Clinical Forum

Investigating the Engagement and Learning of Students With Learning Disabilities in Guided Inquiry Science Teaching

Annemarie Sullivan Palincsar
Kathleen M. Collins
Nancy L. Marano
Shirley J. Magnusson
University of Michigan, Ann Arbor

Abstract: Contemporary reform efforts pose numerous challenges and opportunities for educators and students. The reforms, reflected in the curriculum frameworks associated with each of the major subject matter areas (mathematics, science, language arts, and social studies), call for more rigorous content, higher standards, and teaching for deep understanding such that students will engage in successful reasoning and problem solving, not only in the context of school, but in everyday life and as lifelong learners (cf. American Association for the Advancement of Science, 1989; National Council of Teachers of Mathematics, 1989; National Research Council, 1996). This ambitious agenda is made all the more complex by the concomitant call that these standards define the

The research was conducted using an array of ethnographic methods. The findings were summarized in a set of claims concerning the engagement and learning of these students. Finally, cases of individual students were constructed to illustrate these claims. The article concludes with the case of one fourth-grade student as he engaged in a program of study investigating why objects float and sink. The case revealed (a) the ways in which, in the context of guided inquiry, the student achieved a number of positive outcomes; (b) how his learning problems, principally with regard to print literacy, revealed themselves in his activity; and (c) how contextual features served to enhance and deter his engagement and learning, as well as the engagement and learning of others.

Key Words: Learning disabilities, cognitive engagement, science education, teacher mediation, classroom interventions
expectations for all students. For example, the reauthoriza-
tion of the Individuals with Disabilities Education Act
(IDEA, 1997) mandates that students with disabilities have
access to these curricula.

As the title of this clinical forum suggests, enabling
students with special needs to realize success in contempo-
rary inclusion classrooms requires collaboration. The
research described in this article has been designed for the
purpose of exploring the possible nature of this collabora-
tion. Who might collaborate in the service of included
students and toward what ends? What role might primary
collaborators assume to advance the learning of identified
students? How should the process and outcomes of these
collaborations be evaluated? These questions have guided
the research reported in this article for the past 3 years.
Specifically, the research has been conducted in fourth- and
fifth-grade classrooms during science instruction. This
research has been possible because of the collaboration that
the researchers have established with the general education
teachers working in these classrooms.

GUIDED INQUIRY SCIENCE

Virtually all contemporary educational reform documents
call for the teaching of science to be inquiry based. The
assumption guiding this mandate is that as students engage
in inquiry activity, they acquire the knowledge, skills, and
habits of mind that will enable them to come to deep
understanding of the big ideas in science and to become
facile with the process of engaging in scientific reasoning.

Although there are various instructional models that reflect
the teaching of science as inquiry, the orientation guiding
the instruction featured in this research is called Guided
Inquiry supporting Multiple Literacies (GiML) and is
reflected in the heuristic presented in Figure 1. (For a more
complete description of this heuristic and the instructional
implications, see Magnusson & Palincsar, 1995.)

The heuristic is organized according to phases of
instruction set within a particular problem space, that is, a
guiding question that is broad and identifies a general
conceptual terrain (e.g., How does light interact with
matter? Why do things sink and float?). Inquiry proceeds
through cycles of investigation guided by specific questions
(e.g., How does light interact with mirrors?) or a particular
phenomenon (e.g., shaping a ball of clay to hold the most
weight). Integral to this orientation is the conception of the
classroom as a community of inquiry (cf. The Cognition
and Technology Group at Vanderbilt, 1994; Wells, 1995).
Hence, the investigations and documentation of data
gathered in the course of the study are conducted in pairs
or small groups. Furthermore, a critical feature in the
instruction is the reporting phase, during which the
investigative teams share their data, speak to the evidence
they have gathered to support or refute extant claims, and
contribute new claims for the class's consideration. The
curved lines represent a cycling phenomenon in which
students experience the same phase repeatedly in the same
or different contexts. This is the recursive aspect of
instruction that is required to promote meaningful learn-
ing—particularly with respect to scientific inquiry. For
example, one needs sufficient experiences examining

Figure 1. The Guided Inquiry supporting Multiple Literacies heuristic.
designered to provide occasions for interaction, joint deliberation, and the collective pursuit of shared goals, particularly with regard to the teaching of science in the elementary grades.2 (For a complete description of this professional development effort, see Palincsar, Magnusson, Marano, Ford, and Brown, 1998.) The teachers represent 14 schools in six districts, one of which serves a rural community, two of which serve urban communities, and three of which serve suburban communities.

Conversations with these teachers regarding the engagement and learning of students with learning disabilities in the context of guided inquiry teaching have been useful for focusing attention in the course of conducting research in these classrooms. For example, on August 7, 1998, during a focus group discussion with a subset of five upper elementary (grades 4 and 5) teachers, they were asked to identify the opportunities and challenges of GIsML instruction for students with special needs. Several excerpts will provide readers with the flavor of this discussion:

**Nan:** I think about the hands-on aspect of GIsML instruction. These children many times need that touching, tactile, kinesthetic experience. Sometimes it helps them get into the abstract concepts by beginning with something to touch...to try out...the what ifs.... So many times, the kids who don’t participate in the discussions or share their ideas do participate here. Something to manipulate makes them less self-conscious so they begin to talk a little bit and share their thinking. Having something in their hands or something to try out and do seems to make all the difference for them.

**Doris:** I think the identification of these kids with being scientific thinkers is powerful for these kids. They recognize themselves, sometimes for the first time, as being thinkers...then language emerges and a belief that they can write. The opportunity to draw and label as they investigate is a good starting point.

**Kim:** I didn’t have any learning disabled kids in my class last year. All the identified kids were emotionally impaired. I did have a couple of attention deficit kids and those kids were the ones I focused on last night in preparing for this meeting. (We had asked the teachers to recall the experiences of several of their identified children in preparation for this focus group discussion.) GIsML was helpful for them because lots of times you don’t get a true assessment of what’s going on in their heads on paper because they don’t have the patience to get their thoughts down. During the public sharing (a phase of GIsML instruction), it allows you to press them on their thinking a little bit and allows them to make themselves known within the classroom as having thoughts and ideas. Difficulties with spelling and reading can be real issues, but this gives them another place to shine.

These teachers’ remarks informed the data collection process documenting the involvement of identified children in GIsML instruction. For example, the research was designed to look for evidence and counter-evidence regarding the teachers’ claim that these children can reveal

---

1 There were 18 teacher participants the first 2 years of this work (1996–1998) and there were 14 active participants the third year of this work (1998–1999).

2 The participants in this community of practice met biweekly (for 4 hours each meeting) during the 2 academic years from 1996–1998, and once monthly during 1999. In addition, they committed 2 weeks of full days during the summers of 1996 and 1997 and 1 week during 1998.

---

**Research Context**

The context in which this research has been conducted has provided the opportunity to learn in collaboration with general educators who were committed to learning how to teach science effectively from a guided inquiry perspective.1 This professional development project has been associated with inquiry-based approaches to science learning disabilities require significant coaching to engage productively in the kinds of reasoning that are typically characteristic of scientific literacy (cf. Driver, Guesne, & Tiberghien, 1985; Lemke, 1990; White & Frederiksen, 1998).

Research investigating the experiences of students with learning disabilities in guided inquiry science instruction is sparse, and little of it is classroom based. Carlisle and Chang (1996) concluded from their classroom research that students with learning problems fare poorly and express doubts concerning their capacity to perform successfully in these classes. The potential for students with learning disabilities to profit from inquiry-based experiences is signaled in the research of Dalton, Morocco, and Tivnan (1997), who found that students showed greater attainment of conceptual understanding in an inquiry-based condition when compared with an activity-based (essentially un-guided) condition; however, the students with learning disabilities did not demonstrate the same conceptual growth as their non-identified peers.

Explanations for the difficulties experienced by students with learning problems in the context of science instruction vary and suggest different forms of intervention. For example, Gersten and Baker (1998) recently argued that students with learning disabilities must become “fluent with essential factual and conceptual knowledge” (p. 24) before they can profitably engage in inquiry-based instruction. Furthermore, Woodward and Noell (1991) and Mastropieri, Scugghs, and Butcher (1997) argued that students with learning disabilities require significant coaching to engage productively in the kinds of reasoning that are typically associated with inquiry-based approaches to science instruction. These findings suggest the following questions:

- What constitutes helpful guidance for students with learning disabilities in science instruction?
- How can guided-inquiry instruction promote the conceptual development of students with learning disabilities?
- What would enable these students to profit from the opportunities guided inquiry instruction appears to provide students who do not have learning disabilities?
more about their thinking during the investigation phase of GIsML instruction than might be revealed in formal assessments or in the writing the students do in their notebooks. In addition, the teachers have contributed to shaping the research agenda guiding this work:

**Researcher:** What other kinds of questions would you like to see this work answer that you haven’t heard on the table yet? Are there questions that if you just had the luxury of leaving behind your role as a teacher and could become a researcher exclusively in your classroom, what would you be curious about?

**Nan:** What are their self-perceptions? How do they see themselves as learners? Some of them clearly know by the third or fourth grade that they’re not making it as well as some of their peers, so what have they internalized? What are their self-conversations all day long when situations come up? I think that many of them spend a lot of time avoiding revealing their deficiencies.

**Fran:** And even, are they aware of them (in reference to deficiencies) and how aware? Keith came to me at the beginning of the year and said: “How do kids know that stuff?” He actually verbalized it. It was such a shock to him that other kids knew all this stuff. He was truly puzzled.

**Jasmine:** I’d like to have some thoughts on how the children themselves could advance this process. I saw some children during the light investigation really pressing their peers to speak more or to push their thinking further.

### The Investigation

Recall that the overarching purpose of this research was to investigate the engagement and learning of students who have been identified as having learning disabilities as they participate in guided inquiry science instruction. The vehicle used to conduct this research was the construction of case studies of included students in the context of guided inquiry science teaching. The specific questions guiding this inquiry included:

- What are the opportunities and challenges that GIsML instruction presents students with special needs?
- How do students with special needs respond to these opportunities and challenges?
- What hypotheses emerge from the data that will usefully guide subsequent research investigating the means of mediating students’ participation in GIsML for the purpose of enhancing their engagement and learning?

Typically, teachers instructed a GIsML program of study over several weeks (2–5 weeks) on a daily basis for 45 minutes to 2 hours per day (dictated by scheduling constraints and teacher preference). The research methods employed reflected a range of ethnographic procedures including (a) videotaping, (b) focused observations documented by participant observers using field notes, (c) debriefings with the teacher following instruction, and (d) structured interviews with the identified children.

Prior to beginning the GIsML program of study, each teacher identified the students for whom there were individualized educational programs. Typically, there were three identified children in each classroom, with an additional two or three children who the teacher had referred for evaluation, or was considering referring, principally because of concerns with academic achievement and/or behavior. The teacher determined how these students were grouped for the purposes of small-group work.

**Observational research.** One focus for the observations was the entire class. This focus was more or less problematic depending on the participant structure in place. For example, within GIsML instruction, there are several phases when the participant structure is whole-class presentation and/or discussion (e.g., during the presentation of the question/challenge/problem that will guide the investigation, when planning for the investigation, and when the children are reporting and comparing the outcomes of their inquiry). There are other phases when the students are working primarily in small groups (e.g., during the investigation activity, when preparing to share the results of their investigation, and when generating claims they wish to make following their investigations). The researcher followed the teacher during both whole-class as well as small-group activity (using a video camera and field notes). In addition, there was a sound system that was adequate for capturing students’ participation in these whole-group activities.

During the small-group activities, a researcher continued to follow the teacher (who was wired with a remote microphone) while other researchers focused on the activity of the identified students, rotating attention from one child to the next in 15–20 minute intervals. If the observer found the child to be totally disengaged in the activity of GIsML instruction for a 5-minute period, the observer intervened for the purpose of exploring procedures for reengaging the student, starting from low-level intervention and proceeding to more supportive intervention, only to the level necessary to reengage the child. An example of a low-level intervention would be asking the student to explain what he or she is doing. A more high-level intervention would include offering to record the child’s thinking if he or she appeared to have writing difficulties. The nature of the support as well as the student’s response to the intervention was recorded in the field notes.

In addition to characterizing the opportunities and challenges associated with GIsML instruction, the research was designed to determine how students with special needs responded to these opportunities. Some of the data useful to answering this query result from the classroom data described above. However, to understand what the students, as individuals, acquired in the way of scientific concepts and the ability to engage in scientific reasoning as a function of their GIsML experiences, the classroom data clearly needed to be augmented with additional data. These data included (a) formal assessments that were administered pre/post-GIsML instruction, (b) individual interview data, (c) artifacts that were generated by the students in the course of GIsML instruction (e.g., student notebooks, posters, and other forms of writing), and (d) video records and field notes.

**Formal assessments.** There were three formal assessments administered to all student participants in each class: a standardized reading assessment measuring vocabulary...
knowledge and comprehension, a pre- and post-assessment of the students’ conceptual understandings of the topic of the program of study, and a measure that assessed children’s attitudes toward and beliefs concerning the nature of science and scientific problem solving.

Relative to the identified students, these formal measures were used for several purposes. One purpose was to gather information regarding children’s prior knowledge. These data informed the teachers’ thinking and decision making as they planned the program of study with the university-based researchers. A second use was to compare the entering knowledge and beliefs of identified children with those of their unidentified peers. And, of course, a third reason was to be able to assess changes in students’ thinking following the program of study. However, these are all fairly static measures that do little to inform the issue of how children have come to these attitudes, beliefs, and understandings. The remaining three data sources (individual interviews, artifacts, and video records and field notes) were useful for addressing this question.

**Individual interviews.** Each day, following the instructional session, the identified children were interviewed using the following set of questions:

- What happened in class today?
- What did you do today?
- What did you learn about (topic under study)?
- Was there anything helpful to your learning today?
- Was there anything that was unhelpful to your learning today?
- What would have been helpful to your learning today?
- Is there anything else you would like to tell us?

Engaging the students as informants served the following purposes: The interview provided the occasion to ascertain the child’s perspective on the day’s events, the child’s comments enabled elaboration on the field notes for the day, and, finally, the child’s reflections on the day’s events could be juxtaposed with the other records of the day’s events.3

**Student artifacts.** The artifacts, including student notebooks and the posters completed by pairs of students, provide another window on the child’s thinking and learning throughout the instruction. It was not uncommon for a child in a small-group activity to assert to the position of the group on an issue, but to then reveal in her own notebook entry that, in fact, she had a more accurate or complete conception than did her peers. These artifacts were also invaluable to learning more about the mediational means and semiotics that children draw upon in resourceful ways when traditional writing is ineffective for them.

**Video records and field notes.** Finally, the (partial) video record and field notes were integral to “getting another look.” Specifically, these tools were essential when trying to fill in the details regarding the day’s events, or when checking on the relationship between the child’s account and the events as they appeared to unfold to an observer.

### Constructing a Case Study

Following data collection, the next challenge was the design of the case studies themselves. Working from the multiple data sources described above, the goal was to represent the experiences of each child in a manner that captured both the activity of the child and the context in which this activity was unfolding. Furthermore, there were many possible foci for each case study. To guide the construction of the cases, the researchers began by generating a set of claims about the opportunities and challenges that students with learning disabilities experienced in GisML instruction. For each claim, there was supporting evidence derived from the data.

Table 1 presents a set of claims and supporting evidence derived from the analyses of observational and artifact data collected on five identified students in one fourth-grade classroom. This class was engaged in the GisML program of study that examined why objects sink and float. Much of the investigation focused on (a) constructing and manipulating the Cartesian diver system (CDS),4 (b) working within small groups to construct an explanation for how it is that the diver within the CDS can both float and sink, (c) designing posters to share the group’s explanation with the class, and (d) participating in whole-class presentations and discussions regarding the CDS.

The five students for whom data were collected included four students who were identified as having learning disabilities and one student whose parents refused school services for the learning disabled, although she had been identified as having learning disabilities and was being provided supplementary support outside of the school setting. Table 1 suggests that there were different classes of claims that arose as the profile for each child was analyzed. Some of the claims were related to opportunities that were fostered or denied as a consequence of the children gaining entrée to the activity; other claims were related to the students’ responses to the print literacy demands. Data used to support these claims were drawn from a broad range of sources, including observations that were gathered in real time via field notes or that were constructed later with the use of video records, interviews with the children, and the students’ artifacts.

These claims were then used to inform the design of the individual case studies. The case of Don, presented in the following section, illustrates the pattern demonstrated by a number of identified students who experienced difficulty documenting their thinking in the course of the inquiry.

---

3 We are keenly aware that these individual interviews are themselves a form of intervention. We have frequently observed children using these interviews as occasions for “rehearsing” ideas that they will subsequently bring to the classroom (e.g., the day after the interview).

4 The CDS consists of a small test tube (referred to as the diver), partially filled with water that is inverted and inserted in a larger test tube that is completely filled with water and then capped with a piece of rubber sheeting. As the child presses on the rubber sheeting, the air in the small tube compresses, allowing more water in the diver, which then changes the density of the diver relative to the total system and causes it to sink. When the pressure on the rubber sheeting is removed, the reverse process occurs and the diver floats.
This case illustrates how these students were able to participate more fully and reveal more about their conceptual understanding when they were (a) supported in the writing activity by others who could assist them to navigate the print literacy demands, (b) given the opportunity to document graphically, and (c) provided access to environmental print. The ultimate goal in the construction of these individual cases was to use them in conversations with general educators and educational specialists, including speech-language clinicians and resource/consulting teachers, to identify the kinds of interventions that might be implemented in general education settings. These interventions would then enhance the learning of included students. The second purpose was to illuminate the kinds of roles that educational specialists might play in the students’ education. These issues will be addressed in the discussion section.

**The Case of Don**

Don, a fourth grader aged 10:8 (years:months), was identified as “profoundly learning disabled” by the school psychologist. Exacerbating his school-related difficulties was high absenteeism due to severe bouts of asthma. Descriptions of his learning disability included poor fine motor skills contributing to his difficulty with the mechanical aspects of writing and significant delays learning to read and understand text. He had been receiving resource consulting services from a teacher for students with learning disabilities since first grade. In the fourth grade, these services included three 1-hour periods per week that were focused on reading instruction. Results of the standardized reading achievement test administered at the beginning of fourth grade indicated that Don was in the eighteenth percentile on the vocabulary measure and in the

<table>
<thead>
<tr>
<th>Claim</th>
<th>Evidence</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>The participation of the identified students was influenced by the nature and amount of appropriate assistance or intervention received.</td>
<td>Positive evidence: Gail, Don, and Buddy (Gail not actually identified) Negative evidence: Abe and Ardis</td>
<td>Field notes/close observation; videotapes; some trial intervention with Ardis</td>
</tr>
<tr>
<td>Students who struggled with writing were supported in participating fully when assisted with the documentation of their thoughts.</td>
<td>Buddy’s and Don’s initial notebook attempts and their subsequent responses</td>
<td>Videotapes; journals; close observation/field notes</td>
</tr>
<tr>
<td>Students who struggled with writing were supported in participating fully when given the opportunity to document graphically.</td>
<td>Don’s journal—graphics of diver show evolution of his argument</td>
<td>Journal; close observation/field notes</td>
</tr>
<tr>
<td>Environmental print and graphic documentation served to support students who initiated using it; this could be developed and its use made explicit for other students as well.</td>
<td>Buddy’s test strategy and Don’s journaling — both graphic and written</td>
<td>Close observation/field notes</td>
</tr>
<tr>
<td>Participating—gaining access “to the floor,” to the investigation materials, or to the approval and support of peers—was difficult for these students in both small- and large-group contexts.</td>
<td>All of the identified students except Gail</td>
<td>Close observation/field notes; videotapes; student interviews (Don and Buddy)</td>
</tr>
<tr>
<td>The ability to learn from large-group discussions was difficult for these students unless they were provided concrete support (e.g., a discussion guide, notes on board/overhead projector).</td>
<td>Don and Buddy’s self-report of this; lack of engagement of the others (especially Abe)</td>
<td>Videotapes; interviews (Don and Buddy)</td>
</tr>
<tr>
<td>The opportunity to engage in one-on-one discussion, particularly with the teacher, seemed important for these students for engagement, development of thought, and as a rehearsal for sharing with others. Peer discussion did not work as well.</td>
<td>Abe—who did not ever truly engage—is an extreme example of what happens without this type of support. Don and Buddy exemplify how these opportunities (when they are recognized by the teacher) can support students in entering large- and small-group discussion.</td>
<td>Close observation/field notes; videotapes; interviews (Don and Buddy)</td>
</tr>
<tr>
<td>Given appropriate social and cognitive supports, which do not appear untenable in a classroom setting, these students were able to participate and express an understanding of floating and sinking during the activity.</td>
<td>Buddy, Don, Ardis, and Gail (seemed to support self with journal)</td>
<td>Videotapes; close observation/field notes; interviews</td>
</tr>
</tbody>
</table>

---

Table 1. Claims, evidence, and supporting data emerging from observational research for the five included students: Gail, Don, Buddy, Abe, and Ardis.
first percentile on the comprehension measure when compared with other students his age on whom this test was normed. Don’s performance on the pre-assessment of conceptual understanding placed him in the bottom third of the class; however, his performance on the post-assessment (completed 6 weeks following the pre-assessment) placed him at the mean for his class. In other words, Don achieved a level of conceptual understanding that was consistent with that attained by the average achieving peers in his class.

The following case description examines how Don engaged in the program of study on floating and sinking (described previously), including the challenges he confronted, the kinds of assistance that were provided to him, and his response to that assistance. To begin, an observation is provided that occurred before the teacher started the GIsML instruction.

Fourth grader Don S… sits at his desk—which is aligned with those of five other students to form a table—hunched over his journal. His teacher has just told the class to review their journals and to select an entry they wish to share. Don flips through the pages of his notebook, each entry about 1/2 of a page long, stops briefly to reread one with the heading “My Pets” softly to himself, and then turns to an empty page. He writes “Christmas” at the top of the page, and then slowly begins to write a description of the gifts he received. Don’s pencil moves slowly across the page and he pronounces each letter name softly to himself as he writes it. He stops often to look around the walls of the room. Beginning a sentence related to his computer, Don pauses, and pulls a magazine from his desk. He flips quickly and assuredly through the advertisements and stops at one for Sega Genesis. With the magazine open on his desk, Don puts one finger under the word “Genesis” and, again pronouncing each letter name to himself, slowly writes the word in his journal. Don repeats this process, using the same magazine, throughout the construction of his journal entry.

This observation indicated that, although independent writing may be challenging to Don, he brings a number of strategies to this task. For example, he attempts to independently sound out the words and he draws on the environmental print (available on the walls and other text sources) to assist him with spelling.

Four days after this observation of Don’s approach to writing, his class began a guided inquiry investigation into the nature of density, floating, and sinking, which spanned several weeks. On the first day of instruction, Don’s teacher, Ms. Jentzen, asked the class to identify items that they thought would float, sink, or sink and float. After the class created a list of items, she asked them to identify what characteristics contributed to an object’s sinking or floating. These conversations lasted 15 minutes, and Don’s only contribution was the nomination of a “printer” as an object that would sink.

Next, Ms. Jentzen showed the class the CDS and asked them to predict what would happen if she pressed on the rubber sheeting at the top. Don volunteered, “I think when you press down on that (rubber sheeting) the tube will go down because of air pressure.”

Although Don’s initial contributions to the classroom discussion may be meager, his conjecture that “the tube will go down because of air pressure” reveals that Don is cognitively engaged in the problem at hand and, in fact, is bringing a relevant scientific concept to his prediction.

Ms. Jentzen then told the students to behave like “a class of research scientists” and to build their own diver systems. She explained that the diver was a good example of something that sinks and floats, and asked them to determine, “Why or how can it do that?” The students then constructed their own diver systems in pairs of two. Don constructed a working CDS in three attempts and was able to assist another student at his table to construct one as well. After constructing a working system, Don was reluctant to set it down or to end the investigation, stating, “I’m trying to figure out how this works by looking at it.” In his lab notebook, Don wrote “I Thank you pis don it gobo up” and drew a picture of the CDS (see Figure 2).

Don’s activity during the engage phase of GIsML is noteworthy. Although other children struggle to build a sensitive CDS successfully, Don is successful on his third attempt. Furthermore, his success with this activity provides him an occasion to share his expertise with other members of his class. Don’s reluctance to leave the building activity to make his lab notebook entry may be a reflection of the success that he was enjoying, in hand with a reaction to the challenges he is likely to confront while writing his notebook entry. Don’s initial entry is lean and does not address the teacher’s query: why or how can it (the CDS) do that (sink and float). We know from the initial class discussion that Don has some productive ideas concerning this explanation, but these are not revealed in his written entry.

The following day, the class conducted a similarly structured firsthand investigation using another version of the diver, called the Australian system, which is an inverted CDS that operates on the same principles as the original CDS. Ms. Jentzen began by asking the students to draw the Australian diver in their lab notebook: “In your journals today, please draw the Australian...
dive and label it.” A graphic of this dive remained at the front of the room during the day’s firsthand investigation.

When his first attempt at constructing the Australian CDS didn’t work, Don noted out loud that it was due to the “empty balloon.” (The students had used rubber sheeting, not a balloon, during the first day’s investigations.) After his second attempt, which included wetting the balloon, Don noted that the dive was “bobbing” within the system and wouldn’t sink. Don again completed a working diver system on the third try. After completing the working CDS, he quickly took it apart, stating that he was going to “try to make one under water.” When he again succeeded, he announced, “Awesome! We got some air in there!”

At this point, 36 minutes into the lesson, Ms. Jentzen instructed the students, “Please see if you can come up with some claims for both the Cartesian and the Australian divers and how they work.” Don began by drawing a picture of the Australian CDS. He then slowly wrote, “I think that if you press down it well” and then paused, looking around at his tablemates and the room. Noting the difficulty Don was having, as well as how Don’s verbal prediction had varied in length and complexity from his written lab notebook entry on day one, a research assistant asked Don if he wanted assistance writing in his notebook. He readily agreed and dictated the following, which she transcribed verbatim, “I think that if you press down on it, it will go down. If you leave it, it will stay at the top. And if you leave it straight on your desk it will balance in the middle” (see Figure 3).

These events are interesting in several respects. First, Don continues to demonstrate his skill and the enjoyment he experiences with the engineering aspects of this activity. Don is clearly thinking about the mechanisms at work in the CDS when he observes that the reason the Australian system is working differently (at first) is because of the “empty balloon”; furthermore, he notes with glee that the reason the system worked then was because of the presence of air. It is entirely conceivable that, if a teacher were not within earshot of Don, she would have no way to recognize the productive thought in which Don is engaged or the level of conceptual understanding that he reveals in his spontaneous comments. This is especially true if the teacher is left to rely on the written entry that Don makes in his notebook, which is initially incomplete and reveals nothing concerning the fact that Don has essentially “discovered” neutral buoyancy through his manipulation of the CDS. On the other hand, with fairly minimal assistance with transcription, we get a much richer picture of Don’s thinking.

The next day, Ms. Jentzen instructed the students to go back to their earlier lab entries and the systems themselves, and to work as a team to make claims about why the divers behaved the way they did. Don asked a research assistant for assistance and again dictated an entry into his lab notebook, “When you press down the water level in the diver goes up so the diver has the ability to sink.” The research assistant then read the

Figure 3. Don’s second notebook entry and transcript.
entry out loud to Don, and he said, “Wait a minute,” and changed “down” to “up.” He then dictated two additional sentences. The revised entry read, “When you press up on the balloon water level in the diver goes up so diver has the ability to sink. When you don’t do anything the water level goes down so the diver goes up.” Don then drew four depictions of the CDS (see Figure 4).

This entry is significant for several reasons. First, it is noteworthy that Don seeks assistance with the writing on this day. Furthermore, he engaged in editing his work. Finally, the length and completeness of this entry is improved.

The next day began with more time for the students to work on preparing their posters for sharing. Don responded to this opportunity by observing his CDS with two members of his group, Abe and Noreen. Noreen had commandeered the poster and was trying to write a claim on it when Don and Abe interrupted with the CDS, and insisted that she document that the “air was squished,” and “the air was compacted by the water pushing it,” offering her the diver as evidence. Soon after this, the class reconvened to listen to two groups share their posters. Ms. Jentzen again began the class by allowing the groups time to “revise their claims” based on the sharing they had heard the day before. Ms. Jentzen repeatedly emphasized that they were to try to determine why the diver sank and floated, and to express this reason in a claim. Noreen again

![Figure 4. Don’s third notebook entry (transcript and revision).]
took over the writing of the poster for Don’s group. Don again tried to contribute to the poster, insisting that Noreen document the importance of air bubbles in the system. When he was not responded to, Don first took the CDS and said he was going to “take it apart and see how it works.” He didn’t take it apart, however, but instead walked over to another group with his thumb on the balloon, poised to sink the diver, and challenged, “Race you!” Later, he came back to his group and picked up his notebook. He asked a research assistant to help him write, but then said he wanted to do it by himself. He added to his previous entry, “Why bcus The air gets smoler so it can sek” (see Figure 4).

These observations are significant for a number of reasons. First, they reveal a troubling pattern that emerged across a number of the cases that we have constructed of identified students in GIsML instruction (see Palinscar, Magnusson, Collins, Marano, & Hapgood, 1999). Despite the fact that Don had a number of important contributions to make to his group’s poster, he has difficulty gaining entrée to the construction of the poster. Don’s thinking about the role that the air bubbles are playing in explaining the behavior of the CDS has the potential to advance this group’s presentation in significant ways because changes in the volume of air relative to the volume of water are critical to having a complete explanation for the behavior of the CDS. However, his thinking is not acknowledged and his potential contribution is never realized. Furthermore, likely discouraged by Noreen’s lack of uptake, Don resorts to negative behavior, threatening to take apart the group’s CDS and challenging another group to a race—essentially engaging in off-task behavior. However, it is also noteworthy that Don returns to his lab book and initiates making another entry, one that, in fact, he makes without assistance. What is particularly exciting about this entry is that, for the first time, he adds to his entry an explanation that reflects the role that he believes air is playing in the behavior of the CDS.

As the inquiry progressed, Don again took the initiative to use his notebook independent of assistance. During a period of sharing, Don tried to explain to the class his thinking about the importance of bubbles in the system. He stated that, “Also what I noticed too, sometimes when you press up the water goes up and sometimes there are small bubbles on the bottom.” He then drew a version of the CDS on the board and added, “What I figured out is that when water gets pressed there are bubbles sticking to the bottom of the balloon.” When two students said they hadn’t observed this, Don advised that “They are very small.” Later, the students had time to write in their lab books, and Don wrote, “it thars in to little BoBd Sum air stas in the Diver and gets smaler” and depicted two versions of the Australian CDS, one with and one without bubbles (see Figure 5).

This case features a youngster who has significant language-related problems that are manifest in both his reading activity and his writing activity. Nonetheless, this student is actively engaged in scientific problem solving, constructs the CDS more quickly than other students, is triumphant in sharing his learning with others, and is engaged in very productive thinking regarding the behavior of the CDS (“the air was compacted by the water pushing it down”). With minimal assistance from an adult, he is able to express his thinking more fully in his written entry.

**Figure 5. Don’s fourth notebook entry.**
This article concludes with a discussion of the implications of these findings, returning to the initial questions posed at the beginning: Who might collaborate in the service of included students and toward what ends in the context of conducting ambitious instruction in the general education setting? What role might primary collaborators assume to advance the learning of identified students? How should the process and outcomes of these collaborations be evaluated?

**DISCUSSION**

The case of Don offers a number of possible responses to the questions raised above. First, it is noteworthy that Don’s teacher had to make special arrangements for him to be present in the classroom during the conduct of this program of study as he was generally working outside the classroom, with the learning disabilities specialist, during science instruction. There is no question that Don’s reading and writing challenges suggest the need for explicit teaching to strengthen these areas. However, science is an instructional context in which Don can demonstrate a number of strengths. For example, he was extremely successful with the engineering aspects of constructing the CDS. He was a close observer, paying more attention to the details in this investigation than was typical of his peers. Also, he capably met a number of the cognitively demanding aspects of this instruction, such as thinking about the relationship between the claims he wished to make and the evidence that he had for those claims, or thinking about evidence that would be convincing to others. Another strength was that he demonstrated metacognitive awareness as he checked his dictation for its clarity and coherence and revised his entry when he recognized limitations in his initial attempt. It is also noteworthy that Don persisted in the face of one of the most demanding activities he confronted during the school day: generating written text.

It is worth noting that the lenses used to examine Don’s activity closely are not the lenses that educators—whether they are classroom teachers, speech-language pathologists, or learning disabilities specialists—typically bring to instructional contexts. One implication is that these lenses require having a deep knowledge of both the subject matter and the ways of thinking and reasoning within that subject matter. Elementary teachers and educational specialists do not have a tradition of thinking about teaching, learning, or intervention in discipline-specific ways. To appreciate the strengths Don brings to this instruction, one must first appreciate the demands of this kind of instruction, as well as the ways in which Don productively mirrors the skills and habits of mind that are productive to advancing one’s thinking within the scientific domain. For general educators and specialists to collaborate productively in inclusion settings, it will be necessary to consider two issues jointly. One concerns the subject-specific nature of the instruction to ensure that appropriate ways are designed to support the learning of identified children. A second issue pertains to the identification of the learning goals and indicators of success within the instruction.

A second implication addresses the nature of the social support that might be provided to students like Don. In inclusion settings, the responsibility for ensuring that students like Don have access to the curriculum and instruction typically rests with the classroom teacher. Indeed, although Don was fairly successful at gaining entrée to the large-group instructional context, he was more challenged in the context of the small-group activity, where his contributions were ignored or rebuffed. In the complex classroom environment (Don had 27 classmates), it would be easy for the teacher to be oblivious to this phenomenon and ignorant of the events that might lead to “acting out” on the part of the identified student. A specialist shadowing Don in this instructional context, on the other hand, can note these often invisible aspects of classroom life. Furthermore, the specialist could assist a student like Don to identify strategies for effectively gaining entrée to the group activity. Finally, a specialist could assist the teacher to model for a class effective ways of engaging in small-group interaction (i.e., sharing turn-taking, using the materials, and finding a good match between the skills of the participants and the tasks to be done).

A third implication is that specialists consider the ways in which interventions can be tailored to enhance the capacity of the child to be a more active participant in the instructional context. Don’s profile, as revealed through standardized assessment, indicated that his reading comprehension placed him at the beginning of the first grade; however, it was clear that he was capable of handling the demands of cognitively challenging instruction at the fourth-grade level. In addition to providing direct instruction to enhance Don’s reading fluency (which almost certainly underlies his comprehension problems), interventions to enhance his print literacy might include the preparation of a vocabulary glossary. This glossary could be prepared by the specialist, posted in the classroom, and, central to the topic of study in this example, include words, such as density, float, sink and, air. Furthermore, given the fine-motor difficulties Don experienced, providing him the opportunity to use a piece of equipment, such as Alpha Smart, to record his ideas could be beneficial. Don was independently finding alternative ways of representing this thinking; for example, through the use of diagrams. A specialist could assist Don to use these alternative representations more effectively (e.g., numbering his diagrams, labeling the parts of his diagram, and spacing them appropriately on the page).

Readers may recall that this research included the use of individual interviews with students. These interviews were invaluable in several ways. The students were able to provide insights into the impediments or enhancements to their learning. Don, for example, commented on how helpful it was to have assistance with his writing, noting that he usually got so tired trying to write that he would only write a little of what he knew. These interviews also provided a powerful opportunity for children with language
problems to “try out their ideas” before they actually were called on to present these ideas to the class. This opportunity to essentially “rehearse” before making a public presentation gave an enormous boost to the confidence and sense of self-efficacy of these identified students. Encouraged by the interviewer that they had important ideas to contribute to the class, the students offered to participate with far greater frequency. Classroom teachers rarely have the luxury of debriefing individual students regarding their classroom-related learning experiences. A speech-language clinician or learning disabilities specialist, on the other hand, as part of students’ remedial programs, might use this time to assist them to prepare their ideas for public presentation.

Each of the issues in this discussion points to ways in which the skills of general educators and educational specialists could be used synergistically to advance the learning of students with special needs when they are participating in rigorous curricula and instruction. Underlying these recommendations is the assumption that there is a shared understanding of the purpose of the instruction, the targeted subject-matter understandings, and the ways to advance children’s learning within the instructional context. The research program reported in this article suggests that, without this shared commitment, the mandate of IDEA will not be realized.

ACKNOWLEDGMENT

The research reported in this article has been supported by a grant from the U.S. Department of Education (H023V70008) to the REACH (Research Institute to Accelerate Content Learning through High Support for Students with Disabilities in Grades 4–8) project. The authors wish to thank the school-based members of the GIsML community of practice for their many contributions to the research reported in this article, most especially Pat Delaney, Jasmine Dudzik, Sally Freeman, Beverly Ingraham, Lynne Kochmanski, Debbie Swanson, and Linda Verhey. The authors gratefully acknowledge the recommendations made by Patricia Prelock and two anonymous reviewers in responding to an earlier draft of this manuscript.

REFERENCES


Received November 16, 1999
Accepted March 21, 2000

Contact author: Annemarie Sullivan Palincsar, Educational Studies, University of Michigan, 610 East University, Ann Arbor, MI 48109-1259. Email: Annemari@umich.edu