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Children's Science Journals: Tools for Teaching, Learning, and Assessing

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TO EXPAND OUR UNDERstanding of children's science learning, we need to expand our science teaching methods. One way of expanding our methods is to incorporate science journals into our lessons. These journals provide an opportunity to access and assess changes in children's understandings and thinking, identify misconceptions, and provide a more complete picture of children's understandings of science phenomena (Dana, Lorsbach, Hook, and Briscoe, 1991). To do this, we need to examine what children create with their drawings and writing as they construct and represent their understandings in science journals (Doris, 1991).

What is an effective way of using children's journals in science teaching, and how can we assess children's journals for science learning? In other words, what are the characteristics, or indicators, we look for in children's journals to assess their science learning? We can offer some answers to these questions, drawn from our collaborative research program with elementary school teachers and children in grades 3–6.

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Tools of the Trade

There are two general ways in which children's science journals may be used during an investigation. The first use is primarily as a log in which children describe their experimental procedures, record their observations, and report their conclusions. While this approach encourages children to attend to procedural details and to make numerous, accurate observations, it also constrains children's focus to the science experience at hand. The journal serves as the final product and provides little opportunity for children to elaborate their writing and thinking. From an assessment perspective, this approach provides

Table 1. *Instructional outline for using children's science journals.*

Instructional Phase	Children's Activity (Writing and Drawing in Journal)
Pre-Investigation	• Explains existing ideas and understandings. • Describes purpose of the investigation. • States the question(s) to be answered by the investigation. • Makes predictions based upon existing ideas and understandings. • Describes investigation plan/explains procedure.
Investigation	• Records observations (qualitative, quantitative). • Records ideas and thoughts about investigation based on observations. • Reflects on existing ideas and predictions in light of observations and ongoing findings. • Creates drawings, charts, or tables for organizing data.
Post-Investigation	• Answers question(s) using observations and data collected during the investigation as evidence. • Uses information and other resources to explain the results or relate to findings. • Creates charts, graphs, concept maps; transforming the data. • Reflects on existing ideas and predictions in light of findings and explanations. • Identifies ways of conducting the investigation differently or improving the investigation. • Proposes new questions for investigation.
Communication	• Uses information written and drawn in journal to communicate or share the investigation with others, also to apply findings to the everyday. May include ◆ Science conference or convention ◆ Science article ◆ Science book ◆ Science poster ◆ Poetry, songs, or stories

limited information about children's science understandings and learning and tends to be confined to the procedural and factual knowledge children draw from the science investigation itself.

The second approach for using children's science journals provides a structure for guiding children's writing and thinking. With this view, the science journal is not the end product, but instead it functions as a tool for facilitating children's thinking by serving as a resource for the creation of a final product. This approach allows assessment to move beyond procedural and factual knowledge to children's conceptual understandings and attitudes.

This technique is simple and easily implemented, involving four phases of journal activity: pre-investigation, investigation, post-investigation, and communication (see Table 1). This approach, unlike the first, requires that more time be devoted to a teaching/learning/assessing process that values the use of children's journals as a central component in learning science.

Pre-Investigation Phase. The pre-investigation phase lays the groundwork for the investigation and for children's science learning. During this phase, the children's focus of inquiry is articulated. The students write and/or draw in their journals to clarify and express their existing ideas about a particular science phenomenon and their questions about it. Children then state the purpose for the investigation, present their question(s), make predictions based upon their prior ideas and understandings, and plan the investigation or explain its procedures. This pre-investigation journal writing and drawing provide an opportunity for children to think about the investigation and make explicit their questions, ideas, and understandings for later reflection.

Giving children the opportunity to write about what they already know enables them to solidify their understandings and provides a base from which the investigation can confirm or challenge their existing ideas and questions. Recording the purpose and stating the questions for the investigation help focus children's planning and observation. Making predictions assists children in examining their own ideas in light of the investigation's questions and findings. Also, writing and drawing about the procedures keep the investigation on track and help children link procedural knowledge with conceptual knowledge.

Investigation Phase. The investigation phase involves more than collecting and recording data or obser-

vations and is the backbone of the learning process. Children also organize their data into charts and tables and write about their new ideas concerning the investigation and their findings to date. It is a time when children may reflect, in writing, about their initial ideas, questions, understandings, and predictions as well as their investigation procedures. Students externalize thought through writing and drawing on the journal page, and if appropriate, they seek and record information from other sources to assist them in understanding and explaining the investigation.

Post-Investigation Phase. The purpose for post-investigation journal writing and drawing is to assist children in interpreting and explaining their investigation results, while also reflecting on their existing understandings. Children can now refer to their prior journal writing and drawing to further develop their ideas about the investigation. This is the most difficult task for children because it pushes them to draw conclusions based on their own interpretations using the evidence collected during the investigation.

To do this, children must first transform their data into graphs, charts, or concept maps and then use the transformed data to support their written and drawn interpretations. At this time, children use other resources (science textbooks, magazine articles, trade books, software) as tools to assist them in composing written explanations about their investigation results.

Finally, children write reflections about their initial predictions and questions, summarizing what they have learned, how their ideas have changed, and how they think the investigation relates to the "real world." They also reflect on the investigation, identifying ways they could conduct the investigation differently or improve it, as well as proposing new questions for subsequent investigation. Such written reflection is essential to promote children's explorations of their own thinking and learning processes, but is often omitted if science journals are used primarily as logs for procedures and observations.

Written reflection is essential to promote children's explorations of their own thinking and learning process.

Communication Phase. In science, journals and logs are seldom used as a means of communicating and sharing information with others. Instead, the science journal functions as a tool scientists use to *create other products,* such as oral presentations or journal articles that are then used to communicate findings and other information to other members of the community. Children's science journals can also function as tools for constructing other communication products instead of as final products themselves.

The nature of this final product depends on the extent of the investigation and the audience. For example, children may construct a product that is used at a peer "science conference," or meeting, where they orally present their findings with other young scientists. Other options include writing an article for publication in a classroom or school science magazine, developing a science book for other children, creating a science poster, or writing a poem, song, or story to communicate their findings. By creating a presentation, poster, or other work, children are engaged in exploring the genre of scientific narrative and in synthesizing and applying their new understandings to a new context.

Assessment with Journals

New ways of teaching science require that assessment processes must themselves function as teaching/learning activities. Assessment must also incorporate more than one domain of children's science learning. Using children's journals allows teachers to assess children as they engage in the multiple dimensions of active science learning. These journals enable teachers to assess the domains of conceptual understanding, factual and procedural knowledge, science processes, and attitudes.

There are many different indicators that may be used to assess the domains of science learning. In this section, we first present several sample indicators, then describe a process for constructing scoring rubrics to assess science learning, and we close with suggestions for successful implementation.

Assessing for Conceptual and Factual Understanding. Assessing children's journals for conceptual understanding cannot be accomplished by looking at single sentences or words, but rather by analyzing the entire journal over time. After analyzing the journal, teachers can determine children's prior understandings and follow the changes in these understandings throughout the science experience.

Children's conceptual understandings are displayed through their use of written narrative to interpret or explain, while factual understanding may be expressed through labels and descriptions. To assess children's factual understanding, the journal page may also be analyzed for specific content information that clarifies the meaning of specialized scientific vocabulary.

A child's conceptual understanding of complete metamorphosis may

Figure 1. *Assessing journals for science understanding.*

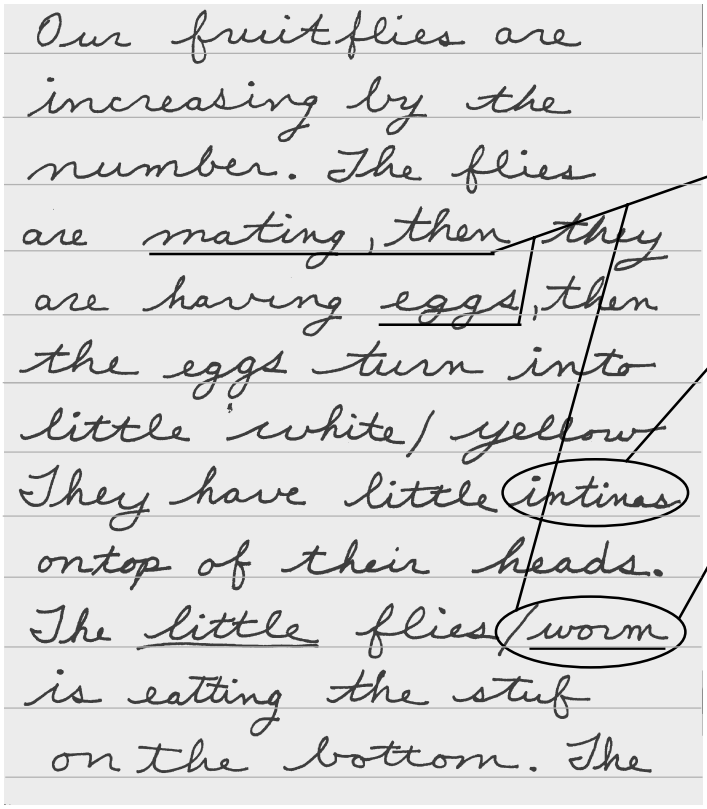


Table 2. *Sample checklist for assessing the science processes in children's journals.*

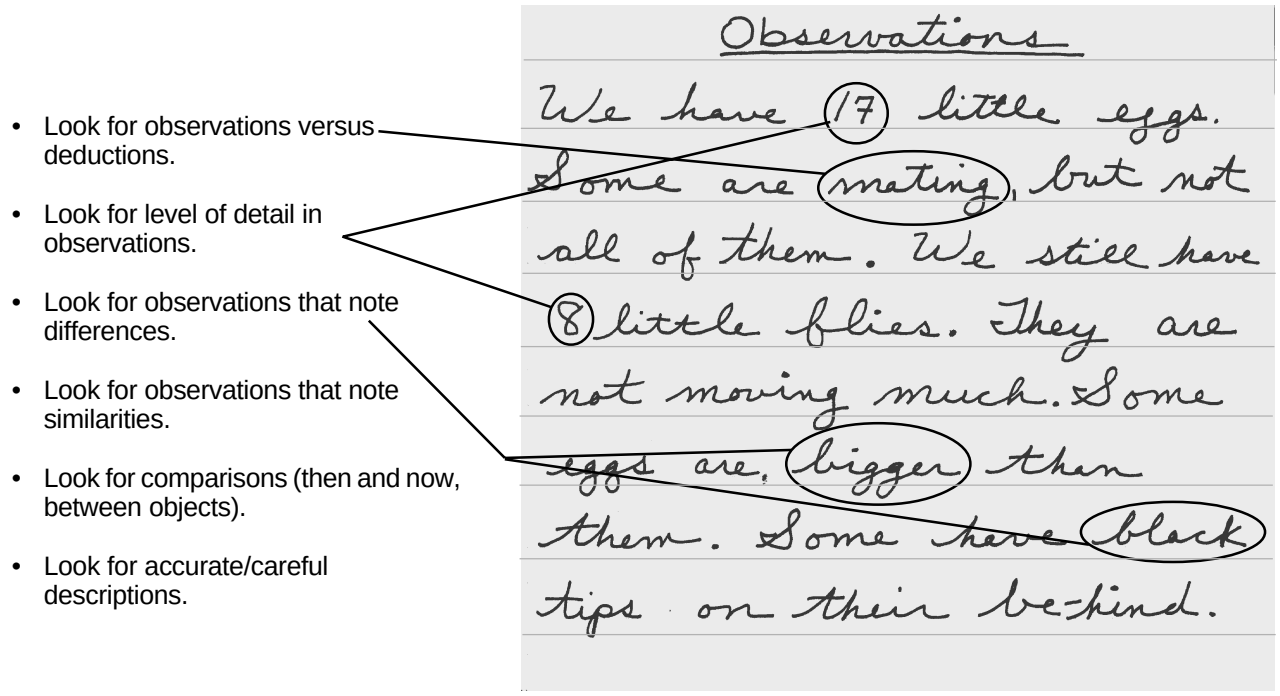
Science Process	Excellent (complete and accurate)	Acceptable (partially complete and accurate)	Unacceptable (incomplete and inaccurate	Not Observed
Clearly stated question(s)				
Clearly stated prediction(s)				
Data organized and neatly presented				
Data represented in chart or graph				
Description of procedures				
Explains the use of materials and equipment				
All variables identified				
Investigation controls variables				
Conclusion based on evidence				

be determined from the sample journal page shown in Figure 1. The written description chronicles the process of mating, eggs, and worms, indicating that the child's understanding of complete metamorphosis of fruit flies does not include an understanding of the pupa stage. From the perspective of factual understanding, the child uses *worm* as a label instead of *larva*. This use of *worm* suggests a lack of understanding that insect larva are not the same as worms.

Assessing for Procedural Knowledge and Science Processes. When assessing children's journals for the use of the scientific process, teachers can analyze the writing and drawing for several items:

- the investigative question, predictions, observations (see this section for more detail),
- descriptions of procedures and explanations of material and equipment use,

Figure 2. *Assessing journals for observations.*



- the identification and control of variables,
- the representation and organization of data,
- and conclusions based on evidence.

Although different schemes and scoring rubrics may be developed as tools for assessing children's journals, the checklist in Table 2 provides a simple means for assessing the journals for the science processes. It is not necessary to assess every item on the checklist every time, but over time, each item will be assessed a number of times.

Children's observations are essential for learning, but unfortunately they are often downplayed in the science teaching process. It is from science observations that the child begins to construct scientific understandings. Children may, however, have difficulties in observing similarities and easily observing differences, erroneously recording deductions as observations. To assess the quality of these observations, teachers can analyze journals for the following indicators:

- actual observations versus deductions,
- level of detail (qualitative and quantitative),
- notations of similarities and differences,
- comparisons between phenomena in terms of position (spatial) and time (change),
- and accurate, careful descriptions.

The child's journal page shown in Figure 2 illustrates level of detail. The entry specifies the number of eggs (17) and number of fruit flies (8) in the vial; however, their positions in the vial are not indicated. Qualitative differences are noted in that some eggs are "bigger" than others and that some have "black tips," but the child does not note any similarities in either the eggs or the adult fruit flies. Further, the child indicates that some fruit flies are "mating," but this is a deduction, not an observation.

To assess the quality of children's observations, specific scoring rubrics need to be developed based on the nature of the activity and the importance of the children's observations in the teaching/learning process.

Assessing for Science Attitudes. The purpose of assessing attitudes in children's journals is not to reward the expression of positive attitudes or penalize the expression of negative attitudes, but to reward children for representing their feelings and attitudes about the science experience through written language or drawing. To assess children's attitudes, teachers can analyze the journals for expressions of excitement, interest, and curiosity. Teachers may also look for reflections on cooperation, tolerance of ambiguity, persistence, and resourcefulness.

(continued on page 46)

(Journals,
continued from page 17)

Assessing Children's Drawings. Children's journal drawings may be analyzed to assess all science domains. Specific performance indicators reflected in drawings include

- appropriate and accurate sequences;
- detail, scale, and accuracy;
- actual objects versus stereotypic drawings;
- relationships between objects and realistic positions;
- and care and neatness.

The child's drawings in Figure 3 illustrate the appropriate and accurate sequence for complete metamorphosis, but lack scale in terms of size of egg, larva, pupa, and adult. The drawing of the adult fruit fly displays detail and accuracy but tends to be stereotypic. Also, the child's positive attitude and feeling of involvement in learning about fruit flies are indicated by the care and neatness.

Constructing Scoring Rubrics for Assessing Children's Journals. While the previous sections have described possible performance indicators for each science domain, scoring rubrics need to be developed to assess the science domains based on these indicators. The scoring rubric will depend on the nature of the science activity and the instructional goals and values identified for the activity.

Although there is no universal scoring rubric, guidelines do exist for developing reliable and valid scoring rubrics. Teachers must first determine whether they wish to assess the child's journal as a whole (giving a single score) or as individual components (giving multiple scores). In the first case, a holistic scoring rubric is needed, and in the second, an analytic scoring rubric is required.

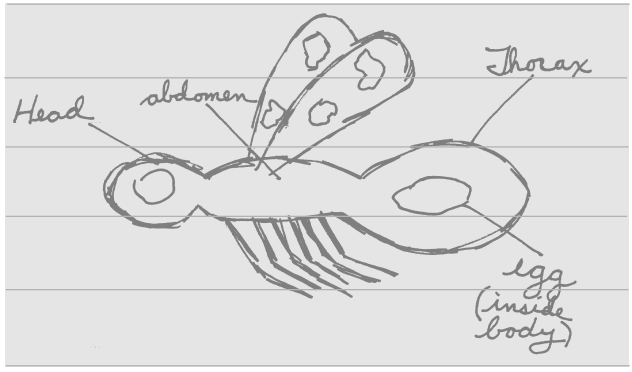
Regardless of the scoring system selected, the scoring rubric must be built upon science learning that the teacher values and the instructional goals for the science experience. With these instructional goals and values in mind, teachers need to determine which indicators may be used to assess children's journals. After identifying these indicators, teachers define the criteria that will accurately assess the child's performance for each indicator. They then describe the possible performance levels (based on the criteria) using either an analytic or holistic format. The performance levels should clearly differentiate children's abilities and serve as the scoring rubric used to assess children's journals. And finally, the scoring rubric is revised based upon children's work.

The planning matrix in Table 3 may be used to assist in the development of a scoring rubric for assessing children's science journals.

Suggestions for Successfully Assessing Children's Journals. For a holistic scoring rubric, four to six easy-to-use performance levels should be developed. Scoring rubrics should be revised based on children's actual

Figure 3. *Assessing journal drawings.*

- Look for sequences.
- Look for scale, detail, and accuracy.
- Look for actual objects versus stereotypic drawings.
- Look for relationships between objects and realistic positions.
- Look for conceptual understanding.
- Look for care and neatness as indicators of attitude and feelings of involvement.



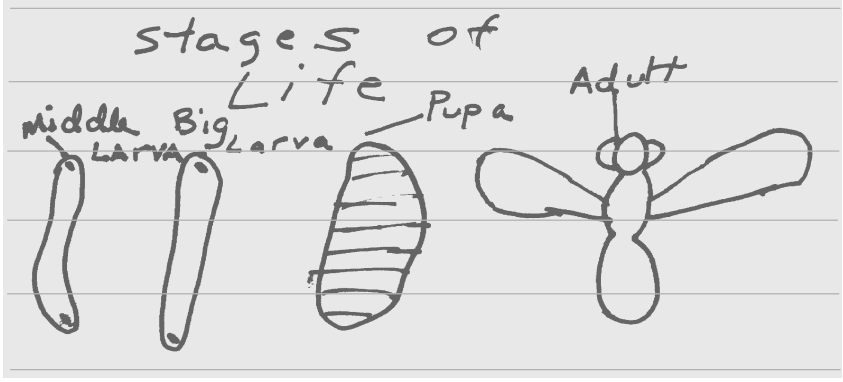


Table 3. *Planning matrix for developing scoring rubric.*

Step 1 Instructional Goal/Value	Step 2 Indicators	Step 3 Criteria for Indicators
	1.	1.
	2.	2.
	3.	3.
	1.	1.
	2.	2.
	3.	3.
	1.	1.
	2.	2.
	3.	3.
Step 4 Performance Levels Based on Criteria	4.	
	3.	
	2.	
	1.	

journals, which ensures that the scoring rubric aligns with children's abilities and differentiates performance levels.

Limit each journal assessment to three or four goals and to two or three indicators per goal. This ensures not only that multiple science domains are assessed through multiple indicators, but that the assessment is efficient and practical to use. Rotate the goals and indicators used to assess children's journals so that each goal and indicator is assessed in multiple activities over time. This ensures manageability and develops a picture of the child's abilities throughout the school year.

Scoring rubrics should be shared with parents, other teachers, and school administrators to keep them informed about children's journals and the assessment procedure. Keep examples of children's work as evidence of performance and share scoring rubrics with the children before they engage in the science activity and journal writing. This will assist children in understanding the expectations and will guide them in completing the task.

Closing Thoughts

Often, curricular materials and instructional documents provide the classroom teacher with insufficient background for using children's journals. Under these circumstances, the use of children's journals simply to follow a curricular plan has little consequence for the teaching/learning/assessing process and can leave children with a negative experience.

On the other hand, using science journals along with the techniques offered here emphasizes the importance of children's own cognitive and verbal efforts to make sense of science phenomena.

Resources

Dana, T.M., Lorsbach, A.W., Hook, K., and Briscoe, C. (1991). Students showing what they know: A look at alternative assessments. In G. Kulm and S.M. Malcom (Eds.), *Science Assessment in the Service of Reform*. Washington, DC: American Association for the Advancement of Science.

Doris, E. (1991). *Doing What Scientists Do: Children Learning to Investigate Their World.* Portsmouth, NH: Heinemann.

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