Questioning and the Generative Student Investigation

The "why" question has always captivated our imagination. Why is a sunset red? Why did child labor flourish in coal mines? As enticing as these questions are, their answers can be more challenging than we might anticipate. They demand a certain level of knowledge. Unfortunately, the questions themselves—whether in math, science, or history—often cause us to shy away from addressing children's natural curiosity. However, the very act of questioning can be a key in engaging students in some of the most memorable and beneficial learning experiences possible. "Why" questions can become "what if" and "how" questions that result in purposeful and meaningful investigations, and enhancing students' abilities to generate these questions can contribute greatly to the arsenal of strategies they should acquire during their schooling years. Question asking, often referred to as question generation, is a research-supported strategy for improving comprehension of reading material in science and the social studies (National Reading Panel [NRP], 1996). Development of the ability to generate and refine "what if" and "how" questions is also, as we'll explore here, an essential component of the investigative process.

Capturing the spark: The "why" question

It is not surprising that the initial question that leads to worthwhile research comes in the form of a "why" question. It is a natural response to something of interest. The following examples represent very likely "why" questions that we might encounter upon providing a prompt in either science or history. The prompt could consist of a story, or even simply pictures or a brief video, related to a particular phenomenon or situation (in this case, a sunset or a child labor scenario at a coal mine).

Transcending Subject Boundaries

"Why" questions are the generative catalyst—effective but often ignored. They lead to deeper inquiry, student engagement, and learning, regardless of the topic or subject studied.

Good facilitators can turn the "why" into the "what if" and "how," and follow the students' lead toward realistic critical thought and student-initiated learning.

Science Example:

Why is a sunset red?

History Example:

Why did child labor flourish in coal mines?

To move forward in a systematic manner in such a way that students can simultaneously learn more about the topic and about how to empirically investigate a topic, the "why" question must be narrowed and refined into something we can actually investigate. This requires that students generate "what if" questions. These types of questions are often referred to as operational questions, or controlling questions for additional research or investigation. Saying that we then help students move from "why" to "what if" questions that become operational or controlling questions is easy enough—doing it in reality requires a great leap. Doing it so that student learning is scaffolded, so that students can follow the transition from phase to phase, requires care and planning.

The operational question

An operational question can be directly investigated, either through specific research, confined investigation, or some method of obtaining first-hand observations and evidence that informs or helps us to answer the question. Though the original "why" question is not necessarily answered during the process, we still move continually closer to that goal as our investigations proceed, and as questions that are addressed lead to new questions. The operational question, often called the controlling question in a focused research exercise, has several advantages (see right).

Operational questions:

- involve learners in a process of inquiry;
- encourage observations and direct critical analysis of information and/or data; and
- open avenues for further investigation by exposing new information or considerations related to phenomena or situations being investigated.

A key to effectively utilizing operational questions is that students generate the question. Over three decades ago, science educators described operational questions as those asked by, meaningful to, and productive for, the learner (Alfke, 1974). The ability to generate meaningful questions does not just happen through serendipity—the role of the teacher is of paramount importance. Researchers later found that when the act of generating questions was modeled by elementary science teachers students tended to ask more questions of this nature than control group students not exposed to modeling (Allison & Shrigley, 1986). This has been supported in question generation research in the area of reading comprehension (Rosenshine, Meister, & Chapman, 1996), less removed from any science or historical investigative process than we might assume. There are numerous reasons for this, and all illustrate the importance of the transitional phase between the initial "why" question and the operational question. The "why" question creates interest, and even prompts students to look up information and read about a topic. However, the prior knowledge needed to understand what is read is typically absent. Students need prompts, and teachers can provide these by modeling the question generation process. The prompts should be engineered to scaffold students' learning experiences, and to get at the prior knowledge needed to proceed in as informed manner as possible. Implicit in this reasoning is the idea that teaching students to generate effective questions and learning to do so as a teacher are inseparable. See The Eliciting Prompt: Initiating Student Questioning Via Spontaneous Observation (http://www.designedinstruction.com/learningleads/eliciting-prompt.html). As demonstrated, the prompt may come in the form of a simple experiment involving observation, provision of a set of data, or reading material that is investigated together with the teacher using a variety of reading comprehension strategies to ensure that no one is left behind at this stage. If the type of materials to which students are exposed during the eliciting prompt are suitable, it is not too early to seize the opportunity to begin scaffolding student experiences toward acquisition of skills that are required throughout an inquiry or investigative process, such as comparing and contrasting information or drawing distinctions between inference and actual observations.

From prompt to controlling idea: Establishing coherence

A controlling idea is an observation-supported statement that can help to guide development of questions and research conducted as students attempt to investigate and find answers to those questions. Sometimes a controlling idea can become a theory—an explanation of a phenomenon or event that is based on underlying principles that have been verified at least to some extent. Some theories are very evidence-based, some more loosely based on a set of assumptions about the causes of behavior and rules that specify how those causes act. For the purpose of continuing an investigative process, and generating the questions necessary to fuel that process, the act of establishing an initial controlling idea is important. Following initial collection and analysis of data and/or findings (from sources or physical experimentation), establishing a controlling idea helps to create order and to guide acquisition of new information and ideas, even if the idea is altered, upgraded to a theory, or the assumptions on which it is based are modified. Continuing with our previous science and history examples, possible student-derived controlling ideas might be expressed as follows:

Science Example:

Visible light from the sun bends as it comes through the earth's atmosphere and we see mainly long wavelength light in the evening.

History Example:

Children were cheap for tasks requiring only minimal training, easy to conceal, and raised little objection from family or other adults.

The controlling idea or assumptions students formulate based on spontaneous observation, as discussed in the eliciting prompt, lead into deeper investigation that becomes more focused as operational questions are posed, revised, and refined. As students delve into the additional information surrounding a topic, they will inevitably tap previous research and theories. Since in any subject, most research inevitably comes from previous research, it is important that we assist students in efficiently locating and extracting necessary information from the resources they encounter. This can, depending on the situation and the time available, be supplemented (even supplanted at times) by direct experimentation. When exploring research in an attempt to conduct deeper analysis, students will be called upon to read critically and to comprehend what they read, and we can help them to develop

> Primary source materials in text format are rich instructional resources that can significantly enhance student learning… but only if they can comprehend what they are reading. Find out how the two can be addressed hand-in-hand. Read the article Reading Comprehension and Historical Thinking: Classroom Realities in Building a Context Connection to find how the research from more than one field supports a parallel approach.
>
> Access at:
> http://www.designedinstruction.com/learningleads/reading-historical-sources.html

these skills. For insight into reading comprehension as it relates to reading primary historical text sources, see Reading Comprehension and Historical Thinking.

From controlling idea to operational questions: Implementing dialogic talk and a question assessment model

While the goal of the eliciting prompt is to spur student generation of ideas and operational questions that drive and guide further investigation, there is little reason to assume that students can or will make that leap on their own. Just as helping students improve their question generation skills toward reading comprehension requires an active role on the part of teachers (see Research Précis Reading Comprehension: Question Generation at http://www.designedinstruction.com/research/brief_ed_03_1.html, and Research Précis Reading Comprehension: Combining Question Generation and Multiple Strategies at http://www.designedinstruction.com/research/brief_ed_03_2.html), so to does helping students acquire the skills needed to generate operational questions. This is a key point—even if for the sake of a certain investigation the teacher and students were able to develop a good set of operational questions on which to proceed, yet students did not acquire the skills to do so on their own, then the objectives are not fully met. It does not mean the process was unsuccessful—success could mean students moved a step closer to the objective, and that it will take many such steps to reach the goal. It simply means that we should keep in mind the objective, and not try to skip it so that we can "accomplish" the investigation.

We should also keep in mind the difference between *understanding how to do something* (supposedly), and being able to actually *do* that something. For instance, we can assume (and it will typically will be the case) that fairly early in the course of instruction students will grasp a basic understanding of operational questioning in the declarative sense (e.g., the knowledge that it is done, and even many aspects of how to do it, as well as its connection to establishing controlling ideas or fundamental theories). These understandings are necessary, and can be achieved primarily through *explanation*. However, helping students to develop the procedural knowledge—the ability to independently create, select, and implement effective operational questions—is a far more daunting task for the instructor. This requires that we *model* the question generation processes with students, that we *mediate* their own independent and group efforts, and that we help them to *assess* whether or not their efforts have been successful. We've established these fundamental needs based on the assumptions that students, to be successful operational question-generators, must know what it is they are doing, be able to do it, and be able know when they have done it. The **EMMA** (explain, model, mediate, and assess) approach to student generation of operational questions addresses these student needs.

EMMA, an instructional approach for helping students learn to generate operational questions, addresses the teacher's role in the process in:

Explaining in order to ensure students understand what an operational question is and what it is used for in an investigation.

Modeling in order to ensure students develop the skills to implement self-regulated strategies toward development of questions.

Mediating in order to ensure students are redirected as needed, and that they develop the skills to organize and apply their thinking.

Assessing in order to ensure students know what constitutes an effective question and when they have attained that goal.

Explain: Provide your students with prior information that will facilitate understanding of the meaning and use of operational questions. This may be addressed via classroom discussion or with a set of simple notes or handout.

Model: Numerous strategies are effective for helping students to see and use strategies for developing operational questions. One effective method is dialogic talk. Teachers, especially science, should try the Investigation-Colloquium Method (http://www.designedinstruction.com/learningleads/investigation-colloquium.html), created over 30 years ago (Lansdown, Blackwood, & Brandwein, 1971) and proven effective in subsequent research studies for promoting the interactive student discourse that can naturally produce operational questions in abundance from which students can draw to continue their investigations. Given the nature of dialogic talk, we should recognize the necessity of students developing the listening skills to adequately capitalize on rich discussion.

Mediate: In addition to roles in mediating discussion implied in the Colloquium Model, these Teacher Questioning Tips: Effective Techniques for Mediating Dialogic Talk (http://www.designedinstruction.com/learningleads/teacher-questioning-tips.html) provide some guidelines for helping maintain an appropriate place and level of involvement in classroom discussions. In addition, as suggested in the Investigation-Colloquium Method and the teacher questioning tips, students' abilities to make sense of dialogic talk are improved by use of strategies that employ an accompanying concrete task—creating a simple graphic organizer or map of student observations is one example of a way to structure input from dialogic talk into meaningful connections and relationships from which operational questions might be more easily identified.

Assess: To help clarify the characteristics by which the quality of the questions generated can be measured, check our S3 Assessment Criteria for Operational Questions (http://www.designedinstruction.com/learningleads/s3-question-assessment.html). These criteria provide not only the guideposts by which students can make determinations regarding their own generation of operational questions, but also constitute an excellent set of indicators for teachers to score students' question generating abilities.

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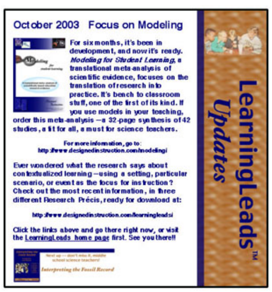

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