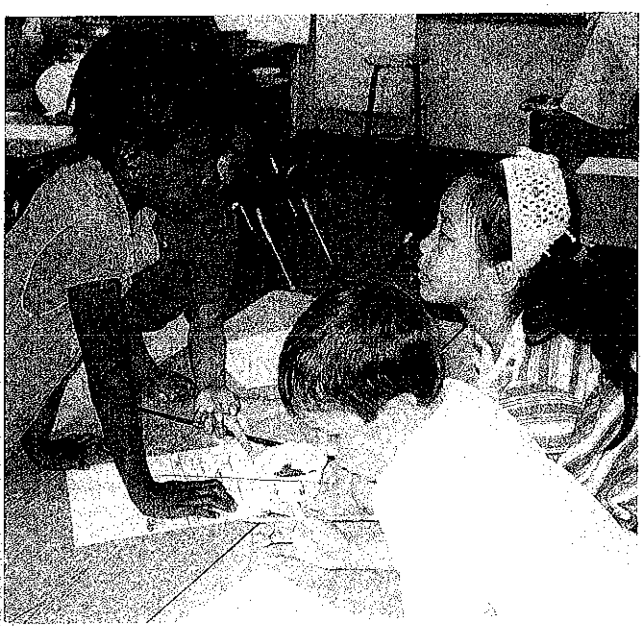
Documenting Early Science Learning

Jacqueline Jones and Rosalea Courtney

Young children are fascinated by the natural world. They explore how things work, wonder what is and is not alive, and think about why some things change their shape and form. Science explorations such as planting seeds, studying animals, and baking bread are a natural part of early childhood classrooms and can provide the settings in which teachers can observe how children are making sense of the world around them. The real evidence of children's early science understanding comes directly from these everyday experiences.

Records of children's conversations, anecdotal notes and photographs of their actions, and samples of their drawings and constructions all form the classroom-based data that helps teachers learn how children are thinking about the natural world. The documentation process itself helps teachers gain a deeper understanding of individual children in the class *and* enhances general knowledge of how young children make sense of the world. Finally, by engaging in the documentation/assessment process of collecting, describing, and interpreting evidence of young children's emerging science understandings, early childhood educators are able to provide more appropriate science-related experiences and learning environments.



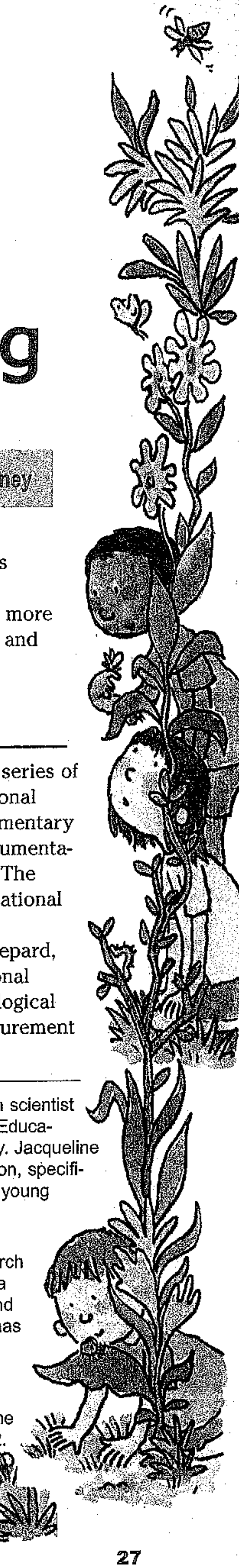
Guiding principles

Three principles developed through a series of ongoing collaborations between educational researchers and preschool and early elementary teachers guide the classroom-based documentation process (Chittenden & Jones 1998). The principles reflect sound practice in educational measurement across the developmental continuum and across content areas (Shepard, Kagan, & Wurtz 1998; American Educational Research Association, American Psychological Association, & National Council on Measurement in Education 1999). .

Jacqueline Jones, Ph.D., is a senior research scientist in the Research and Development Division at Educational Testing Service in Princeton, New Jersey. Jacqueline studies assessment in early childhood education, specifically classroom-based strategies to document young children's science and literacy learning.

Rosalea Courtney, M.A., is a senior research associate in the Teaching and Learning Research Center at Educational Testing Service. Rosalea has been involved in a number of preschool and elementary education research projects. She has worked closely with teachers to investigate ways to document and assess children's science and literacy learning.

This material is based on work supported by the National Science Foundation,Grant No. 9731282.

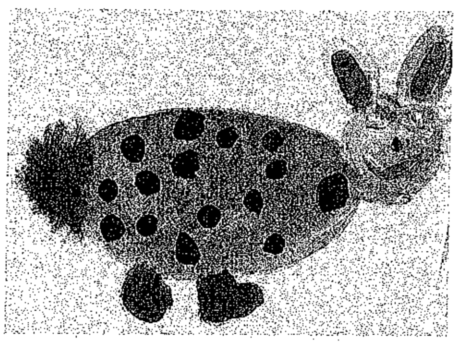


> The real evidence of children's early science understanding comes directly from everyday experiences.

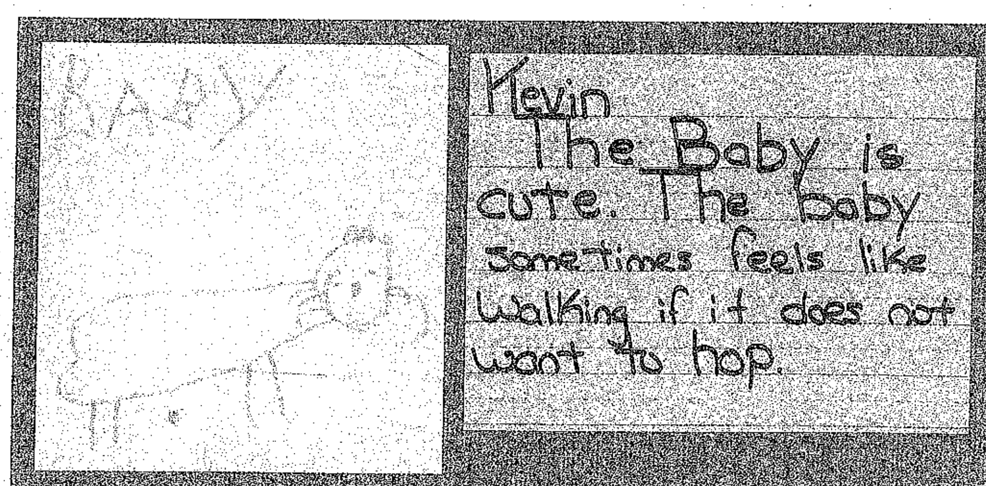
1. Collect a variety of forms of evidence

It is important to collect a variety of records because children vary in how they convey their ideas. Some children demonstrate their understanding through constructions or drawings while others are more comfortable talking about what they see or think. Educators can learn a great deal about children's thinking by listening carefully to their language *and* looking at samples of their work. Examples of various forms of evidence that are a part of most early childhood classrooms include the following:

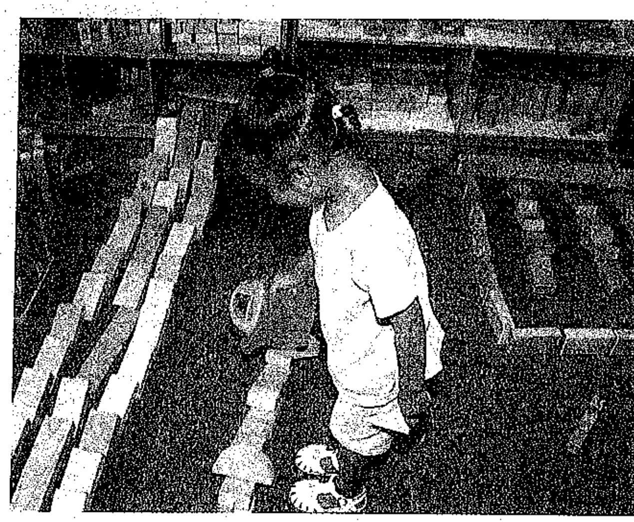
A drawing—A preschool child's observations of the spots on the class rabbit, the shape of its ears, and its bushy tail can be seen in her drawing.



Drawing and dictation—Drawings alone may not always reflect a young child's ideas and perceptions. The child's thinking about the rabbit (named Baby) is more visible when the child's dictated comments are added to the drawing.



Photographs—Images of children at play can reveal their emerging science thinking. After a preschool class had finished shucking corn, the teacher photographed this child's spontaneous construction of a "corn garden" in the block area. She pretends to water the garden.



© Rick Toone, ETS

A record of children's language—Making records of children's conversations can reveal children's emerging ideas (see "How Does the Moon Change?" on p. 29). Collecting children's language works best when teachers use open-ended questions that invite the children's participation. Questions such as What have you noticed about . . . ? or What might happen if . . . ? or What are some things you know about . . . ? imply no single best answer. Instead, they encourage children to respond from their own observations, experiences, or conjectures.

2. Collect the forms of evidence over a period of time

Classroom-based evidence should be collected over a period of time because young children's learning is not linear. Rather, it is episodic and based on individual experiences. Any single piece of evidence captures just one moment in time when a child may be struggling with an idea or question. A teacher who collects evidence over a period of time can see the evolution of an idea or concept. For example, a review of entries in children's science journals over several weeks can reveal the development of more focused and detailed observations.

How Does the Moon Change?

Grade K/1 conversation

Gale: The moon doesn't really get smaller and smaller. It just changes its shape.

Tommy: It DOES get smaller and smaller. That's the only way it can change its shape.

James: It gets smaller and it goes behind the clouds and changes its shape, or there's another moon that's another shape.

David: Everyone thinks the moon is low but it really is high but it gets lower one day at a time.

Gale: Sometimes when you're walking at night, it looks like it's following you but that's because you're moving.

Steven: If you're walking, the moon is walking with you.

David: It seems like the moon is moving when you're walking because the whole world is moving slowly and the moon is moving too.

Steven: When you're driving in a car, everyone's going slowly but the moon is going fast.

Sam: When you're riding in a car, the moon is following the car. The car is fast and the moon is too.

Jada: Every car has a thin string that pulls the moon.

Children's understandings of big ideas such as life processes and changes in matter are not established firmly with one experience. Children need time to return to these ideas and concepts, to ask new questions, and to fit new learning into established ideas. The evidence of young children's learning is most useful when it is viewed over a period of weeks or months.

For example, some children in a first-grade classroom observed the life cycle of silkworms from eggs to adult moths over several weeks. The children wrote their observations in their science journals (see "Life Cycle of Silkworms: Science Journal Entries" on p. 30). In one child's journal, a number of entries describe the silkworms' size and color: "They are brown when they are little and they are green and brown when they are big." She also notes differences between the newly hatched caterpillars and human babies: "The little ones that just hatched is not moving like us when we were babies. We did not know how to do anything like them." In a later entry she writes about how the silkworm caterpillars are dependent upon humans to find food for them: "They don't live in trees. They don't live in the ground like the other worms. They don't live by themselves. You have to take care of them."

© Rick Toone, ETS

3. Collect evidence on the understanding of groups of children as well as individuals

Science is an inherently social activity, and children should be encouraged to discuss their ideas with one another. Collecting evidence of group learning helps the teacher to get the bigger picture of what the class as a whole is questioning or coming to understand about a concept. In addition, group evidence can give the teacher a better sense of what children bring to a topic, what they share, and where there are experiential differences. When evidence is collected for groups of children, patterns in thinking become apparent. For example, group conversations at the beginning of a unit can identify prior knowledge and can highlight misconceptions that are shared.

In one case, a kindergarten class had been observing caterpillars as part of their study of the life cycle of butterflies. During circle time, the teacher asked the class,

Life Cycle of Silkworms: Science Journal Entries

4/10: They are brown when they are little and they are green and brown when they are big.

4/18: Their whole body looks like a elephant's trunk.

4/25: The little ones that just hatched is not moving like us when we were babies.

4/26: Their heads is fatter than their body. And their heads are white and their body is brown.

5/1: Now they are growing and changing colors. When they are babies, they were brown, but now they are white.

5/2: You have to take care of them. You have to give them some leaves. One is eating and Tyler is right. They do start by eating from the edge.

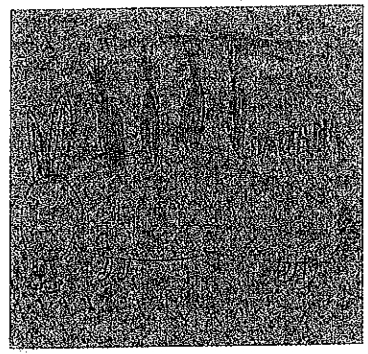
5/4: Now they are growing and they are learning how to eat fast. But when they were babies, they eat slow, but they are not little any more so now they eat faster. They were very hungry and my big fat one is eating fast just the way I said . . .

5/10: I have a question. What's the black stuff on top of their face?

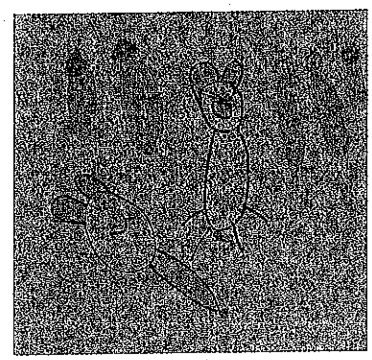
5/11: One of my silkworms were making silk and I thought it was shedding skin, but it was not shedding skin. It was making silk.

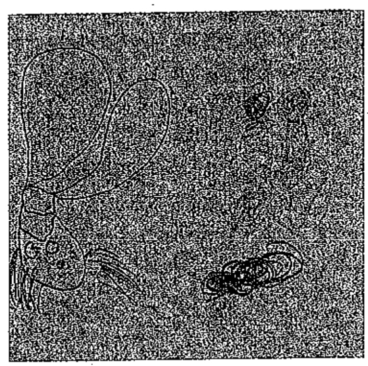
5/19: When I cleaned out my container and gave my silkworms some leaves . . . some of them have to share and they was fighting together and then was eating and one silkworm eat a whole leaf. And he still eating another leaf. He was really hungry.

"What do you think is happening to these caterpillars?" Each child had an opportunity to respond to the question. The teacher wrote out each child's statement, producing a record of the class discussion. (See "What's Happening to These Caterpillars?")



In another example, preschool children made this collection of drawings when a rabbit was brought to class. Although there were no carrots in the classroom during this visit, each of these drawings shows the class rabbit with the food. The association between rabbits and carrots appeared to be shared by many of the children.





What's Happening to These Caterpillars?

Jason: They don't look like caterpillars. They look like celery 'cause they are green.

Gabrielle: Two of them are starting to change into cocoons. They look like celery. One of the caterpillars is moving.

Morris: One is already in a cocoon. Four are still caterpillars. One is not moving so it's a cocoon. Cocoons can't move.

Sam: I see one moving.

Jaella: One has something sticking out.

Kiri: Two look like trees. Some stuff is sticking out of the body.

Tom: One looks like a leaf. One is all squished up.

Zack: Two don't look the same. One looks like it has bumps on the side.

Jason: They don't look like themselves so they must be cocoons. They're not long like the others.

The documentation and assessment process

With the guiding principles as a foundation, documentation and assessment of young children's emerging science understandings consist of a five-stage cycle of identifying, collecting, describing, interpreting, and applying the classroom-based evidence in order to plan more appropriate experiences and environments.

◦ Identify appropriate science-related goals and concepts, activities and experiences, and classroom settings.

It is important to have some agreed-upon notion of what we as educators want children to experience, explore, and understand. In addition to specific curriculum goals, teachers who participated in this documentation process often used the *Benchmarks for Science Literacy* (American Association for the Advancement of Science 1993) or the *National Science Education Standards* (National Research Council 1996) to guide their expectations for young children. These documents were especially useful in providing a focus for collecting those samples of children's work that highlight specific science goals.

◦ Collect evidence of children's learning, including records of children's conversations and children's work samples.

Records of children's conversations and their work samples can take a variety of forms, including whole-class discussions, individual interviews, drawings, constructions, and diagrams. Consider which forms of evidence will give the best indication of how children are coming to understand the selected science goals and concepts. For example, many teachers have found that asking a child to dictate a description of his drawing and attaching the child's comments to the drawing can provide more information about the child's understanding than the drawing alone.

◦ Describe evidence of children's learning without judgment and discuss it with colleagues.

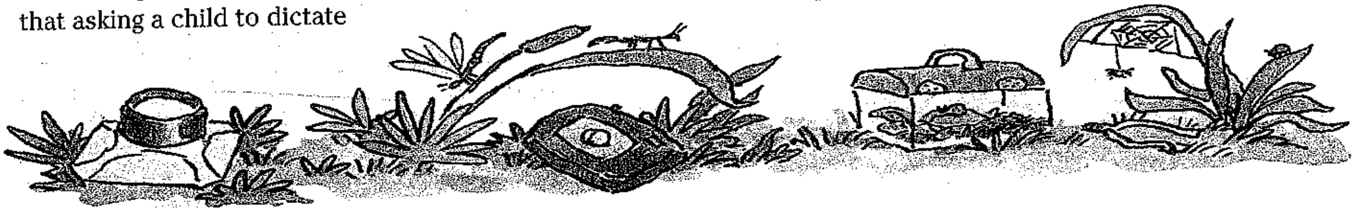
The first step in understanding what children are learning is to take a close look at what is actually in their language records, drawings, and constructions before reaching a conclusion (Himley & Carini 2000). Description is a skill that takes some practice. It may be easier to see what is missing or incorrect in children's statements or work samples than it is to focus on the knowledge that is represented. Working with colleagues on a careful description of children's work samples and records of their language can provide new and useful insights into children's learning (see "Steps in Guiding a Discussion of Children's Language Records"). Another teacher, or a parent, can bring a new perspective, often seeing things in the work that the child's teacher may miss.

Steps in Guiding a Discussion of Children's Language Records

1. The teacher presenting the language records provides contextual information for the group: the science-related goal(s), science topic, classroom setting and activity, and specific prompt (question or set of directions).
2. Colleagues read the language record silently, or participants take turns reading a line of the record aloud.
3. The presenting teacher and colleagues discuss the record using descriptive statements *only*.
4. The group summarizes the descriptive statements.
5. Colleagues ask any additional questions related to the context, the child, or the record for clarification.
6. The group identifies how statements and questions in the language record reflect the science learning goals for the class.

◦ Interpret evidence of individual and group understanding by connecting to learning goals and identifying patterns of learning.

At this stage the children's work should be compared to the standards and goals identified by the teacher at the start of the cycle (Stearns & Courtney 2000). Does the work demonstrate the intended goals, such as observation or prediction? Are some additional types of work samples needed to demonstrate understanding? Are patterns of understanding emerging for the whole class? For example, if the teacher wants the children to observe living things in the classroom—noting changes that take place over time—and



Group evidence can give the teacher a better sense of what the children bring to a topic, what they share, and where there are experiential differences.

to ask questions about their observations, then journal entries can be used as evidence that these goals have been met.

- **Apply new information and understanding to improve instruction and curriculum and future assessment.**

The major purpose of assessment is to inform instructional practice. Therefore, the information from the documentation and assessment process must be tied directly to new planning. The process begins anew as the teacher uses information and insights gained from the process to identify the next set of the science-related goals and experiences. The cycle continues with children's emerging science understandings being nurtured and documented in the everyday life of an early childhood classroom. Teachers have found this process valuable for understanding the learning of individuals and groups, for guiding instruction, and for reporting to parents.

References

American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy.* New York: Oxford University Press.

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. 1999. *Standards for educational and psychological testing.* Washington, DC: American Educational Research Association.

Chittenden, E., & J. Jones. 1998. Science assessment in early childhood programs. In *Dialogue on early childhood science, mathematics, and technology education.* Washington, DC: American Association for the Advancement of Science.

Himley, M., & P.F. Carini, eds. 2000. *From another angle: Children's strengths and school standards. The Prospect Center's descriptive review of the child.* New York: Teachers College Press.

National Research Council. 1996. *National science education standards: Observe, interact, change, learn.* Washington, DC: National Academy Press.

Shepard, L., S.L. Kagan, & E. Wurtz. 1998. *Principles and recommendations for early childhood assessments.* Washington: National Education Goals Panel.

Stearns, C., & R. Courtney. 2000. Designing assessment with the standards. *Science and Children* 37 (4): 51–55, 65.

National Science Education Standards

Excerpt from Content Standards: K-4 (http://www.nap.edu/html/nses/html/6c.html)

Science as Inquiry

Content Standard A: As a result of activities in grades K-4, all students should develop

abilities necessary to do scientific inquiry.

Ask a question about objects, organisms, and events in the environment.

This aspect of the standard emphasizes students asking questions that they can answer with scientific knowledge, combined with their own observations. Students should answer their questions by seeking information from reliable sources of scientific information and from their own observations and investigations.

Plan and conduct a simple investigation.

In the earliest years, investigations are largely based on systematic observations. As students develop, they may design and conduct simple experiments to answer questions. The idea of a fair test is possible for many students to consider by fourth grade.

Employ simple equipment and tools to gather data and extend the senses.

In early years, students develop simple skills, such as how to observe, measure, cut, connect, switch, turn on and off, pour, hold, tie, and hook. Beginning with simple instruments, students can use rulers to measure the length, height, and depth of objects and materials; thermometers to measure temperature; watches to measure time; beam balances and spring scales to measure weight and force; magnifiers to observe objects and organisms; and microscopes to observe the finer details of plants, animals, rocks, and other materials. Children also develop skills in the use of computers and calculators for conducting investigations.

Use data to construct a reasonable explanation.

This aspect of the standard emphasizes the students' thinking as they use data to formulate explanations. Even at the earliest grade levels, students should learn what constitutes evidence and judge the merits or strength of the data and information that will be used to make explanations. After students propose an explanation, they will appeal to the knowledge and evidence they obtained to support their explanations. Students should check their explanations against scientific knowledge, experiences, and observations of others.

Communicate investigations and explanations

Students should begin developing the abilities to communicate, critique, and analyze their work and the work of other students. This communication might be spoken or drawn as well as written.

You can read all of the National Science Education Standards online at **http://www.nap.edu/html/nses/html**