TEACHER-TO-TEACHER
C'DEBACA – Science & CSI

Segment 1 – Mystery Objects

FS: The goals of this particular workshop are kind of diverse but, number one is in every single workshop at Teacher-To-Teacher since that is the title, we want to connect teachers to other teachers. We want to connect teachers to the presenters so that individually we may have a great deal of knowledge, but collectively we have connections to the greater world and so my connections become your connections here. Because I believe that good work that teachers do needs to be shared. Museums operate on that philosophy all the time. If something good comes up, a museum is going to get it out to as many people as they possibly can. Teachers worry about that too.

Second thing is I want to give you a model for teaching in terms of the populations that I serve, the diversity of the kids that I serve in terms of their reading abilities, in terms of the courses they've taken, in terms of their mathematics background that would meet the needs of those kids and not slow everyone down. It's more like an on-ramp to get them up to speed and that's the… instead of the who, what, why and where kind of model, we start with the why, we go to the what and how is interwoven and I'm going to show you how that works. And the other thing is to give you some good ideas. No teacher workshop would be worth it's salt if you didn't go home with at least one or two or three or twenty great ideas that you could implement into your classroom. And we're going to start with an activity that's called "Unclogging Your Plumbing." It's called Mystery Objects, but the purpose of this is to unclog your plumbing and it came from a tiny little box like this that became the centerpiece of all mysterious things in my classroom.

On your table are some different objects…mystery objects if you will. I want you to decide on one object that you don't know it's function. In science class we are all about form and function and each one of these objects has a form, it's metal, it's plastic, it's round, it's flat, it's got little…screws…it attaches different pieces,

it's got raised surfaces or rough surfaces or smooth surfaces so you are going to look at the form, and then you are going to hypothesis a function based on that form. The form dictates the function. And then the third thing I want you to do…you know look at form, you are going to hypothesis the function, when we process out and we talk about this as a larger group, you're going to tell me what the function is, your hypothesized function, and you are going to defend that with the form. Makes sense? Show them the object.

I told them somebody said it was medieval Barbie's hairnet. Do they make a medieval Barbie? But it unrolls, I mean it's actually cylindrically shaped, flat tube sealed at one end of mesh…some kind of wire and if you were to hypothesize the type of the wire, would you think in the humidity that I've been living in this summer, that this is iron? Probably not or else it would probably…you'd see some pattern of rust on it. Okay. What do you got for form?

FS2: Well we put that it was some…I put down…steel mesh, I don't know if that was my word or my group's word.

FS: That's all right.

FS2: …that it was coarse to the touch. It's not smooth.

FS: Texture…good.

FS2: We said it was strong but… and we couldn't break or tear it. We said that it was the tube sewn closed at one end and it was about eight inches long…we didn't mention it's width. Okay, we need to throw that in. Two and a half inches…good. She's got a good idea of inches. And we said it rolls up like a sock.

FS: Okay. Oh…very good! Now what do you think about function?

FS3: Well we had several functions. We talked about how it could be a filter…put it on the outside of a pipe or on the inside of a pipe to catch something. A scrubber or scraper.

FS: Yup.

FS3: And some sort of cleaner…that maybe you could put something down in there and clean, a bag or storage …

FS: Very good! It will probably be on the market tomorrow as a purse. Anybody knows what that does? What its actual function is? It's a filter that is used on the drainpipe of your washing machine is where that actually came from. All of the thinking that you did in terms of form and function is excellent and it gives me two windows into your world. One it tells me that you guys understand form and at least several people in your group are concerned about measurements. And instantly I would clue into…ooh that's a really important piece of science is to be able to describe things in terms of their size. In science will use metrics more than we will use inches, but that's an easy conversion to teach kids to do. So I know that you are interested…you are going to look at measurement and so I probably don't have to focus you in on measurement of objects, but I can refer to that and I can have an expectation that you would be doing that.

Your form and function is awesome because you are describing that as metallic and you are even starting to use some terms like steel and at the elementary level like at the fifth grade level that would be wonderful. If I was looking at an activity leading into activities on periodic table when I was doing mystery objects I would want to put different metals in there for you to identify different aspects some that are heavy, some that are light, some that look like they are kind of corroded and some that look like they are pristine or brand new, some that are silver, some that are maybe a brassy color. If I can get you to argue from evidence I'm a happy camper because that is what a conclusion is all about and that's what good writing…who's an English teacher? One time. Arguing from evidence. When you are supporting there you are making an assertion and you are giving some support of information, that's what paragraphs writing is all about. Awesome!

Two really interested things happened when you guys do this activity and I do this the first four weeks of school. One thing is it's a window into the ideas and the background of your kids. Kids won't tell you that they are making sense of content based on their background, but they always are. There is this background knowledge up here that kids don't often let us into. If the distance between the background and the content is too broad, and if we are not connecting the kids background to the content, we are not narrowing that gap, there is this whole zone of misconception and the kids will make erroneous connections and that's how we have kids graduating from Harvard University that say that the seasons are caused by the proximity of the sun to the earth as opposed to the tilt or angle of the suns rays. And so these misconceptions of these big global broad science concepts come about because the kids have this background and they can only connect content in ways that make sense to them based on what they currently understand. If it looks like a lizard, it must be a lizard. If I've never seen something that looks like a lizard that isn't a lizard, I'm still going to call this thing a lizard. Does that make sense? And so this provides a window into the kids knowledge and background which is very, very powerful.

And I just grabbed a random sample of objects. This one actually connects chains…bike chains together so that you can repair them. You knew that. So if I gave this to this table, and he knew that, I would know that he has an understanding of repairing bikes. That's a fairly special idea. Now, if he's being fairly reticent in his conversations with his group, and I can't drag into the content, what I'm going to do is I'm going to use some bicycle analogies or I'm going to use some examples on mechanics or on some science principles that involve bicycles and guess who's eyes are going to light up? Guess who is going to feel like the smartest kid in the class…which is great. This is content neutral, and when you've got kids from all over the map dealing with content pieces, you want something that is content neutral. You don't want a kid to say, gee, I'm the

smartest math whiz in here and so if you give me a match problem, I'm going to blow my table away, because that kid will do the math and the rest will watch. When it's content neutral, everybody is an expert. Everybody can examine form. Everybody can hypothesize function. And there is no smartest kid at the table. There are kids that are more skilled at communicating form and function, but everybody has background and experience and can contribute to the group activity. So the reason I do this the first four weeks, it's straightforward to get them thinking and unclog the plumbing; to get some information on their background so that later on in my examples…in my metaphors, in my analogies, in my lessons, I can bring in interest areas from the kids, but also very, very importantly, it's to get the group to jell. For kids that are at risk, for English language learners, for kids that are special needs, this may be the first time that they have ever really felt an integral and important and valuable functioning part of the group.

Segment 2 – Form & Function

FS: My bright kids that are the "shooting stars" that think they are the whizzes of math…those kids. The ones that get every question right and bright is not describing their abilities. Bright is describing their ability to work within a system that is designed for their abilities. Those kids feel a little frustrated and it's okay. That level of frustration causes them to grow and so it doesn't slow them down, it's increasing their growth, but probably in divergent areas of thinking but it's making the group come together.

As department chair, I had a real dilemma. Any of your schools have a terminal science class? Does that sound awful? And that's what they are called. There is a science class for kids at most high schools where they aren't successful in any science class and at the end of their career, as juniors or seniors, the counselors are so scared that they aren't going to have the credits necessary to graduate that they put them in a science class that is mostly packetized. And those kids are put into a "numb" zone that is completely out of their learning style and doesn't give them a chance to really grow. It's a very horizontal…give them some content… give them a credit and get them out the door, so that they can graduate. I want those kids in chemistry and physics and I was having difficulty attracting them into chemistry and physics based on their math background and also based on their perception of their own abilities. Guess what forensic science does? Those kids are successful and I get a greater population of special needs into chemistry and physics. I get a greater population of kids at risk into chemistry and physics because they say hey if I can do this and C'DeBaca says this is really tough stuff, I can probably handle chemistry and physics.

Now we do this: we examine each object, we determine the use, we record the work. We are thinking on three levels. Form, function and arguing from evidence. They are presenting their findings as groups, we do it for four weeks and it only takes when you get going, it takes about five minutes in each class.

Now where would you find the best source of these mystery objects in your building? What do you think? Custodian is exactly right. The custodian is your number one source because he or she will have stuff down in a junk draw that nobody in history…you could send them to the Smithsonian and they would have trouble finding out what it does. So ask your custodian first.

Second good source of material is your kids and they'll bring something in its stump the teacher time. They'll say, ya know, Ms. C'DeBaca, I got this for you and I go Wow! Man this will really stump them. And I'll start heading over to the mystery box to put it in and they'll go…ununun. And I'll go…what do you mean? They'll go…you…me…okay. It's plastic, it's got a top that looks like it might connect to…kind of looks like a…top of one of those soda bottles…it's got this little piece down here that looks like the other part of a soda bottle…it's got a little kind of a and then I'll say, well…I'm not sure. I'm going to guess it's a test tube. It's a thing that holds fluids and the kids are laughing like crazy by this time but they'll give you great objects. This is a baby soda bottle. They call it a pre-form. They take this and they manufacture this and then they put this bottle through a process where it goes through a heated area whether it's a water bath or air bath and they a form clamps around it and it's inflated with air once the plastic is soft and it gets to the size of a two liter bottle. But they make excellent test tubes. Now don't put these in direct flame. Personal experience shows me that they melt kind of pretty, but they burn for an incredibly long time and if you've got sprinklers in your room well its shower time. They are a great tool for teaching science and they are great for mystery objects too because you can put mystery objects in there that you don't want the kids to touch. So when I'm doing the periodic table and I want…or I'm doing elements, mixtures and compounds, and I want to have a mystery object that's elements, mixtures and compounds, I will put those into those pre-forms and pass those around. If there is anything I want to seal up because I don't want it to evaporate or dry out or whatever, I can put it

in one of those and I can stick a little bit of Elmer's Glue around the rim and it's archivally sealed I guess you could call it.

I want to teach the why first in kids. We…a lot of times teach the how…the skills. Anybody know when they learned about the parts of the microscope in biology class? Was it like the first couple of weeks? Every biology class that I've ever taken, teaches the parts of the microscope early on because it's hands-on and it's pretty engaging, the microscopes are cool and then the teacher doesn't get back to the microscopes for weeks and all of a sudden the kids are going to have to use the fine focus and the coarse focus and focus in on some tiny microscopic animal or a piece of hair or piece of lint or whatever you are examining under the microscope. Kids can't remember how to use the microscope because it was taught out context. The how is disconnected from the why or the what. So I don't do that in CSI class. In forensic science the how is interwoven, so when we need to use the microscopes, that's when I teach them to use the microscopes and the parts of the microscopes and it works seamlessly. The why comes first because most of the kids in a non-traditional science class will want to know why first. Why do I have to know this? Well you are going to have to learn a little bit about the systems of the body because you are going to read an autopsy report. Well if you are going to solve a crime and it's going to involve metal, you got to figure out how to analyze which metals are which. We got to pay attention to form and function. We've got to do this right, so the content is the what, but the why has already set the stage for.

In high schools and junior highs, and to a certain extent, in elementary school, one kids ends one class and may or may not… may have a conflict or may have a good even happen in the that class. That's baggage that is put into their little duffel…comes on their sack and comes on their back and they move to the next class. Any conflict, any problem, any good events that happen in the hallway are going to get put in that sack too and then they are going to come into your

classroom, they are going to sit and they are probably going to have some kind of bell work. Bell work for those that don't use it or don't know it's some work that you use to get the bell…get started and teach bell to bell. I always have a quote up on the board. It's always on the right hand side of the board. It's a motivational quote. I'll send you those if anybody wants them and those kids know that they have to get out their little notebook and they have to get out their pen…their learning log or their journal and they have to write the days quote down and they have to write the date, that way they've got their pencil out, they've got their notebook out…they are ready to go! That's bell work, but it still doesn't unclog the plumbing. And so in order to get them thinking and to allow them time to get rid of whatever they had in the hallway or in their last class, this gets them thinking and it gets the plumbing cleared so that whatever content I'm going to deliver is not going to face what we call cognitive interference from some emotional event that might have happened to them before. And the probability of that content being absorbed by those kids or retained goes way up. Okay? So this is called unclogging your mental plumbing. We tackle challenging work with puzzles, with thinking things, with brainstorming. We might discuss some ideas. We might critique our own thinking on a lab we did before. It's anything that can get the brain moving…that can get those channels open and get them on a different level.

Now treasure boxes. For some strange reason, as engaging as I am, nothing…nothing worked better than this for my kids in forensic science class and I just came upon it by accident. I'd found this at a local discount store and I thought it was kind of a cool place to store post-its and whatever. And I had it opened one day and I had the school announcements in here and I pulled the school announcements out and I said let me read the announcements. And I noticed that usually with kids it's like…okay…I'll stop talking when she starts telling me to, but they were all listening to the announcements and I

thought…something wrong? So I thought maybe it was the box and so I tried it later on. I usually tell them what the school lunch is at some part of the day because I think that's a mystery. I'll get all kinds of nasty emails from school because…our lunches are pretty good, but still there is a mystery meat involved in school lunches…no matter what they tell you. So I'd pull out the school lunch and I'd read it and I'd notice that kids were paying attention and I thought…hummmm whatever I take out of this box seems to take on a special significance. We are going to milk this as long as we can. And so when I teach solutions, we were teaching solutions in chemistry and I usually use some kind of sucker. We talk about solute and solving and solvent and dissolving, rate of dissolve, factors that affect the rate of dissolving. I usually give the kids some kind of sucker. It's always after Halloween because you can buy suckers for about $1.00 for 6,000 suckers at Halloween and so I usually put them in here or put some of them in here and they know we are coming up…that solutions is going to be our next unit and I say what does this have to do with solutions? It came out of the box, they are all paying attention. Okay they are all paying attention because they are edible too, but I mean it's kind of an interesting way to do it. If I was teaching now, forensic science…this last couple of months, I would pull out a small object like this and say, okay, we are going to discuss something that has to do with forensics and we are going to look at the forensic evidence of a recent action…which one do you think it is? This is a small bus. London bombings…exactly. I'd get a double decker if I could find one, but this was the only one that happened to be in the junk draw of my house. So then I've got something that I can use. I've got a tangible object and if I have a kid that feels a little disconnected, I'm going to say, I want you to help me out here. I'm going to give you this object that is to remind you to keep me on track. We've got this much time to talk about the London bombings and then we've got to get onto something different, so I want you to keep track of time and give me a heads up.

You're the keeper of the time and keep me on track if I start taking these wild bird walks, you are to say, Ms. C'DeBaca, London bombing. And so this kid has something that tangible they can hold in their hand. They've assumed a level of importance and I can choose any kid in the class to do that to. If it comes out of here, it's magic. Some of the things you want them to think about. Jacob's ladders are always mysterious. You have a kid that has some kinetic aspects that need something…they fiddle with their pencil, sometimes just sometimes fiddling with their pencil is enough to keep them engaged. Sometimes giving them a challenging puzzle or something during those periods of times when they are done with their activity and they are starting to drive the rest of their group nuts or they are starting to make your nerves raw…there are some times when you can have a puzzle stuck into this box and you can go, come here and you can go…here ya go. Figure this out. I'll talk to you later. They'll be sitting there going…okay, let's see…and it's wonderful creative thinking, systems analysis that's doing something you want to do in science. They are still actively engaged, they've just finished the work that you had for them that day and you don't have to slow down…you don't have to speed up the rest of the group, you don't have to slow that person down in order to get your day accomplished. But I would encourage you to use something like this because if it comes out of this….it's magic! It's magic!

Segment 3 – Cases, Content & Chemistry

FS: We studied Laci Peterson in this year's forensic science class. Every forensic science class should have a kind of an ongoing mystery that they are looking at and it should be real. You have to be fairly careful about what you are choosing. I don't choose…I try not to choose any that involve sex or something that is incredibly gory or violent or really frightening and with younger kids I would probably follow a mystery that is historical as opposed to something that is current just to keep it on the safe side. But…kids want to follow something; there is some consistency that they have a continuing story that is going on. Good example would be…in fifth grade or sixth grade if you've got a book that you are reading to the children or the children are reading out loud…if there is some oral reading going on and you only get to read a segment of that book during the day. As the year goes on, they look forward to that time because they want to find out what is going on with their characters. It's a great tool. Well this gives some continuity to that because the kids want to find out what's going on in the case. Do I have to read the announcement? Absolutely not. I can find a student that is more than willing and some students that I can stretch into reading whatever the update is. And if you go to CourtTV.com, they follow any of the major cases and they usually archive a lot of the major case information. I was reading off Laci Peterson updates and information and one of the students…a young man at a table was doing this. He had fingerprints, hair and fiber, he had DNA, he had materials I think was another, and he was putting the evidence in these columns…he was organizing it. I never told them to take notes. They were taking notes because I'd done the why first, because it was important for them and they thought I want to stay up on this and when we discuss this, I don't want…I don't want to act as though I don't know, the information is right there. They want to solve the crime. Faster than the jury was making their decision and so somebody else notices that he is taking notes in some sort of grid format and all of a sudden

everybody is doing it and I'm looking at people's notebooks and I'm thinking…did I nap through a period of time, did I teach them…and I said, why are you doing that? They go because it makes sense. I'm thinking…duh! Okay and then somebody even put the…in one of the cases we were discussing, put the different suspects down and was organizing the evidence in two ways with the evidence in vertical columns and with the suspects and the evidence that connected them in horizontal columns and I thought…brilliant! This is great. We use that all the time now and I make sure that I give the kids credit for that, but it comes about organically because of the way the course is structured. In many schools in order to boost the literacy rate of some of their kids…in order to expand their vocabulary, they have school-wide vocabulary programs. A lot of teachers at the secondary level are not as on board with that as we should be, and so in order to make it a little bit more exciting as opposed to… these are the vocabulary words of the week, they come out of the mystery box and all of a sudden they are kind of cool. It's great. It works fabulously for vocabulary!

Now we are at the what level. The what level is the content and no science course is worth its salt unless you are teaching content. The power of a science course comes in the ability to understand complex scientific principles and kids are scared off by that in many cases. They are scared off by the math and sometimes they are scared off by the abstractions. In chemistry in particular and in physics. But they shouldn't be, because if I do my job right and I'm connecting background to content, I can teach, in a forensic science course, cell theory. Cell theory should proceed any discussion at the high school level of DNA. And understanding how a cell is structured is really kind of cool. There are times when I have to teach some content that is what. That is sheer memory work and we generally teach it one level deep. We tell the kids here are the parts, here is a diagram, label the diagram and the kids don't retain the information that they need to retain. I've given them a diagram. They've labeled the diagram. They've

either seen a movie or they've heard a mini lecture on how blood flows through the heart so they've had it at one layer and possibly two layers deep. Now I have this blue balloon in front of me and I ask the kids to organize themselves into a heart in the room…into the parts of a heart so that I can walk from one portion of the heart through all the different portions and not get really get too confused because I'm fairly old. So we've got this balloon which represents…I'm the blood that needs to be oxygenated…the blood returning from the body and I go up to this the superior vena cava and I say who are you and where am I going and that kid will say well I'm the superior vena cava and right now you are going enter the right atrium. I go okay. So then I step through and I'm at the next kid and I say what are you and who am I going to? And they'll explain it and I'll walk all the way through the heart. When I return, pulmonary you'll see there, from the lungs into the pulmonary veins, all of a sudden I've got the balloons shifted and when I shift the balloons they know that now I've picked up oxygen from the lungs… and I walk my way through the remainder of the heart. The kids get to know this. They've known it from the diagram, but now it's making more sense and I'll even have kids doing this weird thing. They'll say I'm a tricuspid valve and they'll go…they'll make a tricuspid valve using their chin and their hands or something…they'll say I'm a bicuspid valve. They'll do that almost organically or I could actually tell them to do that. By the time I'm done, I go all the way through the heart, now you are the superior vena cava, I hand you the balloons and I take your place and you do exactly what I did. Now when I do it three levels deep…three levels deep will give me about a 90% retention rate on one of my Friday quizzes…even among my special needs kids, which just blew me out of the water. So we do that…we do that with cell theory. When we talk about the parts of a cell, we make a big cell. Some kid is going to play the part of the mitochondria. Standing in as the mitochondria today will be Owen Wilson. Then I can talk about genetics and DNA. They know cells, they feel empowered, they got

it going. I can do circulatory system. I can talk about the nuances of the circulatory system…arteriolosclerosis, some plaque build up in the arteries. Why does it build up in one artery and not in another? Where is a most likely place…why do you have more aortal aneurysms than any other place? And some kid will have had a dad or a mom or a uncle or a loved one that has had a heart condition and will come to class and tell you after you've done that: I was able to talk to my uncle and tell him why his heart attack happened. And they'll pay attention to some of the stuff that's going on in the news. You build interest from background because once you have content approaching you, if you have background that will allow you to connect that content…to allow you to feel empowered, you are going to pay attention to it.

We do that…this right here is our why. The autopsy for most of this stuff, because early on and I'm happy to send you…I've revised a bunch of autopsies to make them a little…not a little…ummm a little less complicated, but also more solvable by kids so that there is a closer line between…it's still a little bit veiled, but between cause of death and understanding the systems of the body to where you can't read the autopsy report and really understand cause of death unless you understand these other parts of the autopsy report where they are examining organs. And so the autopsy report gets handed out early on and the kids say…I don't understand this…this looks like Greek…and I go no, it's probably Latin, but still older language, but we can understand that. We can do the roots and shoots kind of thing where we understand the prefixes and suffixes and we can derive the meaning of the term based on what it sounds like from our own language. But this makes them want to know about blood types and circulatory systems, health and illness, it develops an interest level that pervades everything.

Now this comes naturally. Kids love anything that crawls and has legs. Teachers that teach chemistry are not particularly fond of forensic entymology, but we do it anyway because it's an important part of forensics. Chemistry is where my heart

lives and so there is a ton of chemistry in my forensic science course because I want these kids to be empowered by high level science that is fairly abstract. So we do elements, compounds and mixtures. We do toxicology; we do drugs and poisons which is pretty interesting, especially if you do it around prom time. I am really tired of losing kids around prom time because of drinking and driving. When I do drugs and poisons from a forensic science perspective and they understand systemically what happens, and I do drugs and poisons together for one solid reason, I want them to understand that these and these work in their system pretty much the same way. And so when we talk about the systemic interpretation of drugs it has an impact. Arson…any fire department will allow you to take the coolest field trip on the planet. They burn houses to prepare their firefighters for the real thing and generally they also do it to investigate arson…to be able to let their arson investigators have some practice. They will take you to one of those sites…either where they are burning a house or where they've burned one and they will let the kids touch some of the wood that told the arson investigator where the accelerant was and it's a very…this is high impact stuff for kids. But arson investigation gets into vapor pressures and the gas laws in chemistry…I mean, there are some really great secondary science stuff. At the elementary level it gets into fire science safety and it's much better than having the kids just go home at Christmas time and see how many lights are plugged into one outlet cord.

This one, thermo chemistry identification of unknown metals. You take a metal of known mass that you don't know what it is and you heat it up in a water bath so that the water temperature and the metal temperature are going to be the same eventually…right? So then you know the temperature that the metal started. You take that metal out and you put it into water at a known temperature…like 20ºC and you watch how much the water temperature increases. You've got the quantity of water, the quantity of metal, and the temperature change of the

water. The temperature of the water is directly related to how much energy that metal gave off because every metal has a specific heat. Well if I can get kids to analyze what that specific heat is, they can identify the metals. My high school kids in chemistry class, Chemistry 3, 4, can do that easily and give me a right answer. But could they tell me how that process worked? Absolutely not. It was the way I was teaching it. When I did the why first…like if we were analyzing that metal, the kids knew the parts of the equation that lead to an understanding of that, but they could tell me why you had to use water in order to heat it up and put the metal in that water, because water has a known specific heat. Why you transferred it to another piece…another container of water and why you had to know the mass of the metal and the quantity of water and why you had to know the temperature change and they can plug the numbers into an equation and give me the right answer.

Segment 4 – Murder Investigation

FS: I always do a murder investigation at the high school level if I can because it's just so much fun to have one of the drama students traipsing through the hall with fake blood dripping off their body, lay them down in the room, chalk outline them, take pictures of them and put up the yellow tape. They just love that. They just…the drama department just loves that! And so I don't want to deprive them of any of that and some of the kids that are helping me set up the crime scene love to put some blood splatter around if they can. If somebody…if you have an accident or a death in your school, you have to switch to an accident investigation…you have to switch to a theft investigation…something that is a little more content neutral and be fairly sensitive about it. But I always kill a fictitious teacher's aide. It's why I have such a difficult getting teachers aides. But I make up a teacher's aide like Myra Maines. Myra Maines died one year. Another year I killed Ricky Mortis. That was this last year. But you can do a physics of forces in motion. We always do an accident investigation too and we do it around the time when I'm worried about car accidents. Your safety transportation, state level safety transportation group, will actually bring out accident investigation stuff to you. Blood splatter analysis. You can get on the web and you can get certified in blood splatter analysis, but for kids I want to reinforce geometry and all kinds of stuff. So…butcher paper on the floor; I use as blood a mixture of cornstarch, water and a little bit of red food coloring because as the water evaporates it seems to glutenate almost like congealing blood. So they have this on the floor. They'll measure in meters and fractions of meters and they'll drop blood. At a certain consistency that same viscosity same thickness of blood and they'll analyze the pattern that the drops leave. It leaves a different drop as it is closer to the target than it does when it is higher from the target. And then we start with angles. These kids that have never really successfully indicated that they could measure angles will know that this is a 90º angle and that this angle is 45º

and they'll start getting different angles. Everything from 90 to 80 to 70 to 60. We can go down to about 30, then they've got a set of data…a reference set if you will. And I can give them some blood splatters that I've created from a known height or a known angle and I don't mix height and angle. Now I can say…at what height did I drop this blood splatter? Was it at a 90º angle and if it was, what height? This one was dropped at an angle from one meter, what angle did I drop this from? And they may have to do a little bit more experimentation but they are doing what real science researchers do which is creating a reference set of documents that they can use for comparative analysis, and in that we can talk about all kinds of aspects of blood. We can talk about RH factors; we can talk about why you take blood thinners. This one is a problematic piece. I don't want to teach kids about guns. What I did early on was I brought in the Bureau of Alcohol, Tobacco and Firearms to discuss forensic investigation. A guy had a great big gun right here in his suit pocket and that's the only thing the kids paid attention to and I thought, I got to get beyond that. So I lose the guns totally in a forensic course and we talk about ballistics. We talk about the physics of motion of projectiles. And so, how much force and velocity would it take for a bullet to be fired from this region and embed itself in a wood panel three inches deep? There is a ton of physics in there. We talk about vectors and angles. You can do an awful lot with ballistics and never even mention the word gun. And so we focused on the ballistics, we focused on the projectile motion, and we didn't talk about guns except we did mention caliber, we talked more about the bullets, and guess what happens when the Bureau of Alcohol, Tobacco and Firearms guy comes in next time? They don't even notice the gun. They are talking about do you really use string in order to connect to the point of origin? How do you tell if that bullet that is embedded in there was fired from a distance or close-up? What types of patterns do you look for in ballistics?

Now integration with other subjects. Now that you've got the why down for science, you got to integrate it with other subjects. And this is pretty powerful stuff. The worst investigator has to write good reports. The worst investigator has to write and read decent memos. The worst investigator has to write and read good letters and the worst investigator has to do reading on a variety of levels. The mysteries come about because I want my kids to read more mysteries and they do. We do a book report. We read tons of articles. We read courtroom transcripts. They are dull as dirt, but the kids will wade through them and pull out information in a grid. Their writing improves; their mathematics improve; percentages and ratios, big time, but geometry fits into ballistics and it also fits into blood splatter, but trigonometry fits in in big ways and the kids don't know that they are doing trigonometry, but they have to. At what height did this body fall? It's one level to say they were pushed or they fell, that's one level and if you are talking in just among yourselves you can probably talk about that with fairly good accuracy but the courtroom has a whole another level. In order to convince the jury that you are certain that that person was pushed off the balcony at this height, you've got to be able to explain the math. And so math becomes a power tool as opposed to something that they can fear and you can always team them up to where the trigometry and the math becomes embedded as a how portion of your course and the kids may be be getting the sequential mathematics instruction, but they are getting empowered to use mathematics. Social Studies, an obvious match. But this is the big payoff. In any course like Forensic Science where interest feeds in, I don't…I can analyze content. We use the Iowa Test of Basic Skills and I'll talk about some increases, but any criterion reference to assessment, and I'm happy to send you any of my classroom assessments that you want, become easy. I give a quiz every Friday, I give a test about every two weeks to hold them accountable for the content, but the authentic assessment that occurs when we do a crime scene is very anecdotal and it's recorded fairly

well in their investigators logs. I can pull an investigators log and get out much more data on what that kid understood and what they didn't understand. It's like the difference between a true/false question and an essay question. But I've never been able to really measure persistence. In this format I can. I can document how long a kid will persist at a problem versus how long they will do it in a regular class and guess what? That's 75% higher. Observation and analysis. You guys were going much deeper than most people…if you were directed to do something; you were really analyzing those mystery objects at an observation and analysis piece that was much deeper. Kids will do it much deeper too. Partly because there is a payoff. You are going to be participating in something that is group based and your efforts become important to the group.

Arguing from evidence. Big time! This is huge because you have to defend your opinions in crime science. And explanations with clarity. You've got to be clear and precise and you cannot overstate something that is not backed by evidence, which is pure science and good science.

Segment 5 – Information Integration

FS: Mystery paragraphs. Now we are getting into some of the integration. If you teach English or fifth grade or elementary school, you know that you are going to have kids that can't read very well and my kids…their reading levels were all over the board. There is a lot of reading in a forensic science class and so I had to get them up to speed. So I obviously called in an expert. I asked one of the reading teachers what they do. And she said, well, the toughest things for your kids to do…as evidenced on the Iowa Test of Educational Development, is they can't decode language. They get on a word that is confusing to them and they stop. They go kind of stiff legged like a Missouri mule and they don't go anywhere until they get some help with figuring out what that word is. Their decoding skills are really low. These are called mystery paragraphs. Any paragraph will do. You can get it out of People Magazine if you want to, but a paragraph that has some information and then you choose to delete some words from that paragraph, based on… that missing word has to be evidenced somewhere in the reading. That word is evidenced in this last line. Joe was about _____. He had his first term paper ever to do, but it would wait until Sunday. That and his long wavy surfer hair cut. What evidence does that give you? Of what might fit in that blank? Age. Exactly. And if it's his first term paper, give me a range. Yeah, exactly. Ninth grade. Probably ninth, tenth grade. So we could guess his age there. T he kids get that. They won't get that if I have a big word there, but they get that they can find evidence within this reading and they'll look for the evidence. These three little blanks become mysteries that they solve by reading. And guess what? They'll read it. They'll persist on down. So when they go into the reading teacher's classroom and she is teaching decoding skills, her worksheets are mirrors of mine. But she is using terms without blanks and she is saying, okay you've hit a word that is tough for you, where do you find evidence that tells you what that word means? And so the kids say, I don't know and she

goes, didn't you just do this in mystery paragraphs? They go yeah, but that's different. And they go, no it's not. Look for evidence. Put a blank there. Eliminate the word and put a blank and guess what? When the word goes away, the meaning comes back. The best ones that I've got I have in my collection came from students. Where students actually created the mystery paragraph. Guess what? With the myriad of documentation that we have to do in the classroom, I hand the mystery paragraph to a kid on an overhead transparency and I have the kid lead the other students through the mystery paragraph. A student will go up to the overhead, flip the transparency on because transparencies are magic and if they come out of here…big time…and I'll say lead them through the mystery paragraph and I can deal with kids that have been absent, some issues that might relate to a question about a grade, somebody that is going to be gone for a while, somebody that has some issues that I need to work with right then or some attendance that I have to clean up or clear up. We've got it covered and I've got a student that can lead the kids through that and it works seamlessly. That increased the reading levels of my test groups of kids in two periods greater than one year. They made greater than one year growth. Significant numbers of them in the 75% range made two years of growth in one year, and part of that I think is mainly based on that…that I'm communicating with another teacher, that they are getting reading in the content area that actually relates to my class. Can I do something that has really good science content in there? That has heavy science content? Absolutely! I can do a writing from Isaac Newton. I can take some historical document and use it that uses old English if I want to. I did include a ransom note activity in here. Let me tell you real quick how it works. Jon Benet Ramsey's case is a big case that is still in my kids minds open. So we do a lot of document analysis. Observation and evidence. So what I do is I talk about the aspects of writing. And you can do a ton of things with document analysis, but comparison of writing gets to

construction, how the letters are constructed; do they get bigger, smaller; the shape of the letters; oval, flat. Fluency is the macro review, the flow of the writing, how does it flow? Is it slant, tilt, all that stuff. And natural variation is the micro view. Do the letters all…in your writing, you may make the letter "s" different at the front of a word than you do embedded within a word. And so I tell them about the different aspects of writing and we discuss in those four broad general categories. I give a sample of my handwriting and sometimes I'll sign it as Julia Roberts or something because we look so much alike. I'll write the name fast and slow and with different pens and I'll write it five times and then on several of these pages… and then I'll Xerox those… and then on several of the pages, I will sign up here the name that I've signed down here. Writing it either fast or slow so that it looks a little different than here, but it's still my writing and then I'll get an English teacher or a social studies teacher or somebody down the hall to try to forge whatever this signature is down here up here and so I have some forged signatures up here with the sample set of real signatures and I have some real signatures with a sample set of signatures and I hand those out to the kids and I say tell me who has the forgeries. That's a really good content neutral piece that teaches the scientific skill of observation. But it leads into chromatography. Chromatography is the analysis of inks and ink pigments. To analyze mixtures they use some processes called chromatography. Gas chromatography is used in forensics, thin layer chromatography is used a lot of times, but we use paper chromatography and this paper is available from any science warehouse. You're going to take one of these pieces of paper out of the ziplock and you are going to fold it down the middle like this. And then about 2 centimeters up from the bottom, and it's important that you give it some distance, you are going to put a nice dark mark with either a black, a brown, one of those lime green works pretty good, and orange works okay. You are going to put a big mark there because those are good mixtures. Then you are going to

take this and you are going to put just a little water in the bottom of one of these cups. You just want enough to where it barely covers the bottom of the cup. You are going to set that in there and you are going to let that chromatogram develop. You are going to separate out the pigments. Then while that one's going, I want you to do the elementary version, the lower elementary version of that, which is take one of these pieces of filter paper and you can use coffee filter too and make any designs you want to with as many colors as you want to. You are going to fold that in half, you are going to fold that in half again, and then this one is going to go into one of these little Dixie cups. In this cup you are going to fill it so that the point of this will be under water just a little bit and capillary action…just like plants get their water, that is going suck the moisture up through this filter paper and spread those pigments out because that… mixtures can be separated based on their densities, based on their affinities for different substances and in this case, inks have…we are going to use water because this is water soluble ink. They move if they have a really high attraction for the water. They are going to move with the water up the paper. If they are more attracted to the paper, they are just going to move a little ways on the paper and they are going to layer lower. So different parts of that ink are going to separate out based on their attraction either for the paper or the water. And as they move, you can analyze which pen wrote a ransom note or which ink is which based on the way that separates out because it separates out with mathematical precision.

Now while that's developing, you'll start to see some color separation, but let me explain to you a little bit about what's going on. Attraction and repulsion with scotch tape is an easy activity. If you take some tape and you just pull it off gently off the roll, both pieces of tape will be charged the same. Right? And two things that are charged the same will attract or repel? Repel. And they will actively repel each other, except that I'm so attractive to tape… Now I'm going to put this up here on the overhead projector and I'm going to strip off some

electrons off of this piece of tape, thus changing slightly the charge that is on this tape. Now that they are charged oppositely what will they do? Besides be attracted to me. They will attract. So you can get them to repel each other if they are the same and attract each other like crazy if you make them different charges. We'll go back to the 60's here. These turn out absolutely great, no matter what your talent is. And what this is showing is that those inks were mixtures and the inks separate out into their component parts. They separate out based on the attraction of the ink component either for the paper or for the solvent. You can do solutes and solvents teaching this. And in this case, you can use it for forensics to get the kids to analyze which pen wrote a note based on the way that the pen comes out in a chromatogram.

Now there is some math embedded in there. The distance traveled by ink component divided by the distance of solvent travel, and this is in your packet, gives you an RF factor for each one of the pigments. That's how they identify inks. But that's not the only place where you can use ratios for kids to do stuff. Think back to blood and percentages. I want my kids to have mathematical power, so I introduce blood factors and they know that if a positive RH is 85% of the population the negative is 15. And they know that these are the blood types percentages. How do I know how many people out of 100 are going to be…if I find blood on a crime scene that is RH negative and B? Fifteen out of 100…15% and 11. They say well I can't add them because that would give me greater than 11% and 15% so that doesn't make sense. I can't multiple them because that give me more than 100%, so the kids eventually in groups can come up with some type of plan for manipulating these, but here's what they come up with. How do they tell… they get two answers in the group? They get this one and they get this one and they go which one is right? Some kids said it's 1.7% and they go…well what is that in number form and they say, well that's .017 and they say which one of these is right and they say that one doesn't look right because this is

going to be .11 and this is going be .15…that just doesn't sound right if I multiply them. The kids will eventually come to an understanding of how to judge the accuracy of their numbers. Use some simple analogies. This is something that kids understand. They understand balloons and they can see a penny in a balloon. To illustrate Newton's laws, if you get a penny moving in a balloon, since it's a low friction environment, an object in motion will stay in motion. It's a good way to give kids some visual experience in order to understand abstract concepts, but even more so, understanding that an electron doesn't really spin in an orbit. That it's orbiting anywhere around the atom… helps them to visualize an electron more accurately. In any of these activities, if you have some content, you start with the why. You do the how as you are going through it. And the what, content, is embedded along with it. If we do one of our activities deep, data shows me anyway that I get about a 45% return on my investment. That I get 45% of the kids that can do it on the quiz or can show me proficiency on the test.

Go to two activities deep, it increases to about 67%. But when I got to three activities deep, when I've done the what, the why and the how, when I've given them maybe something kinetic, when I've done it at a level that really hits the kids in terms of what they really need to know, I'm going to go up to 95%. And for me the big payoff is this, not that just that I've developed proficiency in kids, but I've opened the door for those kids. Those kids that didn't take my chemistry class, that didn't take the physics class, will have the ability to walk through that door give it shot and get more science.