Inquiry Revisited: The Role of Puzzlement in Today's Classroom

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ABSTRACT
Inquiry in today's classrooms has been reduced to a formula for learning the scientific method with any given topic, most often in science in elementary school. While there is value in acquiring a method for approaching a query, students are deprived of the opportunity to construct their own queries, to pursue their natural puzzlement over personal and real-world dilemmas. Questions arise about the value of this procedure in assisting students to develop facility with the genres of the disciplines.

The children come in from an outdoor expedition. These second graders have been exploring a science concept as part of a required lesson. This time they are exploring the effect of wind on objects, part of a larger unit on the concept of air, taken from a district-prescribed science text. Each child has designed and built a paper airplane from sturdy oaktag. Today they have had the chance to try out their designs in a real environment—the playground on a windy day. When they are back inside, they will complete a worksheet on what worked in their design and what they will do to improve the design of the plane next time—even though there will be no next time, at least in this classroom, since the curriculum of the science text moves on to other topics.

All goes well out on the playground. Some planes flew well, some crashed, some designs were successful, some needed more work. One plane, caught by the wind, flew up onto the school roof and stayed there—a great success.

The class moved slowly back inside the building until they were all inside the door. At that point, a little girl screamed, several children shouted and there was a general push of bodies toward the front of the line. There was a call for order, no one listened, and, and for a moment, chaos seemed inevitable. A large garden spider had taken up residence in a corner near the door.

As order was gradually restored and the line moved forward, the hubbub continued with children pushing and shoving. One child shouted, "Kill it!" And another responded, "That's nature."

The spider was put back outside and the children moved on. Back inside the room, the children took up the task of completing textbook prompts on how the wind affected paper airplane designs, "why my wing design worked/didn't work," and "wind makes things fly because…" The large garden spider and the children's divergent responses to it were forgotten, and class turned its attention to completing the worksheets, according to standard, attempting to learn elements of the scientific method, as presented in textbook-driven exercises in today's classrooms.

So, what are we to learn from this anecdote? A form of inquiry is alive and well in this classroom. Inquiry is present in the teaching of the scientific method within the constraints of textbook-driven science curricula—students are investigating scientific concepts appropriate to the specific science curriculum and to the learning of elements of the scientific method.

However, this is a limited form of inquiry, beginning with a teacher-driven query and proceeding through a structured, textbook-driven mode of investigation. I argue that inquiry must go much further and that interpretations of how inquiry is delivered and implemented develop very different modes of language and thinking in learners (Wells, 1999). In the science curriculum in the anecdote above, students are asked to develop a responsive form of inquiry, what I call a "structured" or "controlled" inquiry: "…the scientific method, as the artifact of school science culture, provides an initial way to guide the classroom activity but that its oversimplified approach actively subverts more authentic and model-grounded ways of thinking about inquiry" (Windschitl & Thompson, 2006, p. 825). This form of inquiry answers the textbook- and teacher-developed question, "what happens when…" and allows students to begin to explore causal reasoning, a cause-and-effect approach to phenomena, to develop one aspect of what is commonly taught to students as "the scientific method" as a heuristic for solving queries. Bruner (1986) refers to this as a paradigmatic mode of thinking (p. 13). He writes:

> One mode, the paradigmatic or logico-scientific one, attempts to fulfill the ideal of a formal, mathematical system of description and explanation….deals in general causes, and in their establishment, and makes use of procedures to assure verifiable reference and to test for empirical truth. (pp. 12–13)

Wells (1999) refers to paradigmatic thinking as "…this powerful discursive tool [that] has, not surprisingly, been appropriated by other fields of inquiry, and, in different forms, has come to play a major role in the written genres of exposition and argument in almost all the disciplines" (p. 145).

But inquiry must go deeper; it must include what I am here calling "puzzlement." This is an inquiry that captures learner's own puzzling questions, with stories behind them, and asks students to consider divergent possibilities, to think critically, to answer the question, "Yes, that, but what about this?" It is a form of thinking that captures the confusion and search for clues that accompanies human learning about the world and living in it; it is about being puzzled and having no ready answer for resolution and satisfaction. Dewey (1910) says that critical thinking begins when a learner confronts "the forked road" (p. 11), "…the origin of thinking is some perplexity, confusion, or doubt. Thinking is not a case of spontaneous combustion. There is something specific which occasions and evokes it…the next step is…some tentative plan" (p. 12).

While that element of evoked thinking may or may not have been in the exercise of building paper airplanes to collect data, we do see that "forked road" query in two children's divergent response to a large spider—"Kill it" versus "That's nature"—an inquiry ripe with puzzlement. Bruner (1986) would place this inquiry closer to his second mode of thinking, the narrative mode. He writes: "The imaginative application of the narrative mode leads instead to good stories…It deals in human or human-like intention and action and the vicissitudes and consequences that mark their course" (p. 13). It is "the landscape of consciousness: what those involved in the action know, think, or feel, or do not know, think, or feel" (p. 14).

Wells (1999) writes of these two modes: "The narrative mode is primary, and…underlies children's early experience of conversation. It is the discourse of doings and happenings, of actions and intentions: Agents act in the light of prevailing circumstances to achieve their goals" (p. 144). The other mode, the paradigmatic, recodes,

> almost every aspect of experiences…a way of symbolically managing the complexity and variability of experience, allowing it to be reconstrued in 'scientific' concepts, which can be systematically related to taxonomies; instances can then be counted, and made amenable to operations of mathematics and logic. (p. 145)

Teaching for and about structured and limited inquiry does not always capture the element of puzzlement that is experienced by all learners of all ages as they seek to understand the world around them. Nor does teaching for structured inquiry necessarily translate into learners' ability to use that structure or that discourse to investigate a new query. The fundamental question for current education, I think, is, does inquiry as taught in its limited, formalized, and structured form as "scientific method" prepare thinkers to confront the second, and deeper aspect of inquiry—"How do I know what to think?"—"What evidence helps me to make a decision?" "What do I do at a crossroads?" "What am I supposed to make of this?" This is puzzlement. Although there was an element of divergency in designing and testing the paper airplanes, the unexpected spider presented a much more distinct and divergent situation. Are young students and their teachers being prepared to appropriate the inquiry tools they are given in order to explore personal, and perhaps more pressing inquiry problems?

> The existence of inquiries is not a matter of doubt. They enter into every area of life and into every aspect of every area. In everyday living, men examine: they turn things over intellectually; they infer and judge as 'naturally' as they reap and sow, produce and exchange commodities. (Dewey, 1938, p. 102)

The question for teacher education may well be, how do we best prepare our students for success in today's educational "culture of evidence" (Knapp, Copland, & Swinnerton, 2007) without losing sight of our larger goals to prepare our students and the children they teach to be critical and creative thinkers, to seek and solve knowledge about the world around them, and to be "guided by shared beliefs about the purposes of schooling in democratic societies and about the roles teachers and teacher educators can play in social change" (Cochran-Smith & the Boston Evidence Team, 2009, p. 458).

We will never know whether children's interests were captured by trying to fold the paper into airplanes that would fly, nor will we ever know how an inquiry would have proceeded as to why there are spiders in the world. But we can ponder whether children are being equipped through current inquiry-based instruction to cope with and solve the worldly problems, the future "forked roads," that they will face.

> For many years, the science education community has advocated the development of inquiry skills as an essential outcome of science instruction and for an equal number of years science educators have met with frustration and disappointment. In spite of new curricula, better trained teachers, and improved facilities and equipment, the optimistic expectations for students becoming inquirers have seldom been fulfilled. (Welch, Klopfer, Aikenhead, & Robinson, 1981, p. 33)

On the overhead projector in a 2nd grade classroom I find evidence of pursuit of inquiry in a formulaic assignment. Students are to list their learnings under three categories: "I learned, I know, and I wonder." Below this is a chart to be copied and filled in by these young learners: "My Claims & The Evidence."

This formula for learning the scientific method comes from a popular, elementary school science series. "For most preservice teachers, the 'scientific method' remains the dominant procedural framework for thinking about inquiry—to the exclusion of considering theoretical models as the basis for fruitful questions and for conceptual refinements after investigations" (Windschitl & Thompson, 2006, p. 829). While the procedures begin to follow Dewey's (1910) injunction to "extend the problem to whatever…perplexes and challenges the mind…" (p. 9), they fail to provoke a "forked-road situation which is ambiguous and presents a dilemma with alternatives" (p. 11). The activity does contain elements of what we commonly call "the scientific method," a process taught for investigating an inquiry in any field. "Essential to thinking, for Dewey, was the importance of doubt and systematic inquiry through reflection. However, Dewey felt very strongly that thinking needed to be trained in order to move beyond basic instincts" (Sevey, 2010, p. 24).

In 1910, when he wrote *How We Think*, Dewey called for formal, trained inquiry as an extension of the "forked road situation." He specified that thinking involved a five-part process which he called "steps": "(i) a felt difficulty; (ii) its location and definition; (iii) suggestion of possible solution: (iv) development by reasoning of the bearings of the suggestion; (v) further observation and experiment leading to its acceptance or rejection" (p. 78). Kliebard (2004) writes:

> Although Dewey was articulating a version of how thinking in general takes place, the act of thought he formulated ultimately became transformed into

> a series of five more or less invariant steps constituting *the* scientific methods for high schools students… (p. 231, italics in original)

Kliebard notes that in revising *How We Think* twenty years later, Dewey attempted to unseat this rigid interpretation by including a section that specified that the "phases" were not "steps" nor were they "fixed" (p. 231). Kliebard writes:

> His efforts at reconstructing his version of reflective thinking and correcting some confusion was[sic], as seemed to be Dewey's fate by and large, ignored. The controversial belief that there existed a series of sequential steps comprising *the* scientific method has persisted to the present as a staple of the teaching of science. (p. 232, italics in original)

And so inquiry learning inherited a rigid, five-step process that has come to be known as "the scientific method." In curriculum and pedagogy, it is too easy for inquiry to be reduced to its formulaic state, with only correct answers being sought from students, rather than allowance being made for pure puzzlement to be the source for investigation. Such a reduced form of inquiry, or inquiry-as-formula, fails to allow for the essential role of puzzled engagement, reducing inquiry to a five-part thinking process. Although a learner may experience interest in a prescribed lesson with a built-in problem, the learner's own puzzlement is not guaranteed, expected, or provided for. With a prescribed and built-in problem and inquiry, it is far too easy for the teacher and the learner simply to follow the formulaic path and not puzzle at all. In studying the impact of teacher-driven inquiry in mathematics instruction, Jaworski (2004) found that, in spite of teachers' best intentions and strong training, there were times when student-directed inquiry simply could not occur: "While some episodes provided clear evidence of challenge, there were others in which challenge was lacking, in which the teacher answered her own questions and offered her own explanations in response to students' apparent inabilities to do so" (p. 18).

In textbook-driven inquiry lessons, as we see in the following anecdote, learners may experience a situation that is only confusing and puzzling as they try to make the prescribed experiment work, thus further confounding the development of useful inquiry strategies. A fourth grade classroom works on a prescribed textbook lesson on electromagnetism. The creation of a circuit should eventually allow a wire-wrapped nail attached to a D-battery to pick up a metal washer. The lesson doesn't quite go as planned, washers aren't moving and children are frustrated.

There is plenty of confusion and puzzlement in this lesson—children and teacher are all involved with worried frowns, trying to make this experiment work. But this is merely "frustration puzzling"—it does not result in Dewey's "forked road" decision-making or a plan for finding information and resolution, nor is it resulting for some in teaching of "the scientific method" as a method for query investigation, or even as a heuristic being taught for answering a question. Rather it results in curricular frustration and abandonment of the experiment. Some children simply drop out and put their heads down; a few children become seriously engaged in making this work by trying to solve the problem; many look around and talk about other things; some play with the washers. This is not the self-generated puzzlement that will eventually lead to more genuine and personal inquiry; this is frustration that leads to a learning dead end, regardless of the teacher's helpful intervention. In their critique of the scientific method as it is taught in today's classrooms, Windschitl and Thompson (2006) write:

> …even though [the scientific method] encourages naïve empiricism and often dispenses with the need for deep content knowledge to inform the inquiry process, it provides the only structure within which many teachers feel comfortable engaging their students in hands-on work. Teachers relying on this heuristic are often successful in getting their student to ask inquiry-appropriate questions, to work with the materials of science, and to talk about data. (p. 825)

In this anecdote, inquiry is used as it is taught in elementary schooling—a vehicle for investigation and training learners in the scientific method and conveying some testable results. "Puzzlement" is a much more specific and focused term and I am using it to characterize those real world encounters and moments when dichotomies and contradictions arise and are confronted. In today's classroom, curriculum and its implementation are subject to many factors: time is always of the essence, testing and school stress are real, and the "daily grind" often compounds distracting factors. In reviewing an earlier study done by a colleague and herself, Jaworski (2004) notes:

> However, later, under the stress of a Friday afternoon lesson, students' unwillingness or inability to offer explanations, and time factors in finishing an activity, this same teacher entered a funnelling process in which she herself explained the concepts she wanted students to address. She was aware of the conflict between her aims and actions, but she needed a closure to current activity and, in the moment, no other actions were obvious. In

> reflecting on the activity later, she explained that what she would have done, ideally, did not fit with time factors and the mood and behaviour of students. (p. 5)

In sharp contrast, Duckworth (2006) writes of a particular curriculum she observed in action:

> Instead of expecting teachers and children to do only what was specified in the booklets, it was the intention of the program that children and teachers would have so many unanticipated ideas of their own about the materials that they would never even use the booklets. (p. 8)

We note here that inquiry and the role of puzzlement do not only exist in science education and curriculum. All of our examples have been situated in the discipline of science, a natural context for inquiry, particularly with the teaching of the scientific method. However, both inquiry and puzzlement, given time and opportunity, reside in all disciplines, and in all areas of daily life, and in the world around us. Wells (1999) lays out the role of language-as-inquiry, dialogue in action, in the various disciplines and summarizes:

> In each of these cases…the activities…are different, and so are the discourse genres through which these activities are enacted….the different discourse genres perform complementary and interdependent functions, together with constituting, in large part, what it is to 'do' science, history, or literature. (p. 140)

In the classrooms of English language arts and social studies, we often approach inquiry through structured debates and position papers. While working with a stance on a topic is valuable in teaching children how to investigate and defend a position, and how to present that position to a critical forum, this debate format only begins to prepare learners to confront the complex form of inquiry that requires a weighing and evaluation of contradictory and divergent ideas—such as we might find in children's discussion of their reactions to the garden spider in the first anecdote, or in citizens' evaluation of a political debate, or in legal debates around a legislative or Constitutional issue. Literature in its many languages fosters the contemplation of moral ambiguity, promoting much puzzlement in readers. The teaching of social studies provides rich fodder for endless questioning by historians and social scientists who are often engaged in moral puzzlement over "forked roads." Jaworski (2004) writes: "Two factors, however, were always clear to me: (1) the power of inquiry in processes of learning; (2) the importance of dialogue in coming to know" (p. 28).

Back in the day, when I had time and liberty, I experienced an extended pursuit of mathematical puzzlement that was undertaken by my sixth graders and me. As a child, I was taught very formal math, purely algorithmic, no inquiry allowed, and my students were well on the way to also having this same limited form of mathematical inquiry. But my delight was in exploring with my sixth graders some of the higher ideas in math, some of the theories that reside behind the algorithms that plagued my high school years. I wrote about it in Cordeiro (1994) and characterized our pursuit this way:

> In an effort to promote concept formation in pre-adolescents, to develop powers of thinking, to sow seeds of curiosity, to 'get behind' the computational surface of traditional instruction, I have engaged students in thinking about some 'big ideas' in mathematics. (p. 266)

Big ideas are characterized in three ways, they extend into a variety of contexts, they begin with the intention to develop conceptual thinking, and they are ideas that continue to intrigue the experts (p. 266). This last requisite satisfies the definition of puzzlement—big ideas continue to puzzle even the experts.

We set out to explore group theory (Cordeiro, 1994). I had assembled materials and learned as much as I could about this big idea, and throughout the month of this free-flowing inquiry, I managed to stay ahead of the students as we explored this query. What I had not predicted or prepared for was the students' puzzlement. They kept up just fine with the mathematical explorations I led, but they voiced continuous puzzlement at how people had thought of this. I wrote:

> I had narrowly seen the study as an opportunity to explore the world of mathematics. I had not…expected us to focus finally on the power of the human mind and its manifestation in mathematics. Nor had I seen an exploration of group theory as an opportunity to expand our notion of patterning in the world around us. I had underestimated the minds of children. (p. 290)

This extended inquiry into the world of group theory followed up on a study done with an earlier sixth grade class the year before, studying the big idea of infinity. I wrote:

> Whether or not any child becomes a world-class mathematician, we have nonetheless fulfilled the first requirement: we have made the introduction to the concept…a playful and exploratory experience, which has optimized the chance for independent thinking. Further, each child in that class comes away feeling that what they thought…was important, not wrong and a new direction. (Cordeiro, 1988, p. 564)

Elements of playfulness and exploration in pedagogy appear as key to allowing for the introduction of puzzlement as an earmark of learning and inquiry. But playfulness and exploration are scarce commodities in today's hectic classrooms, even though they are essential to fostering students' pursuit of their puzzlements. Jaworski (2004) writes of inquiry in mathematics education:

> [This] just start[s] to sketch the kinds of complexity I see in trying to develop teaching. They include dealing with in-the-moment decisions involving cognitive and sociosystemic factors relating to the diverse needs of pupils in class and beyond: time factors, syllabus demand, mathematical or didactical beliefs, emotions of teachers and pupils and more. Teachers tried to balance challenge and sensitivity within a management of learning that was both inclusive of students (sensitive to their thinking and needs) and focused on deep consideration and development of mathematical concepts. (p. 22)

Passmore (1980) posits that we teach capacities and he outlines two kinds of capacities that are taught: open and closed. He distinguishes between them in this way: "A 'closed' capacity is distinguishable from an 'open' capacity in virtue of the fact that it allows of total mastery" (p. 40). Closed capacities can be "converted into routines" (p. 41). "Open" capacities, on the other hand, allow that,

> the pupil can take steps which he has not been taught to take…the teacher has not taught his pupil to take precisely that step and his taking it does not necessarily follow as an application of a principle in which the teacher has instructed him. (p. 42)

The teacher can "prepare the way" (p. 44) and may teach closed capacities first to lay the groundwork for learning an open capacity. Passmore specifically addresses the case of science instruction: "In the school science course, the child was to acquire established techniques; later it was supposed, he might blossom out into being an imaginative scientist" (pp. 47–48). But Passmore warns against then assuming that closed capacities must be taught first, because children may become "so wearied by the endless preliminaries…of any attempt to think for themselves, that they were completely bored by their school life…and certainly not attracted by the prospect of becoming scientists…" (p. 48).

In our anecdotes, we see the potential for "curriculum weariness" in children, their inability to go beyond the preparatory work in learning closed capacities as we try to move them into higher thinking, into the open capacities that allow for higher level problem solving and inquiries into their puzzlements. Unless curriculum and curricular practice quickly move learners into realms of investigation, passing over the tedium of learning strategies and methods, we risk losing learners' interest. Passmore writes: "A school system has to make up its mind what level of capacity it is going to take as its objective. There is a minimum below which it has failed to teach the open capacity at all" (p. 43). Berlak and Berlak (1981) characterize this issue as a "knowledge as given versus knowledge as problematical" (p. 147) dilemma of schooling. They write: "This dilemma focuses our attention on the pull toward treating knowledge as truth 'out there', and the alternative pull towards treating knowledge as constructed, provisional, tentative, subject to political, cultural, and social influences" (p. 148). When curriculum and pedagogy treat knowledge as problematical, a puzzlement, this results in activities designed to develop children's thinking, "an assumption that persons are capable of creative and critical examination of the world that they take for granted" (p. 148).

Here is the heart of the problem, what has been lost in today's classroom interpretation of inquiry. Without a firm grasp of inquiry in our philosophy of education, we are at risk of losing the opportunity for children to learn diverse ways of thinking and expression. "…an inquiry-oriented approach to curriculum creates opportunities for students to engage in many modes of discourse, both spoken and written" (Wells, 1999, p. 161). Creating a diversified and personalized curriculum for children is our only hope for developing in each child the widest possible range of cognitive and discursive opportunities for achievement.

> Certainly the material world is too diverse and too complex for a child to become familiar with it…the best one can do is to make such knowledge, such familiarity, seem interesting and accessible to the child…to catch their interest, to let them raise and answer their own questions, to let them realize that their ideas are significant so that they have the interest, the ability, and the self-confidence to go on by themselves. (Duckworth, 2006, p. 8)

This requires a view of the classroom that goes beyond curriculum and practice and sees everyone who is in that space—students and teachers alike—as being engaged in a shared process of learning and dialoguing, so that,

> …the emphasis is on the learner and the conditions that enable him or her to master the means for full participation in the activity of inquiry, both alone and in collaboration with others…a community of inquiry, in which learners share with the teacher the responsibility for deciding on the topics and on the means for their investigation… (Wells, 1999, p. 164)

By 1938, Dewey had allowed for inquiry to go beyond simply teaching a structure such as he wrote about in 1910. By 1938, he allowed that when approaching a forked road situation, inquirers would seek "warranted assertions" (p. 9) based on external and structural factors. In 1938 he wrote, "…every inquiry grows out of a background of culture and takes effect in greater or less modification of the condition out of which it arises" (p. 20) and he warned against teaching for short cuts in inquiry, which "begins in doubt" (p. 7), and may end prematurely, the result of too much structure, if the "problem is taken to be closed and inquiry ceases" (p. 118).

Wells (1999) reminds us that, in the end, learning how to know is all about learning how to think and communicate within a genre, about learning how to inquire and discourse about it. Teaching about inquiry, and teaching in general, is an elegant and informed process of preparing people how to reason and articulate their reasoning within different genres for many different types of inquiries. We as teachers are charged with schooling children into "…the various functions that language performs in the different activities that we might expect students to engage in in the classroom…as an apprenticeship into the various modes of knowing…on which the curriculum is based" (p. 140).

Writing about inquiry and education, Wells sees the goals of education as twofold, "…to ensure that the young are socialized into the values, knowledge, and practices of the culture…and to nurture the originality and creativity of the individual…to fulfill his or her unique potential" (p. 157). He sees goal one as creating "responsible and productive citizens," but should not goal two also do the same? Jaworski notes, "In my view, inquiry is both a *tool* and a *way of being*. In constructivist terms, it can be seen to stimulate accommodation of meanings central to individual growth. In sociocultural terms it is a way of acting together that is inclusive of the distributed ways of knowing in a community" (p. 26). This is how we prepare an educated citizenry to think, discourse, and act.

Duckworth (2006) proposes the heart of education as "the having of wonderful ideas." I certainly agree and find that wonderful ideas often start from a learner's puzzlement over a dilemma, the learner's discovery in a rich and personal context, and the learner's discursive advancement of that idea and its implications. Without that allowance for meaningful engagement, a school's pursuit of the teaching of inquiry becomes merely a formula for problem solving and not the rich tool for addressing a learner's unique and puzzling query and for developing a learner's discourse repertoire.

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