Encouraging Writing to Think: Young Children Writing in Science

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In this notebook entry, young Ava shared her thinking about the relationship between mass and momentum, a question that she had been investigating with her second-grade classmates. She accompanied her written description with a carefully drawn illustration, providing evidence that she was considering a number of variables that were relevant to investigations of balls moving down ramps, including: the starting point, the height of the ramp, the mass of the ball, documenting the distance the can moves at the bottom of the ramp, and even-what appear to be-the number of revolutions she thinks the ball makes on its way down the ramp. In this paper, we speak to the opportunities that young children have, in the context of guided inquiry science instruction, to use a range of writing, in the service of building subject matter knowledge.
Introduction

As there is more recognition of the importance of providing early elementary school aged children with opportunities to engage with non-narrative texts (e.g., Duke, 2000; Smolkin & Donovan, 2000), there is also increasing interest in providing young children with opportunities to engage in non-narrative writing (Wray & Lewis, 1997). Science instruction, with the opportunities it affords for experiencing a range of authentic reasons for writing, has often been suggested as a potentially generative context for students to practice many forms of writing (Hand, Prain, Lawrence, & Yore, 1999; Keys, 1999).

It is generally acknowledged that children’s ability to think and solve problems depends upon a rich body of knowledge. This knowledge is most useful when it is connected and organized around important concepts that are explored in the context of solving real problems (Bransford, Brown, & Cocking, 2000; Chi, Feltovich, & Glaser, 1981). In the course of this exploration, attention has to be paid to building upon the initial ideas (knowledge and beliefs) that children bring to these problems (Smith, diSessa, & Roschelle, 1993). The activity of writing is often thought to be a powerful means of advancing thinking because of the possibility for children to both exhibit their initial ideas as well as to reflect upon and refine them (Klein, 2000; Langer & Applebee, 1987; Rivard, 1994).

Recently, concern has been expressed about the opportunities that young children have to engage in knowledge building. For example, Neuman (2001) has speculated that early literacy programs have emphasized the teaching of process to the exclusion of content; that is, so much attention is paid to how children learn that relatively little attention is paid to what they learn. The conundrum is that attempts to teach children reading, writing, and thinking in the absence of providing meaningful purposes for this learning makes our work considerably more difficult. Furthermore, children and their teachers are greatly disadvantaged when denied rich subject matter information with which children might read, write, and think.

Supporting Neuman’s contention is the research by Taylor, Pearson, Clark, and Walpole (1999) documenting the limited opportunities that children in grades K-3 had to develop knowledge and thinking even in the context of schools that were effectively “beating the odds”; that is, schools that were realizing higher early reading achievement gains than would be predicted, given the demographics of the student populations. For example, Taylor et al. reported that only 16% of the teachers in the entire sample were reported to emphasize comprehension.
Another indicator of the absence of these opportunities for knowledge building is the dearth of informational text in the classrooms of young children (Duke, 2000). This is particularly unfortunate considering what we know about how exposure to various text genres interacts with learning. Smolkin and Donovan (2000), in a fine-grained analysis of teacher-student discourse during the reading of both narrative and informational text in Donovan’s class over two school years, found that 83% of the discourse was categorized as meaning-oriented when the children were using informational text, as opposed to 16% when the children were engaged in story book reading. Clearly, text is only one source of knowledge, but nevertheless, it is potentially a rich source of knowledge. For example, the research of Anderson, Wilson, and Fielding (1988) and Cunningham and Stanovich (1997) reveals that exposure to print is highly predictive of vocabulary development, verbal fluency, and subject matter knowledge. The literature on young children “writing to learn,” though more lean than its reading counterpart, provides evidence suggesting that young children are quite capable of engaging in non-narrative forms of writing with which they can deepen their subject matter knowledge (Keys, 1999; Newkirk, 1989; Pappas, 1991b; Shepardson & Britsch, 2001).

Among the articles within this literature that address young children’s science writing, there seem to be four main foci. First, there are studies concerned with the various genre types that children are either sensitive to, or are thought to need knowledge about for producing and comprehending informational text (e.g., Kamberelis, 1999; Keys, 1999; Pappas, 1993). For example, Pappas and her colleagues have examined the range of language registers exhibited by young children, such as those typical of expository reports and fictional narratives (Pappas, 1991a, 1991b, 1993). A second focus has been work done to describe the characteristics of and the variety of young children’s writing in science (e.g., Newkirk, 1987, 1989; Shepardson, 1997; Shepardson & Britsch, 2001). Thomas Newkirk’s book More than Stories: The Range of Children’s Writing in which he categorized the many types of non-narrative writing young children generate is a good example of this type of work. Work of this type has been important in drawing attention to the fact that much of our daily lives (and those of young children) are filled with non-narrative forms of text (e.g., grocery lists, warning labels, newspapers, street signs, and telephone books). Research examining the impact of teachers’ epistemological beliefs and decisions that affect students’ opportunities for writing to learn in science (e.g., Baxter, Bass, & Glaser, 2001; Prain & Hand, 1996) constitutes a third focus for the writing to learn literature.
Prain and Hand, for example investigated teacher perceptions about writing in science over the course of a series of professional development workshops. They found that, although the teachers expressed an increased sense of the value of engaging children in writing during science instruction, there was little evidence that the teacher’s underlying beliefs about the purpose of teaching science (e.g., engaging in inquiry vs. acquiring correct conceptions) had shifted after the professional development workshops. It was also the case that the teachers’ underlying beliefs regarding the purpose of science instruction were found to be related to the types of writing the teachers were willing to consider incorporating into their science instruction. Finally, there is work that describes the use of various techniques for engaging young children writing within science instruction contexts (e.g., KWL’s, quick writes, science journals, concept maps) (Saul, Reardon, Dieckman, Neutze, & Pearce, 2002).

Although all of these approaches to examining “writing to learn” in science add to the collective knowledge base, what is lacking are studies that take a descriptive and holistic look at early elementary school classes writing in science. Studies of this sort may be able to illuminate some issues not yet addressed in the literature such as how to decide which type of writing to use and how to scaffold young children’s writing activity. Another issue currently given scant attention is the potential of writing to both reveal and advance the development of children’s understanding of science concepts and scientific reasoning within classroom contexts.

This study contributes toward the advancement of principles for the use of writing to promote children’s thinking and learning in science via a close examination of the writing activity and written work of second grade children within the context of guided inquiry science instruction. In this paper we report a series of analyses with a focus on: the multiple ways in which young students used writing to represent their ideas in the course of guided inquiry science instruction, the multiple forms of representation in their writing repertoires, the teacher's take-up of student writing to advance her conceptual goals, as well as the teacher’s orientation and beliefs regarding children's writing during inquiry-based science instruction. We take an integrated approach by examining not only the children’s written work, but also the classroom context, and especially, the nature of the teacher’s role in structuring and mediating the writing activity. The claim that we wish to make is that writing during early elementary inquiry-based science instruction can serve to advance both knowledge building, as well as general literacy, specifically with regard to learning how to communicate ideas regarding relationships among variables.
Theoretical Perspective

All aspects of this research are informed by a sociocultural perspective, meaning that this work is premised on the idea that cognition itself is a fundamentally and inextricably socially-embedded phenomenon. Learning and development occur within rich social contexts and these contexts both contribute to and are simultaneously shaped by interactions among participants and with the “tools” of the activity in which they are engaged (e.g. specific language, certain ways of evaluating evidence and warrants, and material artifacts) (Lave & Wenger, 1991; Rogoff, 1998; Wertsch, 1991). With this lens, it is helpful to think in cultural terms about learning environments such as classrooms. The classroom is viewed as a “community of learners” who share (or are being enculturated to share) expectations about the purposes and ways of behaving in school. One of these “norms,” is that school is, in large part, a place to learn to think within multiple traditions (Adler, 1982; Phillips, 1993). The study of history, for example, may require a particular set of “tools” that may be different in some ways from the “tools” for the study of science, or art, or mathematics. Student learning of these fields is measured by the changes in the ways children participate in the practice of doing science, history, art or mathematics (Rogoff, 1998; Rogoff, Matusov, & White, 1996; van der Veer & Valsiner, 1994; Wertsch, 1991). With a sociocultural perspective, at higher levels of mental function, instruction is critical to learning and may take many forms. Most obvious is instruction by more experienced and knowledgeable people in a society (often teachers), but also critical are peers (Forman & Cazden, 1985) and, indeed, cultural artifacts (Lave & Wenger, 1991).

In addition, with this perspective, which is built upon Vygotskian foundations, the notion of “tools” has particular importance. Concepts, strategies for approaching problems, words, and graphical symbols are all considered “tools” people use to advance to higher levels of mental functioning. As Davydov and Radzikhovskii have described Vygotsky’s position, “all the tools that are developed artificially by humanity are the elements of culture. This was not a simple assertion, but a concrete proposal for the scientific analysis of the sociohistorical determination of mind” (Davydov & Radzikhovskii, 1985, p. 54). Thus, within a classroom context, analysis that identifies the range of “tools” (writ large) at play is important for understanding the kinds of learnings that may have been possible for participants in that context.

For this study, we use an interpretive case study methodology (Merriam, 2001) of one classroom engaged in a unit of study on Motion Down Inclined Planes. Case study, with its focus
on process, is a particularly good match with the sociocultural perspective that we bring to this research to the extent that the unit of analysis for this work is individuals in interaction with one another and in interaction with cultural tools (broadly writ to include ideas, materials, texts generated by the children and texts generated by the researchers) (Rogoff, 1995; Rogoff et al., 1996; Wertsch, 1991).

The Instructional Context

Guided Inquiry supporting Multiple Literacies

The classroom teacher featured in this research was a member of a professional development Community of Practice (Palincsar, 1998). This community met regularly for three years to co-construct effective teaching practices consistent with a particular teaching orientation called Guided Inquiry supporting Multiple Literacies (GIsML; (Magnusson & Palincsar, 1995). From this orientation, instruction unfolds according to cycles of investigation set within a particular problem space, namely the pursuit of a guiding question that is broad and identifies a general conceptual terrain (e.g., What influences the motion of objects?). The recursiveness of multiple cycles of investigation promotes meaningful learning – particularly with respect to scientific inquiry. For example, one needs sufficient experiences examining natural relationships among phenomena (e.g., the relationship between mass and speed of a moving object, given a set amount of force, or the relationship between speed and momentum, given a set amount of mass) before one can meaningfully test explanations for these phenomena.

Inquiry within an investigation is guided by specific questions (e.g., How does mass affect the speed of a ball rolling down an inclined plane?) or a particular phenomenon (e.g., a ball rolls down an inclined plane and strikes a can), and proceeds through phases of different aspects of investigation: preparing to investigate, investigation (data collection and analysis), preparing to report, and reporting. Integral to this orientation is the conception of the classroom as a community of inquiry (The Cognition and Technology Group at Vanderbilt, 1994; Wells, 1995). Hence, the investigations and documentation of data gathered in the course of the investigation are conducted in pairs or small groups. Furthermore, a critical feature of the instruction is the reporting phase during which the investigative teams share their data with the whole class, contributing new claims and evidence for the class’s consideration, as well as speaking to
evidence they have to support or refute extant claims. This is followed by whole class discussion regarding claims about which there is consensus, claims that have been sufficiently refuted by evidence from the investigative groups, and claims that need further investigation.

In the course of GIsML instruction, students and teachers participate in two forms of investigation. In *first-hand investigations*, children directly explore the physical world, manipulating variables in phenomena – they are investigating, making observations and measurements, and drawing conclusions about how the world works. In *second-hand investigations* children inquire about others’ investigations and interpretations of phenomena, typically from consulting text-based information.

The ultimate goal of GIsML instruction is not only to support children’s learning of scientific understandings, but to enable students to experience, understand, and appreciate the ways in which these understandings have resulted from the use of the tools, language, and ways of reasoning that are characteristic of scientific inquiry (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Lemke, 1990; White & Frederiksen, 1998).

*School & Curricular Context*

During the 1998 – 1999 school year, Mrs. Fé MacLean taught second grade in a semi-rural school in Southeastern Michigan. The families in this community had a wide range of incomes and educational levels. District level data indicate that 14.5% of the students qualified for free, or reduced cost, lunch. The racial profile of the district was quite homogeneous with approximately 90% of the school population of European descent. During the 1998-1999 school year, when data for this study were collected, there were 21 second graders, all of whom were of European American descent, and ten of whom were girls. Mrs. MacLean, a veteran teacher with over thirty years of primary grade experience, had been a member of a community of teachers investigating inquiry-based science teaching since 1996 (Palincsar, Magnusson, Marano, Ford, & Brown, 1998). In the spring of 1999, she and her second graders embarked on a program of study regarding the motion of balls down inclined planes. This program of study focused on several scientific relationships (e.g. influence of mass on speed, influence of speed and mass on

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¹ With the exception of Mrs. MacLean, who has consented to the use of her real name, all names in this paper are pseudonyms.
momentum) and highlighted particular aspects of scientific problem solving, such as conducting a fair test, running multiple trials, and accurately recording data.

Mrs. MacLean’s 10-day program of study on motion included 2 first-hand and 2 second-hand investigations. In the course of the second-hand investigations, the class used two “big book” texts that had been designed for this program of study. The texts were written to loosely model a scientist’s notebook, authored by a fictional scientist, Lesley Park (Palincsar & Magnusson, 2001). Written in the first person, Lesley “thinks aloud” as she: (a) generates questions prompted by real world phenomena that she has experienced, (b) plans and conducts investigations to address her questions, and (c) interprets the data she has collected and determines how these data address her question. Figure 2 shows several pages from the first big book used in this program of study. Entitled “Sledding Down a Hill, Rolling Down a Ramp,” this book focused on the relative amount of time it takes objects of different mass to reach the bottom of an inclined plane. The book begins with three pages illustrating a child and an adult sledding down a hill and reaching the bottom of the hill at the same time (see Figure 2). Observing this outcome piqued Lesley’s curiosity and prompted her to ask the question “Will something heavy and something light always get to the bottom of a hill in the same amount of time?” In a practice that is conventional to the conduct of science, Lesley decides to devise a model of the sledding situation. Using a ramp and two balls of different masses, she conducted a series of trials examining the speed of two balls down the ramp, which she documented in tabular form.

Figure 1. First 4 pages of the big book “Sledding Down a Hill, Rolling Down a Ramp

The curricular plan has only 2 first-hand investigations. However, in practice, Mrs. MacLean’s class replicated one of Lesley’s investigations (mass-speed) in a first-hand fashion two times during the 10-day program of study.

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2 The curricular plan has only 2 first-hand investigations. However, in practice, Mrs. MacLean’s class replicated one of Lesley’s investigations (mass-speed) in a first-hand fashion two times during the 10-day program of study.
During both first- and second-hand investigations, Mrs. MacLean asked the children to write about their own ideas and interpretations of the investigations. This writing was in addition to the writing children did while collecting data during first-hand investigations, as well as the writing Mrs. MacLean did while documenting whole-class discussions.

**Methods**

**Data Sources**

**Videotapes**

All whole class instruction and most small group and individual (i.e., writing) activity were videotaped. All totaled, there were approximately 11 hours of videotape, which spanned the instruction over the course of 10 school days.

In general, the camera remained on a tripod to the side of the “Big Space” area of the classroom where the class convened as a group. During whole group instruction, the research assistant operating the camera focused the camera on each speaker. During notebook writing times and other times when children were working in pairs or in small groups, the camera followed Mrs. MacLean. Sound was recorded via two boom microphones, as well as a remote microphone that Mrs. MacLean wore.

**Class-generated Artifacts**

The class created several types of texts as a part of the instruction. Among these was a list of “Claims About Motion” to which the class added as they conducted first- and second-hand investigations. In addition to this list, there were: (a) data tables and other data records, (b) records of children’s predictions for various situations, and (c) publicly displayed records of children’s ideas about several aspects of the investigations: possible sources of experimental error for Lesley’s experiments in Big Book 1, and possible variables to change for Lesley’s experiment in Big Book 2.

**Children’s Writing**

During the 10 days of instruction for this unit of study, the children responded to five writing prompts. These were written in response to prompts posed by Mrs. MacLean. The children generally worked in pairs but were encouraged to write their own ideas. Typically each child wrote several sentences and drew an accompanying diagram on unlined white paper.
Interviews with Mrs. MacLean

In the spring of 2000, the first author conducted a series of 6 semi-formal interviews with Mrs. MacLean regarding her thinking about the role of writing in her science instruction.

Data Preparation and Analysis

Transcripts of videotapes

Transcripts were prepared by a commercial service. Additions and corrections to these transcripts were made during multiple viewings of the videotapes. In addition, remarks regarding intonation patterns and gestures were added to the transcripts.

Time-use analysis

All video-tapes were analyzed to create a detailed time-use analysis. The resulting table showed a to-the-minute account of the activities in which the class was engaged.

Content Analysis of Children’s Writing

A File Maker database was created for all of the children’s written work. The children’s invented spellings and punctuation were maintained, but – for ease of reading and analysis – conventional spellings were inserted in parentheses. This database was searchable by child and date. Thus, one could look at changes within individual children’s entries, as well as across all students’ entries, for a specific date.

The contents of these writings were analyzed in various ways depending on the nature of the prompt. For example, we looked across related prompts (e.g., for Days 1 & 2) to determine if children’s ideas and/or ways of justifying and illustrating their ideas had changed. For all writings, analyses focused on the range of ideas expressed in addition to the extent to which children justified their ideas with specific evidence.

Instructional Content Analyses

The videotapes and transcripts of the instruction underwent a series of content analyses. Using a combination of inductive and deductive approaches (Stake, 1994) the multiple stage analysis process resulted in the data being coded along three major dimensions: (a) scientific reasoning (e.g. “fair testing,” dealing with anomalous data, measurement issues), (b) scientific content (i.e., ideas related to the variables of mass, speed, ramp height, momentum, or some combinations of these), and (b) teacher moves (e.g. various types of questions, making
distinctions, introducing vocabulary). The transcripts of writing prompts from during the children’s writing activity were further analyzed to identify (in addition to the themes listed above) the tasks posed, the literacy demands of the tasks, the supports provided specifically for the tasks (e.g., environmental print, sentence starters etc.).

Interview Content Analyses

The first author prepared interview transcripts. The transcripts were coded using a mainly inductive approach which resulted in identifying several themes and characteristics of Mrs. MacLean’s thinking in regard to the purposes, challenges, and benefits of asking young children to write during inquiry-science instruction.

**Findings**

*An Overview of Writing Activity within the Instruction*

**Time Use**

Over the course of 10 days, the class conducted 4 investigations. Two of these were “second-hand” investigations and involved the use of big books designed and constructed by the GISML research team. The first of investigation in which the class engaged examined Lesley Park’s notebook in which she asked whether balls of different mass have different speeds when going down a ramp. Following this investigation, the class collected data about whether changing the starting height of a ball (by changing the ramp height) would affect its speed. Following this was another first-hand investigation (with the children collecting data in pairs). This time the focus was on the relationship between a ball’s speed (varied by using 3 different ramp heights) and its momentum (as measured by the distance the ball hit a can that had been placed at the bottom of the ramp). The class again read one of Lesley’s notebooks during the fourth and final investigation, which concerned the relationship between a ball’s mass and its momentum. Below is a table that shows the overall sequence of the instruction as well as some details about the focus of the instruction. The bolded bullet points in the “scientific reasoning opportunities” column signify that writing was an integral part of these activities.
<table>
<thead>
<tr>
<th>Day &amp; Amt. of Time</th>
<th>Mode of Instruction &amp; Materials Used</th>
<th>Conceptual Topics</th>
<th>Sci. Reasoning Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wed. 2/17/99 (28 min.)</td>
<td>Second-hand Investigation Big Book 1: “Sledding Down a Hill, Rolling Down a Ramp” p. 1 – 8 Written Reflections about data table (not videotaped)</td>
<td>Relationship between mass (of a ball) and speed (down a ramp).</td>
<td>• Having a question to guide one’s research • Modeling a real-life event • How to conduct a “fair test” • How to read a data table</td>
</tr>
<tr>
<td>2 Thur. 2/18/99 (1 hr. 13 min.)</td>
<td>Second-hand Investigation Big Book 1: “Sledding Down a Hill, Rolling Down a Ramp” p. 4 – 8 Written Reflections about data table</td>
<td>Relationship between mass (of a ball) and speed (down a ramp).</td>
<td>• Understanding the question driving the experimentation • Understanding what the data in the data table represent – how were the data collected • Accounting for differences within data for same ball across trials</td>
</tr>
<tr>
<td>3 Fri. 2/19/99 (1 hr. 25 min.)</td>
<td>Second-hand Investigation Big Book 1: “Sledding Down a Hill, Rolling Down a Ramp” p. 8 – 12 First-hand Investigations (1) Replicating mass – speed experiment (2) Ramp-height &amp; speed</td>
<td>Relationship between mass (of a ball) and speed (down a ramp).</td>
<td>(1) mass-speed (2) ramp-height-speed</td>
</tr>
<tr>
<td>4 Mon. 2/22/99 (52 min.)</td>
<td>First-hand Investigation Ramp-height &amp; speed continued (long ramp used)</td>
<td>Relationship between ramp height and speed of a ball.</td>
<td>• How to document findings • Making predictions based on partial findings • How much data is enough • Analyzing data</td>
</tr>
<tr>
<td>5 Tues. 2/23/99 (38 min.)</td>
<td>First-hand Investigation Ramp-height &amp; speed continued Written Reflections about findings</td>
<td>Relationship between ramp height and speed of a ball.</td>
<td>• Interpreting data</td>
</tr>
<tr>
<td>6 Wed. 2/24/99 (1 hr. 52 min.)</td>
<td>First-hand Investigation Speed &amp; momentum: Will changing the speed of the ball affect how far a can at the bottom of the ramp is hit?</td>
<td>Relationship between speed and momentum</td>
<td>• Devising a new question • How to do a “fair test” of a question • How to record data</td>
</tr>
<tr>
<td>7 Thur. 2/25/99 (42 min.)</td>
<td>First-hand Investigation Speed &amp; Momentum Written reflections about findings</td>
<td>Relationship between speed and momentum Relationship between ramp height, potential energy and kinetic energy.</td>
<td>• Analyzing data • Graph representation of class’ data • Questioning anomalous data • Making claims based on data</td>
</tr>
<tr>
<td>8 Fri. 2/26/99 (57 min.)</td>
<td>Second-hand Investigation “Little book” version of “Sledding Down a Hill, Rolling Down a Ramp” First-hand Investigation Re-replicating mass-speed experiment</td>
<td>Relationship between mass (of a ball) and speed (down a ramp).</td>
<td>• Experimental procedure • Making predictions for intermediary case based on data for extreme cases • Accounting for differences within data for same ball across multiple trials</td>
</tr>
</tbody>
</table>
Day & Amt. of Time | Mode of Instruction & Materials Used | Conceptual Topics | Sci. Reasoning Opportunities
---|---|---|---
9 Tues. 3/2/99 (1 hr. 22 min.) | Second-hand Investigation Big Book 2: “Clowning Under the Big Top, Moving Energy from Here to There” Written reflections about above question | Relationship between mass (of a ball) and momentum. Relationship between mass and potential energy. | Examining a real-life problem and coming up with possible solutions How to test possible solutions to a problem Predicting effect of using balls of different mass

10 Wed. 3/3/99 (45 min.) | Second-hand Investigation Big Book 2 Written reflections about question (not videotaped) | Relationship between mass (of a ball) and momentum. Mass-potential energy | Making predictions for intermediary case based on data for extreme cases Interpreting graphical representation Making claims based on data

Table 1. Summary of the instructional sequence for the Motion unit of study in Mrs. MacLean’s class

A time analysis revealed that the majority of time (49% or about 5 hours) was spent conducting first-hand investigations. Whole-class work with the big book texts comprised 35% (or almost 4 hours) of the instructional time, while the remaining time (approximately 2 hours) was spent engaged in writing in pairs or trios. Of particular note was that of 5 writing prompts 4 were posed during the course of the two second-hand investigations (2 during each second-hand investigation).

Types of writing and Participant structures

Analyses of the instructional data revealed that the class engaged in roughly six types of writing events. When examined within the context of the instruction, certain types of writing seemed to occur within certain activities and participant structures. A summary of these data are presented in Table 2.

<table>
<thead>
<tr>
<th>Types of writing</th>
<th>Description</th>
<th>Participant structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions for the investigations</td>
<td>Posted on the board throughout an investigation, the guiding question was a focal point. Sometimes the question was written out by Mrs. MacLean and read aloud by the class.</td>
<td>group discussion</td>
</tr>
<tr>
<td>Predictions</td>
<td>Mrs. MacLean recorded the children’s predictions regarding the outcomes of various trials at various points during the investigation. In the case of predicting during the reading of the text, Mrs. MacLean added paper or wrote directly on the laminated pages.</td>
<td>group data collection group interpretation of texts</td>
</tr>
</tbody>
</table>

3 The actual amount of time was probably about 3 hours for writing activity. The 2 hour amount is what was recorded on videotape, but two of the 5 writing episodes were not videotaped in their entirety and therefore the amount of time the children spent writing on those days is not known with any certainty. However, judging from the amount of time (usually about 30 min.) the children spent writing on other days, it is likely that the total amount of time spent in writing activity was closer to 3 than 2 hours.
Types of writing | Description | Participant structure
---|---|---
Data collection records | Data collection records took various forms. Data tables were created for the ramp-height – speed investigation as well as the replications of the mass-speed investigation. Documentation of the speed-momentum investigation was more complex and involved creating a compiled “graph” of the data which took up the entire chalkboard. | whole group and individual / pairs / trios
Critiques of the investigations | At multiple points during the instruction, particularly during the first text-based investigation, Mrs. MacLean recorded the children’s ideas about issues such as factors that could account for variability in a set of data collected under the “same” conditions. | whole group
Data interpretations | Three of the five writing prompts asked children to write their interpretations of specific data that the class had either examined in one of Lesley’s notebooks, or had collected first-hand. Generally, these interpretations were then discussed – eventually resulting in the generation of class claims (see below). | individual/pairs/trios
Claims | The class kept a “class claims” list which was added to and remained posted in the room throughout the investigations. In addition, the final writing prompt involved each child writing a “claim” about the relationship between mass and momentum. | group and individual

Table 2. Relationship between type of writing and participant structure of the instruction

What is evident from Table 1 and Table 2 is that writing in some form was an integral and pervasive aspect of the instruction. Many of the types of writing were done only during whole group instruction. Some, such as writing claims, were modeled and practiced in whole group discussions and later taken on by small groups or individuals. Strikingly absent was any writing listing the procedures used during data collection. In the texts, procedures could be inferred from the diagrams of the investigative set-ups Lesley Park utilized, but at no point did the class engage in writing about “what they did.” Rather, the emphasis was on “what they thought” -- about the data, about what might happen next, about why something might have occurred as it did, and about what could be concluded. With these very general characterizations of the writing activity in Mrs. MacLean’s class, we now turn to more detailed examples of several themes which emerged during our analyses of the instructional data.

Themes from the Content Analyses of Writing Activity

In this section we highlight three episodes from the instruction that exemplify characteristics of the writing activity. Our purpose here is to provide rich and contextualized examples of some of the underlying purposes Mrs. MacLean seemed to have for writing during her inquiry-based science instruction.
Theme 1: Using writing as a springboard for group discussion

Mrs. MacLean generally started each science lesson by gathering the children in the Big Space near the front of the room to review the investigations and ideas that were on the floor. She often used children’s written work during these discussions. Sometimes she recounted to the class how many children had expressed a certain idea in their writing and sometimes she showed the rest of the class how a child had tried to communicate their idea in a diagram or in their words (or both). She also often asked some of the children to say more about what they had meant in their writing and the example below is of this nature:

On the afternoon of the first day of the unit of instruction on motion, Mrs. MacLean asked the children to write about what they thought a data table in Lesley’s notebook showed. The class had been quite challenged to interpret a data table that showed the number of seconds a 10 gram ball and a 50 gram ball had taken to roll down a ramp over 4 trials each. The class had needed help to decode the organization of the table as well as to understand the link between the quantitative data presented in the data and the investigative method Lesley must have employed to generate those data. On the morning of Day 2, after a quick review of the first several pages of *Sledding down a Hill, Rolling down a Ramp*, Mrs. MacLean shared with the whole class some of the children's written responses about what the table may have meant. She especially highlighted children's writing about which she had questions, for example:

Mrs. MacLean: …I didn't understand this...can I ask this uh,... Josh? It said, (reading from Josh’s paper) "The balls got to the bottom of the ramp at the same time, but in different order." Did you think that they were both going down at the same time... each time? What did you think, hon?

Josh: Uh...They're going down at different times.

Mrs. MacLean: They went down at different times. O.K., and there was something interesting here. (looking at another of the children’s writing) Jeffrey... Jeffrey and Marcus (these two boys had worked together to write their responses)... now, you have to explain to us what you meant by this... this is what Jeffrey says... (reading) “when Lesley put the balls on the ramp they stayed together”... that’s the first ramp. (reading again) “But, on her trials one would get there before the other.”. because you were thinking that they were always together... is that why you said that?

(Jeffrey nods.)
Mrs. MacLean: Oh, O.K. I think that’s what you were... because there were two together... one would get down there before the other because you were looking at the numbers side by side. Is that what you were doing? O.K., now I understand what you were saying.

The children’s writing indicated that many of them were confused about how Lesley had derived the numbers in her data table. Some children had not made the translation back from Lesley’s quantitative data to the procedure with which she had collected the data. Thus, despite a conversation the day before about the difficulty of timing two balls at the same time, some children continued to imagine that Lesley had put both balls on the same ramp and tested their speeds simultaneously while other children thought Lesley was using two different ramps. In other words, the class did not have a shared understanding of what the numbers in the table represented, nor of the context in which these data were generated.

Having established that this was an area of confusion, Mrs. MacLean was then able to engage the class in a series of activities aimed at clarifying the way in which Lesley collected her data. In addition, the class spent more time thinking about how there could be variability in the data across the four trials for just one of the balls. Eventually, many children in the class came to the conclusion, that (at least on the basis of Lesley’s data), it was possible for balls of different mass to travel down a ramp in the same amount of time. We suggest here that Mrs. MacLean’s use of the children’s writing facilitated both her understanding of what was confusing for the children. This in turn allowed for the instruction to take the productive tack of engaging the class in discussions about the methods Lesley employed as well as the possible sources of error that could account for the variability in her data.

Theme 2: Using writing activity as an opportunity for meta-level engagement with ideas

The importance of metacognition in children’s academic learning has been recognized and discussed in various guises for about three decades [Borkowski, 1990 #183] and metacognition is considered “both a product and producer of cognitive development” (Paris & Winograd, 1990, p.19). Deanna Kuhn’s work has been very important in drawing attention to the importance of meta-level processes during the consideration of evidence and theories when reasoning about evidence-based problems as in the case with scientific inquiry. As she has recently written, “awareness of the sources of one’s knowledge is critical to understanding evidence as distinct
from and bearing on theories – an understanding that lies at the heart of scientific thinking” (Kuhn, 2000, p. 178).

That young children have difficulty with meta-level awareness, such as distinguishing between an assertion and the evidence supporting that assertion is well documented, as is the finding that young children also have difficulty articulating how they have come to know something (e.g., Flavell, 1999; Kuhn, 1999). Writing activity in Mrs. MacLean’s class was often an opportunity to be more explicit about one’s sources of information and to make a distinction between what one might conclude from prior experiences and what one could conclude on the basis of specific information. For example, on Day 2, as the children wrote about what they now thought about Lesley’s question (“will something heavy and something light always get to the bottom of a hill in the same amount of time?”), she was adamant that the children should use the data table to answer Lesley’s question. During almost every individual interaction as the children wrote, she first focused each child’s attention on Lesley’s question and then asked him or her to make a distinction between what the child might personally believe and how the data from the data table addressed the question. Below is a portion of a typical example of how Mrs. MacLean posed the task to a child (underlining signifies emphasis):

[Talking to one child while that child is working on a written reflection] Think about the question. Will something heavy and something light always… O.K. Looking from this table, not from your head, from this table... does this table say anything about... answer the question. What is this table’s answer to that question. If you think about this table... how does it answer the question? Are they coming down in the same amount of time or are they not? Well, that’s what I want you to write. Because that is what I want you to think about. What is this table’s answer to that question?

This push and stress to focus on “this table’s answer to the question” is reflected in most of the children’s responses on Day 2. Although a few children used the table in this way on Day 1, far more did so on Day 2; in fact, 9 of the 15 children for whom there are notebook entries stated that weight did not affect speed. Only three children maintained that the balls had reached the bottom of the ramp in different amounts of time and the remaining three children’s beliefs were indeterminable as their notebook entries were either incomprehensible or simply restatements of

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4 This question has since been revised to be “Can something heavy and something light get to the bottom of a hill in the same amount of time?”
the numbers on the data table. Bill’s entries are representative of the change in many of the children’s thinking from Day 1 to Day 2. On Day 1 he believed that weight would affect speed:

I think that something heavy and something light will’t (will not) roll down at the same tim(time) and not tie by rolling down a ramp because they are different.

Here, Bill was focusing on the issue at hand – the differing mass of the balls and their speeds. He also suggested that the reason for his statement that something heavy and something light would not “tie,” was because the balls “are different.” While this is not what a physicist would think, Bill did offer some justification for his belief. On Day 2 Bill wrote:

They went down at the same time but at different Trial. the Table Told me that the The 10 gram ball and the 50 gram ball are as fast and as good as each other. The 10 gram ball can go as fast as the 50 gram ball. It does not matter the Waight (weight).

Although Bill still did not yet express a scientific reason to explain why weight would not make a difference in this case, he used the data table to conclude that the 50 gram and 10 gram balls were “as fast and as good as each other.” His notebook entry indicates that he had learned to read the data table and make an interpretation of the data to answer a specific question.

We see a contrasting case in Adam’s writing. On Day 1, Adam’s notebook entry read: “The datea (data) Lesley made tells me that the ramp mate (may) of not bean (been) the same ramp.” With the writing, there is a diagram of a 50 g ball and 10 g ball, which are labeled, poised at the top of two different ramps -- the ramp with the 10g ball is lower.

As was the case for a number of students, Adam did not have an accurate understanding of the question Lesley was asking, nor of the procedure she had used. The context he represented suggested that he thought a lighter ball traveled faster than a heavier ball down the same ramp, and raising the height of a ramp would make the heavier ball travel faster. Thus, he accurately represented the outcome in Lesley’s table (equal times for balls of different mass) from the perspective of his prior knowledge. By Day 2 Adam no longer believed that Lesley had used two different ramps, and his writing indicates that he was reading the data across the rows, comparing the results for the balls at each trial. While doing this, he observed that the 10g ball and 50g ball “never tied.” Perhaps, despite activities class had engaged in to clarify Lesley’s data collection methods, Adam still thought the balls were going down the same ramp at the same
time as opposed to separate times. He therefore used the data table to say how he thought the speeds were different.

*the talbe (table) tlldo (told) me that naver tide (never tied). So I thank (think) the tiy wis rone (tie was wrong).*

The details provided above illustrate an opportunity Mrs. MacLean created via writing activity to engage the children in focusing on the data at hand, and making a distinction between what they might “think in their heads” and “the table’s answer” to a specific question. For many of the children, writing on Day 2 became, in a sense, a concrete instantiation of another viewpoint – literally an object for reflection\(^5\). We speculate that with a regular diet of activity of this sort we might see young children become more facile at articulating the sources of their ideas as well as becoming more conscious about the distinction between an assertion and the evidence for that assertion.

**Theme 3: Writing as a tool to assess the range of conceptual understandings in the class**

At any given point in the instruction, Mrs. MacLean needed to have a sense of the range of ideas held by the children. Whole class discussion was, of course, an effective means by which to acquire this sense, but there were points in the instruction when Mrs. MacLean seemed to want all the children in the class to have an opportunity to take a position in writing. This, of course, had the added benefit of allowing Mrs. MacLean more access to the range of understandings in the class. An example of such a time occurred on Day 9. At this point in the instruction, the class had read all of Lesley’s first notebook and most of the children had expressed the idea that a heavy and light ball had reached the bottom of a ramp in the same amount of time in Lesley’s experiments. They had also conducted their own investigations of the effect of ramp-height on speed as well as the effect of a ball’s speed on its momentum (as measured by how far a can placed at the bottom of the ramp was hit). On Day 9, Mrs. MacLean introduced the class to Lesley Park’s second notebook text called, *Clowning around Under the

\(^5\) In the subsequent academic year Mrs. MacLean taught this unit of study with a class of first graders. At about this point in the instruction she asked the first graders to write to a similar prompt. In their case, she asked them to fold their pieces of paper in half in order to write (or draw) what they thought Lesley would say, and on the other side what they would say. This would enable the children to engage in the meta-level activity of comparing two (possibly different) ideas about the same question.
Big Top: Moving Energy from Here to There. The new question Lesley was asking was about the relationship between mass and momentum. The situation which prompted this question was a circus act Lesley had seen (as depicted on the first page of Clowning Around, see Figure 3) in which clowns had failed in their attempt to hit a cake box far enough to reach a hungry elephant. This situation prompted Lesley to think about how she could get more energy to the cake box. Drawing upon their own first-hand experiences investigating motion down ramps of varying steepness, the children in Mrs. MacLean’s class immediately suggested changing the height of the ramp, but that had been ruled out as impossible in Lesley’s notebook.

Lesley proposed changing the mass of the cart; however, many of the children were skeptical about this idea because, in the first big book and in the class’ own first-hand investigations of mass and speed, mass had been determined NOT to make a difference in how fast balls rolled down a ramp. By the end of the discussion on Day 9 about the circus situation and Lesley’s proposal to change the mass of the clown cart, it seems that there was variety in the ways the children were making sense of the question posed by the circus situation. About a third of the 18 children, for whom there was writing collected on this day, did not write about the clown problem at all, but instead wrote about other relationships (usually correctly) pertinent to the inclined plane investigations (i.e. ramp-height – momentum, mass – speed, ramp-height – speed). Some of these children may have meant to imply that their thinking about another relationship
was analogous to their thinking about the clown context, but this was not explicitly stated. Four children wrote very explicitly that they thought changing the mass of the ball would not “make a difference” for the clowns because it had not made a difference for the sledders, in Lesley’s book, or during the class’ first-hand investigations. One other child wrote that, given that ramp height had made a difference, mass would not affect momentum, revealing some confusion about what could be considered an analogous investigation. Three of the children wrote about how they thought mass would affect momentum because of the increase in the amount of energy the heavier ball would have to give to the can and move it further. Two of the children expressed uncertainty about the situation. Here are a few examples of the children’s writing from this day:

Jeffrey’s writing about whether mass would make a difference in the new clown-cart situation showed the influence of his own first-hand experiences:

*I think the mass or the weight dose (does) not matter. Because we tryed (tried) it with a big ball and a little ball and they got to the end at the same tim (time).*

A second child, Jamie, referred to Lesley’s first notebook text to justify her opinion:

*I think mass dosesnt (doesn’t) make a diffrence (difference) in how the object moves. I think that because in the first book there were sleders (sledders) and they got to the bottom at the same amount of time and they were diffrent (different) weights.*

Sandra expressed the most strident skepticism of Lesley’s suggestion that changing the mass of the cart going down the ramp might affect how far the cake box was moved:

*I think that Lesley Park is wrong. You see in page 7 in number 2 book she thinks that weight matters. In book number 1 we figrured (figured) out that the weight does not matter.*

She then went on to offer an alternative suggestion that involved a transfer of energy:

*In book number 2 we are trying to figrue (figure) out what the curciuse (circus) cart with the clowen (clown) has to do to get the cake to the elephant. This is what I think: The clowen (clown) at the top of the ramp has to push the cart with the clowen (clown) harder. If the clowen (clown) pushes (pushes) the cart harder then it will give the car energy to give the cake energy to move to the elephant! That is what I think. The End*
Other children agreed with Lesley that mass might make a difference in how far the clown car would be hit. For example, Trevor, who struggled with writing, wrote:

*the little ball doeszit Go dawn the Can a mnt a Kos the Big is srgrlr thyne the little ball…”* (on this same page in Mrs. MacLean’s writing, we have what Trevor read that he had written: *The little (ball) cannot hit the can far because the big ball is stronger than the little ball.*

Jason not only supported Lesley’s notion that weight could affect how far a can would be hit, he also wrote a hypothesis about how the energy would be transferred to the cake box:

*yes the mass dos (does) make a difference in howe (how) far an object that it hits moves because (because) the wate (weight) gives it more enrgy (energy) and give the thing that it hites (hits) and gives the energy to the thing that it hits to make it go far.*

From these notebook entries we can see that most of the children in the class were grappling with the aspects of the new question that were the most pertinent: the balls’ mass, and the issue of energy getting to the cake box. Many were able to articulate their thinking about relationships among variables in the situation and often gave justifications for why they thought about the relationships in particular ways. Clearly the teacher played a significant role in the writing opportunities availed these students. The next features Ms. McLean’s orientation, specific to the use of writing in young children’s scientific inquiry.

**Themes from the Interview Data:**

In addition to content analyses of the classroom instruction, we also analyzed several hours’ worth of interview data with Mrs. MacLean on the subject of her thinking regarding writing activity in science instruction for young children. The results of these analyses essentially corroborated the findings from the instructional content analyses, and we therefore offer only a summary table of these results here. Several examples of Mrs. MacLean’s responses for theme from the interview data are provided.

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<tr>
<th>Theme</th>
<th>Examples</th>
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| **Focusing on a Specific Question Allows for Writing to Serve as a Thinking Tool** | • What guides me is the concept we're trying learn, and that's why I post those questions. “This is the question.” It is very easy to get, off, target. Simply because there's so much.  
• The focus is the question. … I kept posting the question. Because we had to focus any document and in writing so that it answers that question. If it doesn't the writing is |
<table>
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<tr>
<th>Questions Suitable for Inquiry Require Careful Crafting</th>
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<td>• You know this KWL thing, I’m not too fond of those because they come up with questions that don’t lead to anything that you can really and truly investigate in a focused way. And they are so scattered sometimes, so that if I ever do a questioning thing, I have already set the context, so that there are questions that they have to do and will lead to productive investigations because I don’t think it is fair that you get questions that you don’t pursue.</td>
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<td>• There is this general notion, or big idea that we should be pursuing children’s questions. And I think for some they interpret that (to mean that) any question that children ask, is fair game. On the other hand many of us say well we already have the standards. And there are certain concepts required in those standards and it is not just for the standards sake, I think to some extent they are fairly. I don’t know that they are perfectly thought of, but thought of with some kind of coherence maybe or that is probably a logical way to introduce things and we can build on some things in science. … Gordon Wells says that it doesn’t matter where their question comes from as long as they make it their own. Now that it has become their own, then even though it was my question or the Big Book question originally, … it then became their own question. And now they are answering the question that came from the Big Book. But it is a way, like the guided part, you have to put them as a kind of direction for a concept. So those drawings tell me whether they are proceeding in that direction, or is there a child who is totally out of it and how can I help him and that is what the drawings tell me.</td>
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<th>Writing Provides Opportunities to Interpret Data and Express How One has Come to Think in a Particular Way</th>
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<td>• You know what I like about science? It’s something special, because you’re always making a position that you’re either defending or refuting. It’s your position or somebody else’s. … You’re explaining how you got to a solution. … I don’t think there’s a place as clear as in science, that you have to (take a position) – it’s a claim that you’re either defending, or it can’t be because. you have to have a reason.</td>
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<td>• Most informational text in science don’t do that (take a position and defend it) well. But I think it’s what I ask the children to do. And I think I’ve become more and more like that since GI5ML. And probably, before (becoming involved in GI5ML), I would just end up with claims, (but now) I don’t think it’s too early for second graders (to be asked), “why do you say that?”</td>
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<td>• When we first started GI5ML, we reflected a lot on our own videotapes. And, at least for my teaching, the questions tend to be very very similar – like, &quot;why do you think that?&quot; But in reaction to – they have a claim and why are you thinking that? I'm asking them to illustrate and explain what their thinking is. But if you look at all those questions, it's almost like you're repeating the same thing over and over… (laughs)</td>
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<th>Children May be Able to Use Multiple Forms of Representation to Clarify their Ideas</th>
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<td>• By second grade, they can illustrate them – I think it’s become part of their writing. I think it becomes, the illustrations are more precise, and are clearer – it is clearer in terms of, it shows their thinking.</td>
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<td>• I am hoping that the children can use literacy purposefully, as a way, as a tool, for thinking. Now when they write (their ideas) down, that’s where they clarify their thinking. … Whatever claims they make in science, they’re really hanging in the air until they draw. Now they have to decide, what am I going to draw. I think I take that from my adult point of that until I write something, especially these last five years, to</td>
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What we see here is a highly experienced and accomplished teacher advocating for providing young children with quite specific questions and writing prompts, rather than for asking open-ended questions or soliciting a long list of child-generated questions. Her rationale for this approach included the notion that she would not want to ignore any child’s question, as would eventuate with an extensive list. In addition, she recognized that asking a question suitable for empirical inquiry is a highly challenging task and that children taking ownership of the questions posed may be more important than the origin of the question. In other words, for Mrs. MacLean, a child can take ownership of questions that did not originate with that child and can become highly engaged in the inquiry based on such questions. She also discussed the importance of young children’s drawings. As she put it, “whatever claims they make in science, they’re really hanging in the air until they draw.” For Mrs. MacLean, then, the act of writing in science for young children includes making drawings, in fact perhaps privileges drawings as a means of communicating ideas. In addition, the fundamental purpose of having the children write during scientific inquiry is to help in the process of clarifying one’s thinking. The communication of that thinking then becomes important as children check for “the CAP” in their writing (i.e., whether it was “clear, accurate, and precise”) and use various forms of representation.

**Discussion**

**Purposes for and characteristics of the writing activity**

In this paper we have presented descriptions of children engaged in writing during inquiry-based science instruction. As we have seen, the children grappled with many challenging aspects of investigating the motion of balls down inclined planes. Their writing activity served multiple purposes, including giving the children opportunities to review and consolidate their ideas as well as opportunities to reformulate and extend their thinking. The writing also served as a means of on-going assessment of the children’s thinking, upon which the teacher modified her instruction and shaped whole class discussions. In other words, the children’s writing, and the
writing done in the context of whole class instruction, was integral to the instruction and served to advance the scientific inquiry process in which the class was engaged.

An interesting characteristic of the writing activity in Mrs. MacLean’s class was the relative preponderance of whole-group writing activities. Indeed, the children were never asked to work completely independently on writing tasks. From a sociocultural perspective, having multiple shared experiences involving activities such as predicting outcomes, recording data, critiquing investigations, and formulating claims can benefit children because they may see their peers and their teacher thinking and working in ways just beyond their independent performance levels -- it is through social interactions of this kind that learning can occur.

The writing activity in Mrs. MacLean’s room was not open ended; rather, she guided her students to particular kinds of writing tasks. For example, Mrs. MacLean did not emphasize the writing of investigative procedures. This choice was motivated by her desire to have children use writing activity as a means to think about their understandings of the relationships under investigation. This choice may also have had pragmatic considerations in that the mechanics of writing can still be quite cognitively consuming for second graders and Mrs. MacLean wanted the children’s thinking focused on the scientific ideas at hand. Understanding investigative procedures is, of course, an important aspect of scientific inquiry, and there will often be value in asking children to write out the procedures they have done, particularly when different groups of children use different procedures. But, in the case of Mrs. MacLean’s class, focusing on the investigative questions was arguably a more productive tack.

An aspect of the children’s writing activity that was not constrained was the form that the writing should take. Children were highly encouraged to draw as well as write about their ideas, but Mrs. MacLean did not dictate whether children should use particular sentence starters, particular forms of diagrams or graphic organizers. She did not even ever explicitly suggest making comparative drawings (although these were modeled in Lesley’s notebook), and yet many of the children often drew comparison cases to communicate their thinking about the relationships under investigation.

We suggest that the kind of writing in which Mrs. MacLean’s class was “writing to think” which can be characterized as having as its focus fairly specific conceptual questions. We think it useful to distinguish this kind of writing from other forms of writing that are sometimes encountered in early elementary science instruction. To do this we have combined two continua
borrowed from a study by Baxter, Bass and Glaser (Baxter et al., 2001). These continua were used separately to describe teachers’ orientations toward in science (from “open” to “guided”) and to characterize writing prompts (as being more or less “product” or “process” oriented). We have slightly modified and combined them to make a four-celled diagram for characterizing a variety of writing in which one might consider having young children engage (see Figure 4).

![Figure 4. Model for characterizing inquiry-science writing-tasks.](image)

Baxter et al. (2001) used the idea of “open” investigations to refer to investigations for which students posed the questions and designed the experiments. “Guided” investigations were those for which a question was posed and children were given a set of procedures. In our model, we are contrasting the focus of the writing activity as being more or less “open” as in “open-ended” or more or less “guided” as in focused on a question most likely posed by the teacher. The second axis of our model has as its anchors the words “product” and “process.” In Baxter et al.’s study, teachers’ approaches for having their students write about an investigation were considered on the “product” end of the continuum if children were being asked to
document the investigation (often as if for an audience unfamiliar with the investigation). Tasks that were on the “process” end of the continuum asked children to interpret the data from their investigations. Our way of using these notions is quite similar with “process” tasks being those that emphasize making sense of an investigation, and “product” tasks being more for either demonstrating mastery of specific ideas or communicating something about the investigation in a more formal way, such as a report. We would say that most of Mrs. MacLean’s writing tasks fall into the “guided-process” quadrant, in the sense that there was generally only one question posed and it was generally of Mrs. MacLean’s (or Lesley’s) crafting, and that the emphasis was on making sense of the investigations and interpreting data. Our purpose here is to suggest that thinking about writing in this way may be helpful for clarifying the purposes for and approaches with which one is having children engage in writing. It is not to say that any particular writing form is always preferable to any other – all writing tasks have affordances and constraints – the key is to maximize the potential benefit of both.

**Instructional implications**

Several instructional implications can be derived from the research reported in this paper. For example, teachers may wish to think about using writing during inquiry based science instruction for some of the following purposes:

- as an assessment of individual children’s thinking and ability to communicate their ideas in written form
- to assess the range of conceptual understandings in the class to better plan instruction
- to provide grist for a whole-class discussion
- to review and consolidate learning

In addition, they may find employing some of the following strategies helpful when asking children to engage in “writing to think” tasks:

- posting a focus question for the writing
- de-emphasizing writing about the procedure the children used and focusing on the big ideas
- encouraging the use of abbreviations
- suggesting ways to communicate ideas (e.g., contrasts) in diagrams
- keeping class-generated brainstorming and data sheets posted in the classroom to provide environmental print
Concluding thoughts

While not denying the importance of learning various genres, we approach writing in science less from a language arts perspective and more from the premise that writing and science content learning may be synergistically linked. Writing can be used to express ideas, but used in ways that may be more directed than in the tradition of Britton’s “expressive” writing (“explaining something to oneself”) but not as formal as being of a specific scientific genre. In addition, young children’s writing can serve multiple purposes within inquiry-science instruction. Young children also demonstrate that they are quite capable of incorporating more than prose, or narrative descriptions of what they have done in their science writing. Form is, of course important, but more important at the early grades, is, we think, inculcating the habit of writing in order to communicate ideas. In the realm of science, we think it is most important that children practice to justifying their ideas with evidence and have opportunities to communicate their understandings in writing.
References


