar one of those sports drinks must have in it and it's amazing – stick your little densitometer in one of those sports drinks and see how high that comes up to the top. It's a good application. So in lower elementary we might which floats higher, which sinks, which floats lower – similarities and differences floating and sinking with a variety of things and we would do something called dancing raisins, okay? Now a lot of you know dancing raisins. I'm going to give you a little – like heard it on a grapevine – yeah – I don't do a good Marvin Gaye – but you got some raisins there and you've some Sierra Mist or some Mountain Dew or something else – grab a couple of those glasses, but some of that Mountain Dew or that liquid in there, take about 4 or 5 of the raisins and put them in the liquid. Now in your observations try to tell me why they're floating and sinking. No raisin left behind. Alright. Okay, now what do you notice? Let's go to this back table 'cause I've been ignoring you occasionally and you are my gifted group. Alright, now what do you see happening? Give me some observations. "Well we're observing that the carbonation is lifting the lighter weight raisins initially because they're dehydrated. And we're hypothesizing that as the raisins are absorbing the liquid plus more sugar that they're sinking." That's a good guess. It's not accurate, based on the science, but it's a really good guess. That's very good. I like that. Now you're on the right track on the carbonation. Carbonation is CO_2 that they add to make this sparkly. It's actually added to make it taste kind of tangy. And so the raisin surface is really kind of wrinkled, right? And so it's allowing – it has a surface that allows that carbonation to attach. I would have kids with a difference of texture as opposed to telling them. So the kids will – I'll say what about a raisin is allowing them to do that? You know, what if I put something smooth in there? You can try it with grapes. You can try it with something smoother, but it works better with raisins. It'll actually work with spaghetti, 'cause it has a smooth surface. But microscopically spaghetti has more – and it's not as fast as raisins. So the little carbonation attaches to those wrinkles or folds and it gets enough air to where it changes the density of the raisins related to the density of the Mountain Dew and it lifts them. Yeah? ….Some of the raisins are down and up, down and up, down and up and some are not. Clearly it has to do with how much water is in the raisins" I think you're right. And that would be easy to test. Leave some raisins out on the windowsill and check those against fresh raisins you've got in the box. Great!

And here's my favorite parent teacher conference activity. You take one of these glasses and a can of Mountain Dew and a box of raisins and put them in a brown paper bag outside your door. And you choose a male student – has to be male. You say "when I ask you to go get me water you are to get the bag outside my door, you're to go away for a few moments. You're to pour the Mountain Dew into the glass. And I use a beaker that we don't use for anything else. Pour it into there and then put a couple – about 5 raisins in there and you're to wait a minute-and-a-half or two minutes and then you come back and when I say where did you get this water from, you're going to tell me the boy's bathroom." They'll go along with anything. So the kids do that, he comes back and I see the parents are sitting around the table, it's open house night, and I'll go “where did you get this?” and he’ll go “boy’s bathroom” and he’ll go “my gosh – do you know what those are?” tell him not to tell you at this point cause some guy’s will go “yeah raisins, I put them in” – you want to tell him to keep his mouth shut – you say “those are sewer lice and those are the largest most – they’re still alive – those are the most active sewer lice I’ve ever seen – we must be infested!” At the very minimal – if there’s a school board member in the room at that time – you’re going to get new bathrooms. But you place it down and you say “I’ll have the custodians take a look at that later on – that is amazing.” Well first off the parents are going to go Ugh. Leave it right by your glass or your cup of coffee. Because later on there’s going to be something that the hand me some of those raisins will you – okay – I’ll put them in here. Let’s pretend that that’s my cup of coffee and these are the sewer lice. You’ve played with these – I don’t actually want to drink them. So if they’re side by side kind of like this – and you have them right there – all you have to do – because the kid has put them in there – hopefully he hasn’t really put anything else in there – you sit there and you wait until the parent asks you a question – and they’re going to ask a question and you say quickly you have to move this to your lips and you say that’s interesting, I haven’t thought about that. (Cough) “You’re terrible.” It’s kind of – tangy – I don’t remember your question. It’s like – it’s not important. If Joey misbehaves just send us a note home I’ll be back later we’ll see you. You’ll teach them the moonwalk essentially. Table will clear. It ‘s like “where did they go.” You’ll get some funky phone calls. I’m gonna warn you about that. Because the first time they did this I had a principal that came up to my room and said “C’de Baca, we’ve gotta talk for just a minute” and I said “yeah” he said “you like nutrition” I said “it’s good – it’s good for you” he said “do we have an infestation of sewer lice?” and I said “not really” he goes “what do we have an infestation of?” I said “not doing raisins” and he goes “that’s probably what I thought” and he said “you still have at least one parent that really believes that there are sewer lice in the school – so you might have to do a little damage control so they don’t go home and start calling the school board repeatedly unless you really want new bathrooms, saying get those sewer lice out of the school – they’re going! I don’t want my kid going to the bathroom where there’s sewer lice and I don’t want a science teacher drinking anymore”. Anyway, but it’s a good activity with kids and it’s also a good event, works well with third graders through – probably not good with primaries, ‘cause they’ll go drink it. With third grade, probably up through sixth grade, where you do something like that the kids are gonna go “aah” and you’ll say “could I really do that?” and what do you think is going on here? And then you can take them into dancing raisins, but those kind of discrepant events are always fun to build relationships with kids. Alright, this is density in a liquid system – and it is exactly that. The system of the raisin changes its density based on the carbonation that comes in. You can do this also, but I wouldn’t drink it, with vinegar and baking soda – yeah. Vinegar and baking soda if you don’t have any liquids. Um, some considerations as you’re going through this is – when you’re talking about density there are some variables that you want to bring out. Like in this case the variables the kids might want to test are what? What could they test if they wanted to see how this works? Besides different kinds of pop. Exactly – you guys noticed what about your depressed raisin – your suicidal raisin? “We had one that came to the top and never again sunk – it just stayed up there.” Exactly. “And we had some that were really active – so.” Good analogy for science classrooms there isn't it? "It looks like the more, the more clumps, the more water-dense, the more active." So if you have a raisin that's really dried out, okay, I had an aunt kind of like that – no she'd been in the sun a lot. She was from Palm Springs. Um, if you have a raisin that's really dry and you put that in, is that going to behave differently than a fresh raisin? Are there different objects you could put in the water that will do the same thing? How heavy can an object be before there's not enough carbonation to lift it up. Here's some fish – put at least one of your fish in there – make sure you take a fish home – they need homes. But the fish we noticed in a workshop just last week will also rise and fall. But generally they only rise – I don't see them fall very often. Fish are a little bit heavier than the raisins and so it takes a little bit more bubble-stuff to get them to lift. Kids will want to test different liquids, different materials, different temperatures. And the temperature at which – you know you can drive all of the carbonation out of a pop pretty quick. But the temperature of liquids makes a difference too – okay. You want to change one variable at a time and that's important to teach kids. And at the high school level and at the sixth grade level we start introducing them to intrinsic and extrinsic variables. One of those variables changes depending on how much stuff there is and one does not. And we'll get into those in high school. Let me go on to a couple of other things here real quick. We've talked about density of fruit. We've talked about density of liquids, in manufacturing wine and grape juice, sugar and iced tea is another one, fat in milk. They even use density in terms of blood – they do centrifuges. We've talked about density in gases. You cannot talk about density in gases in junior high or fifth or sixth grade without mentioning bubbles that float to the surface in the tub. Enough said! The standards are included in your handouts because these are the standards that directly relate to the activities that you've done today. But even more important is this concept. In order for you to make content sticky – we talked about teaching at three-deep, assessing at three-deep – you want to make sure that you ask yourself some fairly good rich questions – like for example – how is floating related to density? And get rid of some of the stuff like you did with the treasure items – get rid of some of the stuff that's going to impede their ability to understand the key concept you're going for. Buoyancy is one of those. You know, boats float, but they're made of steel. But that's a whole different concept. What is heavier than water? That is a really key point in understanding density. If a kid could explain to me things that are heavier than water in terms of density – boy, that's good! Differences that there are between objects that float and objects that sink, ability to test your theory, kids making models. One of the best models I ever saw was from a kid that was not able to speak English, was from southeast Asia, and made a wonderful, balanced chemical equation. It was so elegant with no words. Example, example, example – the more examples you can give kids, the better off. Like when we explaining about seasons – assess them while the content is hot, and reassess them later on. That's relatively important – more important as you get into the higher grades. There is some student work on each one of these activities in the handouts that will also be on the web pages. That student work is student work that was created by students at the 4^{th}, 5^{th} and 6^{th} grade level. And that student work gives you an example of a student that really doesn't have it, an example of a student that is approaching the understanding, and an example of a student that has it. And they're not perfect pieces. They're pieces from real students, to give you an idea of the kinds of student work you can accept, or can expect from your students, when you're setting the bar appropriately high enough. If you want to have success for all kids – no raisin left behind. You want to identify your content clearly. Density was the content – every activity you did today was related to density. You want to find a great activity that illustrates the content. Explore with the kids and let them ask lots of questions – questions are good. Tighten up your connections in your examples – practice it with groups of kids and make notes after you've run something – to anticipate something later on. What you did today will make me go back to my room tonight and write some notes, based on some of the things that I saw you doing. Ask more questions – don't go too far with kids – with you I can go as far as I want. With kids, you want to be connected to the content level that's appropriate. You don't want to get into buoyancy – you don't want to go too far in terms of density. You want to keep it at the right level, even though you really want to advance it for some of those gifted kids – do that away from the main group so that you're not frustrating, or taking the focus away from what you really want kids to take home. And give kids a chance to wrap it up. Ask kids – and we're over time here – but what I would ask you is "what did you learn about density" if you were my class, and I would start taking notes. And how powerful is it, when you're a student in a classroom, and your teacher sits down and takes out a tablet, listens to you intently, gives you the gift of their undivided attention, and writes down your words? That is such a powerful thing – and it's the best way you can wrap a lesson up. So, I appreciate you being so attentive today, and being willing to explore with me, and thanks for coming. (MUSIC) For more information or a free online follow-up to this program, log on to www.ed.gov/teacherinitiative. This broadcast and the follow-up are brought to you through a partnership of the U.S. Department of Education and the Panhandle Area Educational Consortium.

The Teacher-to-Teacher initiative was created by the U.S. Department of Education to provide the latest strategies and research on educational practices that work in the classroom. This series features teachers from across the country presenting techniques that can be used with students of all ages. This series is just one way the Department of Education is helping teachers get the support they need so "No Child is Left Behind." (MUSIC) Hi, I'm Shannon C'deBaca. I'm from ?? Community Schools. I teach at Thomas Jefferson High School in Iowa. We're going to do density of solids. You'll see us move into kind of an onramp, backtrack to do the treasure hunt activity. We'll do a little bit with densenometers. And then we'll wrap it all up with dancing raisins and a lot of fun. This was a good group. I hope you enjoy density (MUSIC). Welcome, I appreciate you guys coming out on the end of the afternoon, and I promise that your time will be worthwhile. We'll have some fun. We'll learn some great stuff. The title of the presentation is Taking the Dense out of Density. But it's basically a standards unpacking unit that teaches you how to take a concept – any concept in your curriculum – and move it from a series of activities to something that the kids take away good content from, so that you get a chance to say "Okay, I've got a concept that I want to teach in my class. Can I use this as a template to make sure that my kids, without stressing me and turning my hair as gray as C'de Baca's, without making me eat and gain weight like C'de Baca, without making me have heart attacks, can I get the kids from point A to point B, from knowing very little about a subject to have a master level experience to where they can apply the particular content in new and different ways. And that's the goal. And so we are giving you some activities. You know that there is no science and no elementary science that doesn't exist without toys, so we'll use some toys. We're going to start with the concept of density, only because its one of those very difficult concepts to teach grade 2 through even grade 12. Now at the elementary level, particularly at the primary, we're looking at just differences mainly. We're not going to do the numeric, the data gathering, the quantitative stuff about density, we'll do qualitative – it's heavier than, is lighter than, and we'll segue. We'll move them slowly into the concept of density, building a foundation that allows them to construct accurate knowledge, because the biggest thing that drives people crazy is at the secondary level, and I work with secondary people mostly, is when a kid comes in and they've constructed this really beautiful world of incorrect knowledge. And we try to tinker with that. But trying to tell somebody that – like the seasons we were talking about this morning, trying to explain to someone that the summer season is not caused by the sun being closer to the earth and giving more heat. It's such a pervasive misconception that even when they interview Harvard students as they're graduating from Harvard they did this shedding light on science program they will say "Well it's because the sun is closer to earth at that time." Or have you ever seen those Leno Jaywalks? When he asks people, when asks them science pay attention because some of those things are really frightening. But we want to get kids not only to come out of this and say I like science, I like school, I like you, but we want them to say I am competent in science, that I can tackle problems twice my size. So we're going to go back and we're going to unpack a little about the density of solids. We're going to do an activity that I love called Pencil Hydrometers, okay. We're also going to do a couple of other activities that I just love that some of them are kind of gross and some of them are kind of fun. Now this particular unit on density stemmed from an activity where a kid said – you know how you're teaching your heart out and you're up front and you're giving kids all kinds of great stuff and the kids say "I've got to go to the bathroom," you know "Why did my uncle's hair fall out?" They come up with off-the-wall stuff. This kid that I didn't think was even paying attention raised his hand and he said "Why do fish float when they die?" And I teach chemistry, and I'm going "What?" And he goes "My uncle and I were out fishing," and I go "Okay I got that part," and he goes "Well we were using a little explosive." I don't even want to know this part. But he says "And you know we would set that off, it would blow up and some of the fish in that particular region would float to the top." And I thinking you fish differently that we do. And it got us off on a tangent that was very valuable because we were getting ready to do physical and chemical properties of matter. And so I said "You know, I've gotta go back and ask you what you know about density." And so I asked them and from their elementary school instruction they had a variety of theories about density and about sixty percent of them were constructions that teachers had taught with all their heart and soul, but the kids had constructed their own little world as adults often will do when you talk to parents sometimes it happens, when you talk to your children that happens – they construct their own little world. You said "I can't go to the mall tonight," but you didn't say "if I go this afternoon and it extends into night I think that's probably legal." Okay, so getting understanding is tough. Communication is tough. And so I went back and started teaching the kids and I found that I wanted to back clear into elementary school with them and see what they knew and what they learned and take it from there. And so this series of lessons for elementary stems from that. It also stems from my experiences teaching 4th grade, which my hair was dark – it was gray by the end. Some of my first years were in the elementary level and I loved it. I mean those were the best years and unfortunately if you have a certification in science and your district can't find chemistry or physics teachers, you get bumped up. And I love teaching high school kids – their sense of humor is my sense of humor. However elementary holds my heart because I love staring at a group of kids and having them go Wow! And the wow factor is a little bit more apparent in elementary than it is in secondary. In secondary you have to get to wow a little bit more – I've got to get through some politics first in order to get to the wow, but the elementary kids you can wow them with a plastic fish. So we'll start with a plastic fish. Now I'm gonna tell you up front when we were in Denver I got these plastic fish at the little place that sells all of these old trinkets I think in Omaha, Nebraska. And they sell them by the gross and whatever. And I said "Do you have any plastic fish?" And he goes "Oh yeah we got plastic fish." So he found these little cute plastic fish and I'll give you some fish in a minute. They sink. So the whole point of the plastic fish was to do the activity where the fish float, but I'm going to tell you right off hand, these fish sink. And so what it is about this fish that makes it sink is different from most fish. Most fish will sink all things being equal. There are scales. What else does a fish have that would be heavier than water? Bones, yeah. Fins that are cartilage or something. Fish guts. Okay. All that stuff would cause a fish to sink. So a fish likes to be able to open up some sort of fish valve and be able to have gasses come into the fish to change the density. Really dead fish float because of a chemical reaction called decomposition, but a submarine works in the same way. And so you can use the analysis of a submarine to explain to kids, fish. And it gets back to density to tell you – and I wouldn't use this with very young kids. A submarine sinks and becomes neutrally buoyant because it has these two tubes – these ballast tubes are generally filled with water. And a submarine is made of what? Metal, which is usually more dense than water. You're going down in a large metal tube, and so the submarine would normally sink. So they take compressed air and they force the water out of these tubes until they've got enough air, like a life jacket, on both sides of this submarine in order to make it neutrally buoyant in order to give it enough lift, because of the gas, the whole submarine calculated in terms of its mass relative to the mass of water and that submarine will lift up. And if you want the submarine to go down you just open up a valve and let some of the gas out and the submarine will go back down. And so you can continue to do that until you run out of compressed air, which no submarine really wants to do for obvious reasons. So we're going to take a look at the density of solids. From point A to point B – and I like to teach things three-deep. I explain this in the secondary workshop. Three-deep means I give the kids an activity that's kind of fun. I give them a model that they can get their hands on, whether it's a model that they can manipulate or a model that's drawn on an overhead or on a piece of chart paper or on a chalk board and then I also give them another opportunity to demonstrate their understanding in some sort of activity. And that's called three-deep. And I test them three-deep. Three-deep means you explain it to another person, you explain it to me generally in writing or orally if I was working with primary kids I'd say "Now, tell me what you're doing here. Tell me what you're seeing." Listening for cues to the construction of knowledge that they have and then I might do some sort of form of assessment that allows them to see if they really have it. And with upper level kids its different than with lower level kids. I like a lot of oral give and take where I can talk to the kids and listen to conversation. So to give you a background in density so that you have more background than then kids most of you know density pretty well. I'm going to cover that and then we're gonna go back and we're gonna to do pencil hydrometers from a teacher's prospective. I explain to the kids that density is kind of interesting because let's use a Volkswagen. The record is held by the University of Texas and it's like, I don't know, 30 people in a Volkswagen. They're obviously not people my size. And we could not do that in Iowa. I think the record in Iowa, corn-fed, lots of beef, is 6. California it's 136 – no I'm kidding. Hollywood it would be 900. But a Volkswagen – kids know what a Beetle is or they'll know what a small car is. You can call it a Yugo or whatever – a very small Ford – what are they Focus or whatever? But if you had a car that had 42 people packed into it, it would be heavier than a car that only had 12. Okay and the kids will obviously say "12 you-people or 12 me-people?" That kid's out! So density depends on how much matter is packed into a single space. Now at your table there is a thing that has some film canisters in it. Take that out, will you? What I want you to do is to line those up from the heaviest to the lightest - heaviest to the lightest. I want everybody at your table heft those just a little bit. I don't know about those two. This one's heavier than this one. This one I think is next. Yes, yep, yep, check. Ok Stan, Come on around. Ok, I agree. Now you want to verify even further, and you got a chance to do it, because the film canisters have the same volume. And volume is a unit of space. My volume is much greater than say Linda's volume. Okay. But the film canisters we've controlled the variable and the variable we've controlled was volume. Yeah. Open them up and see if there are more pennies – I used pennies for this experiment – in each one of those. And you can check even 1 and 4 to make sure, or you can check the other ones as well. Now an interesting note for teachers, and this is on your GEMs website as well if you've attended the GEMs session. If you type in density and you do a search on the GEMs site you'll see several activities involving pennies. Pennies changed in 1982. Anybody know what happened to them? Now pennies now are a very thin coating of copper cause someone brilliant at the Treasury Department was probably sitting around over coffee and said "You know, Sally, a penny has more copper in it than a penny. So we may be losing money on these things." In their infinite wisdom they said "Well let's make them out of something else." They thought about plastic I'm sure or some kind of polymer. They thought about other types of metals – aluminum – and do you remember doing the war years? Don't raise your hands because we can tell. We can tell who remembers this. During the war years they made them out of steel when copper was in short supply – that's the big WWII. So they didn't want to go back there, because the copper penny has a certain Americana to it. So they didn't want to change the look of the penny, so they said "Can we do anything else?" And they came up – material science came up with a solid core of the penny made of zinc, which is a cheaper metal, and the outer surface of the penny is copper. It's a little more expensive to make because you've gotta kinda dip them like a chocolate I think. But it made a penny that makes a different ring when you drop it on the floor. If you drop a pre-1982 penny on the floor and a 1996 penny on the floor the ring will be different because the two densities of the metal are different. And so one of the things that you can do with elementary kids in the upper – 4^{th}, 5^{th}, 6^{th} – is you can take some pennies that were pre-1982 and pennies that were post-1982 and ask the kids to hypothesize about the differences. And with younger kids you can do the same and different kind of activity with film canisters. You're still teaching them to control one of the variables – volume. But you're getting them to use their tactual senses to examine something that's fairly complex and fairly difficult to teach to that level of kids, which is mass. Anyway, so these pennies – if you know a chemistry teacher – send them all to Joseph and me. If they notch the edge of a penny, a fairly strong acid will eat away the zinc. You could put this in a little beaker of acid and the inner core – the zinc core – will be removed from the penny and you'll end up with this absolutely paper thin copper penny. They are absolutely amazing and if you can get a couple of those for your little science kit to show kids it's a really powerful thing. So kids get the idea that there's a difference in pennies if you want to do this penny. But in this activity here they get an idea that there's a difference in terms of the amount of stuff that is stuffed into one of these film canisters and you've controlled an important variable. Now if you get across the point that density depends on how much matter there is packed in a unit of volume you've gotten through the unit of solid density – no problem – you're there, okay? Now you want them to look at some other things and it becomes a little bit more problematic because sometimes you know you have to back up to get onto an on-ramp. You have to backtrack through the city to get back up to speed. When I take kids through this one of the things that they're not very good at is observing. Have you guys noticed that? If you say "Give me five good observations about what you're looking at" what will they come up with? Blue, looks like a fish, has eyes, has those finny things, tastes nasty – oh that's 4^{th} grade – no that would be 2^{nd} grade wouldn't it? So here's what I want you to do. This is called a treasure hunt and this is primary. It leads up to density or it comes in to the point where you say "Boy I've got this incongruence going here, I've got this little – the kids are not making good observations, they're not understanding what I'm saying – I want to focus them and I want to redirect them." There are treasure bags at each table. Treasure bags are things that you just gather from whatever drawer you can find and inside these treasure bags there are a variety of objects – round, round and round – I don't think there are any square things. There are things that look like other things. Here's the rules of the game. Treasure hunt game means you can take one object out of there. You don't want the people around your table to see which object you've removed. Then you are to look at that object in your hand carefully and you are to make 5 observations that you think will describe that to another person. You may use color, but you can't use "it looks like a butterfly". You can use "it looks like it's made of wood". You can use "it looks like a rock'. You can use "it's smooth", its texture, any of those, but you can't say "it looks like a butterfly". So do that now – take an object out. Yeah and then after you've got your observations made put it back in there clandestinely, on the sly, and then we're going to have one of your partners try to identify that from your five observations. It's a good reason to take all of that junk out of your junk drawer and put it into zip locks. The surface is smooth. It has a circle or a ring on the back of it. You notice how your eyes dart over certain things every time she tells you something? The middle of it has sort of a rectangular shape. And the ends of it sort of have the top part of a heart shape. Sort of a top heart short. Now do not feel bad if you do not get if they don't get it…(discussion) What were the clues that led you directly to the object? The best clues. Texture of the material it was made out of. Like wood, or stone. Let me hear her clues Concave, had a circular edge to it. As they struggle to explain something and they need better words that are connected to descriptions – like convex – then the vocabulary becomes extremely important and its very apparent when a kid doesn't understand what convex or concave or one of those words mean at the 6th grade level because you'll see these kind of flashes of panic go across their faces, because its one of their 5 clues. You can make it okay for the kid to ask the meaning of a word from someone else and they're learning a vocab word. I almost guarantee you that you won't forget – I may teach convex and concave in my classes, but if they do it and they learn it from a peer while they are trying to guess an object they will remember it more effectively than if I stand up in front of the class and give them what convex and concave is because its tactile, its real – awesome explanation – very well done. Did he explain it? Will you forget it? Maybe. Now Joseph – you had an interesting – because of Joseph's vision it was a very unique experience because if you're working with kids that have vision impairments of any kind – that have limited vision – then their tactile senses – it's not that they're super-people – they don't turn into automatically have the super-Spiderman sense of touch, but its that they have to use different methodologies to explain. We rely on color. We rely on material sense – like it is wood, it is a stone. But when you are relying only on the tactile sense it becomes much more difficult. That's what primary kids are doing because their language development is not there yet. So where this might be a fairly easy task for us, although some would argue in this room, at this table in fact, this is a very difficult task for primary kids and when they get it done you know how you want to give kids a real sense of success where they say "I did that, I feel pretty good about it too." This is something significant for primary kids through the 2nd grade – even through the 4th, 5th or 6th grade. We have 6th graders in our district who will say "When are we going to do treasure boxes again?" because they want to get better at it and it brings up a little competitive edge in some cases, which you want to minimize, but its something that they can hang onto and something they can feel good about. And under the table, very clandestinish, sneaking in vocabulary words. And you know what's interesting is that sometimes your special education students will significantly outperform your regular ed kids. Because they are used to having to go through some motions to explain things in a different way. They come from left field or right field, where a lot of kids will come right down the center and be very factual and matter-of-fact and expect that this person is going to understand exactly what I am saying. Special ed students do not have that expectation at all times. They'll say "I don't know that you're going to understand what I'm going to say to you, so I'm going to explain it a little bit more clearly or a little bit deeper or I'm going to use a metaphor. They'll use light, they'll use analogies, they'll use the most incredibly creative ways of describing objects that you'll ever see. And you'll see other kids – regular ed kids – say whoa – you know, like that was brilliant. And it was. You're just smart in a different way. This is one of my favorite activities and you can use this at primary, you can use it at middle, intermediate, junior high, high school. One of the favorite things that my high school kids do is categorizing. Periodic table comes into chemistry, right? It's one of our least favorite things when we're taking chemistry, but it's one of the chemistry teacher's favorite tools. If this activity goes on prior to and the categorize things prior to they understand things a lot better. We were talking at one of these tables about the elimination factor. Sometimes it's very difficult. We have a tendency to look at things – like here's a good case in point. You send your 12-year-old son. You say "I want you to go to the garage and get me the hammer." And if you don't have a well-organized toolbox, your 12-year-old son will go out there and say in a loud voice "I can't find it." Where it's probably sitting right there. But it's in the middle of some tools and its not like they're standing up doing a little hammer dance saying "here I am". They're not used to eliminating information, whether it's in reading that's not important, or whether it's in summarizing and finding the key point of a reading passage – they can't do that. They can't eliminate unnecessary information. In science we have to. We have to learn how to eliminate unnecessary information so we can focus in on what's important – whether its curriculum, whether its scientific investigation – so this does that. Because how successful would you be – these guys were going green and we were talking about there were only how many green things – three green things. If they eliminated everything that wasn't green and just had the green stuff sitting in front of them – how easy would that have been? Would you then use that technique later on? Could there be some transferred learning when you try to talk about reading you could say "I want you to eliminate stuff that's not important – just like we did in the treasure hunt." Okay, I can do that! There's a hook. There's a cognitive, conscious hook in their brain that's like – can you remember, sometimes when you remember people's faces or names, you have to give some association with that – like Linda – you would probably remember her because of her unforgetable hair – you would probably remember that. I remember her because of some other horrible… (laughter) You'll remember somebody based on somebody they look like. And kids sometime remember based on something they did. Very memorable. Those are hooks that you use to cognitively associate things. We don't do enough of building in that on what you've done in elementary. If I died and went to heaven, my died and went to heaven wish would be that we could articulate some of these activities so that when the kids come into my classroom if they would have had elementary teachers I would know what the elementary teachers had done and they'd say "C'de Baca just sit and listen and I'll show you what I'm doing with my kids" and I could do some of the same things so the kids aren't relearning things in a different language, relearning things in a different pattern. I could save myself all kinds of agony and we don't do that enough. This is an activity that could articulate that way. Alright so what does this teach kids about density? Well it teaches them to start looking at physical properties because you are describing things how? Smooth – what else? Color, texture, shape, utility (good one), now there's a link, heft – there's a link directly to density when you start saying its hollow. And some kids might say "What do you mean, hollow?" in particular primary levels. Well, it doesn't have anything on the inside. That's where those film canisters come into play. If you go to Walgreen's or Osco or Walmart or any one of those places that develop film and you say "I'd like you to save me some film canisters", they will save you lots. They'll give you more, and they're wonderful for science. But I'm going to warn you, tell them if you're going on summer vacation. At the end of summer vacation last year I forgot to tell the Walgreen's folks that I didn't need film canisters anymore. And I had this message about four times on my answering machine that said come get your film canisters. And each time it got a little angrier. So I went there and I thought how many film canisters could there be. In the back there were six lawn and garbage leaf bags full of film canisters. So I filled up the back of my van and went to local elementary schools dropping them off and I told the principal "Don't ask me what these are for, but your elementary teachers are going to want them." And it was kind of like "If you'll leave, okay – I'll take a bag if you'll leave." So you can get these for free. It's a really easy thing to do. And since you're controlling the aspects of the variable of volume, then you can put anything in it in terms of mass. Pennies work great because they're cheap, they're easy to find, and they can count them and see how many pennies are in there. But know that there's a difference in the terms of the pennies that we talked about before. Okay, we've got density of the solids down. We've got the ability to describe on the right track. I might go back to something like treasure things to say. I need you to describe things better. Your ability to describe things, say at 4th, 5th or 6th grade level, needs to be a little bit stronger, so let's go back and do something so that you're describing things with more detail. Hollow, heft, smooth, shiny, cold, warm – you're using the range of descriptions, you're using your senses better. And now let's take a look at density from another aspect. At the 6th grade and 5th grade level I would probably do the density and film canisters quantitatively, using numbers. I would bring out a scale and have them weigh them. Have them notice that you can calculate the volume of the cylinder by submerging it in water in like a graduated cylinder, or a beaker that has some graduated markings on the side. You can fill it up to a certain level, pop that little film canister down into it. I would probably fill the film canisters with pennies so that it actually sank. And you record how much the level of water goes up. That difference is the volume of the film canister – easy way to get volume. Or you can look it up on the web. Once you've got the volume of the film canister you can figure out the mass of this film canister with the pennies in it. And 1 and 4 are going to be significantly different, right? Then you can figure out the density. Density is mass divided by volume. So you can do it qualitatively by just looking at the heft, or quantitatively where you're actually measuring. You can take pennies out and say – this is a cool thing and we've got a hand-out on it later on – how much does one penny weigh? What's the volume of one penny? And this is in your hand-out too. What's the mass of one penny? Okay, what's the volume of 12 pennies? And what's the mass of 12 pennies? And if it truly density, the relationship will be linear on a graph. That's a 4th, 5th and 6th grade concept. And it becomes a really good way to teach them graphing. Joseph? [Joseph:] "You used the word weigh a while ago and now you're using the word mass. What is the difference?" Well, mass is a quantity of substance. And weight is effected by gravity. So right now I weigh a little over 125 pounds. I'm in the ballpark – I've got an error factor of 75 something percent, but okay. If I go to the moon – the moon has less gravity. Have you ever watched astronauts walk on the moon? Okay they kind of bounce and lilt. I'm less – I am JLo on the moon. Okay, maybe not. But I'm certainly not Rosanne. I'm lighter on the moon in terms of my weight, but the amount of C'deBaca that there is never changed. There's a certain amount to me. Five pennies is five pennies is five pennies, but if you weigh five pennies on a scale – here on earth it's dependent on gravity it's going to have a certain weight. The mass – I could weigh the mass anywhere. And mass is measured in a scale. And the scale is a little bit different – or balance, excuse me. If I took and I put five pennies on this side of this balance and I put a certain weight on here – this would be dependent – how much this went up or went down would be dependent on what I put on this end, right? And it would be the same, whether I had it on the moon, on Jupiter, stay away from the U planets, on Venus, Mars, Earth – it would be the same no matter where I was, because this weight and this way I'm comparing apples and apples. That's mass. When I'm thinking about weight I'm dependent on the pull of gravity, okay? Now, that get's us to another aspect of density… (MUSIC)

Which those of us that are my size – we are not gravity-friendly, okay? That help? Yeah. [Joseph:] "?????????? is to fill your bathtub up with water with kids. And ask they slide in the bathtub you will see those kids go from 100 down to x amount" Because you're in a less gravity-dependent – you're still gravity-dependent, but you're more buoyant. Parents all over probably really appreciate that with their electronic ?????????, don't they? The ???? at home he's a professional. Now that gets us to another aspect of density. Runners, and this is more for your information in upper elementary than it is for primary, but runners, like you have more of a runner's build than I do. I don't know why, I'm just guessing here, but if we went on a cruise ship, and the cruise ship went down, she's shark food. Okay, even bottom feeder food. I am a life raft for half of my floor. ????? are fat tissue is lighter, is less dense rather, than lean muscle tissue. And so, its one of the reasons why some of the runners have a difficulty swimming. Your triathlon is no easy piece of work for somebody that's a die-hard runner, 'cause their more lean muscle tissue, they get into that water and they don't bob to the top like a cork like I would because of the difference in density. If you'll go to the, if you join the Air Force or the Army, they take a weight measurement of you. They get you completely naked and take your weight – and it's a job I want. But – alright, next – you're 175 pounds – if they want to get an indication of your fitness and that is bicep composition. So what they'll do – they put you in this tank – claustrophobics need not apply – that's filled with water, and its got these calibrations and you're submerged in the water, you exhale as much air out of your lungs as you can, and then all of a sudden the level of the water raises an equal amount to your – based on your volume. And if you're fluffy – like me – your volume is going to go up more than if you are lean. So now they've got my volume and they've got my mass and they can postulate my density. And there are some really good human anatomy tables that can tell you what percent of your body fat is. And any good fitness trainer will explain to you your level of fitness based on body fat, as opposed to based on how large or small you are – or you think you are. And its good to tell kids that, because you've got a lot of kids that are extremely thin that have a high percentage of body fat. And kids that are a little bit stockier or a little bit heavier that have a pretty good fitness level because their body fat composition, the percent of body fat, is lower. It's a real good way to integrate physical education or integrate some health concepts into it and it's something that kids don't understand and its based on density. Back to density. So we've ???? questions at this point, and feel free to interrupt me at any time and say "C'de Baca" as Joseph wants to do. (Question) Ooh, ooh, now we're getting into the concept of air pressure that doesn't attack density, but its an interesting phenomenon. Is there a difference in gravity and weight based on where you are on the planet Earth, and that's a really good question. And the differences are minor, but they're enough to throw some things off – yeah. (Question) "Which is where we want our detention facility ???????? [Question] ???? that they would win more on the surface – and the reason for that is, and correct me if I'm wrong, you're closer towards the center of the earth." I believe that is correct – I believe it is. "Gravity pulls you towards the center of the earth and not just ?????. But the closer you get to the center, the greater the pull of gravity and the more" It also depends on the mass of the object that's attracting it and the earth is pretty massive – the earth is pretty massive – and I don't know if the difference would be great but I know that physicists could answer that. There's a ask ???? or ask a physicist on any web-site. Any time one of those questions goes up I send my kids right to the computer and I say "type it in". And some physicist somewhere who's having a cup of coffee is waiting for that question to come along. Of course you'll get about a nine-page response if it's a physicist. But for the chemist, the chemist will give you three sentences – the physicist will give you nine pages of stuff and an assignment. Alright - I like to go from the concrete, which is solid density, to more abstract to more abstract. And so if I was going in phases of matter I'd go from the concrete, which was solid density, to liquid and then to gasses. And gasses are really tough at the 6th grade level because the kids are going to take that all kinds of places, which you know on a ????. So lets go to liquids first and for liquids we're going to use a very highly technical piece of equipment called a ?freeform??? Anybody know what these are? Alright. These are awesome. ??? equipment once again – these are called preforms. When they make soda bottles or water bottles – not your water bottles, but these were at one time, these are going to be made into w???? before I stop them in their developmental stage. We're going to be made into 2-litre pop bottles. They take these performs and they make out of plastic and they come just like this. They put them in a mold, they heat them up and they inject air into them until they fill the mod and this becomes a 2-litre pop bottle. If you contact your bottling company, you may be able to sweet-talk them into sending you a case of these performs. 'Cause if they're any way damaged – like if water gets on them, or one falls off the truck, or they get any dirt on them, they don't use them. Generally the bottling company in your area will probably be happy to give you some of these. And they're wonderful because you can put stuff in them and you can seal them off. Now they're tough to see through if you really need to see things distinctly. So we're going to be making a small modification in this particular activity, but these work great. And what I want you to do is with your partner there – or partners – I want you to put enough water in here to where its up above this little rim here that looks like a little collar. Okay, just about that yellow thing there would be great. Find some water and put it in there. Its still water – its okay. Just water is okay. You're going to make it messier in a minute – oh yeah. Alright – now – the next thing I want you to do is to cap it off and put that aside for a second. These are called pencil densinometers. And I want you to take one of those lovely golf pencils. And I want you to do what we call in science calibrate the pencil. Now to calibrate the pencil we have to have some even markings along the side, and so with those little metric little rulers we've got there, would you mark off in ½ centimeter marks all the way up the pencil. You guys doing okay? Enough pencils and stuff back there – okay. Yep - from the point of the pencil all the way to the end. [question] But it's the relationship between your weight and your volume. Yeah and it would be a ????????? a very good one at that. Place the densinometer in it. And I want you – I would probably put it point up – try it point up. And then I want you to count the number of markings that are above the surface of the water. What variable could we change? We're not going to change the pencil – we've already got that calibrated – that took so much work on our part. What other variable could we change? What's that? Change the amount of water – I could put it in a taller cylinder – I could do that. What else could I do? Change the temperature? Don't have a hotplate, but that's a wonderful one to do. 'Cause temperature changes density. I could change the way the pencil went in – okay what else? Very good. Alright. I'm going to cut it ???? – its okay – it's a white one. Alright, if we change the liquid we're changing – there's a relationship between the density of the pencil and the density of this liquid. And so I'm not going to ????? it up – this is water – so what if I changed this to something different? And so on your table there are some little vials with a white powder named sugar – that's a white crystalline substance known as sugar. You get the one from the 60's. I don't know why it says 60's on it. There's another one right there. What I want you to do is dissolve as much of that sugar as you can in your container without it overflowing. We may have to empty out a little water into one of the glasses. And then I want you to shake it up. And now you have a sugar-water mixture as opposed to pure water. You could always add more water. Now for those of you that really like clean elementary rooms – sugar is cheaper, but salt is cleaner. Salt will not make your kids sticky. Exactly ?as ugly ? if you live in California. And then you want to dissolve it. They're making a break for it. All have your kid that's driving you crazy do your shaking. Say "okay I want you to agitate this for 20 minutes – instead of agitating me for the next 20 minutes." For our purposes here they don't all have to be dissolved but I would have kids dissolve it. I would probably even have kids put one tablespoon in one, two tablespoons in another, three tablespoons in another – particularly at the 5th and 6th grade level. Now insert the pencil in it again and note if there's a difference. Ahhh. That was in the way. Movers and shakers. Okay, now see if that's consistent across the - that's alright. Is it easier to see it without it? You know another thing you can do? Here – watch. Hold it steady, hold it here, I'm going to add a little bit of water to that.

Now – and it doesn't matter - I mean you've got it towards the bottom so its relative. Is it higher in the water than it was before? What - by about what – one mark maybe? Let's gather some data. What change did you notice in terms of numeric value, in terms of how many marks were out of the water, between trial one with pure water and trial two with sugar water? How about this table back here? "???? The pencil did not ????" Okay, did you take a reading? Do you know how many marks it went down? "A mark-and-a-half." A mark-and-a-half – alright. How about this group? "We do notice that the sugar ??? didn't ????" Great! And those.. "the other one that's strongly marked is three marks and it rose the water level all the way up to the top of it." Okay, so the water level came up as well? "That's right." How about this group? One-and-a-half? How about this group? "Two." Two? Okay. "You guys ?????? up one." "Two markings or one centimeter? Cause the markings are at ½ a centimeter. Ours went up two markings." So did you guys go up one centimeter? "It did." Okay, so did you guys go up two centimeter or one centimeter? "One centimeter" One centimeter. So one centimeter, one centimeter, a-centimeter-and-a-half, about a centimeter-and-a-half. Your results are going to be pretty consistent with kids. It'll go up about a centimeter-and-a-half and you can vary the amount of sugar, but you're not going to get a whole lot of difference until you get a whole bunch of sugar in there – 'til it almost gets to be syrup. But it's interesting for the kids to know that if I change the density of the liquid then something's going to float higher. Now that's akin to buoyancy and buoyancy is kind of a real sticky concept. The only thing I stick with this is in terms of density and I'm comparing the density of one object to the density of the other. With the theory being – if it more dense than water it will sink – if it is less dense than water it will float – if it's the same density of water it's going to settle somewhere in the middle and I can compare it based on how much it floats. Like, for example, if I am swimming in salt water I am going to float at a certain level. If I'm swimming in fresh water its different than salt water. And the saltier the water the greater degree of float. In forensics, when they test a piece of glass and they want to know the density of a tiny sliver of glass that they might need to solve a case, they have a set of reference liquids that they know the density of. And they'll put that tiny sliver of glass that's too small for them to measure in these different liquids. So they can take it out of the liquid and put it in another liquid and when they find a liquid that it floats right in the middle of, what do they know? The density of the glass. And the glass from your glasses is a different density than the glass from the window pane, and its different from the glass in your headlights, and its different from the glass that might be in the watch face that you're wearing. I mean different glasses have different densities. And sometimes that can match up, 'cause you can't match up a sliver with where the glass came from, but you certainly could if you could test the density of the different glasses that you think it might match. And so it's a real good application at the 6th and 5th grade level to forensic science that kids are kind of hot on. In terms of fruit juices, fruit juices are measured now with a much more high-tech instrument that does some refractive index measuring. But they used to use a densinometer. Winemakers used it for years which was to measure the amount of sugar. You use it when you do your anti-freeze in your car if you leave in the northern climates. This will mean nothing to you from Southern California, but in Minnesota in the winter its really important that you know how much anti-freeze you have in your car so they draw out a little liquid out of your coolant system and they have this tiny little BB in this u-shaped tube and it will float at a certain level. Well its somewhere between the density of anti-freeze and water – this little BB is. And where it floats will tell you how much anti-freeze – percentage-wise – and how much water is in your system and will tell them whether or not they have to add anti-freeze or whether or not they can add water. And it's a really good way to test how much cold your car will withstand before it will not start, or because things will freeze up and in Minnesota I'm firmly convinced that there are human beings that are still frozen somewhere in Minnesota, 'cause it gets that cold up there. Winemakers or people that make fruit juices can use a densinometer – looks like a big turkey-baster. Same process and it will tell you how much sugar because you made this liquid more dense by adding sugar. Because then you made it sugar-water, which is obviously more dense. One the GEMs site there is a really good activity with potatoes. If you clue into density, they called ???, I think they're from ???? There's one where you can take pure water and then sugar water and then you put a potato in one and in water its going to sink and in the sugar water it will float. But if you make a mixture where the bottom is sugar water and the top is plain water the potato will be right in the middle of the liquid. It's a really good activity. You can do the same thing with different colors of liquid. You can take a couple of glasses – like 6 glasses. In glass #1 you put pure water. In glass #2 you put some salt – well, better yet, start with a glass of pure water and add tons of salt to it. Color that one color. Take out part of that before you color it and put it in the next glass and fill that glass up with ½ again as much water, so that you have kind of a serial dilution going on. This one is really salty, this one is less salty, less salty, less salty, less salty. Then what you can do is you can take a clear piece of aquarium tubing, or a long tube like a one-liter pop bottle or something. If you add the liquids very slowly, the layers of salt will layer with the most dense salt water being on the bottom, the next dense and the next dense. You can make a whole rainbow of salt water and it's a good way to talk about liquid density. You know? Questions at this point. Now liquid density is really complicated. And at the lower levels I would just be talking about similarities and differences. I probably would not do this with lower elementary kids, but I might do the salt water one and talk about what do you see? Not explain what's going on – the phenomenon – but explain the observation that one layer will – one liquid will layer on top of another one and I might relate that to salad dressing. In your refrigerator you have some salad dressings – particularly Italian salad dress. If you have salad dressing what floats on top? The oil floats on top. If you ask kids in high school what's more dense – oil or water. Kids will think oil is denser because its thicker, but it floats, so it must be less dense. So we have to realize one of those seasonal misconceptions. But at the elementary school if you're saying "Take a look at some salad dressing, you don't have to explain the phenomenon to them. You've introduced the phenomenon a little bit in a way that you don't have to explain a thing or connect it to the word density, but later on they'll have that idea that "Oh, wait – the salad dressing oil floats." And so when its introduced later on it comes perfectly okay. "???? Verify ??? testing the different milks. The whole milk, the 2% milk and the 1% milk and the skim milk and of course he predicted that skim milk would be less dense because, you know, it 's had all these things taken out of it. The ??? of his project was not true and then when he went back and remembered that the oil floated – that fat floats to the top – it turned out to be the whole milk was the least dense." Fattier, yeah. He did great. "Because he was a mathematician, he did his all with measurements. He didn't put them in…He found the volume and found the density – he was a real math guy." You teach kids with ???? Now that particular type of experiment is well within the range of kids in terms of helping them through the measurements – not primary – but certainly 4th, 5th and 6th grade when they measure the volume and they can measure the mass they can say "Well why does this milk come out with a lower number than this milk." And teaching them what's in milk is kind of important. I mean there's a nutritional value there. We did a milk experiment that's kind of fun. Its in the hand-out under 5 that's called the exploding colors of milk could be a good follow-up to that. Coins – and I put these fake, plastic coins only because I thought they were kind of cute on your table. They're identical copies of – okay not very good I don't think – I'm looking at the Liberty head of this quarter and I don't think – is it George Washington on the quarter? It looks a little more like Martha, but. It says – stamped across the top – copy – like I'm not going to know that this is not a real coin. Maybe in some countries I wouldn't. There are coins across the world that have different densities. In China there are some coins that actually will float. And so if you have any parents or any friends that travel, if they'll bring you back some different coins of the world its really interesting for the kids to see the different densities of the coinage because it's a good connection into some other ranges of ???? – social studies and things like that. So we've got that pencil hydrometers made, we know that there's a connection to real life and forensic science, we know that there's a real ??? connection to that in terms of fruit juices and the sugar in fruit juices and it's a way that they measure things and antifreeze – cars. Good science involves accurate measurements and so far we done things kind of qualitatively. We've been looking at characteristics of things and the only measurement we did was making some ½ centimeter marks. Well it's a good idea particularly in the transition from 4th to 5th to 6th that we get them to start thinking quantitatively and saying "Can you measure this more accurately? Can you create a densinometer that will really accurately measure liquids?" And here's one good challenge to do to say "Look, I've taken a container here and I've mixed some sugar and some water in here. I want you to tell me within a tablespoon how much sugar and how much water I put in here. Design an experiment to do that." Talk them through some experiments that might be similar and then let them go with it. And I guarantee you it'll be a struggle for them, but it will be an effective struggle in terms of they're starting to think "Well I've got to measure something, and I've got to prove it to her, so we might have to start actually counting these. Maybe we'll have to go down to ½ of ½ a centimeter – a quarter of a centimeter – maybe we might have to use something besides pencils. What else will float?" It's a real good challenge. It's a great take-home challenge for like the holidays, when you want to be really friendly with the parents and you give something for the kids to work on that's going to keep them busy, they will erect a statute in your honor in the family living room if that kid is busy and engaged. So you teach them to measure carefully and accurately. Now we haven't done that yet, but that is important and it gets to be important in terms of the middle grades. You want them to accurately describe things and that you want to get them better and better at describing things all throughout their school experience. Now you want to start getting them better at measuring things and that's introduced here. These little things can actually measure the density of liquids, but even more importantly you can measure volume and you can measure mass and if you have trouble coming up with materials and equipment, always ask scales. This is a terrible reference, but if you talk to your police department – every police department in the United States busts somebody that's selling some sort of medication under the counter. And those drug busts usually they have some sort of sale. So the police departments will have scales of all shapes and sizes highly accurate in some cases that go unclaimed because generally drug dealers don't go back to the police station and say "I think you have my scale." That doesn't happen that often – I'm not sure why. But some of the scales are worth $300-$400 and some of them are much cheaper than that. But if you contact the police department and you say "if you bust a crack-house – no – if you have a drug bust, or you have a seizure that involves some sort of measuring device like a scale. I am a teacher – not a drug dealer – but my kids would love to have that so they could practice some of their measurements so that they might become – no, wait – so that they can become scientists later on." And sometimes you might have to do a little talking to do it, but if it had them once they're released, it's a great way for them not to destroy that material, but to give it to the school and so you could get a scale that would do that. Exactly – from something bad comes something good. Different super balls and different plastics have different densities too and they use it based on water and I've got a range of super balls here for you guys to take a look at anyways – to just see some of the differences in the textures and some of the differences – you can tell sometimes in the bounces of things – this one actually looks like either a glob of really old gum. Yeah, this one would go all over the place. This either looks like a specimen sample or a rock or something – I'm not sure what it was. But plastics have different density and so when they grind up plastic – pass those around to people that say "I'll toss these to you" – when they grind up plastics into tiny little pieces, some of the plastics that are recyclable will float. And they'll skim those off and they'll use those for a certain application and those that sink go to a whole other hopper and they're used to make park benches and some other things – high density polyethylene, recycled plastic – but it's a real good application of density. Its how they separate things sometimes - ??????? too. Another good application of density involves gasses. No, you guys can play with those. Its like being back in junior high – it kind of feels comfortable. The mass connection of this – while I've completely lost half of you with the super balls, which is good – is that you can graph this. Now on this graph on the overhead for those of you who might not be able to see it – mass is on the vertical axis, okay? And on the horizontal axis across the bottom is volume. And those units – mass is usually measured in grams and one gram is about the mass of a paper clip. And the volume called one centimeter, or one cubic centimeter, or one milliliter – I explain it to kids as if I was able to cut off – kids remember things if they're gross, if they're larger than life – okay so I say I'm going to slice off the top of your little finger – speaking just metaphorically here – I'm going to slice off the top of your little finger and that top of your little finger represents about a cubic centimeter, about a milliliter. They'll understand that – that's a good point of reference. So if I had something that had a volume of 2 and a mass of 2, it would have a density of 1. Mass divided by volume is density. Probably introduced about the 5^{th} grade level. But the graph that you get when you graph mass and volume – particularly of something like a penny, those groups of pennies, as the mass goes up and the volume goes up, you'll get a line that looks straight across. Where the density doesn't change. This is where the density is actually going up. I'm measuring increasing volume, but I'm also measuring increasing mass. Now watch what happens. I've got 2 divided by 2, if that was that dot point there that would be 1. 3 divided by 3 is going to be one. That's where the density remains the same. I stated that wrong before. If I had a glass where the density was flat-lined across – I see some graphs from kids. What they'll graph is they'll graph number of pennies versus density. And so if you've got number of pennies across the horizontal axis and across the vertical axis you've got the density, the density doesn't change irregardless of how many pennies you've got and so they get this flat graph and they say "I don't understand why your graph looks like that and my graph looks like this." Well its flat-lined. And I say "Well, what changed?" "Well, I changed the number of pennies." "Well would the density change if you change the number of pennies? Look at your graph and see." And they eventually get to the understanding, well no it doesn't. Density is a quantity or a descriptive powerful characteristic that doesn't change irregardless of how much you have. If I have this much gold it has a density of about 19.something grams per cubic centimeter. And if I have this much gold it has the same density. So if density doesn't change, irregardless of how much stuff you have, it becomes really valuable. 'Cause no matter how big or how small a piece of matter you have if you can identify its densitiy, you could probably identify the material that it is. And so the fact that density doesn't change, its better even if kids do come up with one of those flat lined graphs. If they graph the number of pennies versus the density of pennies and they come up with a flat line, that was a much better way for me to show kids density doesn't change than when I did the mass connections accurate graph like this. Because when kids see that they think "Well density changes. Density goes up. We use this all the time in science classes and I couldn't figure out why my kids kept thinking that density goes up. And one kid finally said "the graph goes up". I went "what graph goes up" and they go "mass versus volume" and I go "well it does, but does density go up?" Does density go up? No. And so because of the mistaken one I kept that on an overhead. I plopped that on the overhead and its number of pennies versus the density and it's a flat-lined graph. Kids get that. Sometimes even when we do accurate graphing we promote misconceptions of science and so we have to be real careful because you'll look at that you'll think "density goes up, right?" Okay. Now let's go on to – lower elementary. I don't want to leave you guys out on this. Floaters and sinkers are really important – really good. Take a big clear bucket – one of those Tupperware things – what do you put in it. An orange. What does an orange do? Float. What happens if you take the life jacket or the skin off an orange? Sinks. Okay, what does an apple do? How many of you have bobbed for apples? What does an apple do? If an apple sinks somebody's given you something really bad. And one of the reasons we use bobbing for apples is because apples do float. Apples are less dense than water and so you could stick your head barely in the water and if you have a large enough mouth you can grasp the apple in your mouth. It would be easier to actually grab the apple under water, but you would probably drown in the process and that's such a downer during a Halloween party. Uncle Joe caught the apple, but he's at the hospital right now receiving some ?????. If you try different fruits, your tropical fruits that have a lot more sugar will probably do what? Float or sink? Probably sink. You could put a kiwi in and a kiwi goes down like a stone. Bananas are interesting – depending upon whether you leave the skin on or not. Different fruits that have thicker skins – like bananas and oranges – do different things. Apples will float. You can put stuff in there. What's another mutation of this? I know somebody in here has done this. Nope. That's a good one though, that's ?????. Diet Coke versus regular or Diet Pepsi versus regular. Have you guys never done this? Ah! What's in regular Pepsi that's not in Diet Pepsi? Sugar. And so if you take 2 cans of soda – and the cheaper the better – but a regular and a diet and you put them in water – the regular soda will sink to the bottom and the diet one will float to the top because of the difference in density based on the sugar and the liquid. So if you're ever at a party and the ice has melted down and you're searching for those diet pops that they never buy enough of – all you have to do is skim the surface of the cooler and you 'll find the diet pops. If there's nothing floating on the top you're out of luck. If you have to go to the bottom of the cooler its going to be regular pop. But it's a great way to explain to kids and kids will want to try all kinds of different pops. They'll want to try High V and Safeway and Albertsons and let them. Let them bring in any kind of pop they want. They'll want to try Welch's grape juice. But the key is if has a aspartame or a sugar substitute in it, its generally going to float. We've found a few rare exceptions but not many – usually in the fruit juice stuff. Its interesting too if you're going to measure the density and you get a really high sugar concentration of some of those sport drinks, some of those sport drinks are sugar and sugar. And when they do a density calculation on that and they can figure out – they can compare it to if you had pure water, what would the density of pure water versus water with a tablespoon of sugar? They can actually do a pretty good job of ramping up to try to figure out about how much sugar one of those sports drinks must have in it and its amazing – stick your little densinometer in one of those sports drinks and see how high that comes up to the top. It's a good application. So in lower elementary we might which floats higher, which sinks, which floats lower – similarities and differences floating and sinking with a variety of things and we would do something called dancing raisins, okay? Now a lot of you know dancing raisins. I'm going to give you a little – like heard it on a grapevine – yeah – I don't do a good Marvin Gaye – but you got some raisins there and you've some Sierra Mist or some Mountain Dew or something else – grab a couple of those glasses, but some of that Mountain Dew or that liquid in there, take about 4 or 5 of the raisins and put them in the liquid. And Aunt Shannon will tell you a story. My favorite open house or teacher conference activity with parents. It will guarantee that you will be seen as a psycho and the parents will cut you some slack - some major slack. I'm recommending this highly. Yeah. Now in your observations try to tell me why they're floating and sinking. No ??? left behind. Alright. Okay, now what do you notice? Let's go to this back table 'cause I've been ignoring you occasionally and you are my gifted group. Alright, now what do you see happening? Give me some observations. "Well we're observing that the carbonation is lifting the lighter weight raisins initially because they're dehydrated. And we're hypothesizing that as the raisins are absorbing the liquid plus more sugar that they're sinking." That's a good guess. It's not accurate, based on the science, but it's a really good guess. That's very good. I like that. Now you're on the right track on the carbonation. Carbonation is CO2 that they add to make this sparkly. It's actually added to make it taste kind of tangy. And so the raisin surface is really kind of wrinkled, right? And so its allowing – it has a surface that allows that carbonation to attach. I would have kids with a difference of texture as opposed to telling them. So the kids will – I'll say what about a raisin is allowing them to do that? You know, what if I put something smooth in there? You can try it with grapes. You can try it with something smoother, but it works better with raisins. It'll actually work with spaghetti, 'cause it has a smooth surface. But microscopically spaghetti has more – and its not as fast as raisins. So the little carbonation attaches to those wrinkles or folds and it gets enough air to where it changes the density of the raisins related to the density of the Mountain Dew and it lifts them. Yeah? "?????like the little dry raisins? What's the story there?" In some cases yeah.. There are some raisins that are just really, really dry. They've lost a lot of their liquids and they've become hard as a rock and so they've become more dense. Yeah. And these raisins are ?????? Some of the raisins are…down and up…down and up…down and up and some are ??? clearly it has to do with how much water is in the raisins" I think you're right. And that would be easy to test. Leave some raisins out on the window sill and check those against fresh raisins you've got in the box. Great! Okay. So. You what? You ironed your raisin? You flattened your raisin out and what happened? Did it come back up at all? Gifted group, what did I tell you? I ironed our raisin out – is that great? This is awesome! Yeah. I don't know what happened to them. They were here a minute ago. Interestingly enough these fish are going to do the same thing and we'll show you that in a minute. Joyce – you've had some explanations from your group. Can you tell me kind of in your own words what you think is happening here. Give me your best thinking. "The carbonation is attaching itself to the raisin and then the raisin is popping I guess it's the air – I don't know – then it goes back down then the carbonation attaches to it again and it comes back up." Yeah, once it gets up to the air there's not much to encapsulate that carbonation, right? So it says "I'm going to going to join the other gases – I'm outa here – adios amigo raisin." So yeah, you're right on the track and you'll see that happen. Good! That's good! And here's my favorite parent teacher conference activity. You take one of these glasses and a can of Mountain Dew and a box of raisins and put them in a brown paper bag outside your door. And you choose a male student – has to be male. You say "when I ask you to go get me water you are to get the bag outside my door, you're to go away for a few moments. You're to pour the Mountain Dew into the glass. And I use a beaker that we don't use for anything else. Pour it into there and then put a couple – about 5 raisins in there and you're to wait a minute-and-a-half or two minutes and then you come back and when I say where did you get this water from, you're going to tell me the boy's bathroom." They'll go along with anything. So the kids do that, he comes back and I see the parents are sitting around the table, its open house night, and I'll go "where did you get this?" and he'll go "boy's bathroom" and he'll go "my gosh – do you know what those are?" tell him not to tell you at this point cause some guy'll go "yeah raisins, I put them in" – you want to tell him to keep his mouth shut – you say "those are sewer lice and those are the largest most – they're still alive – those are the most active sewer lice I've ever seen – we must be infested!" At the very minimal – if there's a school board member in the room at that time – you're going to get new bathrooms. But you face it down and you say "I'll have the custodians take a look at that later on – that is amazing." Well first off the parents are going to go UGH. ??? Leave it right by your glass or your cup of coffee. Because later on there's going to be something that the hand me some of those raisins will you – okay – I'll put them in here. Let's pretend that that's my cup of coffee and these are the sewer lice. You play with these – I don't actually want to drink them. So if they're side by side kind of like this – and you have them right there – all you have to do – because the kid has put them in there – hopefully he hasn't really put anything else in there – you sit there and you wait until the parent asks you a question – and they're going to ask a question and you say quickly you have to move this to your lips and you say that's interesting, I haven't thought about that. (Cough) "You're terrible." Its kind of – hey – I don't remember your question. It's like – it's not important. If Joy misbehaves just send us a note home I'll be back later we'll see you. You'll teach them the moonwalk essentially. Table will clear. It 's like "where did they go." You'll get some funky phone calls. I'm gonna warn you about that. Because the first time they did this I had a principal that came up to my room and said "C'de Baca, we've gotta talk for just a minute" and I said "yeah" he said "you like nutrition" I said "it's good – it's good for you" he said "do we have an infestation of sewer lice?" and I said "not really" he goes "what do we have an infestation of ?" I said "not doing raisins" and he goes "that's probably what I thought" and he said "you still have at least one parent that really believes that there are sewer lice in the school – so you might have to do a little damage control so they don't go home and start calling the school board repeatedly unless you really want new bathrooms, saying get those sewer lice out of the school – they're ???? you know I don't want my kid going to the bathroom where there's sewer lice and I don't want a science teacher drinking anymore". Anyway, but it's a good activity with kids and its also a good ????? works well with 3rd graders through – probably not good with primaries, 'cause they'll go drink it. With 3rd grade, probably up through 6th grade, where you do something like that the kids are gonna go "aah" and you'll say "could I really do that?" and what do you think is going on here? And then you can take them into dancing raisins, but ?????? those kind of ???? events always fun to build relationships with kids. Alright, this is density in a liquid system – and it is exactly that. The system of the raisin changes its density based on the carbonation that comes in. You can do this also, but I wouldn't drink it, with vinegar and baking soda – yeah. Vinegar and baking soda if you don't have any liquids. Um, some considerations as you're going through this is – when you're talking about density there are some variables that you want to bring out. Like in this case the variables the kids might want to test are what? What's a big test if they wanted to see how this works? Besides different kinds of pop. Exactly – you guys noticed what about your depressed raisin – your suicidal raisin? "We had one that came to the top and never again sunk – it just stayed up there." Exactly. "And we had some that were really active – so." Good analogy for science classrooms there isn't it? "It looks like the more, the more clumps, the more water-dense, the more active." So if you have a raisin that's really dried out, okay, I had an aunt kind of like that – no she'd been in the sun a lot. She was from ????. Um, if you have a raisin that's really dry and you put that in, is that going to behave differently than a fresh raisin? Are there different objects you could put in the water that will do the same thing? How heavy can an object be before there's not enough carbonation to lift it up. Here's some fish – put at least one of your fish in there – make sure you take a fish home – they need homes. But the fish we noticed in a workshop just last week will also rise and fall. But generally they only rise – I don't see them fall very often. Fish are a little bit heavier than the raisins and so it takes a little bit more bubble-stuff to get them to lift. You killed it! What did you do? Here, add a little bit more of the Mountain Dew. Get a little bit more liquid in there and see what happens. ???? its going up. Alright. ???????? And the other bubbles were trapped beneath - would trap some carbon dioxide too. And you can test you, you can turn the fish over and see if some of the carbon dioxide bubbles – the carbonation bubbles – will be released and the fish will go back down. Kids will want to test different liquids, different materials, different temperatures. And the temperature at which – you know you can drive all of the carbonation out of a pop pretty quick. But the temperature of liquids makes a difference too – okay. You want to change one variable at a time and that's important to teach kids. And at the high school level and at the 6th grade level we start introducing ????? to connect ???? variables. One of those variables changes depending on how much stuff there is and one does not. And we'll get into those in high school. Let me go on to a couple of other things here real quick. We've talked about density of fruit. We've talked about density of liquids in manufacturing wine and grape juice, sugar and iced tea is another one, fat in milk. They even use density in terms of blood – they do ?????. We've talked about density in gases. You cannot talk about density in gases in junior high or 5th or 6th grade without mentioning bubbles that float to the surface in the tub. Enough said! The standards are included in your handouts because these are the standards that directly relate to the activities that you've done today. But even more important is this concept. In order for you to make content sticky – we talked about teaching at 3 deep, assessing at 3 deep – you want to make sure that you ask yourself some fairly good rich questions – like for example – how is floating related to density? And get rid of some of the stuff like you did with the treasure items – get rid of some of the stuff that's going to impede their ability to understand the key concept you're going for. Buoyancy is one of those. You know, boats float, but they're made of steel. But that's a whole different concept. What is heavier than water? That is a really key point in understanding density. If a kid could explain to me things that are heavier than water in terms of density – boy, that's good! Differences that there are between objects that float and objects that sink. (Tape ran out – missed some) that was so elegant with no words. Example, example, example – the more examples you can give kids, the better off. Like when we explaining about seasons – assess them while the content is hot, and reassess them later on. That's relatively important – more important as you get into the higher grades. There is some student work on each one of these activities in the handouts that will also be on the web pages. That student work is student work that was created by students at the 4th, 5th and 6th grade level. And that student work gives you an example of a student that really doesn't have it, an example of a student that is approaching the understanding, and an example of a student that has it. And they're not perfect pieces. They're pieces from real students, to give you an idea of the kinds of student work you can expect, or can expect from your students, when you're setting the bar appropriately high enough. If you want to have success for all kids – no raisin left behind. You want to identify your content clearly. Density was the content – every activity you did today was related to density. You want to find a great activity that illustrates the content. Explore with the kids and let them ask lots of questions – questions are good. Tighten up your connections in your examples – practice it with groups of kids and make notes after you've run something – to anticipate something later on. What you did today will make me go back to my room tonight and write some notes, based on some of the things that I saw you doing. Ask more questions – don't go too far with kids – with you I can go as far as I want. With kids, you want to be connected to the content level that's appropriate. You don't want to get into buoyancy – you don't want to go too far in terms of density. You want to keep it at the right level, even though you really want to advance it for some of those gifted kids – do that away from the main group so that you're not frustrating, or taking the focus away from what you really want kids to take home. And give kids a chance to wrap it up. Ask kids – and we're over time here – but what I would ask you is "what did you learn about density" if you were my class, and I would start taking notes. And how powerful is it, when you're a student in a classroom, and your teacher sits down and takes out a table, listens to you intently, gives you the gift of their undivided attention, and writes down your words? That is such a powerful thing – and it's the best way you can wrap a lesson up. So, I appreciate you being so attentive today, and being willing to explore with me, and thanks for coming.