Assessing problem generation in inquiry contexts: The first items in the toolbox.

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The question or the way a question is approached must be novel & the question must be relevant to an authentic audience. *(High School Inquiry Teacher).*

Abstract

To date, problem generation in inquiry has not been well-researched and is in need of definitional, theoretical, and methodological advances. This poster describes inquiry, highlights the importance of students asking their own questions in science education, and suggests criteria for assessing the quality of a question. Better understanding the process inquirers engage in to come up with questions of personal interest is the goal of both Redden's and LaBanca's dissertations.

What is Inquiry?

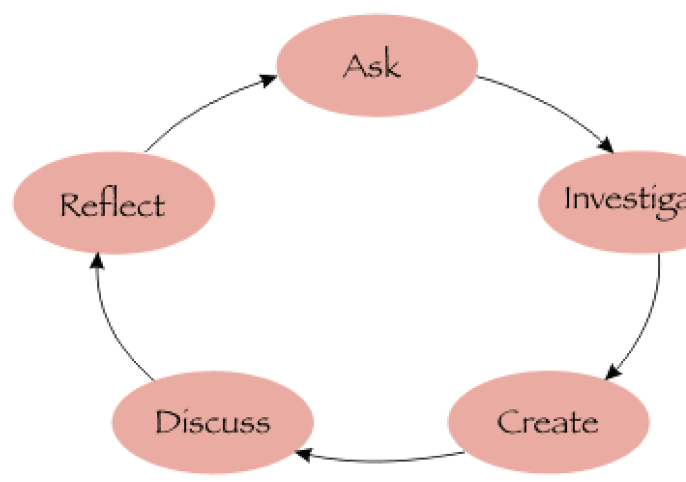
"Inquiry refers to the work scientists do when they study the natural world, proposing explanations that include evidence gathered from the world around them. The term also includes the activities of students -- such as posing questions, planning investigations, and reviewing what is already known in light of experimental evidence -- that mirror what scientists do" (Martin-Hansen, 2002, p. 35).

The ways in which inquiry activities are enacted for different grade levels, subjects, and students vary greatly. Every inquiry classroom fosters a learning *process* that covers certain *content* (guided by the curriculum) by employing *strategies* (cognitive and interpersonal) that will achieve the goals set out by students and teachers within *contexts* that vary according to physical and social resources (Aulls & Shore, in press).

The process of inquiry is in no way linear; general "stages" should interact in complex ways (Krajcik, Blumenfeld, Marx, Bass, Fredricks, & Soloway, 1998, p. 315). For instance, generating research questions influences the designing of procedures and, certainly, knowledge of research methods and various designs feeds back to the kinds of questions an inquirer will ask. Unexpected findings may result in the reframing of questions, and preliminary data analysis has the potential to require the researcher to alter subsequent procedures.

Our lab is focused on constructing an understanding of how teachers can enact and assess inquiry activities to meet the expectations of the QEP and other reform initiatives. When it comes to inquiry, we have pedagogical books and manuals that tell teachers how to enact "it" (English, Cudmore, Tilley, 1998), evidence that students like "it" (Reis & Renzulli, 2003), and evidence that "it" leads to scientific understanding (Bransford, Brown, & Cocking, 2000). Investigating how the process of inquiry unfolds over time is critical to the understanding required to successfully promote its implementation in classrooms that are struggling. Pivotal to students taking responsibility for their learning and for a shifting of roles from teacher to student is the formulation of their own questions that will direct learning. Some questions we have about the nature of the process of problem generation are:

1) What are the strategies used by students?
2) What are the social interactions engaged in towards goal-directed activity?
3) Open-ended, self-directed inquiry learning should be personal, so what is that personal experience?
   a) What emotions might motivate or inhibit student engagement and strategy usage?



A model of inquiry from The Inquiry Page: http://www.inquiry.uiuc.edu/

How do we know good questions are being asked?

Good questions meet the following *criteria* :

1) Either the question is unique, or the approach to answering a question is unique.

2) There must be an authentic audience who will value the work that comes from the question. It must go beyond the teacher and the science fair.

3) The process of generating the question is inseparable from developing the process of answering the question.

A good example: What is the long-term water quality in region X?

Answered by identifying macroinvertebrates in a river and using a standardized matrix to establish an indicator of quality. -OR- Answered by collecting fish from different marshes in the area, and analyzing the livers for toxicology indicators.

A great example: How can we better detect *E. coli* contamination in spinach in the supermarket?

The student understood a problem space that is a public-health concern and realized that the currently existing tests take 24-48 hours using a Petri-dish planting method. He utilizes a genetically modified glow-in-the-dark gene to quantify *E. coli* using a fluorimeter that he built himself for under $100.00.

How do we assess the above criteria?

1) Develop a rubric of context-specific criteria. Set specific objectives for the inquiry project with your students.

2) Observe the students' process of coming up with their question. The process students engage in to reach their question is just as important as the question asked.

3) Request a portfolio along with the students' final project.

4) Ask students to assess the extent to which they feel they met the objectives set at the beginning of the project.

How do we assess a teacher's readiness to support problem generation?

The High Ability and Inquiry Research (HAIR) team at McGill university developed and validated the Strategic Demands for Inquiry Questionnaire (SDIQ) (Syer, 2007). The SDIQ contains an array of items that tap teachers' ratings of importance of pedagogical practices that are critical to inquiry-oriented classrooms. Items that measure the extent to which teachers value activities related to problem generation include:

How important is it in inquiry-based learning and teaching:

1) … for the student to ask questions?
2) … for the teacher to tap into the student's and his or her own interests?
3) … for the student to understand the goal of the task?
4) … for the student to organize his or her own time and space?
5) … for the student to divide the task into a coherent set of do-able steps?
6) … for the student to brainstorm his or her ideas?
7) … for the student to share emotions, feelings, ideas, and opinions?
8) … for the student to question the findings?
9) … for the student to discuss what has been learned compared to what was known before?
10) … for the student to follow-up the project with a new set of questions?

A story of generating a research question, and research questions generated from a story...

Adelle is an 11th grade student who is on the swim team at her school and has a love for nature and everything water. She has spent time working on water purification efforts and collected hundreds of dollars by swimming for a foundation that was installing water purification systems in Ghana. She subsequently initiated a youth group that supports water purification efforts. Adelle registered for an elective applied science research course to pursue her interests in environmental science and to satisfy the required science credits for her high school diploma. Her long-term goals include going to university to study either environmental law or science. The experience she will receive in this course will prepare her well for becoming a lawyer or scientist. She is likely to be motivated through the inquiry process because she is invested in her project. After exploring the unique chemical binding properties of chitin, a nitrogenous carbohydrate found in the shells of crustaceans (lobsters, crabs, shrimp), she has decided to investigate its ability to purify wastewater and contaminated soil.

What was the process of channeling her interests into this specific problem space? Did she entertain multiple potential questions before committing? How did her question evolve through the inquiry process? What role did her level of personal interest play in her problem generation process? What was the interpersonal process of problem generation? What emotions were experienced, and what role could emotional processes have played during her process of inquiry? What is the experience of the process of problem generation for Adelle's classmates who have not yet formed such strong interests? Education researchers approaching these questions will shed light on the nature and range of problem generation processes in science inquiry activities.

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