Conceptual Framework – Data Portfolio

5/31/14

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Introduction: A conceptual model or framework for the purpose of instructional design and development communicates the different types of relationships within the system. It is usually a flowchart or visual representation of these relationships. Usually a conceptual framework is designed first; in the case of QuarkNet, the activities and workshops were designed first and a Data Portfolio (DP) was established. Therefore, the existing activities and workshops need to be incorporated into the framework rather than develop from the framework.

The activities and workshops have a common thread: use of data and its analysis to help students (and teachers) construct their own understanding. The DP provides opportunities to explore data analysis techniques as well as the data itself in order to learn topics.

The following is based on an assumption that the DP is a "model" as described in the QN proposal. It includes: classroom activities, masterclasses, e-Labs. It also includes support materials and resources. This document describes the *conceptual framework*, which shows the underlying concepts guiding the teaching and learning. It addresses the primary question: What are the overall goals for the DP in terms of teaching and learning? Additional questions include: What is the purpose of the DP? What are the learning objectives? What teaching strategies should be included? In terms of the goals of NSF: What contribution does the DP make to the science education community? Addressing these questions is the purpose of a conceptual framework.

Background: The NGSS and Common Core Standards help students improve their ability to make claims and support those with evidence. The NGSS also focuses on using data and data analysis in learning science (and mathematics) in a more meaningful way. Therefore, QuarkNet's decision to use data addresses current standards.

The literature indicates that teachers struggle with how to use data with students. Years of evaluation of the QN program shows students find using authentic data as highly motivational. Evaluation of e-lab posters indicates that when teachers use the e-lab as an introduction to scientific methodology, students do NOT achieve any level of scientific literacy. In addition, years of evaluating masterclass, indicated that students need an introduction to concepts covered in MC, which resulted in suggestions and resources for teachers in the form of classroom activities to prepare the students for the masterclass day.

The DP addresses these concerns by providing scaffolding for activities that are arranged from simple to complex use of data. This allows users to construct a personal understanding as they delve into more complicated data and activities. A summer 2013 pilot Data Workshop for teachers allowed the teachers to progress from simple data and questions to more complex data and questions. Workshop evaluation allowed that this is an excellent learning sequence. The workshop culminated in teachers using complex data with a high degree of facility.

This introduction and background indicates that the conceptual framework should include:

1) Providing the science education community with a framework for ways to address the NGSS and Common Core through data use and analysis; QN has unique opportunities for students to interact with authentic, "real" data.
2) Have a learning sequence from simple to complex for collecting, organizing and analyzing data.
3) The learning should include students (at workshops the teachers are the students) gradually accumulating subject matter content knowledge they will need as they progress through the sequence.
4) The framework should address the underlying and sub-questions (see #2 above).

The DP design assumes that students will have prerequisite knowledge of various science process skills including measurement, making observations, carrying out an investigation; and being able to define and appropriately use terms such as 'experiment', 'variable', 'control,' 'hypothesis.'

Conceptual Framework: The following addresses the four criteria for a QN conceptual framework using the existing activities, workshops and documentation previously developed.
Stated Purpose – to improve student scientific literacy by providing access to primary source data and technology for use in addressing questions and solving problems

Activity	L	Data Use	Data Analysis	SM Conceptual Learning
Mass of Pennies	1	One variable - measured	Organize data into a histogram; seek a pattern	A variable can be examined through measurement
Rolling with Rutherford	1	One variable - measured	Organize data into a chart; interpret histogram	Indirect evidence
Quark Workbench	1	Addressing a question using design technology	Develop rules for developing a model	Combining fundamental particles; standard model as a theoretical framework
Masterclass Calculation	2	Two variables/event display	Pattern Recognition; confounding variables	Event displays show products of collisions
Independent e-Lab Investigations	3	Several variables/ Students explore relationships; do research – ask a question	Correlation (possible); calibration; transform data	Conditions that effect number of comic rays; characteristics of cosmic rays

Characteristics of all the activities:
Students support claims with evidence derived from the data
Learning objectives are behavioral objectives
Students work in pairs or groups
Activities use guided inquiry (except advanced e-Labs in which students ask their own questions)

The following is a suggested generalized conceptual framework that can be used for any science subject area. Students can measure their own data or use provided data.

Level One – Students analyze one variable; they determine patterns, organize into a table or graphical representation and perform simple calculations.
Example in statistics—Number of times a rolled die returns a particular number

Level Two – Students analyze two variables; they calculate descriptive statistics, seek patterns, identify outliers, confounding variables and perform calculations to reach findings; they may also create graphical representations of the data
Example in oceanography – temperature measure at various ocean depths – determine thermocline

Level Three – Students analyze two or more variables through authentic research (student questions); correlations; they transform provided data into usable form; they calibrate or determine useful data.
Example in biology: determine the "carrying capacity" of a population given density and density-independent factors.

The skills used in level one should be applied to level 2 and level 2 to level 3 much as college courses e.g., 101 as a prerequisite to 102, and 102 to 103.