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## **Science Through Language: Language Through Science; Working With Teachers to Make Every Moment a Language Moment**

*Catherine H. Gottfred and John Lybolt*

Leap Learning Systems  
Chicago, IL

### **Abstract**

*Preschool teachers have been tasked with developing emergent literacy skills, frequently co-teaching with a speech-language pathologist. Science activities offer opportunities to provide both content and language experiences in preschool and kindergarten. A “Language Through Science” (LTS) approach integrates language and science in preschool and kindergarten classrooms, emphasizing techniques that can be the language underpinnings of emergent literacy. We review the theory, background, outcomes data, and sample activities of a language-focused science program that can help the speech-language pathologist support content with emergent literacy activities in a classroom curriculum.*

### **Using RTI to Advantage**

The reality of Response to Intervention (RTI), appropriateness of workload versus caseload service delivery, and push-in versus pull-out intervention model in the schools demands that the speech-language pathologist use his/her knowledge and skills to help children achieve their best in language and literacy. Speech-language pathologists’ skills as language experts can provide services to children falling within the Tier Two paradigm in an RTI implementation. Partnering with the classroom teacher to focus on language (vocabulary, problem solving, listening and comprehension, and narrative skills) can support the emergent literacy skills of preschoolers and kindergarteners. Montgomery and Moore-Brown (2006) and Wedl (2005) note that there is increasing awareness by general education teachers, reading specialists, and school administrators of the valuable knowledge the speech-language pathologist brings to the literacy/emergent literacy team.

Classroom play and teacher prompted activities directly engage conceptual language knowledge that is an area of expertise of the speech-language pathologist. The conceptual language available in early childhood science activities underlies the symbolic behavior later involved in phonological awareness and decoding for the beginning reader (Leitao, 2005; Sample, 2003).

### **Teaching Science and Language Growth**

Science is now a state mandate in preschool and kindergarten classes and can be daunting to classroom teachers who may see it as an addition to their teaching responsibilities and as a content area beyond their knowledge scope (Church, 2003; Tu, 2006). Leap Learning

Systems' goal in all our preschool and kindergarten programs is to support the classroom teacher by demonstrating how to make classroom moments a language moment. For example, *Building Language Throughout the Year* (Lybolt, Techmanski, Armstrong, & Gottfred, 2007) is built around the knowledge already possessed by speech-language pathologists. It illustrates how early science thinking and exploration overlaps language skills. Using the language of the general educator, the speech-language pathologist can provide the teachers invaluable tools to deliver science content while supporting the language skills that underpin literacy for every child. The professional development approach implemented by speech-language pathologists in our organization is specifically designed to meet the needs of teachers who work with at-risk students.

The work of Hart and Risley (1995), Hirsch (2001), and Whitehurst et al. (1994) represent a significant body of research that reviews the issues of families, urban and rural, whose spoken language interactions do not provide children with what they need for kindergarten entry. These needs—exposure to enrichment vocabulary, language of dialogue and problem solving, and reading and pre-print interactions with adults—are explicitly addressed in our materials and were written in close consultation with experienced inner city preschool and lower primary grade level teachers. *Building Language Throughout the Year* lays the groundwork for teachers to promote academic and reading success by working with students to achieve these benchmarks:

- Understand vocabulary and concepts
- Use words to problem solve and negotiate
- Listen to meaningful sounds around them
- Acquire new words independently (up to eight new words/day)
- Display sound and letter awareness
- Engage in word play (rhymes, sound identification, songs, rhythmic jingles, call-answer sequences)

These language benchmarks, which are familiar to all speech-language pathologists, will help many students with varied language experience levels that will be assigned to the Tier Two level of RTI.

In classrooms using our Language Through Science approach, teachers and speech-language pathologists co-train in the areas of science and oral language. Co-teaching using the Language Techniques in Table 1 makes classrooms more language intensive. In addition to techniques to solicit language, the Language Through Science program offers activities and follow-up children's literature selections that teachers can use to reinforce science themes. The Language Techniques that are taught can be used by teachers as they read books related to the theme of the activities as well as during the activities themselves. The techniques help reinforce emergent literacy skills by helping students to retain information, imagine and create their own memories, solidify concepts and vocabulary, and make predictions using prior knowledge (Moschovaki, Meadows, & Pellegrini 2007). In addition, teachers using language focused book-reading strategies build links between student's experiences and emergent literacy skills (Justice & Dunaway, 2005).

Table 1 Language techniques used by teachers and speech-language pathologists

<b>What to do/What we call it</b>	<b>The technique outcome</b>	<b>Examples</b>
Use Open-ended Questions: <i>Stimulating opinions and quandaries</i>  <i>Op and Ed moments</i>	Ask questions that help children think...questions that allow more than one answer rather than rote responses. Identify quandaries/ encourage opinions.	“What if we put on one big block? ” “How could we make red into pink?” “Show how you could find someone hiding”
Build new vocabulary: <i>introduce synonyms and exemplars</i> <i>Words Are Tools</i>	Build vocabulary by introduction of less familiar words along with and in place of more familiar words	“You’re right, it looks like a dog, but it is a wolf because it has big teeth and very shaggy fur.”
Build connections between concepts and content: <i>use analogies and similes</i> <i>Connect Ideas</i>	Promote category knowledge by the use of relational words (more/less, closer/further, together/apart, stiff/willow)	“Could pink be a softer color than orange?”
Use think-alouds and talk-alongs consistently: <i>Use self-conversations as you plan (think-alouds) or do (talk-alongs)</i>  <i>Self-Talk</i>	Think-alouds and talk-alongs give students a window into how you plan. For example, as you release students from group-say “speak aloud your thought process”, or, as you arrange the tables for the art project, say aloud what you are doing	“I need ten glasses, ten plates, and about 20 napkins, because this is a messy lunch.”
Engage prior knowledge: <i>talk about prior experiences from print, activities, or home-life</i> <i>Think Back</i>	Descriptions of previous knowledge helps children make connections and categorize new information	“The train book reminds me of seeing the freight train last week when we stopped at the crosswalk.”
Build phonemic awareness: <i>rhyme, rhythm and sound awareness</i>  <i>Rhyme, Rhythm, Recognition</i>	Increasing listening experiences and practicing with manipulations of sounds are important components of emergent literacy	“I’m thinking of an animal that gives milk and sounds like a k...” “Hat and mat sound alike. Which sounds do you hear that sound the same?”

### Specific Uses of Language With Science

The following example describes how science and language come together for preschoolers and kindergarteners. Preschool children learn best when they sift experiences through their fingers, exploring every sensory avenue to the fullest. Science happens when children first observe and then use their senses to manipulate materials; the hands-on manipulation encourages them to remember, recreate, think about or converse about changes they observed. Being "scientific" involves being curious, observing, asking how things happen, and learning how to find the answers (Department of Education, 2005). A scientific method for preschoolers and kindergarteners (Gelman & Brenneman, 2004) involves observation, hypothesis development, data gathering, analyses/ hypothesis testing, and concluding. Gelman and Brenneman observe that children, in their own fashion, engage in regular exploration and hypothesis testing that can be supported by teachers. The scientific method for younger students is not test tubes and lab coats. Science happens when students use their “fingers and noses” to understand as they work with different materials in the classroom and at home.

Science is about observing, questioning, planning, gathering data, making a conclusion and then trying to duplicate an event or observation. For example,

- Science occurs when the student builds a block tower, it falls...he/she tries again, changing their technique....
- When a student changes the way they assemble blocks and then talks with peers about the 'best way' to make the tower higher...
- When a student excitedly explains why the tower became so tall, and their plans to make it taller or more complicated tomorrow.

The student may not have recognized that she was exploring size, mass, shape, balance, inertia, and gravity. In the examples above, the student engaged in a scientific process of recognizing a problem, asking a question, planning an "experiment," gathering data, coming to a conclusion (making a hypothesis), and then using their understanding of how characteristics of blocks can be used to create larger, more intricate designs. The teacher can reinforce students' observations in dialogues with them. Teachers reinforce students' science observations, problem solving, and predictions by using Language Techniques as shown in Table 2.

*Table 2. Mapping Teacher and Children's questions to Language Techniques and the Scientific process*

<b>Question</b>	<b>Language Technique</b>	<b>Science Process</b>
"Why did it fall?"	Problem solving	Conclusion
"How can Sammy help make it more intricate/complex?"	Open ended question	Data gathering
"Which blocks are best at the bottom or top?"	Concept relationship	Hypothesis
"What happens when blocks are not balanced?"	Problem solving	Hypothesis
"How can you make it taller?"	Prior knowledge	Data gathering
"What shapes help you build more intricately or higher?"	Vocabulary building	Conclusion
"Can you use different types of blocks or other materials?"	Open ended question	Replication

Early childhood classroom science involves exploration of cause and effect. After explorations, we expect students to ask questions and make comments about their predictions, successes and failures. These questions are what we consider the heart of the science process. Sometimes the question is brought on because an event is observed (e.g. there is a puddle, when the snow from boots has melted); sometimes an exploration incites wonder (e.g. gathering storm clouds), but either way, science in the classroom setting is anything that makes a student ask 'why?'. Children with well-established tools of investigating, problem solving, and talking through their thoughts are better prepared for curricular demands that include literacy in kindergarten and first grades (Dickinson & Tabors, 2001; Tarff & Warburton, 2005).

## **Organizing Activities**

The Language through Science program is organized around themes (Color, Shapes, Construction, and Water) that can be extended from one to 4 or more weeks. Themes are introduced with a Big Question that orients teachers to change processes relevant to the students. Orienting information includes basic information and interesting facts that can inspire teacher created activities. Using dialogues, teachers relate the theme to the student's background information and use books that support the theme. Each theme includes orienting

hands-on activities that encourage individual exploration. Activities lead students to a developmentally appropriate understanding of what changed as a direct result of their manipulation and an explanation of how the change occurred. Changes occur within a developmentally appropriate time frame so that students can initiate the change process, observe changes as they occur, understand outcomes, and replicate the experience. Follow-up activities allow themes to be extended. All activities include a model for teacher dialogue with their students to encourage observation, vocabulary, comparison, categorization, extension, and conclusions. An example of two activities is presented in Table 3.

<p><i>Activity 1: Daily weigh in</i> Big Question: How can we tell if something is heavy?</p>	<p><i>Activity 2: Building with clothespins, cups and plates</i> Big Question: Could cups and plates be turned into blocks?</p>
<p>Could be used for these themes: shapes, energy, movement, rocks, bodies Senses that are engaged: touch, vision Student data skills: predicting, estimating, calculating</p>	<p>Could be useful for these themes: construction, shapes Senses that are engaged: touch, vision Student data skills: predicting, estimating, calculating</p>
<p>Method:</p> <ul style="list-style-type: none"> <li>• If you have a scale in your room, invite students to suggest objects to weigh, making predictions about weight based on size, shape, and function. This might be part of your group time, or a transition activity.</li> <li>• Language techniques: open ended questions, think-alouds, concept relationships, building vocabulary</li> <li>• This activity is perfect for data gathering using actual weights, comparisons of objects weighed, and predictions versus actual weights.</li> </ul>	<p>Method:</p> <ul style="list-style-type: none"> <li>• Gather paper cups, plates, popsicle sticks and pieces of tape. Encourage students to plan and build exotic structures. This wildly successful project engages student creativity, planning and teamwork using less familiar building materials.</li> <li>• Discuss the planning, difficulties encountered and plans for new structures.</li> </ul>

Each lesson should include suggestions for dialogue, scaffolds for teachers to start conversations, vocabulary suggestions, and language techniques for enhancing book-reading experiences. Books that relate to the themes are provided with appropriate follow-up activities related to each book. Parent materials, including books, vocabulary, and home activities are also made available.

Gathering information about students and teachers participating in LTS in an underserved predominately African-American urban school district

The focus of this program was twofold: to collaborate with teachers in using language stimulating techniques in the classroom, and to determine whether student progress in the science content area might be increased in the short term by intentional use of language stimulation techniques during hands-on science activities.

Over a 10-week period, 10 kindergarten teachers and three Leap speech-language pathologists developed and implemented language-focused science activities and follow-up book readings. After a program orientation on the use of language stimulation techniques, 20 hours of shared in-class language techniques modeling and student instruction in science were carried out. Teachers and speech-language pathologists used tally forms (described below) to share feedback.

If available, a standard assessment of science knowledge for kindergarten students might result in a score, but would not provide information on changes in student knowledge of the process of science exploration or teacher use of Language Techniques. The Peabody Picture Vocabulary Test III was employed as a standard assessment of vocabulary comprehension, but other authentic assessments (similar to language samples) were developed.

Authentic assessment tools to describe the process of science learning were developed and included (a) Dialogue Starters (students' oral responses to scripted question prompts); (b) Science Knowledge Surveys (probing questions about students' knowledge of the Science process, Color, Shapes, Construction, and Water); and (c) teacher use of Language Techniques. The speech-language pathologist administered Dialogue Starters as each science theme was introduced. The Science Knowledge Survey was administered prior to and after the LTS program was completed. The speech-language pathologist tallied teacher use of Language Techniques as the teacher implemented science activities or book readings. Student responses were transcribed by the speech-language pathologist and scored categorically as (a) a no response, (b) a single word content related answer, (c) a phrase or a sentence, or (d) a description linking cause and effect. Teacher and speech-language pathologist reviewed these assessments; teachers felt that this type of authentic tally augmented rather than interfered with instruction, supported individualized intervention, and provided portfolio ready information for individual students.

Following is a summary of each assessment used during this 10-week program with 10 kindergarten classrooms:

- Peabody Picture Vocabulary Test–Third Edition (Dunn, 1996). A selection of kindergarten students received pre-and post-testing using PPVT-III, a well standardized assessment of word comprehension appropriate for these urban classrooms. Across classrooms, standard scores increased from 87 to 90. Vocabulary comprehension in all but two classrooms increased.
- Dialogue Starters. Each LTS lesson was preceded by a series of questions posed to students that are related to the lesson's theme. These dialogue starters were meant to prompt students' prior science knowledge. Teachers elicited students' responses while the speech-language pathologist transcribed; the responses were classified as (a) no response, (b) content, c) phrase/sentence, or (d) linking cause and effect, as described above. In summary, students responded to the dialogue starters with increasingly complex language over the weeks of lessons and book reading activities. Overall, students increased their 'Phrase' responses by 8% and their 'Cause and Effect responses by 12%. 'Off Topic/I Don't Know' answers dropped to 0% from 14% at the beginning of the program.
- Science Knowledge Surveys. A selection of kindergarten students received pre and post surveys, which were conducted one-on-one and transcribed by a Leap speech-language pathologist. Questions elicited the students' background knowledge about age-appropriate concepts related to each LTS theme, and a few general age-appropriate questions about science that map to Illinois state science standards. In summary, students made definitive gains from pre- to post-tests in the complexity of language used to answer questions on the survey. Students increased Cause and Effect answers by 14% when asked general science questions, 8% related to shape questions, 4% color questions, 13% construction questions, 14% water questions.
- Teacher Observation Forms. Leap speech-language pathologists utilized observation forms to record the frequency of Language Techniques that teachers used during LTS activities and book reads. Leap Coaches documented consistent use of Leap Language Techniques by teachers during LTS activities and book reads. There was a

higher use of techniques recorded during book reads than during activities. There was a strong indication that Leap Language Techniques were being used and incorporated into daily teachers' daily instruction. The techniques used most frequently were Asking Open-Ended Questions and Eliciting New Vocabulary. Considering this promising indication of student and teacher change, future implementation will use treatment and control groups for implementation and data collection.

## Summary

The program described in this review focused on co-teaching science content by speech-language pathologists and teachers with the goal of helping teachers use language stimulation techniques more frequently in kindergarten classrooms. Data reported for the kindergarten classrooms indicated changes in vocabulary comprehension, explanations of cause and effect, and transfer of teacher skills in eliciting language enriching responses from students. Teachers found that observing and documenting types of child responses was helpful in individualizing instruction. While the techniques embedded within the program are well supported in the literature, further research is planned to investigate the relationship between specific techniques and improvement in vocabulary development and higher order thinking skills.

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