

**Strengthening Quality Mathematics and Science Learning for All:  
Measuring What Matters**

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<http://www.education.miami.edu/faculty/Lee/lee.html>**

**Kathleen Bergin, NSF**

It's really a privilege and a pleasure to be able to share Okhee with you. Some of you have already had a little bit of her wisdom earlier in the day. In your packet there's a biography of Okhee and it'll tell you that she's a science educator and she's at the University of Miami. And her areas have to do with language and culture and teacher education. Then it'll go on to tell you all sorts of awards. And there will be a test on it tomorrow, so be sure to memorize it tonight. When I asked Okhee if there was anything special that she wanted me to say—and I wrote this down—she said just tell them I'm hard working and I'm a nice person. I want to tell you something more about her. I've noted just a few times because I also have the privilege of working with the Miami-Dade USP. This is a university person who cares deeply about children and learning. She's a person who cares passionately about giving teachers the tools to work with children, children that come from different cultures. She works with schools that the majority of students are Haitian. She works with schools where the majority of the students don't speak any language that their teachers are speaking. And she's working with those children and those teachers in their learning. And that's part of the professional learning community. So I'm now going to let her share with you her passion. Okhee Lee.

## Okhee Lee

Thank you. I'm very delighted to be here. Before I became more Americanized, I would have said I'm very honored to be here because that's the way of expressing my appreciation. And at some point, my colleagues said, "Drop 'I am honored.' It's okay to say delighted."

Compared to all the responsibilities that you have, I guess Kathleen's compliment about my work is really nothing because my university work is much simpler than the work you are doing. Having worked with the Miami-Dade people, I understand the challenges that you are having in urban settings and working with students from diverse backgrounds. I would like to talk about science education for all students. And I would like to extend that notion to math and other subject areas. I'm just picking science as a subject area that can be applicable. When I say all students, I would like to focus on one particular student group. But before I say it, I think I have two challenges that I should admit that I might be facing. One is that the dinner was exceptional, so that means it's about the time to go to bed after a hard day's work. The second challenge is that every time I speak to a group of people, I'm trying to bridge science as a subject area with diverse student populations. It seems that content people talk about issues among themselves, and bilingual and multicultural people talk about issues among themselves. The two groups don't seem to communicate and there doesn't seem to be a bridge. Between the two areas, the students are falling through the crack. I sometimes feel like I don't belong to either area. So I'm going to try to make the connection between the two.

What I would like to talk specifically about is English language learners, ELLs. Different terms are used according to different political orientations. It used to be limited English proficient—LEP—and that suggests limited and deficient. In the state of

Florida, we have a new expression, LEP, the same term, but LEP in Florida means language-enriched pupils. So it's a political and ideological notion based on whether you think of it as subtractive or additive. Also when you think about English language learners, people think of students who do not speak English. But this also applies to students who speak dialects of English and who are learning standard English. Thus, choice of a term has broad implications.

This is the overview of what I'd like to talk about this evening. The first is why science is important for all students, particularly English language learners. The second is the current status of science instruction and assessment for these students. And third, effective practices and policies in science instruction and assessment for these students. Finally, I will talk about the work that I have been doing for the past decade, working in Miami-Dade county public schools. I'm going to talk briefly about the first three issues because we all know the challenges that we are facing, that teachers are facing, and that students are experiencing. I would like to focus specifically on the work that I have been doing and share the implications with you.

### **Importance of Science for All Students, Particularly ELLs**

Now why is science important for all students? We know that science education standards—like NCTM—have a different notion of science learning and teaching compared to the past. It's not just about science content and knowledge, but also science as it relates to mathematics and technology, science in personal and social perspectives, and science in the context of the history and nature of science. And not only science concepts, but also big ideas and underlying themes that cut across science disciplines and science processes. In addition, we are expecting students to learn scientific inquiry—you may say mathematical problem solving. Scientific understanding—you may say mathematical understanding. And then communication. Scientific habits of

mind in terms of questioning, critical thinking, skepticism, arguments, and independence as well as working in collaboration. So we're really talking about a very broad notion of science and mathematics.

Why is science important particularly for ELLs? I said an additive notion of science education. Science is particularly effective for students who do not yet speak English because, at a very simple level, they do hands-on. Hands-on science provides opportunities for students to do things that can help them move from concrete to abstract thinking. It's not a small matter, because if they can see and touch, it is not as language-dependent as text. It relieves language demands. Also because they are working in groups, it promotes communication. It promotes working together. Science also provides opportunities for them to connect what they are doing with where they come from, their personal backgrounds. It gives them more opportunities to relate to what they have experienced. Later on I will focus on how science is also a means to teach English language and literacy—they just go together.

Science promotes mathematics learning, when you think about measurement and data collection, graphing, tables and charts, and what all these mean to science. Habits of mind or scientific dispositions, suggesting that because students understand more and better, they may become more inquisitive and then ask questions, argue, and debate about science. Science is a means to relate to all the other subject areas. When we work with students from different backgrounds, we are promoting multiple languages and cultures as resources and multiple ways of knowing and communicating and seeing the world. These are essential skills in the global community and information technology.

So now I would like to put these ideas in a concrete context. All the examples that I'm going to share are from 4<sup>th</sup> grade students, some from a Hispanic background,

some from a Haitian background, and some from monolingual English of African-American and Caucasian backgrounds. I picked examples from multiple language groups. Here is one example of multiple representations. [Overhead showing a student's writing sample] The students did an activity on freezing. As 4<sup>th</sup> grade, they used a triple-beam balance, so that is their instrument. There is a graphic, there is math, and they did data collection. Before and after freezing, the same weight. If you look at the drawing, before it's a wave, the water is flowing, and the tape is about here. After freezing, the tape level goes down and the water is frozen. And explaining all of this, the kid wrote, "When the water is frozen it doesn't change weight. And when the water freezed it changes volume." It's in the context of doing one lesson. And this is from a Hispanic student.

When I say science in the context of culture and math and reading and all of it, here is another example from a unit on weather. A teacher working with Hispanic students shows the data from the weather section in the *Miami Herald*, high and low temperatures in the first six countries in Latin America. They did the mean, median, mode, and range. I found that this [the median for low temperatures] is incorrect. Now what's interesting here is that in this drawing, there is a hare and this lazy kid says, "I know how to count." Here is a tortoise and this hard-working kid says, "I know statistics." You can see the pride in it.

### **Current Status of Science Instruction and Assessment for ELLs**

Now if science is important for all students, particularly ELLs—the English language learners, what is the current status? And I don't have to go over all the details of what we can do better. At least in the case of Florida—and I believe it's the same in Texas—assessment dominates everything. At the state level, the high-stakes assessment and accountability pretty much drives everything. I told my group a joke that in

Florida, the assessment is called the Florida Comprehensive Assessment Test. It's called the FCAT—F-C-A-T. There is a kid who says, "I like all different kinds of cats, but I don't like FCAT." I'm not making it up. And teachers, because FCAT dominates everything, they call it F-TIGER. In the state of Florida, we have FCAT in reading, writing, and mathematics. Science is left out. In some inner-city schools, demands for literacy and numeracy are so great, guess what? The principals ask teachers not to teach science or social studies. Given the situation, the fact that I have been doing science at the elementary school level and the teachers and principals are asking me to expand the program—to me is the highest compliment. If you ask me how I do it, I can tell you a list of strategies to make it work.

At the district and school levels, if there is no accountability, it is difficult to demand science instruction, and you have to be creative. At the school level, particularly in inner-city schools, because of limited resources, there are few science supplies. Even if there are science supplies, they are locked up because they need to be secured, and teachers do not know where the supplies are and don't use them. At the classroom level, science teachers say why do I have to work with ESL students because they don't speak English yet. ESL teachers say they do not know science content. So ESL students are often overlooked in science instruction.

### **Effective Practices and Policies in Science Instruction and Assessment for ELLs**

I believe that the main purpose of this conference is to discuss what we can do to provide effective practices and policies at the state, district, and classroom levels. And these are the issues that we'll talk about. Instead of me going through what the literature says, I would like to focus on what I'm doing in relation to what we can do better. For example, if there is no statewide assessment, then one way of doing science is to make science as a part of literacy and mathematics. In fact for the last several years

without science assessment in the state, I introduce the program as a literacy and math program. I say the program improves reading and writing and mathematics through science. Teachers at first do not buy it because they often do not teach science.

Elementary teachers have too many demands and they don't want to participate in another university program. They say, "Leave me alone." But for these reasons, we just have to do a lot of basic things to make it work. For example, in our project, we have over 100 containers of supplies for over 50 classrooms, all basic items such as plastic cups, thermometers, and graduated cylinders. Given the demands of everyday teaching, teachers simply don't have the energy or the resources to do hands-on science.

We have to start from very basics that people take for granted, particularly in challenging schools. And I cannot emphasize enough of that. For us, it has taken a lot of work to build the relationship, but it's very important. Once the teachers become more comfortable with science, they will say, "Oh, it's not too bad. I'm learning it." In inner-city schools, students don't have opportunities to do hands-on kinds of things. It's all about reading and writing and computation. Students say, "my hand hurts and I don't want to write." So when students do science activities, they would say, "my teacher is the best teacher." We have testimonies of students who came to the principals and said, "Well, my 5<sup>th</sup> grade teacher doesn't teach science and I want to go back to the 4<sup>th</sup> grade class." Actually, a few of the students sneaked into their 4<sup>th</sup> grade classrooms and hid in the bathrooms to stay in science instruction. With all that, teachers see the value of teaching science.

### **"Science for All" Research**

Now how does it work? The program, we call it "Science for All," and we have a reason for the name. In 1989, the document, "Science for All Americans" came out. I had a colleague in ESL who was very interested in science education, and I spoke with

her about the document. And her first reaction was, “They must be kidding. You mean science for all students, including ESL students?” She thought that it was a joke. And that’s the time that we started working together. At first we called it, “The Promise of Science for All,” and later dropped “the promise.” The purpose of our work has been to promote science learning and literacy development of elementary students from diverse language backgrounds. We started from the early 1990s and then extended it from a small number of volunteer teachers into larger numbers and larger numbers. It involves implementation along with research. At this point, we have two states—California and Florida—in Miami and San Francisco with six elementary schools in each school district. It’s a school-level curriculum, so all teachers participate. The two districts have very diverse student groups. This year we work with the 3<sup>rd</sup> and 4<sup>th</sup>, and next year we’ll be working with the 5<sup>th</sup>. And in the state of Florida, the fifth graders will be tested in science starting from next year.

Now having said that, I’m dreadful of what’s going to happen with science assessment. If it’s facts-driven, then all the good things about science may go down the drain. If it’s all about memorization of facts, our research will be in trouble. If it focuses on science understanding, then our research will be in good shape. Luckily, what I heard from someone who participated in the construction of test items was that the science assessment is going to be about using instruments, hands-on tasks, data interpretations, graphs, etc. This is encouraging.

Now, what we do with the teachers? We developed four instructional units based on the input of teachers. And we do teacher enhancement activities at workshops and at school-site meetings. We also provide all the science supplies. We ask the teachers that we do our best to provide support and they do their best to provide the best instruction. As we became more comfortable working with the teachers and when

we had teacher buy-in, we asked the teachers to do a lot of work. For example, when we did the instructional units, we asked the teachers to do all the revisions and provide us with their feedback to make the units more effective. At a workshop recently, I asked the teachers whether they had any problem with the units and no one said anything. I said to them, "it better be because if there is a problem, it's your problem, not mine." Teachers think they have the ownership of the units. When we do the workshops, we also invite teachers to lead the workshops and everybody has a chance to stand and talk and share. So we try to make it very teacher involved.

Now we have four instructional units, although the project wasn't designed to develop the units. Because of the unique situation of the school district and schools, the teachers wanted to have instructional materials to meet their needs and wanted to participate in materials development. Over the years, we continued to revise and refine the units. One unit is on measurement. It turns out that measurement is a difficult topic for most students. Also the district asked us to work on measurement because the measurement test score was very low. And we wonder why measurement is so difficult because U.S. is still using the traditional system. Another reason why we decided on a measurement unit is because, as we all know, physics and physical science are the areas in which U.S. students are very weak. And that means gathering data and actually doing systematic investigations. This is something that many of our students do not have the experiences at home compared to other more affluent students. So we decided to focus on areas in which students might not have opportunities but need to learn before they go on to middle school.

The next unit is about changes of states of matter, leading to a short unit on the water cycle. [Showing a drawing of the water cycle] This is the water cycle, and these are simulations that relate to the real world. For example, when mom cooks rice and

beans, the water cycle happens. And you can also make the water cycle, and this is what happens. Students learn that the water cycle is a system. Within the system, it has sub-systems of evaporation, condensation, and precipitation. It happens through the interaction of matter and heat energy, and it continues as a cycle. Finally, we go into the weather unit and, as you saw before, students actually read weather maps, use weather instruments to gather data, and compare the results with newspaper information. This is one activity that we do about convection currents. In a fish tank, you put smoke on one side and then put steam on the other side. And we ask students to make a prediction of what will happen. The smoke suddenly changes its direction and goes toward the direction of the steam. This is the main idea of wind, which is basically the movement of cool air and warm air. Students understand the idea that, again, this is a simulation of the natural event, in other words, a model of the real event. And each has a system and, again, it's the interaction of the air and heat energy, the heating and cooling. Teachers help students understand how these two sets similar and different. And students can see the big ideas beyond separate concepts. We're talking about 4<sup>th</sup> grade students here.

We also try to promote literacy as part of science instruction. There are many strategies you can think of. One is compare and contrast, for example, how are they similar or different? This is one of the main strategies of FCAT reading. Other strategies include summarizing, explaining, predicting, etc. Another strategy common with elementary school teachers is the KWL strategy (What we know, What we want to know, and What we learned). This is a way to assess students' prior knowledge and ask them to compare what they have learned after the lesson with what they knew before. These strategies may sound very simple, but the more teachers are explicit about including literacy, the more students learn. Also, these are strategies to prepare for

FCAT reading and writing. Some teachers emphasize reading activities—not only do they read science books, but they also include trade books that are related to science and fun to read. Some teachers would ask students to write about what they did in class, share their writings with family members, and write about what they spoke with family members overnight. This becomes a homework assignment, and they share in class the next day. So they would do a lot of writing.

In addition to these more general strategies, we also ask teachers to promote English language. For example, a student says, “it’s evaporating,” and the teacher asks, “What is evaporating?” The student says, “Water is evaporating,” and the teacher asks, “Water is evaporating and changes into what?” The student says, “Water changes into water vapor.” There is a lot of such linguistic scaffolding using words, and then constructing phrases, sentences, and paragraphs. This may sound very common, but linguistic scaffolding is very important for ELLs.

I should note that our work has been funded by the National Science Foundation. I’m very delighted to have this opportunity to thank for the NSF support. I feel it’s my time to give back to the NSF. In our case, we are teaching science along with literacy, and science instruction is guided by science standards. Within state policies, district policies, and school resources and policies, we start from students—who the students are. In our case, we have students from diverse language backgrounds and different ethnic backgrounds. Starting from the students, we ask teachers to hear the students—what they think and what they know. If you understand your students, you may relate science more easily to students and more meaningfully.

We have coined a term, “instructional congruence.” The idea is that there should be congruence with good science instruction and congruence with literacy instruction. But also there should be congruence with the students in terms of their cultural and

linguistic backgrounds. The role of the teachers is to provide instruction and assessment that integrate all of them. Unfortunately, when people talk about cultural congruence, they talk only about culture. When people talk about science, they talk only about science. Conceptually, it's really nice to separate them, but when you are teaching 30 students in the classroom, you have to do all of them at the same time. The notion of instructional congruence is to build congruence with all of them.

In the case of literacy, if you are in a state that has a bilingual education program, it could be literacy in English and students' home languages. In the state of Florida, it has the English-only policy. It's English for students of other languages, so literacy may be more in English language than home languages. This is unfortunate, but that's the state policy. In our work, we focus on teaching science along with English language by considering students' language and culture. Students learn science and develop literacy, but also learn to appreciate their language and cultural backgrounds, so that they do not lose their heritage. We consider that very important. Otherwise, students may lose their families and communities. So we try to communicate the notion of bilingual and bicultural—behave competently across diverse settings. Again, the notion of additive.

Now, data collection. We collect data in multiple ways. We examine teachers' conceptions and practices with regard to science, home language and culture, and English language and literacy. When we conduct workshops, we emphasize each of them. We collect data through observations, interviews, and surveys in systematic ways with all teachers, and then a small number of case study teachers. With all students, we measure science and literacy achievement using paper-and-pencil tests. And we do performance assessments of a small number of students. We also collect statewide assessment scores in reading, writing, and math.

Assessments present a challenge, particularly in inner-city schools where student mobility is high. There is a high correlation between SES and mobility. If you include the students who take both the pre- and post-tests, you lose a lot of students due to mobility. In some of the Haitian schools, the mobility rate is higher than 40%. That means about half of the students are new and you lose all of the incomplete data. The results would look good with those students who complete all the tests, because the students who stay are likely to be more stable and more academically successful than those who are highly mobile. The results are biased favorably. If you want to be accurate about the results, then you have to think about how to account for student mobility. And if you have a multi-year project, you have to think about how to track the students over the years. Thus the results have different meanings and implications when you consider teacher attrition, student mobility, and all of that.

Going back to our research, you may ask, "What do teachers do?" Let me give a few examples of what the teachers do and how capable students are. When we started with the notion of "instructional congruence," we didn't quite know what we were expecting to see. We were sitting in a classroom with predominantly Hispanic students, and a teacher who came from Cuba said, "When you have fever, what number does your mom tell you?" What numbers do you think the students would say? One hundred, 38, 39, 102, etc. The teacher put down these numbers, two sets of numbers, on the board. The students were puzzled by these numbers. How could the numbers be so different? The teacher put down the transparency of a thermometer and asked the students to look at the numbers. And they would say, well, 38, 40. And then they would say, "Oh, 40 is about the same as 100." In one classroom a teacher said, "Well, this thermometer is bilingual, just like us." In another classroom, in fact, one kid said, "Oh, it's like bilingual." They got the idea that these are two different systems of

measurement, just like there are two different systems of language, that apple is the same whether you say it in Spanish or English. It's the same thing, but you simply use different systems. Ever since, whenever we think about our research, we say "the bilingual thermometer."

Now in terms of literacy, we also work with teachers who have LEP students, however you call them—limited English proficient or language enriched pupils. In one activity, it was about condensation just like what you have now, water drops outside your glass of cold water. And we asked students to look at what was happening outside and inside the glass as well as above and below the water level. It turned out that it was complicated for many students. There's just a lot to look at. Kids were floundering, and the teacher stopped the class. Then she drew the activity set-up on the board and said, "Now, this is the water line. How would you call something above? What would be a synonym for above?" Student said, up, upper, high, and top. Then, the teacher said, "What would be a synonym for below?" Low, lower, down, and bottom. And then she said, "What's inside and outside— in and out?" She was doing a language lesson on vocabulary, starting from up and down and moving into above and below. By the way, a lot of the lessons we developed were based on teachers' insights.

As another example. We use the terms 'increase' and 'decrease' as 4<sup>th</sup> grade vocabulary. In some classes, 'increase' and 'decrease' turned out to be somewhat challenging, so the teachers would say, "Increase means? Decrease means?" Students responded, "Go up. Go down." In other classes with more English proficient students, the teacher asked, "Now, what would be a different word for increase and decrease?" Students responded, "Expand and contract."

So there are many different ways to include language activities as part of science instruction. We also tried to emphasize multiple ways of presenting ideas, such as in

writing, graphs, and drawings. You can gather the data for above and below the water line with cold water and tap water, and then graph the data. You can also summarize your observations in writing. With the teachers' help, students knew what to look for, learned the idea of quadrants, how to be very careful in doing the observations, and how to draw appropriate conclusions. So there are a lot of ways to promote literacy development that you might take for granted. As you see using these examples, literacy and science are very closely related.

Now another example—this is fun. We were doing a lesson that temperatures in different places on the earth are different because the sun's rays are more direct on some places than others. This example illustrates how a teacher combines literacy and science and integrates students' language and cultural experiences. Because the lesson involves comparison of temperature, the teacher started the lesson by doing a language activity on comparative terms. So I will take Kathleen and compare the height of the two students, Kathleen and me. The class compared the two students as taller or shorter. The reason I'm picking Kathleen is because I'm taller than her, which is very unusual. Sorry, Kathleen. Then the teacher compared his height along with the two students, and the class compared the three as the tallest or the shortest. Because the activity involves comparison of temperatures, the students practiced comparative terms, cold, colder, and coldest. Warm, warmer, and warmest. The teacher asked the class to find the rule for comparative terms. You use "-er" and "-est" when you have a word with one syllable. Thus, the lesson started with a language activity.

Then the teacher asked the class to look at the temperatures of the northern hemisphere. The lesson included Haiti, London, Florida, and a few more places. Students looked at the temperatures on weather maps in the newspaper. After examining the temperatures of these places, the teacher said, "What is a pattern here?"

The students came up with the idea that the closer to the equator, the warmer. Then the teacher asked, "Why?" and the students said, "It's because the sun's rays are more direct or indirect." So the students described the pattern and gave an explanation for the pattern. From an ethnocentric perspective, the lesson stopped there, but this Hispanic teacher continued. He said, "Let's look at the southern hemisphere. How many of you are from Colombia?" Hands would go up, very excited now. "How many of you are from Chile?" The class continued with three more countries. And then, the teacher said, "What is the capital city of Colombia? What is the capital city of Chile?" So the class did a social studies activity. And the teacher asked the class, "Looking at the temperatures in the southern hemispheres, what is the pattern?" The pattern is the same as before: the closer to the equator, the warmer. And a kid said, "Oh, I thought that south is always warm." So they talked about what they thought about the south and north, and the pattern. The teacher said, "By looking at the temperatures, what is the pattern in the two hemispheres?" The closer to the equator, the warmer.

A student said, "Well, I'm from Ecuador, and Ecuador means 'equator.' So I'm standing at the equator, but it's not always hot. Why is that?" Another student in a different class said, "I visit my grandma in Colombia every summer, but when I go there, it's not always hot. Why is that?" So kids were really making the connection based on their home backgrounds. And from there, the kids would engage in discussion that elevation would affect temperature. The students made meaning of science and extended their understanding by relating to their home backgrounds.

As we continued our research, we realized that science inquiry was demanding for both teachers and students. Teachers expressed that they lacked the experience of inquiry, did not quite know how to do inquiry, and were not comfortable teaching through inquiry. Teachers requested that they would like to have a lot more guidance in

being able to conduct inquiry and teach through inquiry. We asked them to think of inquiry not as either completely open or completely structured, but think of inquiry in terms of different levels of openness along a continuum. The basic level would be very structured when a teacher is in control. The advanced level would be where the students take initiative and do inquiry on their own. We hope that the students could do inquiry on their own eventually. We ask the teachers to think about where their students are to start with and what kinds of assistance the students need to become more independent. Based on your students in terms of their language, their literacy development, and their cultural expectations, start with what you think is most appropriate and move on. So we see inquiry in different ways, depending on different contexts. This approach seems to relieve anxiety of a lot of teachers.

Now I'm looking at my watch because I don't want to miss the opportunity to share some examples of student performance. We have tons of different kinds of data, but I would like to share with you some of students' writing samples. Again, these are 4<sup>th</sup> grade students. The following is a writing sample prior to instruction on the water cycle:

States of mater used in the water cycle

The new ways to cemulat the water cycle that evpras, condenses, and falls as rain that you need states of mater wich is solid, liqued, and gas, solid can turn to liqued as to gas as to liqued as to solid.

That's pre-instruction writing. The student has some initial understanding of the water cycle. And you see the level of language development and the areas that need assistance, particularly spelling. After instruction, the same kid wrote as follows:

What I learned about this project is that precepitation happens over and over again but in different forms like rain, snow, sheet, dew, hail. I also saw two ways I can simmlate the water cycle. One of the ways is two cups taped together and the

bottom cup is warm water and ice cubes on the top cup on the outside top. The warm water evaporates and the ice cubes cool the top cup and the hot water vapor condenses as a cloud and when the cloud gets heavy it presipetates and the same thing happens to the othere experment but we use a hot plate, a glass pot, a glass lid, and water.

So this student is really explaining what happens and how the two ways of the water cycle—the water cycle in nature and the simulation—are the same. In fact, another kid wrote the same ideas, but using drawings as well as writing. The student wrote prior to instruction:

I learned what matter meant and more about humidity and the water cycle. We did an expirement with the pan and the water in the pan was boiling and when she put the lid on top it got humid.

You see an initial understanding of the water cycle in this writing. In the drawing, you see the writing, “humidity” above the “pan,” “boiling water,” and “Hope you liked it!” with two smiling faces in a big and bold type. We see a lot of positive statements and drawings like this, such as hearts and smiles, to show how much students enjoyed doing science. They volunteered to express their feelings and emotions. The same student wrote after instruction as follows:

#### Matter

Today I learned about the water cycle, evaporation and condensation. We did some expirements to see what would happen. We used material to see what really happened on Earth, but the difference is that Earth doesn't use materials but the same process happens.

Look at the pictures below.

And look at the drawings below the writing. The student drew three pictures, one for the water cycle simulation using a glass lid above boiling water, the other for the water cycle simulation using two plastic cups with ice cubes on the top cup, and the water cycle in nature. She put all three of them together as the same process. Based on her writing sample, we said, “Of course, the three pictures show the same process.” We

learned this idea from this 4<sup>th</sup> grade student and incorporated it in the revised lesson. It was a very humbling experience.

Now let me just show a few other examples. I said earlier that we did an activity on convection currents as a simulation of wind. And here is a writing sample of an ESL Level 2 student who had been in the U.S. for a short time. She was learning English in addition to science. She wrote after instruction as follows:

I saw the smoke go up though the right tub because there was the heat source.

Then I saw that the smoke was going to the left with the stem because cold air was going down From the right tub.

Finally I saw air enter to righ tub and the smoke combinate with the stem to go up because the smoke cant not go up to the right tub because the air *no se lo permitio*.

You see interesting patterns in this writing sample. It shows areas of improvement, for example, spelling such as ‘tub’ for ‘tube,’ ‘stem’ for ‘steam,’ and ‘combinate’ for ‘combine.’ However, this writing clearly shows literacy development. It has sequencing—‘Then’ and ‘Finally.’ The writing also shows science understanding. For each step, it starts with description and then explanation. The student fully understood the concepts and accurately expressed her understanding. At the end, the student wrote in Spanish, “did not allow [permit] it.”

Let’s look at the last example of a writing sample on science inquiry. We asked all students to design an investigation. The task involves how different sizes of openings of containers affect evaporation. For pre-instruction writing, this student did not write anything. After the instruction, the student wrote as follows:

[In the graphic, the student marked “O” for the container with a wider opening (and shorter) and “T” for the container with a narrower opening (and taller).]

*Make a hypothesis:* I think O will evaporate faster.

*What steps will you take to collect the information:* The first step I'll do is put water in the containers till the container is full with water. Second, I'll check every 2 hours to see how much water evaporated & and mark how much evaporated with a pen. Third, I'll write down the information in a chart form.

*What materials will you need to carry out your plan?* I'll need:

- Paper
- Pencil
- Pen
- Clock (time) or watch
- 2 Containers
- Water

*How will you record the information?* I'll record the information in a chart form like this. I'll put the information like that.

Container	Starting (mm.)	2 hours	4 hours	6 hours	8 hours	difference
O	mm.					mm.
T	mm.					mm.

So what would be my conclusion? Whatever you call LEP students, students who speak dialects of English, and students coming from different backgrounds, we do not adequately understand what they bring to the learning process. The more different the students are from the mainstream, the more difficult it may be. Unfortunately, we fail to utilize the resources that these students bring to the learning process. The challenge is how we can find out what these kids are capable of as well as what are the areas they need assistance. We need to think about what teacher professional development requires and what teachers need to know to provide effective instruction. The roles of district and school administrators are also important. In our work, it is no small matter that principals support our research when there is no science assessment, because they think that the program is good for the students and the teachers.

Students enjoy science. Here is a student, and the writing does not make a lot of sense, but she was trying to communicate using a drawing. The drawing showed the

water cycle and wind simulations on a table. And there were three people at the table, including the interviewer and two students. The student drew hearts and smiles with all three people, indicating how much they liked it.

This is as much as I would like to share with you this evening. And thank you for listening.

**Stephen Marble:**

Any questions? I want to tell you a little story then. Before you guys get up and go, I'd like to close with one little story that Okhee told me earlier today. She said—and can I share this? I hope I can share this. She said, “I’m just a little dust in this effort, a speck of dust in this.” And I said, “Oh, like in *Horton Hears the Hoo*.” And she goes, “What?” And I said, “Well, the Dr. Seuss book.” And she said, “Don’t make any assumptions, those cultural assumptions like that.” And I’m like, “Right, very good.” You know, that little speck of dust with all those people on it. But even a little speck of dust pays off. So we sure appreciate your coming and sharing your ideas with us. And as Texas moves into a fifth-grade science assessment, I think there’s an awful lot of ideas that we may be able to build on. So I sure appreciate it.

And whatever happens in Texas happens in Florida, and it’ll happen in other places.

Thank you. And good night.