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ABSTRACT

This paper describes an approach to using science activities as a means to teach English in the English-as-a-Second-Language (ESL) classroom. It is based on the author's work in Preparing Refugees for Elementary Programs (PREP) at the Philippine Refugee Processing Center. Refugee children from Vietnam, Laos, and Cambodia, ages 6 to 12, attend class for 4 hours a day during the 18-week PREP instructional cycle. The paper first introduces the philosophy and daily schedule of PREP. It then presents the theoretical background for PREP's approach to teaching science and English to refugee children. The next chapter, titled "Activities," describes the station activities in the PREP science room, specifying materials, procedures, and language used. Chapter 4, "Process," narrates a sample "discovery science" lesson presented to a whole class and analyzes the principles underlying the presentation. The final chapter, "Conclusion," discusses the relevance of this approach to mainstream and ESL classrooms in the United States. A list of English language units is appended. (KR)

SCIENCE TALK:

SCIENCE IN THE ESL CLASSROOM

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR

THE MASTER OF ARTS IN TEACHING DEGREE

AT THE SCHOOL FOR INTERNATIONAL TRAINING

BRATTLEBORO, VERMONT.

DAVID HUNT BLAIR

OCTOBER, 1990

This project by David Blair is accepted in its present form.

Date: ______________________

Project Advisor: ______________________

Project Reader: ______________________

To my Teachers, Students and Friends

in the Philippine Refugee Processing Center,

And Above All,

To Bert

ABSTRACT

This paper describes an approach to using science activities as a means to teach English in the ESL classroom. It is based on the author's work in PREP (Preparing Refugees for Elementary Programs) at the Philippine Refugee Processing Center. Refugee children from Vietnam, Laos and Cambodia, ages six to twelve, attend class for four hours a day during the eighteen-week PREP instructional cycle.

The paper first introduces PREP: its philosophy and daily schedule.

It then presents the theoretical background for PREP's approach to teaching science and English to refugee children.

The chapter titled ACTIVITIES describes the station activities in the PREP Science Room, specifying materials, procedures and language used. Color prints illustrate these activities.

The chapter titled PROCESS narrates a sample "discovery science" lesson presented to a whole class and analyzes the principles underlying the presentation.

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ERIC DESCRIPTORS: Elementary - Secondary - Education; English - Second - Language; Language - Acquisition; Minority- Group- Children; Refugees; Science - Instruction; Second - Language - Instruction; Teacher - Role; Teaching - Methods; Whole - Language

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INTRODUCTION

This paper, "Science Talk", describes an approach to using science in the ESL classroom that I have developed over the last three years. The essence of this approach is the combination of activity and discussion. Children investigate a science question using carefully selected materials. As they work at the activity, they talk with each other in their native language, and with their teacher and aides in English. The teacher also sets aside time for structured discussion and writing about the activity.

From July 1987 until December 1989, I worked as the Curriculum Specialist for PREP (Preparing Refugees for Elementary Programs) in the Philippine Refugee Processing Center. Roberto Tagalog and I coauthored a paper in Passage magazine (Spring/Summer 1988), "Science and the Communicative Classroom," that summarized our efforts to date. I presented the results of our work with science at the international TESOL conference in San Francisco (March, 1990).

This paper draws on these sources, and above all on our staff's experience in the classrooms. It is divided into the following sections:

SETTING: An introduction to PREP, its philosophy and daily schedule.

THEORY: An outline of the theoretical bases of our work.

ACTIVITIES: A description of the science activities in the PREP Science Room, specifying materials, procedure and language used. This is accompanied by color prints. The purpose of this section is to enable the classroom teacher to duplicate these activities in her own classroom.

PROCESS: A narrative of a sample "discovery science" lesson in the classroom, followed by an analysis of the principles underlying the presentation of the lesson. These principles, when applied to any of the activities described above (or any other science activity), help the teacher to use a "hands-on" activity to develop her students' listening, speaking, reading and writing skills.

CONCLUSION: A summary of the salient characteristics of our approach to science in PREP, and a brief discussion of their relevance to other teaching situations.

CHAPTER 1

SETTING

The Philippine Refugee Processing Center (PRPC) sits on a ridge overlooking the South China Sea, on the west coast of Luzon's Bataan Peninsula. Over the sea lies Vietnam, the first home of most of the PRPC's 18,000 refugee inhabitants. The Vietnamese have come here from countries of first asylum or directly from Vietnam under the Orderly Departure Program. They, and much smaller numbers of Lao and Khmer refugees, have been approved for resettlement in the United States. (A handful of the Vietnamese are bound for Norway instead.) They have been brought to the PRPC for eighteen weeks of schooling to prepare them for their new life in the U.S.A. While a few families remain in camp longer than six months, usually because of illness, most move on to their resettlement site within three or four weeks of completing their eighteen-week instructional cycle.

The U.S. State Department funds the education programs in the PRPC through two contracting agencies, the International Catholic Migration Commission (ICMC) and the World Relief Corporation (WRC). ICMC administers the adult and high school programs while WRC runs the elementary program, PREP (Preparing Refugees for Elementary Programs).

These programs must accommodate all the refugees approved for resettlement and moved to the PRPC. The primary limit on the numbers is the availability of housing in the camp. The politics of resettlement are highly unpredictable, so it is difficult to know far in advance how many refugees will be enrolled in each instructional cycle. A sudden bulge means that new teachers must be hired and trained quickly, while a drastic drop means layoffs. The politics of budgets are also very capricious, so it is a constant struggle to plan wisely for the anticipated needs of the education programs. In spite of this difficulty, the program I worked in (PREP) was well provided for, and as a result, we were able to buy the materials and train the staff that made possible the work described in this paper.

The program for adults contains three components: English as a Second Language (ESL), Cultural Orientation (CO) and Work Orientation (WO). It aims to prepare adults to function in American society and the American workforce by giving them language, cultural and work skills that they can build upon in their new home.

The high school program (PASS) offers ESL, American Studies and math courses, which have both academic and social/cultural goals. There is less emphasis on vocational skills, and the three components are more integrated, than in the adult program.

PREP is the newest of the education programs in the PRPC: it began in early 1987. It serves children from age 6 to 12, who attend school for four hours a day, five days a week during the eighteen-week "cycle". They may go to school in the morning or in the afternoon. With the exception of a few "special" classes, such as visits to the library, AV center, science room or physical education room, the children spend the entire school day with one teacher in a self-contained classroom.

The children are grouped first according to age: classes include six and seven, eight and nine, or ten and eleven-year olds. These age groups are further grouped by their ability in oral English and their literacy in the native language. Other criteria such as math ability, siblings in the same age group and proximity to the classroom are also considered in placement. Depending on the size and background of the cycle, the classes may be fairly homogenous or, in some cases, very heterogenous in ability and ethnic makeup. Classes number between 15 and 25 students: the youngest children are in smaller classes.

Their teachers are Filipino college graduates, some trained in education, others new to the field. Each new teacher receives several weeks of orientation and then starts a cycle. During the cycle, a teacher spends four hours in the classroom and two and a half hours in training every day. On four days of the week, the teacher meets for training with other members of her "team" (usually eight to ten teachers) and their Filipino or American supervisor. Team members vary widely in experience and expertise.

Each teacher hopes to have at least one adult or teenage BA, or Bilingual Assistant, whose role in the classroom is not only to translate when necessary, but also to act as an assistant teacher. The most effective BAs model English as much as possible, keeping translation to a minimum. BAs may work with individual children, with small groups and even the entire class. The BAs receive training parallel to, though less intense than, the training for the Filipino teachers.

PREP bases its training and teaching on the Natural Approach and on the Whole Language philosophy. Teachers provide a great amount of comprehensible input in sheltered English, using objects and pictures to provide context whenever possible. Students are expected to go through a listening, receptive phase, which may last most of a cycle, before producing any significant amount of English.

Language arises from any activity going on in the classroom, and activities are designed to involve and stimulate the children. The PREP classroom is active and often noisy, as children and teachers sing, dance, work on art projects, do choral readings and skits, use classroom objects and their own bodies to work out math problems, and so on. All of these varied activities are integrated around a weekly theme called an English Language Unit or ELU.

The ELUs for the first five weeks deal with topics close to the student: name, age, nationality, the classroom, the body and senses, clothing, family and home. As the cycle progresses and language ability grows, the ELUs expand to cover wider and wider circles in the student's world: plants and animals in Weeks 10 through 12, maps and globes in Week 14, and by the last weeks, the actual transit process that will take the students and their families from the Philippines to the USA. (For a list of the ELUs, see Appendix i.)

Each week, the core language of the ELU recycles throughout the different activities (math, science, arts, recess and so on.) The teachers are trained, and the curriculum is written, to encourage this recycling, not only during that particular week but during the weeks to come.

PREP's work in literacy (reading and writing) centers around the shared reading of Big Books (large format picture books written for beginning readers), sustained silent reading of varied children's titles, and reading one's own work to classmates. Teachers use the writing process to encourage beginning writers, as well as children already literate in their first language, to express themselves with pictures, letters and words. The children "publish" these works and read them to each other.

Math and science in the PREP classroom extend the opportunities for English through many "hands-on" activities that build concepts and language through concrete experiences. The math and science curriculum introduces students and teachers to a style of teaching very new to them, but much in use in U.S. schools.

Chapters 3 and 4 of this paper will describe this approach to science in some detail: first by outlining the activities in the Science Room, then by narrating and analyzing classroom presentations of two science lessons.

The following chapter will present the theory which underlies PREP's approach to teaching science.

CHAPTER 2

THEORY

In this chapter I will trace the lineage of the ideas that we put into practice in the PREP Science Room and classroom science lessons. I can speak only of the theories and people who have influenced me. Other people contributed a tremendous amount to the science curriculum, and they drew from other sources than these.

I will outline the contributions of the following:

- "hands-on" methodologies, as exemplified in the materials developed by Elementary Science Study, or ESS;
- British Infant Schools and the "Integrated Day";
- the Whole Language approach;
- the Natural Approach;
- the "Cognitive Academic Language Learning Approach", or CALLA, developed by Anna Uhl Chamot and J. Michael O'Malley;
- the Investigation-Colloquium Method of Brenda Lansdown, as described by her, George Tokieda and G. Omani Collison.

"Hands-On" Instruction and ESS

"Hands-on" methods of teaching go back thousands of years. In many traditional societies, children learn by doing. While this learning may not be taking place in a school setting, but rather in the context of daily life, the nature of the learning resembles that in a "hands-on" classroom. Children work with materials, they experiment and observe, and from this involvement with materials they come to understand their world better.

"Hands-on" methods found a philosophical home in America within the Progressive Education movement of the early 1900s, based on William James's Pragmatism and John Dewey's Experiential Education. These schools of thought emphasized the creative investigation of our environment. Children learned through direct experience of the world around them.

The post-Sputnik era targeted the teaching of math and science in American public schools. Federal funding encouraged the development of many sets of materials, which were marketed under a bewildering array of acronyms: ESS (Elementary Science Study), SCIS (Science Curriculum Improvement Study), and so on.

ESS grew from Peace Corps work in Africa. Teachers found ways to use local materials in science lessons that involved children in active discovery. From this genesis overseas came a wonderful set of curriculum booklets, sometimes accompanied with materials, on a wide variety of science topics such as astronomy (watching the sun and the moon), animal behavior (mealworms), chemistry and physics (bubbles, batteries and bulbs, magic powders) and so on.

I encountered ESS materials while a graduate student at Antioch/ New England in 1973. I used them in public school classrooms and found that they encouraged my creativity as well as the children's.

They did not come packaged with extensive kits of hardware. While this was perhaps a disadvantage for the regular classroom teacher, it encouraged me to experiment, to develop my own materials - - in other words, to improvise. This experience of creating an activity from scratch served us well in the PRPC.

As my fellow graduate students and our professor, Marvin Hoffman, experimented with these and other science materials, we experienced the power of learning by "messing around". We shared the excitement of our discoveries and the frustration of our failures, both as scientists and as teachers. I applied these methods in the classroom, watched children learning by doing (and sometimes by failing) and brought this experience to the PRPC. "Hands-on" methods found a congenial home in PREP, as the people who developed the original curriculum (Elizabeth Tannenbaum, Else Hamayan and others) were also advocates of experiential approaches.

The British Infant School and the Integrated Day

I was exposed to the philosophy of the British Infant School throughout my Antioch program. I saw it embodied at the Harrisville (New Hampshire) School, Antioch's laboratory school. We worked with curriculum materials, such as the Nuffield Math curriculum, that grew from it. At the same time, I was introduced to the Integrated Day through work in the local schools. I cannot cite any particular work or theorist as the source of the Integrated Day. It was "in the air" in the mid 1970s, a topic at staff development workshops and an interest of many public school teachers. I perceive it as a logical corollary of British Infant Schools and so will treat them together.

The British Infant School movement has reached the United States through many individuals and small schools, among them the Prospect School in Bennington, Vermont and the Harrisville School. This approach emphasizes the primacy of the child's interest in determining the direction, and even the choice, of an activity. Thematic units develop around the child's own themes. Literacy and math skills grow from the exploration of these themes.

The British Infant School classroom contains a rich variety of materials and offers the child many choices of what to work on and how to approach the task. On a given morning, a child might choose to play in the block area, to build with Legos to sit in a corner and read a book, or to paint. She/he not only chooses a material to work with but also decides what to do with it: there is no preassigned task.

These materials do not structure learning: they suggest possibilities. The teacher monitors each child's activity and makes appropriate suggestions for new materials to try, other children to work with, and sources of information when a child needs help. The teacher is actively engaged with the child in the learning process but does not dominate that process. The teacher also ensures that the children share what they are doing with each other and record it in some way: by drawing, painting, writing and dictating.

The Integrated Day relates the activities of the school day to a single theme. Skills are not learned in fragmented "subject areas" but instead through the in-depth exploration of this theme. So the study of Monarch butterflies in the fall branches out to include not only science (the life cycle of the Monarch) but reading (trade books and also the children's own writing), math (graphing the life cycle), writing and drawing (the children illustrate and dictate/write their own books), movement (acting out the caterpillar's metamorphosis), etc.

The theme may carry on for days or even weeks. Student investment in the learning is high. The teacher is responsible for facilitating the learning process, selecting materials, suggesting and encouraging student choices as they do independent work on the theme. The teacher is a partner in learning rather than the director of learning.

The PREP curriculum integrates each week around a theme, the ELU or English Language Unit. The teachers make a conscious attempt in their lesson planning to relate all the skill areas to that theme. In weekly flow charting, each team brainstorms and diagrams the web of relationships between the central theme and each day's activities.

The teacher and student roles proposed by the models of the British Infant School and the Integrated Day found their way into science teaching in PREP, as analyzed in Chapter 4 of this paper. Our insistence on using science activities as an occasion for communication, both oral and written, stems from these schools of thought as well as from the Whole Language movement of more recent years. Language development is the primary concern in early childhood education, and so it is no surprise that the ESL classroom can find much of value in mainstream methodologies.

Whole Language

Whole Language sees language arising from all human activity. The classroom offers limitless avenues to develop and reinforce language in a meaningful context. Therefore, the teacher structures learning opportunities based on actual experience, and these become the springboard for "authentic" communication. Children discuss what they are doing with their classmates and teacher. They record their activities in dialogue journals or other written form. Children do not work from basal readers. They read children's literature; write their own books; read and discuss each others' work. Whole Language and the writing process are natural partners.

Whole Language applies across the mainstream curriculum as well as to ESL classes. Under the leadership of educators such as Ken and Yetta Goodman, it has gained many adherents in American elementary education and seems to have a particularly strong foothold in the ESL profession.

Whole Language has much in common with the Integrated Day and British Infant School models described above. In each, an experience of genuine interest to the student becomes the center of a web of learning. Whole Language emphasizes language and so is a particularly helpful construct for approaching an ESL classroom.

Whole Language came to PREP borne by consultants such as Else Hamayan and Carole Urzua, who helped us all to understand and implement this philosophy. Whole Language taught us how to talk with children as they worked. We learned to make comments specific to a child's activity: "You are putting more marbles in the cup" instead of "Oh, that's very interesting!" We tried to ask "authentic" questions: "What do you see happening?" rather than "What color is that?" (when we know perfectly well what color it is!).

These may seem like minor pedagogical details, but they assume great importance in both language and concept development. I will be discussing concept development more under the Investigation-Colloquium Method. As for language development, the art of giving comprehensible and meaningful input, and of eliciting whatever production the child is capable of at a given time (which may be no more than a word or a nod), is an essential teaching skill within the Natural Approach.

The Natural Approach

The Natural Approach (Krashen and Terrell, 1983) stresses the importance of providing "comprehensible input" to the beginning language student. Students in the earliest phase of language acquisition, called "pre-production", can absorb a great amount of language provided that it comes to them in "sheltered" English and in a meaningful context. The teacher, understanding that the student is not ready to give any English back or can only provide single words, does not insist on the student speaking. This lowers the student's anxiety level, or "affective filter", thus allowing the process of absorption to flourish.

Most of our students in PREP came to us in the pre-production phase. During the instructional cycle, many moved on into "early production". During their visits to the Science Room, children's interactions with English speakers centered on concrete objects and activities. The adults repeated simple words and phrases that directly described these activities. We gave the children many opportunities to respond but did not expect more than we thought them capable of at that time.

In the ACTIVITIES chapter, the reader will find examples of the words and phrases that we could choose from in talking about any of the station activities. The demonstration lessons described in the PROCESS chapter model the English that a teacher might use with a beginning group of students. Our understanding of the Natural Approach helped us to consciously design the kind of language input we gave our students.

The Cognitive Academic Language Learning Approach, or CALLA

CALLA is an instructional program in the content areas of science, mathematics and social studies for LEP students in the upper elementary and secondary grades. It is designed to help them move from the ESL or bilingual classroom into the mainstream classroom. Its authors, Anna Uhl Chamot and J. Michael O'Malley, base this instruction in academic language and content on a "cognitive" model of learning. Their approach stresses the development of effective learning strategies to help with both language and content tasks.

Chamot and O'Malley suggest that science be the first content area into which LEP students are mainstreamed. They find it ideal for the introduction of the CALLA model. This is their argument, taken from Chapter 2, "English Language Development Through Science," of their book, A Cognitive Academic Language Learning Approach: An ESL Content-Based Curriculum:

- Science work is rich in contextual meaning: "the language used in science can be embedded in the context of demonstrations or practical experiments the students themselves carry out."

- The process of working through a scientific problem, from initial observation to a conclusion supported by experience, requires active language use.

- Science experiments contain multiple steps. Students can use language as a means to remember and relate sequential activities.

- Small group work, typical of science experiments, gives many opportunities for interactive language use among the students.

The CALLA model influenced our work in several ways. First, it strengthened our conviction that content and language should be integrated (a tenet of the PREP curriculum) and encouraged us to emphasize science as an ideal vehicle for this integration.

Second, it helped us to design our experiments around a careful sequence of simple, repeated steps. This allowed the students to analyze cause and effect, "the logical connection between successive steps of an operation".

The children worked in small groups in the Science Room or in classroom activities. They talked a lot as they worked. Their own thoughts and interactions with their peers took place primarily in their first language (Vietnamese). However, the adults present could initiate interaction in English - - comments and questions in sheltered English that invited a response.

We did not use science lessons as an opportunity to discuss learning strategies with our students. Their level of English did not usually allow for processing on this metacognitive level. However, we structured science experiences to allow for the use of the three types of learning strategies identified by Chamot and O'Malley:

- Cognitive strategies such as notetaking and prediction;
- Social/affective strategies such as cooperation and questioning for clarification;
- Metacognitive strategies such as self-monitoring and self-evaluation.

The reader will find examples of these strategies in use in the ACTIVITIES and PROCESS chapters. In some cases, we had strategies in mind when we designed an activity: we built cooperation and prediction into many stations in the Science Room. In other cases, opportunities for reinforcing learning strategies emerged from our planning for another need. For instance, we introduced recording sheets in the Science Room in order to encourage notetaking and literacy skills. We found that the sheets also allowed for self-monitoring and self-evaluation, as they told the students when the task was finished and could also provide clues to mistakes they had made.

The Investigation-Colloquium Method, or I-CM

Brenda Lansdown's Investigation-Colloquium Method (I-CM) builds on the work of Vygotsky. In Lansdown's words: "According to Vygotsky, thought and language stem from different roots. He points out that there can be thought without language, without words, and words without thought. The role of education is to bring the two together" (Jan. 1987, p. 9). Vygotsky wrote: "Thought is not merely expressed in words; it comes into existence through them" (1962, p. 125).

The I-CM extends "hands-on" methods through a carefully structured discussion that allows the students to express and clarify their thoughts. In his article, "The Colloquium: Patiently Talking Together" (no date), Lansdown's student George Z. Tokieda writes:

> The I-CM developed by Brenda Lansdown is based on the fact that children (and adults) learn best by doing and discovering and then by talking about their discoveries. The **Investigation** provides the means for "doing", and the **Colloquium** provides an organized way for "talking". During the **Investigation** the children explore with materials which the teacher has carefully structured around predetermined concepts. Through concrete explorations using all their senses, they discover the concepts which are now in their hands so to speak. . . .
>
> During the **Colloquium** that follows, you encourage your students to say what they have discovered in their own words and try to take a back seat in the discussion. Through this collaborative peer group dialogue, students begin to formulate their understanding of the concepts which move from their hands into their heads through the use of experiential language. . . .
>
> Thus structured self-discovery is the essence of the **I-CM**. While most educators are aware of the need for concept-based, hands-on activities, they do not recognize the need for the **Colloquium** which is an equally essential part of the method. For it enables one through the vehicle of experiential language to move from experiential understanding to intellectual understanding - - the vital process involved in "creative thinking." (pp. 1-2)

Lansdown and Tokieda find "hands-on" methods incomplete in themselves. Without the opportunity to share their insights with peers and teacher in a structured discussion - - not merely a random sharing of ideas - - children will not crystallize their ideas. The teacher's awareness of the sequential development of concepts reflects itself in the careful choice and presentation of materials.

These ideas had a powerful effect on me when I read them and later experienced them in a workshop led by Tokieda. The Science Room activities described in Chapter 3 did not include a structured colloquium, but our choice of materials and questioning methods were designed to encourage the kind of "creative thinking" that Tokieda describes. The sequence of experiment and questioning under "Sink and Float an Egg" (see p. 32) is a good example of the I-CM approach.

The demonstration lesson on batteries and bulbs in Chapter 4 bases itself squarely on the I-CM. The teacher carefully plans a sequence of experiences, with a gradually increasing pool of materials, that allow the students to make discoveries by themselves. But the process is not complete without language, and so the teacher makes sure that the students pull aside at regular intervals from doing in order to talk and write about what they are doing.

We could not apply the I-CM in its entirety at PREP, for we were teaching in the children's second or third language. George Collison taught science to Ghanaian school children using the I-CM. He then analyzed their statements in both their native languages and in the school language, English, using Vygotsky's hierarchy of conceptual levels as one measure of their concept formation. In his paper, "Concept Formation in a Second Language: A Study of Ghanaian School Children", he suggests that "vernaculars allow better conceptualization for their native speakers than the second language English."

> The quantitative data indicate that when children used the vernacular as opposed to English, they made more statements, their statements were more often at the complex and preconceptual level, they reported more relationships based on non-obvious linkages, and they used models more frequently. . . .The measures of conceptual levels and relationships are independent of grammatical complexity, and the results are probably not due to unfamiliarity with English.
>
> If concepts are to be meaningful at the children's maturational level, the language for communication of the concepts to and among children is crucial. When the language is foreign, children may mimic adult concepts without any appreciable contribution toward their own conceptual growth. If they can not express the ideas or discuss them with their peers, conceptual growth may be stalled or impaired. . . . If further studies corroborate these conclusions, then the claim that education in a foreign language denies a sizeable proportion of school children appropriate conceptual experience is affirmed. (1974, pp. 454-55)

I make no excuses for using English as the language of instruction in PREP science lessons. That was our mandate. I have no way now of assessing the language and conceptual development that went on in Vietnamese between our students. That also was beyond the scope of our work. I cite Collison's work as a caution that, though our work was influenced by Lansdown's methods, we were not truly applying the I-CM at PREP.

Even the discussion period during the demonstration lesson described in Chapter 4 is not really a colloquium, however effective it may have been in consolidating some language. A colloquium would take place on the floor as a group discussion, with every child having the opportunity to share his or her thoughts, with far less control by the teacher. A colloquium could have taken place in Vietnamese, but it did not. I acknowledge a large debt to Lansdown and Tokieda. However, we adapted their ideas to our situation at PREP, and much of the power of their method was lost in the translation.

Summary

"Hands-on" methods and materials create exciting learning experiences for students and teachers. The British Infant Schools and the Integrated Day tie learning experiences together around common themes and build language and literacy around these themes. Whole Language stresses meaningful communication in a richly contextual language environment. The Natural Approach describes the process of language acquisition and suggests how we can best help learners in the early stages. CALLA argues for the use of science as a first bridge to mainstreaming for LEP students. The Investigation-Colloquium Method outlines a structured approach to integrating discovery and language within the science classroom.

All of these have combined in my training and teaching to lead me toward the approach to teaching science described in the following two chapters.

CHAPTER 3

ACTIVITIES

In this chapter I will describe the activities in the PREP Science Room. Each activity is illustrated by one or more color prints.

The purpose of this chapter is to enable the classroom teacher to set up one or more of these activities in her own school setting: in the classoom as a whole class activity or at a science center, or in a special activity room such as a Science Room. The following chapter. PROCESS, will deal with the challenges of presenting a "hands on" activity to an entire class.

The reader will find much in both the photographs and narrative that is particular to the PREP setting. I include these details because they illuminate our concerns with classroom management and because they illustrate the kinds of interactions that occurred during the activities: between students and students, between students and teachers. I hope that the reader will find that these details, though specific to PREP, have some relevance to her/his classroom experience.

Background

The Science Room first opened in March, 1989. It remained open most of the year, with several interruptions due to shortage of staff and space. Each time it reopened, it contained some different stations and was run by a new teacher. The room shown in the prints (see Appendix II) dates from November, 1989. It is the result of a month of work by one team of teachers who redesigned the stations. It incorporates not only their ideas but the experience of other teachers who had visited previous Science Rooms and given their feedback.

We learned to run the Science Room better with time. We learned how to manage the stations and we weeded out some activities that just did not work. We also found a balance of activities that offered something to children of all ages and interests, and that allowed for a range of language according to the abilities of the children working at the station.

For instance, each Science Room included a senses area, easy for young children to understand and work in, and also simple in the words used. We always had an activity related to batteries and bulbs and another with magnets. We tried to include a station on simple machines that also gave an opportunity to predict and measure (the ramp, in this case); a basic chemistry activity (magic powders in this Science Room, acid and base in a previous one); a station where children could experiment with sink and float (this evolved into the two density stations pictured); and one place just to "mess around" (our "make it" area, and in a previous room an area to blow huge bubbles). Activities changed over time as the teachers got new ideas and as students returning for follow-up visits needed different activities.

Children visit the Science Room for a 45-60 minute period: the shorter time for 6 and 7-year olds. Their teachers may sign the class up for a visit as early as the second or third week in the 18-week cycle, and they may return as often as the schedule permits. One class might visit three or four times during a cycle.

If possible, the visit alls during the part of the day when a refugee "BA", or bilingual assistant, is working with the class. In this case, a minimum of four adult English speakers are present during the visit to the Science Room: the classroom and Science Room teachers and their two BAs. Each adult tends to work with two or three of the eight to ten stations, rather than floating among them all. When necessary, the BAs can translate the directions for the children. Later in the cycle, especially on follow-up visits, the children need less and less translation, and the opportunity for more English input, and more complex English, grows tremendously.

The success of the teachers and BAs at giving comprehensible input and eliciting English from the students varies greatly from visit to visit: not only depending on the level of the students, but also on the skill of the teachers. Some classroom teachers enjoy the Science Room and come often. Gi, who is pictured working with batteries and bulbs and with the ramp, was one of the designers of this room. Teachers like Gi engage actively in working and talking with the children. They are more apt to plan the trip ahead of time, giving the Science Room teacher some directions for the class; and they are also more likely to follow up the visit later in their own classroom with Whole Language activities. Their BAs are also more likely to use English and participate in the activities. Other teachers and BAs hold back more from engaging with the children. They show less interest, make more superficial comments, and fail to exploit the language possibilities opening up in front of them.

On the day the photos were taken, Bert Tagalog and I joined the two teachers and their BAs. A session like this, with a high ratio of enthusiastic English speakers to students, saw a high amount of English in use, not only input from the adults but spontaneous replies and comments from the students. This may not typify a day in the Science Room, but it does speak for the potential of this kind of activity in the ESL classroom.

Orientation
Print # 1

The Science Room teacher, Joey Dandan, greets the children upon arrival. On their first visit, she sits them on the mat near the door and orients the children to the room with the help of her BA or the classroom BA. She explains the procedures for the room and shows some of the materials that they can work with. The children then go to stations of their own or their teacher's choosing. On subsequent visits, the orientation may be very short, and the children will go to stations that they have not previously worked at.

There is a limit to the number of children who can work at any one station. This limit is indicated by a pictograph posted at each station. (The reader can see part of this sign next to "What's Inside A Battery?" in Print #21.)

The children move from one station to another as they complete work with one set of materials. The teachers and BAs may help them to decide when to move and where to go. There is no set sequence for the activities. If a group of children is absorbed with one activity, the teacher may allow them to stay there for half a period. Some stations allow for a depth of exploration and a complexity of language especially appropriate for older children. We do not hurry students away from this kind of experience. We do move children along if we see that they don't understand the activity or have spent enough time with it.

Senses - Touch
Prints 2 - 4

One popular area for young students and children in their first weeks is the Senses area. Children study Body Parts and Senses in their second week of PREP, so even early in the cycle, they are familiar with the language of these stations.

These three photos show the Touch station, where children try to match a piece of fabric that they feel with their feet (and cannot see) to fabric that they can see and touch with their hands.

Two children work together, laughing and talking (doubtless in Vietnamese), then record the pairings that they have found. Each station has a simple recording sheet, in this case a "Magic Slate" on which children write the numbers from the display board that match the letters on the footbox. There is a self-checking key. After the children check their answers, they erase their answers by pulling up the plastic film on the Magic Slate.

Note also the white sheet titled "Science Room" next to each child. This is a station recording sheet on which the children keep track of the activities that they have done in one day. This not only gives them experience in recordkeeping, but it also helps their teacher to plan their subsequent visits.

Materials: paired pieces of material with different textures (carpet, flannel, corduroy, sandpaper, corrugated cardboard, etc.)

a display board above showing each material coded by number or letter

a foot box below with each material hidden, numbered or lettered

Language: feel, touch, hands, feet, fingers, toes, the same, soft, hard, smooth, rough, bumpy, warm, cold, different

how does it feel? is it the same? is it different?

Senses - Smell
Print # 5

At the Smell station, children try to match the smells of garlic, onion, cinnamon, ginger, perfume, talc and so on. Each substance is in a black film container with a hole punched in the top, and also in a clear lab[illegible] container which the children may open. The students use their noses to match the contents of the clear containers, which they can both see and smell, with the contents of the black ones, which they can only smell. Here again there is an answer sheet (a number matched to a name) and a self-check.

Materials: two samples of each: onion, garlic, perfume, ginger, cinnamon, talcum powder

clear film containers labelled with the contents

black film containers with a hole punched in the lid, numbered but no label identifying the contents

Language: the names of the substances, smell, nose, good, bad, like, don't like, strong, sweet, open, closed

is it the same? is it different? how does it smell? do you like the smell?

Senses - Hearing
Prints # 6 - 7

At the Hearing station, each numbered box contains one of the objects labelled on the display below. The children shake each box and match what they hear to the objects that they see. On the Magic Slate, they pair the box number to the name of the material . The box in the upper left corner of the display board holds the answer key.

Materials: paper clips, cotton balls, clothespins, rocks, pennies, sand, etc.

a labelled display showing the materials listed above with their names in English

numbered boxes containing a sample of each material, enough so that it rattles well!

Language: the names of the materials, hear, see, eyes, ears, shake, hand, heavy, light, loud, soft, rattle, noise, noisy, sound

is it the same? it is different? what do you think is inside? how does it sound? is the box heavy? light? what noise does it make?

Density - Liquids
Prints # 8 - 10

At this table, the labelled baby food jars contain liquids of varying color and density: soy sauce, corn syrup, water and motor oil. The taller bottles with lettered caps contain two of these liquids.

The children first identify the two liquids in each tall bottle, using the labelled samples. They write the names in the left column on the recording sheet.

They then shake these bottles. The two liquids mix at first, then separate again. (If the children shake hard and long, and the liquids have similar densities, they may stay mixed. For this reason, we chose motor oil rather than salad oil: the motor oil is much heavier and will not mix with the other liquids.) The children watch this happen and record, on the right side of the sheet, which liquid goes up and which goes down.

The students may work together, as in Print #9, or with an adult, as in Print #10. The presence of a teacher assures some interaction in English. Here is an excerpt from a tape of dialogue between teacher and students, taped in November 1989 in the Science Room:

> (The teacher first identifies all the liquids in the marked bottles, and the students repeat the names. The teacher then asks a student to identify two liquids in an unmarked bottle.)
>
> Student: "Soy sauce ... clean water." (Looking at another bottle) "Water ... cooking oil."
>
> Teacher: "Which is down?"
>
> S: " So ... (unintelligible) goes down, the cooking oil ... up."
>
> Another S: "The clean water down, cooking oil up."

T: "Very good. So the cooking oil is up and the water is down in this bottle. Very good."

S: "This bottle soy sauce and cook ... Karo syrup... (pause) (T: mix together) ... mix together. No up, no down."

T: "Very good! The soy sauce and the Karo syrup mix together. No up, no down. How about in this bottle?"

S: "Cooking oil and soy sauce."

T: "In this mixture the soy sauce is down and the ...

S: "Cooking oil up."

The students repeat words they have heard from the teacher ("soy sauce, water, up, down," etc.) to describe what they see. We also hear a student reaching for a new word ("mix") to make the observation: "no up, no down". The teacher does a fine job of supplying comprehensible input so that the students can communicate with her in English.

The teacher's presence also assures more complete and accurate recording. The answer sheet contains some discrepancies: the two liquids listed on the left for Bottle C are not the same as those listed on the right! The teacher may insist on more accuracy. She may also decide that the children are ready to move on. Perhaps they are too young to understand the directions. Maybe they really understood the process and became careless. In either case, "getting the right answer" is not as important in these activities as interacting in English and participating in the process of observing and recording.

Teachers interested in setting up a station such as this one may wish to experiment with a laminated answer sheet and markers that can be wiped off. This saves a lot of paper, though it can create a messy answer sheet!

Materials: corn syrup, soy sauce, motor oil (denser than salad oil), water (may be colored)

clear labelled bottles, each containing one liquid

clear bottles with tight caps containing two or more liquids: numbered or lettered

Language: names of the liquids, bottle, colors of the liquids, up, down, on top, on the bottom, shake, rise, float, sink, goes up, goes down, heavy, dense, light, heavier, denser, lighter, mix, separate

shake the bottle! what happens? what goes up? what goes down? which one is on top? on the bottom? does the water float? does the oil sink? why?

Density - Float and Sink an Egg
Print # 11

At this station, the children first place an egg into a jar of tap water, and then into a jar of salt water. They observe that the egg sinks in the first and floats in the second. The teacher asks them: why?

They then have the opportunity to try to float an egg by mixing salt into the tap water. The teacher can ask: how many spoonfuls of salt do you think you need to make the egg float? She can also challenge the students to try to float the egg in the middle of the jar.

Here is another example of dialogue between teacher and students. The teacher is asking the children to guess whether the egg will go up or down. The children are giving one word responses: "Up!" "Down!" One child suggests: ". . . . small water go up." T: "Oh, in very small water, very little water, it will go up." S: "Medium."

Here again a child is going beyond repetition of words in response to specific questions to try to formulate an original idea: that the egg will float when there's not much water in the glass. Then the student modifies that idea in response to the teacher's restatement: the egg will float in "medium" water also.

Our teachers found that the children in the PRPC were often able to compare swimming in the stream with swimming in the ocean. They could sometimes make an analogy between that experience and their observation of the egg.

A more sophisticated presentation of this experiment introduces variables of color and temperature. The teacher presents a glass of warm blue water (with salt dissolved in it) and a glass of cool clear water. The egg floats in the first, sinks in the second. Why?

If the children suggest that the color makes the difference, they can experiment with food coloring. They will discover that the egg sinks in any color of water. If they suggest that the water temperature is the key, they try to float the egg in hot and cold water. Again, the egg sinks. Why then does it float in the warm blue water? At this point, the teacher might invite the students to taste that water, or she might put a container of salt on the table and wait to see if a student tries to mix salt in.

This approach requires a careful sequencing of steps, and so the teacher must be present to guide the discovery process. We did not choose this more elaborate version for the Science Room, as we did not have the staff to devote that amount of time and attention to one station. This experiment is well suited for a whole class activity, as described later in the **Process** section.

This station uses great amounts of salt and water. It can also get very wet!

Materials: hardboiled eggs

wide-mouthed jars or glasses

water (hot and cold is optional)

food coloring (optional)

salt and stirring spoons or chopsticks

Language: egg, chicken, duck, raw, cooked; jar, water, hot, cold, colors, fresh, salt, river, stream, pond, sea, ocean; add, stir, spoon, chopsticks, sink, float, middle, more, less

does the egg float? does it sink? can you make it float? can you make it float in the middle of the jar? what will happen if you add more salt? some blue color? some hot water?

<u>Magic Powders or Kitchen Chemistry</u>
<u>Prints # 12 - 16</u>

On the first side of the Magic Powders station, children perform a sequence of experiments with labelled white powders. At any one time, we used four or five of the following: baking soda, baking powder, salt, sugar, powdered gelatin, talcum powder, flour and tempera paint. A mobile identifies the powders in English and Vietnamese (Print #13).

The students place a small amount of one powder on three "testing boards", pieces of black poster board covered with plastic. They put a few drops of water on one mound of powder, vinegar on the second and iodine on the third. They record what they see in the boxes on the left side of the recording sheet (see Print #14). They then repeat the sequence with another powder.

The children notice color change: iodine turns any starch blue, the tempera paint may appear white but turn pink when wetted. Any liquid causes the baking powder to fizz, while the baking soda fizzes when vinegar is added. Liquids bead up on some powders and soak into others. The children may record these observations in Vietnamese or, using key words that we posted at the station (such as "fizz") they may use English. The presence of an adult helps the children to make as many observations as they can.

On the second side of the station (Print #15), the students repeat the same sequence of steps, but here the powders are color-coded but not labelled. The children must observe the chemical and physical reactions and use their own recorded observations from the first side to identify the powders. If iodine turns a mystery powder blue, and they recorded this reaction for white flour before, then they would identify it as flour. The student with the marker is identifying the five powders, following the color code on the jars.

Bert Tagalog shows the completed sheet in Print #16. Several children collaborated on the lengthy notes on the left. Four of the five answers on the right are correct: "tempera paint" was written twice, and no one in the group saw the duplication or insisted that they repeat the experiment.

This station requires a methodical approach to the experiment and the recording, and therefore a lot of cooperation between the students. It requires sophisticated thinking also, especially in spotting an error and deciding how to correct it.

Materials: white powders (salt, sugar, baking powder and soda, tempera paint, talcum, gelatin, white flour, ...) - labelled on first side of station, color-coded only on the second - a display of containers optional

water, vinegar, iodine - labelled at both stations

medicine droppers for each liquid (shouldn't be mixed)

small spoons for each powder

a surface (laminated black poster board, glass slides) on which to test powders

sponges, paper towels - the testing surface must be cleaned after each test!

Language: colors (blue, purple, pink or other light tempera colors), fizz/not fizz, soak in, run off, stay on top, drop, wet, dry, dissolve, change, the same, different

what happens when you put a drop of ___ onto ___? what color do you see? does it fizz? is the powder wet? does the water go (soak) into the powder? run off? stay on top? which one do you think it is?

Batteries and Bulbs
Prints # 17 - 21

At the batteries and bulbs station, we give batteries, bulbs and wire to the children and ask them to make a light. At first, the teacher may use picture cues to ask a very specific question. In Print #18, she asks the students to make a light with one battery, one bulb and one piece of wire, and with the bulb touching the top of the battery. In Print #19, the exploration is more open-ended. There are in fact many ways to make a light!

The exploration can expand in many directions. Can the children make a light when the bulb does not touch the battery? What happens when more batteries and bulbs and wires are added? Now the students must begin to help each other out, to talk with each other! The children may experiment with making a gap in the circuit and making their light flash on and off: they have made a switch. They can bridge the gap with different materials to find out which ones carry the current across the gap. a spoon conducts, a pencil does not.

The poster shown in Print #20 asks the students to generalize from their experience. If they can answer this without actually repeating the experiment, they show that they have gone beyond the "hands on" experiment to understanding the concept of an electric circuit.

In the course of making this station, the teachers themselves became curious to find out what's inside a battery. They did, as shown in Print #21!

Materials: flashlight batteries, bulbs, bulb holders (optional), wire with ends stripped, small screwdriver (for bulb holders), tape so wire can be taped to battery terminals

an assortment of objects (wood, metal, paper) that do or do not conduct electricity

Language: names of the materials: light, strong, weak, bright, more, less, together, touch, flash, on, off, switch, electricity, carry across, break, gap, conduct

can you make a light? another way? can you make a light when the bulb does not touch the battery? what happens if you use two batteries? can you make two lights? can you make the light go on and off? does a pencil carry the electricity across (conduct)? how about a spoon? try the nail!

Electromagnets and Morse Code
Prints # 22 - 25

Magnets are a popular activity for children. They can experiment with different materials and find out which are pulled by a magnet. This leads to charting and graphing objects "pulled" and "not pulled". They can also find out how strong a magnet is: how many paper clips can it lift? how many nails? which is heavier, a paper clip or a nail?

Print #22 shows a simple electromagnet that we used to send Morse code signals. An iron nail wrapped many times with copper wire, then connected into an electric circuit, becomes a magnet (sometimes a very weak magnet!). When a flexible piece of conductive material is put close to the head of the nail, and the circuit is closed, the two can make contact and produce a buzzing noise. When the switch is opened, they separate and the noise stops. This is what we used to make the dots and dashes of Morse code.

In Print #23, Bert is showing the children the correspondence of dots and dashes to the letters of the alphabet. He then taps out his name as an example, and the children record the letters on their Magic Slates. At least one child writes "BERT" (Print #24). The children then go on to tap out other words for each other. A literacy activity disguised in dots and dashes!

In Print #25, one boy is trying to make an electromagnet with another nail and a battery. Bert has allowed the group to diverge into a more unstructured exploration, and he will use their experiments as the basis for more language.

Materials: a nail wrapped in copper wire

a battery or series of batteries

wire and a flexible piece of conductive material

a Morse code chart and Magic Slates

Language: magnet, names of the materials, pull, lift, pick up, not pull, heavy, light, how many?, count

long, short, open, close, switch, tap, Morse code, send, signal, buzz, noise, dot, dash

does the magnet pull/lift/pick it up? show me what the magnet can pull. how many paper clips can it lift? how many nails? which is heavier?

make a long signal / a short one. how many long ones do you hear? how many shorts? what letter is it?

Ramps
Prints # 26 - 27

We built a simple inclined plane. The toy school bus at the bottom of the ramp is tied to a string that runs over a pulley at the top and then down to a bucket. As weights are put in the bucket, the bucket sinks, pulling the bus up the ramp.

In Print #27, Gi asks the students to predict how many weights (marbles, popsicle sticks, batteries) will be needed to pull the car up the ramp. They record their prediction on the station-recording sheet (Print #26). The children perform the experiment, count the weights and record the results. They then compare their predictions to the actual result.

The students can alter the angle of the ramp: it has four positions, according to which hole in the upright "standard" the dowel is fit into. This leads to a different set of predictions. Another variable can be introduced by putting sand paper on the ramp to increase the friction. Always, the students are asked to predict a result, and if possible to explain why they think the result will change.

Materials: a wooden ramp with a pulley at one end, and a post or "standard" that can hold it at different angles

toy cars or trucks on one end of a string

a bucket hanging from the other end of the string

weights (marbles, popsicle sticks, batteries, ...)

Language: names of the materials up, to the top, down, pull, more, less, change, raise, lower, higher, heavy, light, heavier, lighter, put in, take out, count, predict, how many?

how many marbles do you think you need to pull the car up to the top? what will happen if you raise/ lower the ramp? will you need more? less? what will happen if you use batteries, not marbles?

The "Make It" Area
Prints # 28 - 31

Two teachers set up a "make it" area for free, unstructured exploration of various materials. The "make it" area is very flexible. It can contain many different materials and activities.

In Print #28, two boys are experimenting with a balance and graduated weights. The balance can also be a stick suspended from the middle with hooks at regular intervals. Children place objects in small buckets hung from these hooks and compare weights and distance from the balance point or fulcrum - - a variation on the seesaw!

The girl in Print #29 is making a clay and toothpick model suggested by the models other children had already made (Print #30). While many children built house-like structures (perhaps following a drawing put out by the teachers), others explored different possibilities. One child modelled a small animal out of clay and put it inside the house. The animal is a triceratops! The child may never have seen a picture of a dinosaur before, but the poster on the wall in Print #31 served as the inspiration for this creation.

The "make it" area holds many possibilities for language development. The children are truly invested in this work, since it follows their own interest and not any sequence that the teacher has determined. An adult observer can comment on the child's work and ask questions that explore the child's intentions and interests.

Materials: clay and toothpicks

balances, scales, objects to weigh

posters, activity sheets with pictures of possible projects

Language: weigh, more, less, balance, how many? how much?, how far? the center, put, bucket

clay, ball, toothpick, sides, roof, wall, animal, inside, outside, square, triange, tell me

which weighs more? less? how many do you need to balance on this side? how much does it weigh? how far is it from the center? what will you put in the bucket now? what do you think will happen?

what are you building? what shape is this? how many clay balls do you need? how many triangles did you make? squares? what is inside the house? outside? tell me about what you are making.

Living Things
Prints # 32 - 33

By December, 1989, the Science Room was beginning to feature living things, such as the hermit crabs among the shells in Print #32 and the plants in the terrarium (Print #33). We were looking for lizards, toads, frogs and snails to add to the terrarium.

While animals require careful attention, they can be fascinating to watch. Children can record what they see in drawing and writing. They can also ask questions about the animals and look for the answers in reference materials. Over time, they may see dramatic changes: a caterpillar becoming a butterfly, or a tadpole turning into a frog. Live animals are best suited to the classroom where the children spend most of their time, so that those significant and exciting moments do not escape notice!

Children may also perform simple experiments with animals such as snails. A terrarium set up with a bright light shining on one end and none at the other allows the children to explore the question: does a snail like light or dark? hot or cold? Students can find out what a snail prefers to eat by putting in different foods. What kind of surface does a snail prefer to crawl on: a smooth one or a rough one? Different materials such as rocks, glass, sandpaper allow the children to investigate this question.

By asking these questions and providing the necessary materials, the teacher structures the children's experience with the animals far more than by simply allowing them to watch and record what they see.

Materials: small animals such as snails, frogs, toads, lizards and salamanders, insects (caterpillars and cocoons included)

soil, rocks, small plants, gravel, charcoal

glass containers (jars, terrarium, etc.)

a resource book such as Small Pets from Woods and Fields by Margaret Waring Buck, Abingdon Press, 1960, gives directions for setting up and caring for terraria/aquaria and the living things in them

Language: names of the animals and materials, see, do, eat, sleep, move, swim, crawl, fly, run, like, fast, slow, hot, cold, big, small, bigger, smaller, grow, born, die, change, same, different what do you see? what is it doing? what does it eat? how does it move? does it like a hot place? a cold place? what happened? what will happen next? is it the same? how does it change?

<u>Wrapup</u>
<u>Print # 34</u>

At the end of the session, the teachers hold a wrapup discussion. Here, Bert is asking the children what happened at the "magic powders" station. While it is impossible to go over everything in the room in five minutes, this is a chance for the children to tell the teachers what they like and to share with each other something they have experienced in common. Some of the wrapup may occur in the native language, with the help of a B.A. or with our teachers' few words of Vietnamese. (We all learned Vietnamese for "fizz", for instance.) An excerpt from a wrapup follows:

Teacher: "Did you enjoy the Science Room?"

Students: "YES!"

T: "Do you want to come back?"

Ss: "YES!"

T: "What did you do here?" (He moves to one station.)

Ss: "Light!"

T: "Yes, you made a light. And what did you do here?"

S: "Egg."

T: "Egg, salt and water. Why is it going up? . . . How about here? What did you do here?"

Ss. "Touch."

T: "What do you use?"

Ss: "Foot."

T: "Where do you put your foot?"

Ss: "Box."

T: "Yes, you put your foot in the box. How about here?"

Ss: "Smell."

T: "Did you like this smell?"

Ss: "NO!"

The wrapup is a good opportunity to reinforce some of the language the children have used during their visit to the Science Room. It also provides the teachers with some feedback about what activities are most popular with a certain age group.

We encouraged the classroom teachers to follow up their visit to the Science Room with a full discussion and Language Experience chart of their experience at the science stations. This kind of discussion can accomplish something impossible in a five-minute wrapup: it can help to solidify the concepts that the students have been working with. Children do not truly grasp a concept until they can talk about it. While our emphasis on teaching a second language precluded full discussion in the native language, our dialogue with the children aimed not only to teach them English, but also to stimulate their concept formation.

CHAPTER 4

PROCESS

The preceding chapter describes a variety of activities going on simultaneously at eleven stations in the Science Room. How relevant is this description to the situations in which most teachers teach and most students learn? After all, very few classroom teachers have a Science Room to take their children to. What options does the teacher have for presenting science in the mainstream or ESL classroom?

Teachers can set up stations in their classrooms. While it is not possible to run ten stations at once, they can have a science table or corner with one or two activities for small groups. The teacher may assign a group to that activity, or children may choose it during choice or free time. If the rest of the class is involved in self-directed work, the teacher may spend some time at the science table talking with the children about their work. An aide or volunteer can play the same role, so essential for developing English skills for ESL students.

Another option is to present a hands-on science activity to the entire class. This chapter will describe an approach to the whole class activity that focusses on the process of discovery and the teaching of English at the same time. This will be done by narrating and analyzing two sample lessons. The first is a lesson taught in a demonstration mode that I observed in 1989. The second is based on a lesson that I taught in the same year using discovery methods. The two are presented together for purposes of comparison, as the comparison illuminates, some of the differences between discovery learning and more traditional approaches.

A Demonstration Lesson

It is nine in the morning, Week 13 of a PREP cycle. The children are working on the ELU (English Language Unit) Shopping this week. Today, during their ELU period, they are going to blow soap bubbles.

What do soap bubbles have to do with shopping? We will use units of liquid and dry measure today that we use in buying and cooking food. We also hope that the experience of making bubbles will stimulate the use of English as children talk with each other and the teacher. Science and math activities in the PREP curriculum teach concepts in the content area and also create opportunities for communication.

Twenty children ages 8 to 11, seated in groups of four at five tables, are watching their teacher, Anna. Anna is holding up cup, pint, quart and gallon containers and asking the children to compare their size. They have worked with these measures before, and she is eliciting comparisons with "more than" and "less than". Standing in front of the class, she pours water between the containers to help the students answer her questions. "How many cups in a pint? How many pints in a quart? What is more, a pint or a quart? Is a cup less than a pint? etc. "

At 9:10, Anna moves to new units, the tablespoon and teaspoon.

The children will be using these to measure out 3 teaspoons of soap powder into their own cups. Anna demonstrates the measuring out of 3 level teaspoons into a cup. One group of four children will use the teaspoon measure, but she has only one. What can the others use?

She holds up a tablespoon. "This is a tablespoon. How many tablespoons is the same as 3 teaspoons?" Standing at the front desk, she measures soap powder between teaspoon and tablespoon. The children tell her that 3 teaspoons is the same as 1 tablespoon. She writes "3 teaspoons = 1 tablespoon" on the board.

Anna now holds up a half-teaspoon measure. "This is half a teaspoon. How many half teaspoons in 3 teaspoons?" The students shout out several answers, including the correct one. By measuring again in front of the class, Anna helps them to answer that 6 half-teaspoons = 3 teaspoons, and she writes this too.

The procedure is repeated for a quarter and a third of a teaspoon. When five ways of measuring out 3 teaspoons have been written on the board, each table of children gets one of the five measures. They also receive straws and scissors. Following Anna's example, they make a bubble blower by cutting slits into one end of the straw and splaying the pieces outward. It is 9:30.

Now Anna asks for her students' attention. She measures out 3 teaspoons of soap powder into her cup and adds one cup of water; stirs it with her straw; and calls one volunteer forward to blow bubbles. They overflow the cup. The children are delighted. Anna writes "3 teaspoons of soap powder + 1 cup of water = bubbles" on the board, then passes out small bags of powder to each table, then a pitcher of water.

Each child makes her/his own bubble mixture. At 9:40, the class goes outside to blow bubbles and to talk about the sizes and colors that they see.

Analysis of the Demonstration Lesson

Many good things are going on in this lesson. The teacher is not just talking about the steps of making bubbles: she is demonstrating them She has the interest of most of the children, who follow what she is doing closely. They answer her questions based on what they see her doing. By bringing only one teaspoon, she brings fractions into the lesson as the students must find equivalents. At the end of the demonstration, each child gets to go through all the steps her/himself. And everyone blows bubbles!

How could this lesson be improved? As a demonstration lesson, it would be more effective if Anna were demonstrating from a table in the center of her students, rather than from the front. She could also call up students to perform the demonstration in front of the class.

And what if the students were given not only a question to answer but the materials with which to find the answer? Given teaspoons and tablespoons, and some sand or soap powder, the children could find out how many teaspoons are in a tablespoon. Different tables could work on different problems. Rather than watching a demonstration, the students could be doing the investigation themselves.

The teacher would then be free to move among them and ask them questions about what they are doing. The children would have the opportunity to talk with each other as well as with the teacher as they work together. We would hear much more student talk and less teacher talk. The teacher could pull the children together after this measuring time to record their results on a language experience chart which would be referred to on later days.

The culmination of the activity would remain the same: the mixing of a bubble mixture and an exit to blow bubbles, followed perhaps by some drawing and writing. The process of getting to that point would be different, richer in exploration and in language. The next section describes a lesson taught by discovery methods.

A Discovery Lesson

Two weeks later, Anna is teaching a lesson on batteries and bulbs to her class. It is nine o'clock. She sits between the front two desks where all the children can see her clearly. She shows and names four objects: a battery, a bulb, a piece of wire, and a flashlight. She turns the flashlight on and off; opens it to show the batteries inside; points out the bulb. Anna then explains that every two students will get one battery, one bulb and one piece of wire, and they will try to make a light. She turns the flashlight on again, points to the light, and repeats that the students will try to make a light with one battery, one bulb, one piece of wire. She writes the words for these materials on chart paper taped to the board.

As Anna passes out the materials to each table of four, she stops to ask how many batteries each table will get. When a student answers, "One", she shakes her head. Another student says "Two". She nods and, as she passes the batteries out, repeats, "One battery for two students". The language is repeated again for bulbs and wire.

The children sit looking at the materials. Anna reminds them to make a light, and some begin to try, tentatively at first. Soon everyone is involved with their partner arranging battery, bulb and wire. The children are talking with each other, mostly in Vietnamese. In a couple of minutes, light bulbs are winking on around the room.

As each team succeeds, Anna greets their success with enthusiasm: "Great! Terrific! You made a light! Good job!" She passes out paper to each team, and asks them to draw their battery, bulb and wire. She draws a sample diagram at the board, erases it, and again asks everyone to draw. The children do.

Anna calls for their attention and explains that she will give every team another piece of wire. They will try to make a light with one battery, one bulb and two pieces of wire. She passes out the wire. In almost no time, the light bulbs are winking again. Anna has the children draw again, and when most of the teams have completed diagrams, she asks them to put down their batteries, bulbs, pencils and paper and to come sit on the mat in front of the board. It is 9:20.

At the board, Anna writes a big "1" on the chart paper below the list of materials.

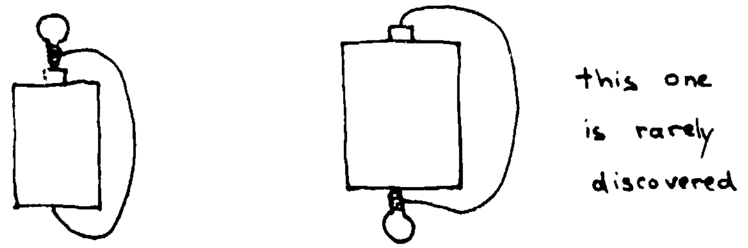
"What did I give you first?" She points to the materials. They name them and she writes the students' responses.

"What did you do with them? What did you make?"

"Light."

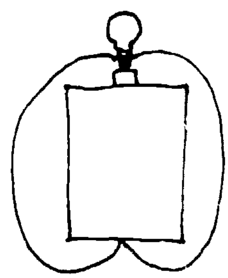
She uses their words in these sentences: "1. One battery, one bulb, one wire. Two students make a light like this:

Figure 1



When Anna writes "2." on the chart and asks, "What did I give you next?", several students can read back and adapt this model, resulting in the following sentences: "2. One battery, one bulb, two wires. Two students make a light like this."

Figure 2



This time Anna calls on a student to draw the diagram on the chart paper.

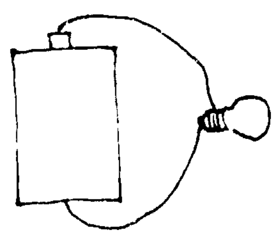
Anna points out that everyone made a light with the bulb touching the battery. She points to the drawings, mimes "touch" with several students. "Very soon you will go back to your desks and you will make a light again. But this time the bulb can not touch the battery." She shows this with battery and bulb, repeats the instructions, and asks the children to go back and work again to make a light. Now it is 9:30.

All of the children make a light again, but none do it without touching bulb to battery. Some almost find the way, but Anna does not show them, just gives them hints when they are very close. Finally, the students are stumped, for while some have arranged the four elements of the circuit in the correct order, none have discovered the difference between the side and the bottom of the bulb.

She quickly puts a circuit together: the bulb lights, and a light goes on in some students' heads! In moments, they are completing a circuit, and Anna moves around commenting on their work and asking them to draw the circuit. She encourages them to try touching the wires to the bulbs in different places until they can predict what will work and what won't. She notices that some tables are sharing their two batteries to make a circuit and talks with these teams about their light

At 9:40, Anna calls the class up front again, and a student writes her classmates' words, copying from the sentences above: "3. One battery, one bulb, two wires. Two students make a light like this:

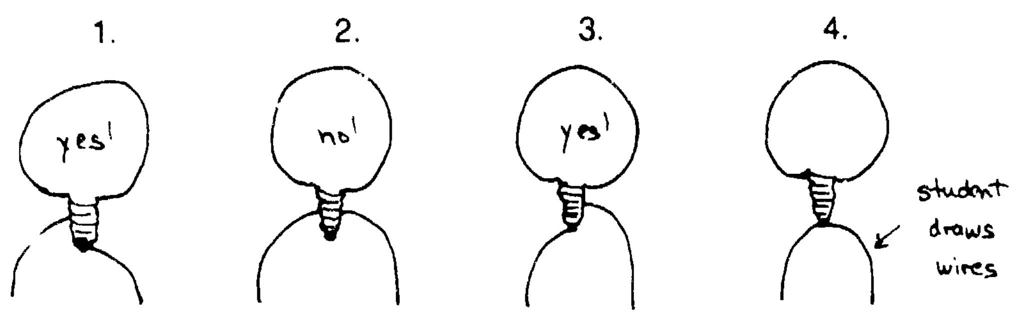
Figure 3



The bulb does not touch the battery." (Anna adds the last sentence.)

Pointing out the <u>side</u> and the <u>bottom</u> of the bulb, she now draws 4 large light bulbs with different wire connections:

Fig. 4

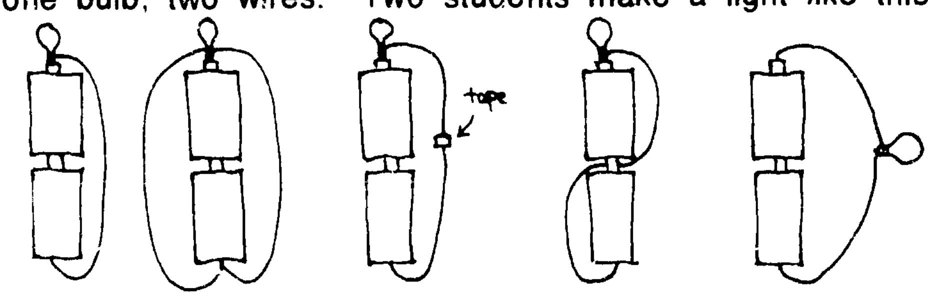


The students are able to answer "yes" or "no" as she draws the first three and asks: "Will this make a light?" She asks a student to draw the fourth combination of wires, and the class answers "No!"

A last set of instructions sends children back to their desks at 9:50 to make a light with two batteries: each team gets one more battery. The children find many different ways of completing a circuit, and Anna again asks them to draw their solutions, then try another way. Some teams are asking for tape to keep their batteries together and to tape the connections together: they are able to leave their desks and the bulbs stay on! One pair finds that they can make a switch by touching the wire to a terminal, then letting it spring back. The children are still going strong one hour after the lesson began.

Anna calls them up again for one last addition to the chart: the students summarize the latest explorations, and one records: "4. Two batteries, one bulb, two wires. Two students make a light like this:

Fig. 5



Anna and the students identify the different parts of these circuits, then she asks: "What kind of light does one battery make?" She and a helper alternate one battery, then two, several times and ask the children to watch the light. She repeats the question.

The students answer, and she writes (adding plurals, articles and verb endings): "5. One battery makes a little light. Two batteries make a big light. Three batteries make a very big light." The children predict this last outcome and confirm their prediction by testing it.

It is 10:10. The lesson has lasted an hour and ten minutes. It will be continued beginning with a rereading of the chart the following day.

Analysis of the Discovery Lesson

In this lesson, investigation and discussion alternate with each other.

During the investigation phase, Anna follows a careful sequence for giving instructions and distributing materials. She has all the materials on hand and knows what to hand out as the lesson progresses. In order to make sure that the students understand the problem set before them, she repeats instructions, checks for comprehension, and uses mime, drawing and writing.

The children quickly become involved in the activity, and with their excitement comes lots of language: in this class, Vietnamese. (If students of different language backgrounds were working together, the children would use more English.) Anna and her aide move through the class, making comments and asking questions in English, suggesting alternatives. encouraging the children, noticing what they are doing. Anna is patient. She allows the students the time to explore different possibilities, some of which are dead ends.

During the activity, Anna asks the students to record in drawings what they are doing. She also pulls them away from doing at regular intervals so that they can talk and write. This discussion period allows teacher and students to consolidate the language that they are using together. As they look at the language experience chart, the students find and repeat patterns, they begin to read the words that they have heard and then to speak them freely.

The discussion also helps the children to form the concept of an electric circuit and to make some hypotheses about the way a light bulb works. When Anna asks them to generalize what they have learned (see Figure 4), they can correctly distinguish the two light bulbs that will light up from those that won't.

Anna establishes a distinct area for discussion, separate from the work area at the tables. By doing this, she removes the temptation to play with the materials during the discussion time. She focusses the children's attention on listening and talking, reading and writing.

This lesson continues for over an hour. The PREP classroom is flexible enough to allow this: by integrating language and literacy into the science activity, the teacher can tie it to the program's overall objectives. If the science topic relates directly to that week's ELU, all the better. However, this is not a precondition of teaching the lesson.

If Anna had needed to break the lesson earlier, she could have done so after either of the first two discussion sessions, at 9:30 or 9:50. The chart remains as a record of what the children have done so far, and when they return to the activity, they will begin by reading and reviewing this record. The Language Experience Chart, shown in its entirety on p. 58, ties one day's activities to the next.

Discovery lessons such as this one can become a powerful vehicle for children communicating with each other and with their teacher. A successful lesson requires good selection and organization of materials, and a structured way of processing the activity.

What are the principles of a discovery lesson? What are the roles of teacher and students? I will end this chapter with a general summary of the key points of the discovery method, distilled from the narration of the light bulb lesson.

The Teacher's Role in a Discovery Lesson

The teacher poses a problem; provides materials; gives instructions; and facilitates the discovery process.

The teacher distributes materials in a set sequence. She controls their distribution carefully, but if students use them in an unforeseen way, she does not necessarily step in to redirect them. The teacher is open to new directions suggested by the students.

The teacher controls the movement, in time and perhaps in space, between activity and discussion. She may move the children, or remove materials, to help the children focus on the discussion.

The teacher provides structure in the room layout: the space for work may not be the same as the space for talking and writing about the activity.

The teacher moves around during the activity. She comments, encourages, asks questions and perhaps suggests new problems (in L2). She also observes quietly what the students are doing and saying.

The teacher directs the discussion time. She listens carefully to what the children say, asks for clarification. elicits more language and makes sure that someone is recording the discussion. She uses this record for followup.

The Students' Role in a Discovery Lesson

The students explore, investigate, experiment with the materials. They work on the problem posed by the teacher and perhaps discover other problems to work on.

The students work together. They talk (usually in L1), help and watch each other.

The students communicate about what they are doing by drawing and writing. They may dictate while the teacher writes, and they may write and draw themselves. The teacher gives students a chance to write in front of the class.

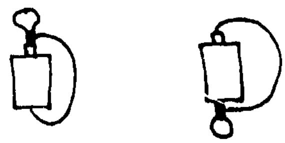
The students read what they have written as they answer the teacher's questions. On another day they may reread the chart on which they have recorded their work. This rereading may be solely for the purpose of review, or it may serve as the departure point for further exploration.

The following page shows the entire chart created during the discovery lesson on batteries and bulbs.

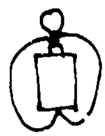
The Language Experience Chart from the Discovery Lesson

A battery, a bulb, a piece of wire, a flashlight.

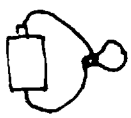
1. One battery, one bulb, one wire. Two students make a light like this:



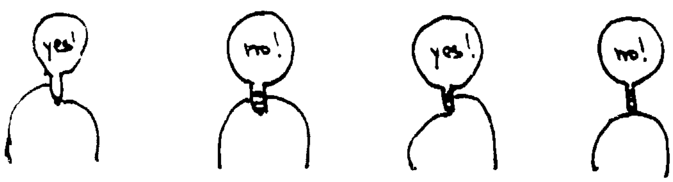
2. One battery, one bulb, two wires. Two students make a light like this.



3. One battery, one bulb, two wires. Two students make a light like this

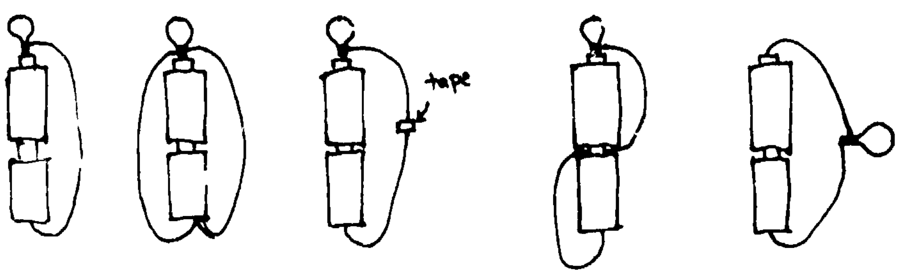


The bulb does not touch the battery.



Will this make a light?

5. Two batteries, one bulb, two wires. Two students make a light like this.



CHAPTER 5

CONCLUSION

This paper has described science activities going on at stations in the PREP Science Room, and a lesson taught to twenty children in their classroom. In both settings, the children are given a problem to work on and the materials to work with; they are allowed to explore the problem themselves. The teachers offer comprehensible input in English and encourage the students to speak, read and write English, either in small groups (as at the stations) or in a larger discussion (as in the classroom). Activity and talk go together.

Is this approach to teaching science and language effective? Based on my observations in both the Science Room and the classroom, I believe that it is. There is no question that the students are actively engaged in this kind of learning. Activity does not necessarily lead to learning, of course. However, I saw children absorbing instructions given to them in English; using that information to explore a problem in a systematic way; making predictions and forming simple scientific concepts; and trying to express their thoughts in English. Their activity was purposeful, directed toward solving a problem and communicating their ideas and needs.

How effective is this approach to teaching science and language? I cannot answer this in quantitative terms. PREP had no testing design comparing the scientific understanding of different groups of children, or evaluating one group for concept and language development before and after their science experiences. We relied on observations of the children's work to judge the success of a lesson. We did not assess the quality of classroom followup, which varied widely from class to class. I base any claims for the value of this approach solely on what I saw and heard happening during the science activities described above.

Can the mainstream or ESL teacher use the discovery approach effectively in classrooms in this country? Yes! The materials are simple and inexpensive. The teacher does not need to have extensive scientific training. She must understand the basics of the discovery approach and have good classroom management skills. She must share her children's curiosity about how the world works. She must enjoy helping children to learn so that she can allow them to explore on their own and, on occasion, to stumble.

PREP was an ideal setting for exploring the teaching of language and science. PREP was conceived as a Whole Language program, rich in a wide variety of language experiences. With the support of our administrators, we had the space, staff and budget available to create the Science Room. Most classroom teachers had Bilingual Aides to work with them as assistant teachers and translators. They had large blocks of flexible time to work with.

The teacher in American schools is likely to work within greater limitations. However, almost any classroom situation holds the potential for exciting learning. Whether at a corner science station, or during a whole class lesson, teachers and students here can enjoy science, and science talk, as much as we did in PREP.

SELECTED BIBLIOGRAPHY

Chamot, Anna Uhl and J. Michael O'Malley. A Cognitive Academic Language Learning Approach: An ESL Content-Based Curriculum. National Clearinghouse for Bilingual Education. Rosslyn, VA. 1986.

Collison, G. Omani. "Concept Formation in a Second Language: A Study of Ghanaian School Children." Harvard Educational Review, Vol. 44, No. 3 (August 1974).

Enright, D. Scott and Mary Lou McCloskey. "Yes, Talking!: Organizing the Classroom to Promote Second Language Acquisition." TESOL Quarterly, Volume 19, #3 (September, 1985).

Lansdown, Brenda. "The Fine Points of the Investigation/Colloquium Method." A paper received from the author. January, 1987.

____. "What Children Learn from the Investigation/Colloquium Method (I-CM)." A paper received from the author. April, 1987.

Lansdown, Brenda, Paul Blackwood and Paul Brandwein. Teaching Elementary Science Through Investigation and Colloquium. New York: Harcourt Brace Jovanovich. 1971.

Tokieda, George Z.. "The Colloquium: Patiently Talking Together." A paper received from the author. No date of publication.

Vygotsky, Lev Semenovich. Thought and Language. trans. Hanfmann and Vakar. Cambridge, Massachusetts: M.I.T. Press. 1962.

APPENDIX I

A LIST OF THE ENGLISH LANGUAGE UNITS

THE ENGLISH LANGUAGE UNITS, WEEKS 1 - 18

Week 1	Personal Information Classroom Safety
Week 2	Body Parts
Week 3	Clothing
Week 4	Family
Week 5	Home
Week 6	Size and Personal Attributes
Week 7	Feelings
Week 8	Health
Week 9	Food and Nutrition
Weeks 10-12	Plants and Animals
Week 13	Shopping
Week 14	Directions Maps and Globes
Week 15	School Locations and People Community Places and People
Week 16	Transportation Telephone Safety
Week 17	Transit
Week 18	Review and Graduation

APPENDIX II

COLOR PRINTS OF THE PREP SCIENCE ROOM