

Tapping in to Kids' Yearning for Learning: First Graders'
Understanding of Inquiry

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ABSTRACT

The aim of this project was to investigate the effects of inquiry as an instructional approach on children's views on learning and the construction of knowledge. Researchers and first grade teachers collaborated using a design-based research method to develop learning environments simultaneously with theory. Student interviews, conducted pre- and post-instruction, capture students' growing understanding of the inquiry process. Teachers and researchers worked together to develop a rubric to analyze the interviews. A repeated measures MANOVA, with follow-up discriminate analyses, revealed that participants' view of knowledge and learning changed in three ways, namely, their understanding of the investigative process, contribution of peers and the broader community to their learning, and ideas and theories as mental objects advanced throughout the instruction.

Inquiry has long been a critical cognitive and creative process for scientists, innovators, researchers, artists, entrepreneurs and thinkers from many domains. In fact, inquiry is essential for any whose mandate requires innovative thinking and working with their communities towards the “sustained creative work with ideas” by building on ideas and revising them (Scardamalia & Bereiter, 2003a, p. 1). Inquiry is “a dynamic process of being open to wonder and puzzlement and coming to know and understand the world. As such, it is a stance that pervades all aspects of life and is essential to the way in which knowledge is created” (Galileo Education Network, 2004, p.1).

Inquiry is an approach to learning that recognizes and supports children’s natural yearning for learning. Research has shown that even very young children develop conceptual understanding by wondering, asking questions and developing naive theories about their environments (e.g., Carey & Smith, 1993; Kuhn, 2000; Wellman & Gelman, 1998). To incorporate an inquiry approach is to build on the innate curiosity of the very young and to nurture and support children on their developmental trajectory towards developing the increasingly metacognitive skills of proficient knowledge creation.

Yet inquiry has not always played a central role in our schools. Where knowledge has been seen as an existing package to transmit, rather than an ever-evolving construct to question, build upon, and improve, there has been little room for inquiry. But because change is ubiquitous and fast-paced currently, it is no longer enough to know what is known. We need to prepare students to figure out what it is we need to know next and how to proceed to find out. A successful knowledge-based

society requires all of its members to participate in meaningful idea creation and to have the literacy and other necessary skills to contribute to this discourse. The literacies and skills needed to be effective knowledge-builders or inquirers require support to develop. Young learners need a “powerful learning environment,” that is, “an environment that immerses students in the effort to advance the frontiers of knowledge as they perceive them” (Bereiter & Scardamalia, 2003, p. 67).

Powerful Learning Environments. Only a few educational contexts offer students powerful learning environments where the focus is on knowledge building. In knowledge building classrooms, when children inquire (i.e., ask questions, seek resources, share information, formulate theories) they are developing skills and habits of mind conducive to lifelong learning – knowledge age skills. Classroom knowledge-building communities cultivate high-level responsibility, as students become decision-makers in their learning. Students decide what interesting questions they will investigate and where will they go for information. Students are also responsible for problem formulation, determining a strategy to help them to investigate, and decisions about how to present their findings to others. When an inquiry approach occurs in a collaborative context, we build not just individual knowledge but also children’s “collective expertise” (Scardamalia, 2000, p. 63). The sharing of this expertise helps to cultivate effective communication as students work together to determine how to share their knowledge with others.

Also, within powerful learning environments, students become more experienced with sustained, creative work with ideas (Scardamalia & Bereiter, 2003a). This work goes beyond simply brain-storming; it challenges students to

think as innovators do, to work with ideas, to test them out, to revise them, to make them useful, and to develop them into theories (Scardamalia & Bereiter, 2003a). Not only do students develop ideas in inquiry; there is also genuine enjoyment in doing so. Scardamalia and Bereiter (2003b) have described knowledge building classrooms as classes where children gain great satisfaction in working with and improving ideas. Working with ideas does not exclude hands on activities for young students, though. Rather, concrete activities have a purpose beyond simple project work or variable testing. The authors used the example of a paper airplane to illustrate this point. In a knowledge building class, building a paper airplane is not a simple exercise in following instructions, but may be used to help students understand the physics behind flight, which in turn may lead to variable testing, but will also lead to the investigation of other additional big ideas, such as hydroplaning, or how propellers work (Scardamalia & Bereiter, 2003a).

Lastly, the meaningful work that is accomplished through discourse in this socio-cognitive environment cultivates the development of self and group monitoring and assessment. Given the responsibility of participating in their own knowledge building and learning over time, students come to understand, with guidance, that they must participate in real work, that they are accountable for this real work, and that this participation and accountability is also collective.

Along with the benefits of developing knowledge age skills, knowledge building promotes a depth of learning and augmented literacy (Scardamalia, 2003b). In his discussion of the benefits of inquiry, Eisner (2004) argued that inquiry has meaning and challenges students with authentic problems that pique their interest.

There is a particular value when ideas or problems are relevant to the student's personal life and experience that cannot be garnered from a textbook. Inquiry immerses students in many literacies, which they critically embrace as they are motivated to learn. Reading becomes reading to learn and non-fiction works become texts of choice (Murray, Shea & Shea, 2004). Murray, Shea, & Shea (2004) described the energy and pathways of inquiry, noting that there are frequent 'eruptions' with more ideas and questions, which is typified by cross-curricular activities. Thus, using inquiry, teachers are able to capture the impetus of children's curiosity, which propels emerging academic skills. In inquiry, "questions of wonderment become the driving force in designing the *what* and *how* of instruction" (Murray, Shea, & Shea, 2004, p. 33).

Inquiry is not new. It has evolved from Vygotskian notions of socio-cognitive thought and was the driving force in Dewey's outlook on education (Dewey, 1938; Wells, 2005). Bereiter and Scardamalia have used this framework for their Computer-Supported Intentional Learning Environments (CSILE) (e.g. Scardamalia, 2003a) and subsequently in Knowledge Forum (Scardamalia, 2003a), which combines knowledge age skills with knowledge age technology. It has been used successfully in science (Magnusson & Palincsar, 1995) and as a template for professional communities of practice (Palincsar, Magnusson, Marano, Ford & Brown, 1998). Brown and Campione (1996) were pioneers in this area with their notions of communities of learners, environments where students were able to take more responsibility for their learning by being given the tools of reciprocal teaching and jigsaw learning. Brown's research (1992) began with a more theoretical,

experimental orientation but her interest in enduring challenges in learning led her to a design-research approach.

Design Research. Design-research traces its origins to Anne Brown (1992) and Allan Collins (1992). In her seminal article, Brown described her evolution from clinically-constructed investigations to research that recognized that classrooms, with their complex interactions of dependent and independent variables, were vast repositories of opportunities where Brown could try to “engineer innovative educational environments and simultaneously conduct experimental studies of those innovations” (p. 141). Brown’s stance on learning and knowledge—its communal nature, the necessary self-reflective components, conceptual change, and the complexities that are the hallmark of all human endeavours-- are all reflected in design research. The power of design research lies in its theory-driven approach (Design-based Research Collective, 2003) that begins by building on existing knowledge and continues on with the potential to build and shape new theory.

Cobb, Confrey, diSessa, Lehrer & Schauble (2003) have identified several features of design-experiments which set them apart from other research designs. One of the most notable features is Brown’s (1992) idea regarding simultaneously creating learning environments and developing theories of learning. Researchers using this mode of inquiry are interested not only in theoretical underpinnings but also the support that is given to the participants within a particular environment. Researchers will frequently ‘intervene’ to change different aspects of the experiment, taking advantage of opportunities that occur or making changes to examine the

interactions. Thus, this type of design goes through cycles of design, enactment, analysis and redesign.

Thus, design research is both pragmatic and theoretical. Cobb et al (2003) noted that the “theory must do real work” (p. 13). Results of the design analysis should lead to theories that are communicated to the educational community. These theories should be derived from authentic settings and help to refine understandings of the learning issues involved. The understandings that have been developed must be usable to those in the professional learning community, blending theory with practice. Also, within this research paradigm, practitioners and researchers work together to produce meaningful change in the context of practice.

Purpose of the study

The primary aim of the study was to develop a powerful learning environment simultaneously with expanding our theoretical understanding of how children conceptualize learning by utilizing a design-based research method. Specifically, we sought to explore the effects of inquiry, as an instructional approach within the language arts curriculum, on children’s views on learning and the construction of knowledge.

Methods

Participants

Participants were drawn from three first grade classrooms in two schools located in a town of approximately 10,000 residents; the town was situated within commuting distance of a large city in Western Canada. Most participants came from middle SES homes. Most students were of European decent but some were First

Nations children. One school served children who lived in town and on farms, whereas the other drew its population from the town itself. All participating teachers had at least 5 years of experience. Between them, the four teachers taught 60 students. Of these, 52 were granted consent by parents to participate in the study. Participants included 28 boys and 24 girls.

Experimental Task and Scoring

A structured inquiry interview protocol was developed that targeted five competency categories that the literature has documented as outcomes of an inquiry approach to instruction (e.g., Murray, Shea, & Shea, 2004; Scardamalia & Bereiter, 2003a). The specific competency categories were as follows: (a) purposeful questioning, (b) multiple sources of information, (c) knowledge, ideas and theories as mental objects, (d) recognition of peer knowledge and community of learners, and (e) knowledge of the investigative process (see Appendix A for the Inquiry Interview protocol).

To develop a scoring rubric, a three-step procedure was used. First, participating teachers' and researchers' constructed inquiry developmental milestones for first grade students, based on knowledge of how low, average, and high functioning students typically perform. Second, participants' responses to the interview questions were examined in light of these milestones and a rubric was developed. Three levels of competence, with 3 representing the highest level of achievement were delineated for each of the six targeted competency categories. Third, the rubric was fine tuned to reflect the students' responses, and illustrative examples were included (see Table 1).

[Insert Table 1 about here]

Procedure

Prior to commencing instruction, participants were interviewed, using the Inquiry Interview protocol. Two Language Arts instructional units that are part of a basal reading program, Open Court Reading (SRA /McGraw-Hill Ryerson, 2000) comprised the instructional intervention: “Things that Go” was completed in October and November and “Weather” was completed in February and March. Following the instruction, participants were post-tested using the same Inquiry Interview protocol. The interviews were transcribed and then scored, using the rubric (Table 1). A sixth category, Mental Verb Count, was added, based on the research of Astington (2000), which indicated that cognitive mental verbs (e.g., think know and believe) reflect developing metacognitive knowledge. The rubric was applied to each response, regardless of the question that generated it.

Description of Inquiry Instruction. Engaging in an inquiry unit requires a different approach to planning for teachers. In a traditional approach to a unit of study in language arts, many aspects of classroom learning activities (e.g. unit objectives, instructional activities, resources and assessment procedures) are pre-selected by the teacher or dictated by published teacher’s guides. Within inquiry, however, teachers shared control of learning activities with students. Students actively participated in deciding what aspects of a topic are worthy of further investigation, how to go about building their knowledge, and how they will share what they have learned with others.

Inquiry requires that materials and resources come from many sources; resources are not pre-set. Teachers relied heavily on the expertise of their school librarians and parents send books to school. Research using the Internet was conducted at home and at school, usually with the help of older buddies. Field trips and outdoor explorations became an important part of the inquiry data gathering. For example, two classes visited a caboose when they were studying Things that Go. Another class went outside to release balloons when studying Weather. Lastly, expert speakers were important and teachers drew upon community resources. In Things that Go, one father, who was a pilot, came in to speak to the children, and another father brought his semi truck, talked about what he does with it and then let the children sit in it and toot the horn.

Although resources were not pre-set, Open Court Reading (SRA McGraw-Hill/Ryerson, 2000) was the foundation of the inquiry units. The Open Court Reading materials included readings on the inquiry unit topics (i.e., narrative and expository). Additionally, Open Court Reading provided the teachers and researchers with the four overarching aims of inquiry that served to anchor their teachings. These aims were (a) to engage students in productive knowledge work (i.e., helping students to take a high degree of responsibility for knowledge building, articulate what they already know and what they wanted to find out, make decisions about how to investigate, gather appropriate resources, and take risks by sharing questions, conjectures, and theories), (b) to create a knowledge-building community (i.e., creating opportunities for collaboration, modeling respect for others' ideas, helping students to see one another as knowledge builders, and widening the

learning community to include others beyond the classroom walls), (c) for students to monitor knowledge advances (i.e., judging how well their inquiries were going, applying strategies when stuck, and reflecting on knowledge growth), and (d) for students to communicate in ways that reflect deep understanding of the concepts and ideas that have been explored (i.e., sharing information and ideas in ways that others in the learning community can understand and finding ways to circumvent limitations such as presenting information orally and using pictures).

Just as the aims of inquiry provided teachers with an overall framework to guide their students' work, a general format provided an overall structure for the sequence of learning activities within each unit. Inquiry units began with a kick-off event to spark students' interest, prompt them to access and share background knowledge, help them to identify areas worth investigating, and trigger curiosity and questions. Teachers sought a means to visually and publicly capture and record the children's ongoing learning. A bulletin board with questions on one side and ideas and theories (albeit naïve ones) on the other was suggested as a way to manage this (i.e., Concept/Question Board). Teachers helped students to record their questions, add information as they found it, and articulate and revise theories. They designed learning activities from day to day to reflect the twists and turns of the students' interests and their growing knowledge of the topic, as well as to incorporate curricular objectives. As students' knowledge grew, teachers sought ways and means for students to showcase what they had learned. They worked towards involving students to an ever-greater degree in making decisions about how to share their knowledge, seeking to increasingly take the role of facilitator rather than director.

Finally, teachers worked with the children to create a suitable culmination and celebration of their accomplishments with the inquiry.

Results

In scoring the Inquiry Interview, all competency categories were rated with a three level rubric. Table 1 includes illustrations of students' responses at the various levels, across competency categories.

A repeated measures multivariate analysis of variance (MANOVA) was conducted to determine any differences between the groups, differences over time, or a group x time interaction effect. Results of the MANOVA indicated a significant group x time interaction [Wilks $\lambda = .61$, $F(12,88)=2.1$, $p < .05$, *partial-eta squared* = .22]. There was also a significant time effect [Wilks' $\lambda=.23$, $F(6,44)=24.4$, $p < .05$, *partial-eta squared*=.77] and a significant group effect [Wilks $\lambda=.62$, $F(12, 88)=2.0$, $p < .05$, *partial-eta squared*= .22].

[Insert Tables 2 and 3 about here]

A descriptive discriminant analysis was conducted as a post hoc procedure on each significant effect. One significant function for each effect was obtained. Standardized discriminant functions (Standardized coefficient) and Structure Coefficients for the interaction and main effects are shown in Table 3. An absolute value of .32 on both the standardized discriminant function and structure coefficients was used to determine the most influential variables in each significant discriminant function (Tabachnick and Fidell, 1996). Examination of these coefficients indicates that Knowledge of the Investigative Process greatly contributes to the interaction effect with Recognition of Peer Knowledge/Community of Learners also a

contributing factor. Across all groups over time, Knowledge of the Investigative Process had a strong weighting and Knowledge, Ideas, and Theories as Mental Objects also contributed to the differences observed. The differences between the classroom groups were most affected by Knowledge of the Investigative Process, with Knowledge, Ideas, and Theories as Mental Objects also a contributing variable.

Discussion

That students responded to the inquiry learning environments to at least some positive degree is evident in the results of the statistical analyses conducted on the pre- and post- inquiry instruction interviews. Knowledge of Investigative Processes contributed to the Time and Group main effects and Time x Group interaction effect. That this variable should be central to first graders' understanding of the inquiry process and knowledge building is not surprising. At this point in their early academic careers, children must master the process of learning how to learn including; how to formulate a question, find information, revise questions based on new knowledge, and share improved knowledge. These metacognitive skills are the cornerstones of inquiry. As the following sample interview segments demonstrate, children understood when to ask questions: When asked: "When do you ask questions," before instruction Child A responded, "When it's time to talk." After instruction she answered, "When I don't know something." Thus, her justification for asking questions shifted from classroom routine to a need to know, suggesting that the control over questioning moved from the teacher to the child. Children's post-instruction responses also reflected a growing understanding of the process of knowledge construction. Researcher: What do you do then if you don't really know?

Child B: “You research and ask questions and you can make an answer.” As well, the importance of research in knowledge building was evidenced in children’s responses. Researcher: “How do you know if your idea is right or wrong?” Child C: “Sometimes my friends say it is wrong, but they really don’t research it out. They just say it is wrong.” This latter response can be seen as reflecting an emergent understanding of Popper’s world 2 (i.e., the world of mental objects and events through her reference to research as a mental event tied to learning) and possibly even world 3 (i.e., the world of the products of the human mind through her implied understanding that researcher knowledge is superior to unsupported opinion and belief) (Bereiter, 2002).

Another competency category that contributed to Time and Group main effects was Knowledge, Ideas, and Theories as Mental Objects. All groups’ capacity to see knowledge, ideas, and theories as mental objects increased across the instructional intervention. The interview exchanges presented in Table 4 illustrate the children’s deepening understanding. Prior to instruction they do not know what a theory is and are understandably unable to articulate a theory of their own. After instruction, Child D states directly that a theory is “something that you think” (i.e., belongs to a mental realm); further, although he does not yet have the details accurately established, he knows that ideas belong in the same realm and that the two differ in terms of certitude. In a similar vein, Child E has become firmly acquainted with theories by the end of the instructional intervention. Whereas prior to instruction, she could not articulate a theory, even when prompted for her “theory of why leaves change color,” following instruction, she differentiated between having a theory and

knowing what a theory is, thus decontextualizing the construct of theory from the content of the theory. Moreover, she has integrated the notion of theory with her knowledge of the investigative process – start with a question and proceed to theorize an answer.

[Insert Table 4 about here]

Finally, Recognition of Peer Knowledge and Community of Learners contributed to the Time X Group interaction effect. As is clear from an inspection of Table 1, although the scores of students in Groups 1 and 2 increased, suggesting that their understanding of the role played by others in their community of learners expanded, the scores of Group 3 members decreased. One possible explanation for this outcome is the variability in how teachers took up Inquiry in their classrooms and the degree to which they understood and supported students in the Aims of Inquiry. Clearly, more research that documents teaching practices is required.

But what do this finding contribute to theory? According to Bereiter and Scardamalia (2003), knowledge can be handled in the belief mode or design mode. In the belief mode, people take a particular point of view, give an opinion based on their knowledge, or develop a critical eye. In the design mode, people work together as collaborative knowledge builders to plan, revise, change, or invent. Whereas both modes are important, Bereiter and Scardamalia (2003) argued that the majority of school activities lie in the belief mode whereas real world activities reside mainly in the design mode. The aim of the instructional intervention used in the present study was to begin to move toward the design mode.

Although researchers have struggled over the last decade to identify a set of cognitive skills that constitute the design mode and knowledge building, recent theorizing has articulated three features of such a powerful learning environment: “(1) the use of complex, realistic and challenging problems that elicit in learners active and constructive processes of knowledge and skill acquisition; (2) the inclusion of small group, collaborative work and ample opportunities for interaction, communication and cooperation; and (3) the encouragement of learners to set their own goals and provision of guidance for students in taking more responsibility for their own learning activities and processes” (van Merriënboer and Paas, 2003, p. 4).

How did the teachers and researchers in this study fare in helping to create a powerful learning environment that supported knowledge building? Did the learning environment engage students in authentic problems, help them to learn and work together collaboratively, and enable them to monitor and take increasingly more responsibility for their learning (van Merriënboer and Paas, 2003)?

We argue that it did. By focusing on the Aims of Inquiry specified in Open Court Reading (SRA/McGraw-Hill, 1005), teachers created powerful learning environments. Specifically, when supporting students’ engagement in productive knowledge work, teachers ensured that they worked with authentic problems by allowing them to set a personally meaningful research direction and decide how to carry out their investigation. These teaching strategies also allowed students to assume a high degree of responsibility for knowledge building. Teachers also assisted in the creating of a knowledge building community by helping students use the Concept/Question Board to share their questions, conjectures, and theories;

modeling collaboration and respect for others as knowledge builders; inviting parents/guardians, other classes, and community members into the investigative process; and providing opportunities to share their knowledge with others in ways that took into account their emerging reading and writing skills. Additionally, teachers assisted students to monitor knowledge advances by helping them reflect on how their understanding was changing and how their ideas were improving.

In summary, by taking an inquiry approach to instruction and, more specifically, by creating a powerful learning environments through supporting the Aims of Inquiry (SRA/McGraw-Hill, 2005) students can helped to understand the Investigative process, see knowledge, ideas, and theories as mental objects, and recognize the importance of peer knowledge and their community of learners. Inquiry is not, however, a lock step process; there are multiple pathways in knowledge building. Young children may begin their wonderings with a personal story, a theory, an idea, or even an opinion. After discussions with others, all of these beginnings can lead to the formulation of a researchable question, a question that keenly needs to be answered, and may well lead to other in depth questions. Within an inquiry classroom, even young children can come to understand knowing as open ended, changeable, and improvable. They can come to view learning as multiple sourced and community based. They can come to view ideas and theories as things that can be evaluated, infinite and within their grasp. However, research into how teachers take up inquiry in their classrooms is essential to a full understanding of these multiple pathways.

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Table 1. Inquiry Interviews Scoring Rubric

Competency Category	Scoring Criteria		
	3	2	1
Purposeful Questioning <i>Q. When do you ask questions?</i>	<i>Questions are directed towards knowledge building.</i> <i>A. When I want to know something.</i>	<i>Questions reflect procedural knowledge so that the child demonstrates an understanding of the social skills related to asking questions.</i> <i>A. When the other kids are done, and they've done talking, then I put up my hand.</i>	<i>Questions are not necessarily motivated by meaning or anchored by any other understanding.</i> <i>A. Right after stories are over.</i> <i>A. After recess.</i>
Multiple Sources of Information <i>Who do you ask Questions to?</i>	<i>Child extends answers to include general knowledge sources.</i> <i>A. I'd watch a movie or read a book.</i>	<i>Answers are multiple familiar people.</i> <i>A. The people at my table and Mrs. Herriot.</i>	<i>Answers focus on one familiar person.</i> <i>A. My mom.</i> <i>Q. Anybody else?</i> <i>A. No.</i>
Knowledge, Ideas, and Theories as Mental Objects <i>Q.1 What is an idea?</i> <i>Q. 2 What is a theory</i>	<i>Views knowledge/ideas as a mental object in that it is a thing that one thinks. Child is able to elaborate on his/her initial statement.</i> <i>A1. Something that you think that you don't know for sure</i> <i>A2. It's a question. It's an unanswered question and we don't know if it's right or w</i>	<i>Views knowledge/ideas as a mental object in that it is a thing that one thinks. Child is unable to elaborate on his/her statement.</i> <i>A1. It's like if I didn't to do stuff and a guy had idea and he's telling it</i> <i>A2. A theory is a thing you think it is.</i>	<i>Child is unable to answer question.</i> <i>A1. I forget.</i> <i>A2. I don't know.</i>

<p>Recognition of Peer Knowledge and Community of Learners</p> <p><i>Q. Can your classmates help You to learn things?</i></p>	<p><i>Answers reflect sharing knowledge from a secondary source, discussion, or offering emotional support</i></p> <p><i>A. Yes. Because they help me to figure things out. They tell you things that you don't know. And they can help you by making you feel better.</i></p>	<p><i>Specific concrete examples are given. No evidence of abstraction.</i></p> <p><i>A. Yes. Like I asked my friend Michael if to has two o's in it because I don't hear two o's and he said yes.</i></p>	<p><i>Child answers that classmates cannot help him or her to learn in class.</i></p> <p><i>A. No. Because Mrs. Smith said that you're not allowed to look at other people's stuff.</i></p>
<p>Mental Verb Count</p> <p><i>Think, Know, Plan, Guess Wonder</i></p>	<p>Count range: 11-18</p>	<p>Count range: 3-10</p>	<p>Count range: 0-2</p>
<p>Knowledge of the Investigative Process</p> <p><i>Q1. How do you know if your Idea is right or wrong?</i></p> <p><i>Q2. If your idea turns out to be right, what would you do?</i></p>	<p><i>Answers reflect a minimum of either a or b and c or d.</i></p> <p><i>a. Question asking.</i></p> <p><i>b. Information finding.</i></p> <p><i>c. Question revision.</i></p> <p><i>d. Knowledge-sharing, dissemination, or application.</i></p> <p><i>A1 Sometimes my friends say it is wrong, but they really don't research it out. They just say it is wrong."</i></p> <p><i>A2. I would start telling people about it.</i></p>	<p><i>Answers reflect knowledge of a and b.</i></p>	<p><i>Answers are not reflective of a,b,c, or d.</i></p> <p><i>A.1 I don't know.</i></p> <p><i>A2. Get happy.</i></p>

Table 2
Means and Standard Deviations of the Inquiry Interview Categories
1=Grace; 2=Kathy, 3=Anna & Joan

Category	Time of Testing	Group 1 N=18	Group 2 N=20	Group 3 N=14	Overall N=52
Purposeful Questioning	Pre	1.5 (.78)	1.6 (.88)	1.2 (.61)	1.5 (.78)
	Post	2.1 (.83)	2.1 (.85)	1.8 (.86)	2.0 .84
Multiple Information Sources	Pre	1.4 (.51)	1.5 (.61)	1.4 (.51)	1.5 (.54)
	Post	1.9 (.87)	2.2 (.72)	1.8 (.36)	1.9 (.71)
Peers Knowledge and Community of Learners	Pre	1.8 (.71)	2.0 (.56)	2.0 (.48)	2.0 (.59)
	Post	2.3 (.60)	2.5 (.51)	2.1 (.83)	2.3 (.64)
Knowledge of Investigative Processes	Pre	1.1 (.32)	1.3 (.47)	1.1 (.27)	1.2 (.38)
	Post	2.7 (.77)	2.7 (.73)	1.5 (.76)	2.4 (.91)
Knowledge as Mental Object	Pre	1.4 (.62)	1.5 (.51)	1.2 (.43)	1.4 (.53)
	Post	2.6 (.70)	2.6 (.76)	2.1 (.77)	2.4 (.75)
Mental Verb Count	Pre	1.5 (.51)	1.6 (.60)	1.6 (.50)	1.6 (.54)
	Post	2.1 (.54)	2.3 (.55)	1.7 (.47)	2.0 .56

Table 3. *Standardized and Structure Coefficient weighting for each competency category for Time, Time X Group, and Group Effects*

Competency Category	Time		Group X Time		Group	
	Standardized Coefficient	Structure Coefficient	Standardized Coefficient	Structure Coefficient	Standardized Coefficient	Structure Coefficient
Knowledge Investigative Processes	-.64	-.82	-.91	-.82	-.98	-.96
Knowledge as Mental Object	-.47	-.72	-.20	-.11	-.32	-.43
Community of Learners	-.26	-.21	-.36	-.34	.03	-.15
Multiple Sources of Information	-.11	-.35	-.08	-.11	-.05	-.26
Mental Verb Count	-.10	-.34	-.30	-.45	.10	-.31
Purposeful Questioning	-.04	-.32	.30	.03	.22	-.27

Table 4. Interview Samples for Knowledge, ideas, and Theory as mental Objects

Pre-instruction	Post-instruction
<p>Researcher: What is a theory? Child 1: I don't know. Researcher: What is your best guess? Child 1: Something you say.</p>	<p>Researcher: What is a theory? Child 1: Something that you think. It's sort of like an idea but it's different. Researcher: Can you tell me how you think it's different from an idea? Child 1: Because an idea you know you know it. But the other one you don't really know it.</p>
<p>Researcher: Do you have any theories? Child 2: Theories, what are those? Researcher: I bet you have a theory about how leaves change, tell me your theory about how leaves change? Child 1: They, like, when they fall they like to and you can pick them up and then you put them under a piece of paper and you can rub all over them and then you get to keep them.</p>	<p>Researcher: Do you have any theories? Child 2: Not at this moment but I know what a theory is. Researcher: Have you had theories in class before? Child 2: I asked why do penguins, like, how do penguins swim under water when they've got feathers. And how do feathers keep them so warm? Researcher: What's your theory about that? Child 2: They have something underneath them that keeps them warm.</p>

Appendix A Inquiry Interview

Inquiry Interview Grade One

Thank you for coming and working with me today. Do you know what we're going to do? (Allow responses) Well, today I'm going to ask you some questions about learning because it will help your teacher and me know more about how to teach you. I'm going to use this tape recorder to record your answers so that I can remember what you said later. There's something else that I need to tell you—these questions don't have a right or a wrong answer. That means that when I ask you a question you should tell me what you think or you can just give me your best guess. Now, do you have any questions for me before we begin? Okay, then, let's start.

**This is (child's name) and he/she is in (teacher's name) class. Today's date is ---
-.**

- 1.** Do you ever ask questions?
- 2.** When do you ask questions?
- 3.** Who do you ask questions to?
- 4.** As you learn more and more about some things do all of your questions get answered (*Show picture prompt*) **OR** will you still keep having questions? (*Show picture prompt*). Point to the card that shows what you think.
- 5.** If you wanted to learn **everything** there is to know about something, say animals, how long would you have to study it? (*Show picture prompt*)
 - (a).** Less than a year, if you studied hard.
 - (b).** A long, long time.
 Point to the card that shows what you think.
- 6.** Do you ever have ideas? What do you have ideas about?
- 7.** How do you know if your idea is right or wrong?
- 8.** If your idea turns out to be wrong, what would you do?
- 9.** If your idea turns out to be right, what would you do?
- 10.** What is an idea? (*If no response, ask:*) What is your best guess about what an idea is?
- 11.** Do you have any theories? **Yes**—what about? **No**—I bet you have a theory about how leaves change (*Show picture prompt*). Tell me your theory about how leaves change.
- 12.** What is a theory? What is your best guess?
- 13.** Can your classmates help you to learn things? **No**—why not? **Yes**—how?

1. Do you ever ask questions?
2. When do you ask questions? (PQ or K IP)
3. Who do you ask questions to? (MSI; PK/CL)
4. As you learn more and more about some things do all of your questions get answered (*Show picture of a question mark with an X over it*) **OR** will you still keep having questions? (*Show picture filled with question mark*). Point to the card that shows what you think. PS
5. If you wanted to learn **everything** there is to know about something, say animals, how long would you have to study it? (*Show two pictures: One with a short solid line and one with a long solid line*)
 - (a). Less than a year, if you studied hard.
 - (b). A long, long time. (KIP)
 Point to the card that shows what you think.
6. Do you ever have ideas? What do you have ideas about?
7. How do you know if your idea is right or wrong?
8. If your idea turns out to be wrong, what would you do?
9. If your idea turns out to be right, what would you do?
10. What is an idea? (*If no response, ask:*) What is your best guess about what an idea is? (KMO)
11. Do you have any theories? **Yes**—what about? **No**—I bet you have a theory about how leaves change (*Show picture of a tree in autumn*). Tell me your theory about how leaves change.
12. What is a theory? What is your best guess? (KMO)
13. Can your classmates help you to learn things? **No**—why not? **Yes**—how? (PK/CL)

Appendix B

Mental Verbs Recorded in Inquiry Interviews

Think
 Try
 Answer
 Tell
 Stuck
 Change
 Check over
 Read
 Write
 Learn
 Ask
 Guess
 Find out
 Research

See
Take over your mind
Know
Thought
Plan
Study
Not sure
Stuck
Write
Figure out
Make up
Teach
Problem solve
Wonder
Theoried
Read
Experiment
Revise
Remember
Invent
Publish
Share
Wrote
Tell
Stumped

Appendix C - Rubric for Inquiry Interviews

Category	Scoring Criteria		
	3	2	1
<p>Purposeful Questioning</p>	<p><i>Questions are directed towards knowledge building.</i></p> <p><i>Q..When do you ask questions? A. When I want to know something.</i></p>	<p><i>Questions reflect procedural knowledge so that the child demonstrates an understanding of the social skills related to asking questions.</i></p> <p><i>Q..When do you ask questions? A. When the other kids are done, and they've done talking then I put up my hand.</i></p>	<p><i>Questions are not necessarily motivated by meaning or anchored by any other understanding.</i></p> <p><i>Q. When do you ask questions? A. Right after stories are over. A. After recess.</i></p>
<p>Multiple Sources Of Information <i>(experts, teacher, web, classmates, parents, books and printed matter, movies/ tv)</i></p>	<p><i>Child extends answers to include general knowledge sources.</i></p> <p><i>A. How would you know if your idea was right or wrong? Q. I'd watch a movie or read a book.</i></p>	<p><i>Answers are multiple familiar people.</i></p> <p><i>Q. Who do you ask questions to? A. The people at my table and Mrs. Herriot.</i></p>	<p><i>Answers focus on one familiar person.</i></p> <p><i>Q. Who do you ask questions to? A. My mom. Q. Anybody else? A. No.</i></p>
<p>Knowledge/ideas or theories as mental objects</p>	<p><i>Views knowledge/idea as a mental object in that it is a thing that one thinks. Child is able to elaborate on his/her initial statement.</i></p> <p><i>Q. What is an idea? A. Something that you think that you don't know for sure. Q. What is a theory? A. It's a question. It's an unanswered question and we don't know if it's right or wrong.</i></p>	<p><i>Views knowledge/idea as a mental object in that it is a thing that one thinks. Child is unable to elaborate on his/her statement.</i></p> <p><i>Q. What is an idea? A. It's like if I didn't know how to do stuff and a guy had an idea and he's telling it to you. Q. What is a theory? A. What you think it is. A. A theory is a thing what you think it is.</i></p>	<p><i>Child is unable to answer question.</i></p> <p><i>Q. What is an idea? A. I forget. Q. What is a theory? A. I don't know.</i></p>

Appendix C continued

<p>Recognition of Peer Knowledge And Community Of Learners</p>	<p>Answers reflect sharing knowledge from a secondary source, discussion, or offering emotional support</p> <p><i>Q. Can your classmates help you to learn things?</i> <i>A. Yes. Because they help me to figure things out. They tell you things that you don't know. And they can help you by making you feel better.</i></p>	<p>Specific concrete examples are given. No evidence of abstraction.</p> <p><i>Q. Can your classmates help you to learn?</i> <i>A. Yes. Like I asked my friend Michael if he has two o's in it because I don't hear two o's and he said yes</i></p>	<p>Child answers that classmates cannot help him or her to learn in class</p> <p><i>Q. Can your classmates help you to learn?</i> <i>A. No. Because Mrs. Smith said that you're not allowed to look at other people's stuff.</i></p>
<p>Mental Verb Count Think Know Plan Guess Wonder</p>	<p>Count range: 0-2</p>	<p>Count range: 3-10</p>	<p>Count range: 11-18</p>
<p>Knowledge of the Investigative Process</p>	<p>Answers reflect a minimum of either a, b, and c or d.</p> <p>a. Question asking. b. Information finding c. Question revision. d. Knowledge-sharing, dissemination, or application.</p> <p><i>Q. How do you know if your idea is right or wrong?</i> <i>A. Sometimes I go on my computer or ask people.</i> <i>Q. If your idea turns out to be right, what would you do?</i> <i>A. I would start telling people about it.</i></p>	<p>Answers reflect knowledge of a and b.</p>	<p>Answers are not reflective of a, b, c, or d.</p> <p><i>Q. How do you know if your idea is right or wrong?</i> <i>A. I don't know.</i> <i>Q. If your idea turns out to be right, what would you do?</i> <i>A. Get happy.</i></p>