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Science Journals in the Preschool Classroom

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Abstract We believe that science journals can be used in the preschool classroom as tools for supporting and assessing children's learning of science- and literacy-relevant content and procedures. To support this argument, we review changes in attitudes about the cognitive competencies of preschoolers and in teaching and learning expectations for early childhood education. We describe practical aspects of using science notebooks with this age group and discuss specific ways that journals support children's learning. Finally, the role of journals in assessment is discussed.

Keywords Science journals · Science notebooks · Preschool science · Preschool literacy · Preschool assessment

Student science journals provide opportunities for learners to solidify understandings (Shepardson 1997) and provide teachers with insight into children's conceptual understandings (Doris 1991; White and Gunstone 1992). Despite these benefits, journals in elementary classrooms are more likely to be part of language arts than science activities (Shepardson 1997). We expect, however, that science journal use will increase in coming years for a number of reasons. First, the National Science Education Standards (NSES), published in 1997, indicate that students should engage in oral and written discourse around science activities. Journals meet this need because they require students to communicate their understandings about science and to revisit these ideas while choosing which aspects of an experience to represent. Second, journals function as an assessment tool by providing teachers with critical information about how individual children conceptualize a particular science experience and interpret it within the context of other knowledge and experiences they bring to the learning situation (Shepardson and Britsch 2001). In addition to being consistent with the NSES, the advantages of science journals in elementary classrooms have become a focus of educational research (e.g., Shepardson 1997; Shepardson and Britsch 2001).

We believe that the benefits of science journals, for both learners and teachers, can be reaped in the preschool classroom as well. This idea would have been quite radical as recently as a decade ago. At that time science education did not exist in most preschools (Bowman 1999; Johnson 1999; National Research Council 2001). It is likely that this dearth resulted from concerns about whether it is reasonable or appropriate to include science in the preschool curriculum. Science is an abstract, theory-laden discipline and, as such, is difficult for many older children and adults, much less preschoolers (Bowman 1999; Johnson 1999). Views of the cognitive capabilities of the preschool mind as prelogical or preoperational seem incompatible with formal science. Further, science classrooms often have been teacher-centered with the instructor as authority, presenting science facts to students for memorization. This type of teaching is not optimal for preschool learners, except when content can only be learned through rote

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memorization (Golbeck 2001). This apparent mismatch between science as it was traditionally taught and what we know about how most preschoolers *should* be taught has led many to dismiss science as an appropriate part of preschool education (Johnson 1999).

Recent developmental and educational research suggests that this dismissal is based on false premises. Current research tells us that preschoolers are capable of more advanced thinking than was previously believed. The authors of the National Research Council's *Eager to Learn* volume (2001) note that young children know a great deal about specific scientific topics such as the differences between the insides and outsides of various objects, cause and effect relationships, and differences in the movement of animate and inanimate objects and the ways they change over time. Further, science educators at all grade levels are moving away from didactic methods towards inquiry-based teaching in which children are intimately involved with exploring scientific topics and phenomena. Certainly, active exploration is a teaching and learning strategy that is effective in the preschool classroom. These changes in attitudes about the capabilities of preschoolers and about the most appropriate way to teach and learn science make preschool science education seem not only reasonable and appropriate, but optimal.

In response to these shifts in thinking, most states have published preschool teaching and learning expectations. Although these guidelines vary quite a bit from state to state, each list identifies science ideas and processes that children should be exposed to and information they should learn before they enter formal schooling. Because the NSES outlines the learning benefits of expressing understandings through writing and drawing, we wondered whether this suggestion was made for preschoolers as well. To find out, we undertook an informal inventory of available state publications (downloaded in 2007) to determine whether they identify science journals as a tool for children's learning. We found that although about a third of the state lists surveyed suggest that children should have the opportunity to record observations or represent data, very few mention the use of science journals specifically. We believe that is an oversight that should be remedied, as there is no reason that the learning and assessment benefits identified for older learners cannot be realized for younger learners as well.

In this article, we argue that science notebooks can be used effectively in the preschool classroom as tools for supporting and assessing children's learning of science- and literacy-relevant content and procedures. In what follows, we describe practical aspects of using science journals with preschoolers derived from our own and our colleagues' experiences. We then discuss specific ways that journals support children's learning. Finally, we describe the role of journals in various kinds of assessment.

Practical Issues with Science Journals

As a teacher (IL) and a developmental researcher (KB), we have introduced and used journals with a wide demographic range of learners. Some children attend university-sponsored preschools. Others live in inner cities and attend schools subsidized by state funds. Many children are learning English as their second language. We have introduced journals to children as young as three, although we are more likely to do so with 4- and 5-year-olds.

We provide children with individual notebooks, and they decorate the covers as they wish, making the journal personal. The science notebooks are introduced to each child as a way to create their own representations of what was discussed during class meetings instead of focusing on the teacher's representation or the ideas of other children. We specify that these are science notebooks for recording or drawing observations (a word and process which is introduced and practiced before journals are introduced), and we employ a variety of techniques to emphasize the function of the journals as tools for recording observations. Extra paper is available when children decide that they would rather generate a creative drawing than a recording of an object or event that they have observed directly. When the inevitable multi-colored pumpkins are drawn, we ask, "Is that the pumpkin you *observed* or the one you *created/imagined*?" We then ask children to draw another pumpkin-the one they observed-to reinforce the function of the science journal as a tool for a specific purpose. Although one could focus children's efforts by reducing the number of crayons or pencils available, we generally allow children a full range of color options but might ask, as an inappropriate colored crayon is chosen, "Hmmmm…Let's look at that pumpkin again. What color did you say it was? Orange?" This indirect approach (as opposed to "You need to use orange") usually concentrates the child's attention and leads to the choice of a different (appropriate) color. We also give children a specific goal whenever they use the journals-to record their observations of an apple, to draw the inside of a pumpkin, to record the two plants we observed-in an effort to keep the focus on the item(s) or events to be recorded. Focused observation prompts have been shown to be useful for encouraging some young children to draw more realistically (Vlach and Carver 2007; see also Sutton and Rose 1998 for discussion of age-related differences). Some hypothesize that becoming better able to do so relates to the development of attentional strategies (Sutton and Rose 1998), a process that

could be supported by using science journals as records of observations.

Because scientists date their work, we ask children to do the same, using date stamps (Gelman and Brenneman 2004; Gelman et al. submitted). At first, many children use these new tools to decorate their journals' pages by stamping multiple times and sometimes making designs. As the novelty wears off, most come to stamp one date per page. This change could also reflect growing awareness of the meaning of the date stamp. Some of our students have shown this awareness when they match the date in their journals to the date shown on the classroom calendar. Dating work is especially useful when science explorations extend over time. As children record the same item or scene over days or weeks, for example a growing sunflower, the changes in the date and the size of the flower mutually reinforce the idea that growth happens gradually over time.

Because most preschoolers do not yet write, children's ideas and observations are communicated through drawing rather than sentences (although letters and numbers often are incorporated as well). Adults can dictate children's descriptions of their drawings, by asking, "May I write something about your journal entry?" or a similar question. They can also probe children's understandings by asking them to, e.g., "Tell me about what you drew here," while indicating specific parts of the entry (Gelman et al. submitted). Such a conversation also obviates the need for teachers to interpret (or misinterpret) the meaning of a drawn product alone (see White and Gunstone 1992). Of course, these teacher–student interactions take real time, something that is at a premium for teachers. The benefits, however, are many.

Discussing the child's drawing and the representational choices he or she made is an opportunity for the teacher to assist the child in deepening understandings through conversation. Many of the roles of an effective teacher (Karen Worth in NRC 2005) are fulfilled as teachers and children interact over a journal entry. As children journal, the teacher observes, asking questions and commenting in ways that acknowledge children's work and thinking while offering the opportunity to extend that thinking or intervene when children demonstrate misconceptions. At the same time, the entries and discussion about them provides teachers with opportunities to deepen their understanding of the child's thinking and skills, not just about science themes and processes but about literacy, math, and so on. From a Vygotskian perspective, teachers model the sorts of questions children might ask themselves as they record observations, providing a scaffold for children's learning. Eventually children could internalize these procedures to self-guide questioning and improving their own efforts. Children certainly can and do use their journals without direct intervention from adults when these are made available throughout the day. Having the journals accessible allows children to record objects and events of interest to them and to "re-read" their entries during free-choice time.

About Science

Journals provide a *motivation* for children to observe carefully. There is a purpose to observing details because these will be incorporated into a drawing and description. Although drawing skill can limit the particular details children can represent clearly, subsequent discussion provides an opportunity for them to describe their observations. When they record, children choose among many possible features to represent. The actual features included in the drawing provide a window onto children's conceptual understandings. For example, even when children are observing and documenting the outside of a fruit, a number of them will include seeds in their pictures or even draw the seeds, then color over them to represent that they are under the flesh and skin of the fruit. Figure 1 is an example of this phenomenon. That children draw what they know to be true rather than what they see at the present moment is a phenomenon that has been described in the drawing development literature (e.g., Freeman 1980).

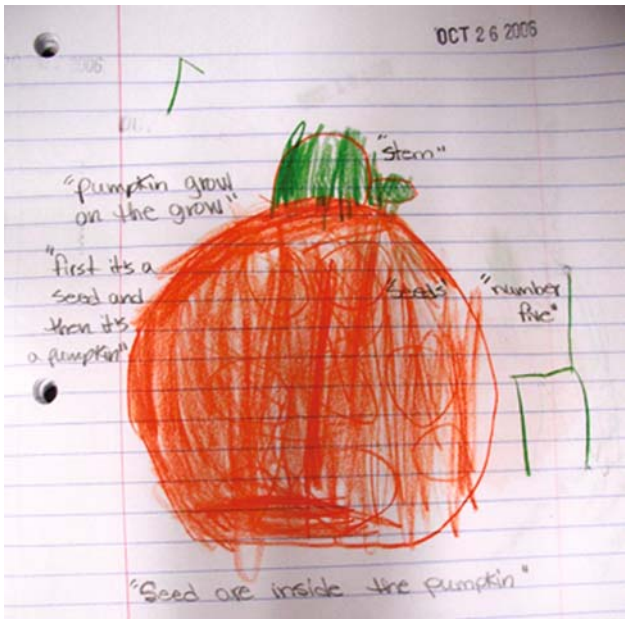

Fig. 1 Before coloring her pumpkin orange, this child (age 4;10) drew circular seeds inside the pumpkin outline. The teacher's aide in the class included quotes of the child's description of her entry, "Seed(s) are inside the pumpkin." The entry also includes the child's description of where ("in the grow/ground") and how a pumpkin grows ("first it's a seed and then it's a pumpkin")

Studies of children's science drawings in primary grades similarly indicate that a fair number draw a stem on an elm leaf, even when the model has no stem (Symington et al. 1981). Although intellectual realism (drawing what you know rather than what you observe) was traditionally considered an immature representational strategy compared to visual realism (drawing what you see), most researchers now view the two representational modes as reflecting different strategies that children employ when asked to represent a 3-dimensional object or display (reviewed in Sutton and Rose 1998).

As teacher–researchers, we can support children's attention to key features, and enhance the representational power of their drawings, by constraining the task in certain ways. We have found that if we ask children to represent the results of a growth experiment by drawing *both* a healthy plant and an unhealthy plant, their drawings tend to represent key features, such as color, stem shape (droopy or straight), leaf size, and number of leaves, because these contrasts are relevant to plants' health. Figure 2 provides an example of a child's drawing of two plants—one that had grown in sunlight and one that had not. The power of contrast to move young children towards more realistic drawings has been noted in the drawing literature as well (e.g., Davis and Bentley 1984).

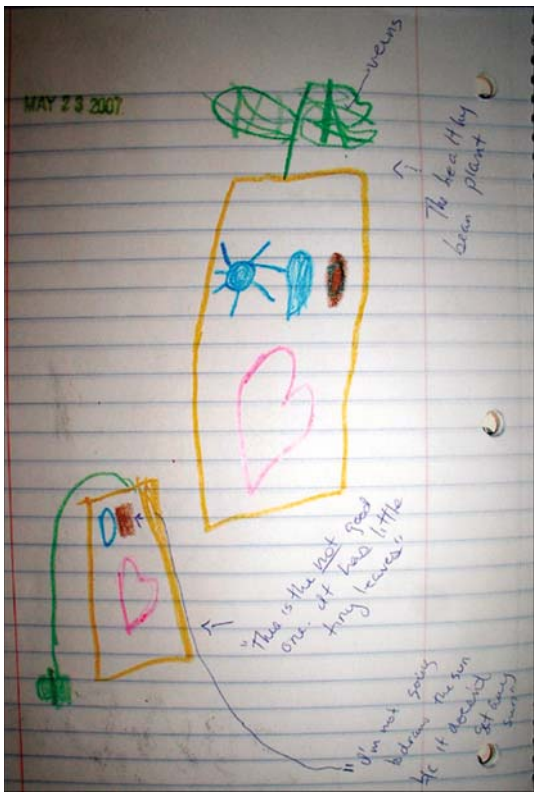

Fig. 2 After an experiment to explore the factors that affect bean plant growth, children recorded the results in their science journals. This child (age 4;11) faithfully drew the plants-including the symbols that indicated whether the plant received sun, water, soil, and/or love. She described the top plant as "healthy" and the bottom bean as the "not good one." She clearly understood the symbols used to label the experimental conditions stating, "I'm not going to draw the sun because it doesn't get any sun"

We have found that providing a communicative context also highlights the importance of accurate representations for learners (but see Light and Simmons 1983). When we asked preschoolers to draw an observed apple, few (3/10) represented color appropriately. This changed when the same children recorded their favorite apple (red delicious, yellow delicious, or Granny Smith) so that their parents would know which kind to buy. Under this instruction, more children (6/9) accurately represented color. That children accurately record color when the communicative power of this feature is implicitly highlighted fits with studies of early writing. A number of authors (e.g., Ferreiro and Teberosky 1982; Levin and Tolchinsky Landsmann 1989) note that preschoolers will "write" the name for an object with a typical color using a crayon or pen that matches (e.g., choosing a red pen to write "tomato"). This is often taken as evidence that children are confusing writing and drawing, but it seems possible that some children could be attempting to bolster the communicative power of their "writing," especially if they know that they cannot spell a word correctly (Brenneman et al. 1996).

Science journals support observation skills and provide insight into the features of an object or event that children have observed and chosen (implicitly or explicitly) to represent. Science journals also support content learning because they provide a chance for learners to revisit a science experience and to think about it again as they record what they see and know. We believe that deeper, more durable learning occurs when we augment hands-on learning experiences with opportunities to further process new knowledge by, for example, applying it to a related problem, making a graph, or creating a journal entry (see also Massey 2004).

Other Curricular Areas

In addition to supporting young children's developing knowledge of science processes and content, journaling supports emerging language and literacy skills. As children describe their entries, they have the opportunity to practice new vocabulary in context. This can happen when a teacher uses a new word to describe the characteristics of a drawn object or when children do so themselves (e.g., the use of yucky, squishy, brown, green, black seeds, and soft like hair in Fig. 3). Talking about observations and drawings of objects and events requires descriptive language, something that is especially critical for students who are English language learners. Students who are acquiring English as a

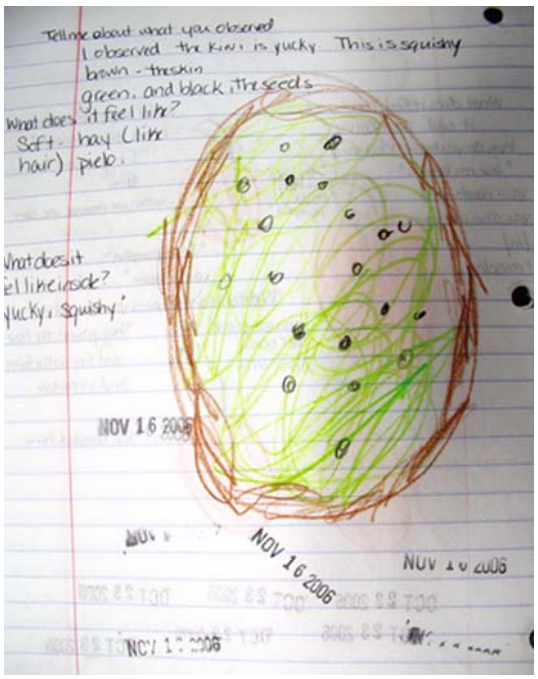

Fig. 3 This journal entry of the inside of a kiwi illustrates attention to detail and the use of descriptive language to label observations. It was produced by a child whose age was 4 years, 10 months

second language benefit from being exposed to descriptive language in meaningful contexts. English language learners begin to make connections between words in their home language and words in the English language, then they are able to use both languages to communicate until they become comfortable and fluent in English. As children become more adept at recording, they will include more detail and will have more to talk about. It is also possible that as they become more familiar with science processes and specific content, that they will use not only more sentences, but more grammatically complex ones. (See also Gelman et al. 2002, for examples from much older students.) Although we do not expect all preschoolers to use complex sentence structures, discussing science content and processes generally, and specifically over their journals entries, provides opportunities to go beyond simple sentences to compare and contrast and to describe causes and effects. The following are statements children made as they discussed journal entries contrasting beans that were planted under varied conditions (with and without water and sunlight). Some comments were specifically about the plants in the journal entry, and others included information learned throughout the planting unit. Note the use of if-then and because statements as well as comparative language:

> "Um, this one (unhealthy plant) is more droopy than the other, but this one (healthy plant) looks very happy. If you stand it up (unhealthy), it will be really, really tall, but if you walk away from it, it will be down, down, down."

> "Well, I think that one (unhealthy), that one on the bottom, isn't growing that good. Because, I think, because it's not really good because it is trying to grow, but it can't because it's missing two things. They are missing the water and the sun."

> Child: Some of the plants (unhealthy) are droopy.
> Adult: They are droopy because they don't have what they need to grow…Can they survive just on love?
> Child: No, they need water and dirt so they can grow.

> "They (healthy plant) have more leaves then the other ones, and they have everything they needed."

Like journals designed for other curricular purposes, science journals encourage emerging literacy skills. By the time they are 4 or 5, most children are aware that written print functions as a referential-communicative tool that differs from drawing (Brenneman, et al. 1996; Tolchinsky Landsmann and Karmiloff-Smith 1992). Seeing adults write as they describe their journal entries serves to reinforce children's understandings that drawing represents visual features of objects whereas writing represents words or speech. What children this age are still working out, however, are the correspondences between specific printed letters and spoken sounds (in English and other phonetic languages). As teachers label children's drawings, they can help children practice sounding out and labeling the letters that should be written to spell particular words. With older children, especially, we find that many like to use invented spelling or ask for help with conventional spellings so that they can label their drawings themselves. Figure 4 provides an example of a child using appropriate letters to label a journal entry. The experiment she was recording involved finding out whether apples turned brown when placed in different liquids, including plain water, lemon water, vinegar water, and salt water.

Some journaling activities also support mathematical thinking. When, for example, five seeds are found inside an apple, children have the opportunity to accurately represent this aspect of their observation, and many do so. Similarly, after an activity that involved weighing three pumpkins, many children accurately represented size differences. In addition to recording quantifiable aspects of a collection of items, children sometimes attach verbal or numerical descriptions to them. In the pumpkin activity, many children described them as small, medium, and large, and some attempted to write the cardinal values for the weights (in pounds).

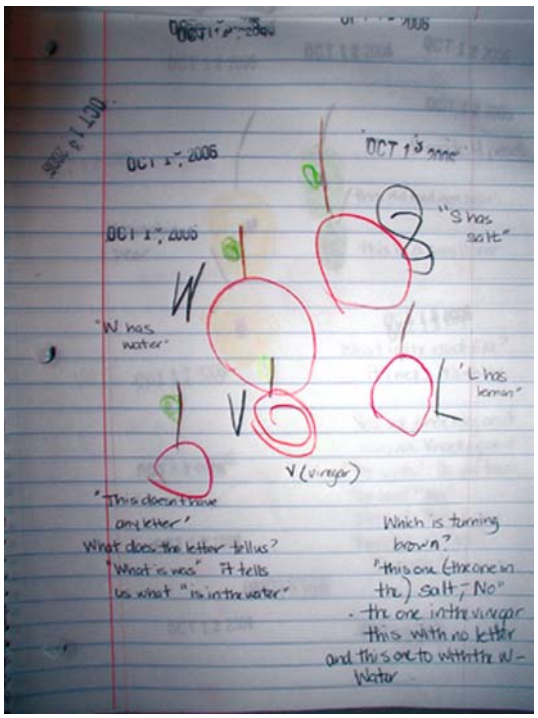

Fig. 4 The child (4;10) who created this entry used the initials of various substances to label them

Journals and Assessment

Assessment is a fact of preschool life, especially in publicly funded programs. A number of instruments exist to assess the quality of preschool classrooms. Recently, an extension of the popular Early Childhood Environment Rating Scale-Revised (Harms et al. 1997) has been published which focuses on ways that the classroom environment supports literacy and science learning (as well as other areas). Seven is the highest rating achievable on any item of the ECERS-E (Sylva et al. 2006). Although journals are not specifically mentioned on the science items, scores of 7 are linked to activities that encourage children "to make close observations of natural objects and/or draw them" and to "ask questions and record results." Journals could also contribute to high quality scores on literacy items on the scale.

In addition to fulfilling important criteria that indicate a quality learning environment, journals can be used to provide insights into individual children's thinking and language processes. As more preschool programs are required to meet state standards, 3- and 4-year-old learning benchmarks are becoming more apparent in school programs. These benchmarks include listening and speaking, writing, print awareness, and comprehension, and each of these features can be assessed in journaling. Journals provide anecdotal evidence of what children understand and their reasoning to support their statements. The time a child spends journaling creates the details that may be necessary to guide a conversation. The child can recreate a sequence of events and then communicate ideas to the listener, providing an opportunity for adults to ask and answer questions.

As preschoolers become more engaged in the recording process, they demonstrate more attention to detail as well as creating an accurate representation of the observed object. It is also important to assess the increased vocabulary, more complex sentence structure, and word choice when children describe their drawings. Figure 3, for example, provides a wealth of information about the linguistic competence of the English-language learner who created this entry.

Although children are often creative about the aspects of their knowledge and experiences that they incorporate into a journal entry (Shepardson and Britsch 2001), sometimes their entries reveal a true misconception. For example, one of our 5-year-old students drew the results of an experiment in which grass seed sprouted in soil but not sand. As she discussed her entry with her teacher (IN), it became clear that the child believed that it was the number of seeds planted, rather than the medium in which they were planted, that affected whether the grass seeds sprouted and grew. Journals provide immediate information so that teachers can catch and address this sort of understanding quickly, perhaps by designing another experiment that systematically varies the number of seeds planted.

Conclusion

Although we believe that the journals and science notebooks used successfully in early elementary classrooms have a place in preschools, we are most definitely not suggesting a pushdown curriculum. Instead, we believe that science journals are not just appropriate, but extremely useful tools for preschool learners and their teachers. Journals provide opportunities for children to observe closely and to represent their observations. Sharing the entry with a teacher allows the student to describe observations using new vocabulary, to practice and consolidate new ideas, and to ask and answer questions. For the teacher, the time shared over a journal entry is valuable as a chance to evaluate children's understandings and misunderstandings of science ideas, to encourage descriptive vocabulary use, and to model the kinds of questions children might ask themselves as they create future journal entries. Teachers can use journals to simultaneously assess and extend children's learning. Science journals provide a tangible record of children's growth as artists, as writers, and as scientists.

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