Center-Level Portfolio: University of Iowa/Iowa State University

The following table, proposed implementation plans by participating teachers, and when available other examples are intended to provide an overall narrative about how and in what ways program participation has influenced teachers in using QuarkNet content and materials in their classrooms (and in-after class events). The value of these qualitative reviews is to expand on the instructional practices measured quantitatively via Teacher Survey responses to specific sets of questions/self-reported by teachers providing narrative examples of implemented or planned instructional practices in teachers' classrooms and in schools. This evaluation approach is consistent with the use of *authentic assessment* to evaluate performance, "teaching for under-standing and application rather than for rote recall" (Darling-Hammond & Snyder, 2000, p. 523).

In keeping with Darling-Hammond, Hyler and Gardner (2017), we do not naively expect a single workshop (or event) to have a measurable impact on teachers' knowledge and subsequent classroom implementation. A characteristic of effective professional development is a program of sustained duration, providing "multiple opportunities for teachers to engage in learning around a single set of concepts or practices; that is rigorous and cumulative" (Darling-Hammond, et al., 2017, p. 15). As such, the table summarizes responses by teachers over the course of several program years and likely several QuarkNet programs and/or events.

These responses come from the Teacher Survey (either the full or update version) where each row represents the responses to open-ended questions from the same teacher over time. Also, each row starts with the original responses to the first time a teacher completes his/her full teacher. If a particular box in the table is blank, it likely means that that teacher did not participate in an event for that program year (or, the center may not have had a major event that year). The table provides the essence of these responses; a given response, as presented, may be a direct quote, a paraphrase, or lightly edited; the intent is to convey the overall idea or its essence from that particular teacher.

Because these are responses to open-ended questions, teachers are free (and encouraged) to provide information that he or she thinks most relevant. Each highlighted response is intentionally anonymous to respect the principles of collecting evaluation data (*Guiding Principles for Evaluators*, American Evaluation Association) and to help encourage teachers to respond frankly to these questions. If a reader is familiar with a given center, it may be possible to "reverse engineer" the identify of a particular teacher. We encourage readers to respect this anonymity. At various times, we may have identified a given teacher by name and/or school; when this happens the written approval of that teacher has been obtained. It is also important to note that the full breath of a response by a given teacher may not be fully articulated in this table. For example, responses related to how QuarkNet may have advanced the knowledge of a given teacher or bolstered a collegial network among participants are likely discussed elsewhere in subsequent evaluation reports.

The table is followed by examples of implementation plans, and at times teacher presentations and student presentations when available. The intent of providing these examples is to deepen the narrative as to what and how teachers have planned (and have used) QuarkNet content and materials in their classrooms and in-after class events (e.g., Physics Club). Examples from Annual Center annual reports may be highlighted as well.

Table

Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years **University of Iowa/Iowa State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
University of Iowa/ Iowa State University	2019	2020	2021	2022	2023
	I have tried to use the muon detectors and do cosmic ray labs with mixed results over the years.				Introduction to Coding Using Jupyter Dice, Histograms & Probability Rolling with Rutherford Cosmic experiences Research using coding
	I no longer teach the atomic structure aspect of physical science.				

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
	2021	2022	2023
	I have used modified versions taken from the listed activities.		
	Mass of a Penny helps to show practices in graphing. Rolling with Rutherford - Interesting to use data to estimate size of objects without actually taking a measurement.		Rolling with Rutherford, Particle Deck, Mass of Z boson, and Mass of Top Quark. Teaching about the structure of atoms and recreating Rutherford's experiments has been worthwhile. The particle deck activity helps in kids finding ways to link items together based on properties that they notice as well as comparing them to the standard model to see how scientists have linked them together. The mass of Z boson and Top Quark activities help in vector analysis for honors and AP classes.
	I have used the Dice Decay and the Cosmic Ray e-labs. The basic decay labs were quite useful. I found the cosmic ray lab challenging mostly because of the hardware interface. We wasted most of our available time attempting to get the detectors to work and trigger rather than looking at what it all meant.		
	This is my first time attending. Looking through them, they look very good! The master teachers in my class have also stated that they are very helpful.	I'm trying to understand the standard model enough that I can incorporate it into some lessons in my 9th grade science and physics classes. Examples: I don't know the names. I am so sorry. I looked at them 60+ days ago and don't plan on writing my lessons until after January. It's far from my mind at the moment!	
	I have not had the opportunity to use them yet as I have only taught for one year.		
	Rolling with Rutherford is great for atomic structure.		
	I don't teach physics; a lot of the activities from previous courses were too in depth for my students. However, I am incorporting Python code from coding camp.		I think there is a lot of good information in there, I just haven't been able to utilize the information in my classes. I try and incorporate bits and pieces when I can into my classes.

Table (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Responses from the Full Survey and then Responses from the Update Survey in Subsequent Years **University of Iowa/Iowa State University**

Center	Program Year (Year of Full Survey)	Program Year	
University of Iowa/ Iowa State University	2023	2024	
	New ideas to teach about quantum particles. Cards and particle journey	The Penny Activity (have used) The particle card activity (will use)	
	Particle Card Sort. There are interactive ways to engage students in abstract concepts.		
	MASS CALCULATION: Z and Top quark both will be helpful in helping students understand vectors in the contexts of physics. Some might be above my classes.		
	I have been unable to use them because our school strictly restricts what lessons are used for each course. The materials are prepared and tested so that a teacher can implement them with confidence.		
	I plan to use cloud chambers, quark workbench to introduce basics about particles other than the protons, neutrons and electrons we focus on in chemistry.		
	Rolling with Rutherford Mass of the Z boson. This provides teachers with quality, real world resources to use to allow students to practice and learn how to use and interpret the data gained from experiments.		
	I teach chemistry and I'm new to QuarkNet.		

Note: Each row presents responses from the . individual teacher from a given center. Empty table cells indicate that the teacher did not participate in QuarkNet in that subsequent program year(s). Or, less likely did not complete the Update Survey; or did not answer specific questions about the use of DAP activities in their classrooms.

The next several pages present implementation plans and ideas posted by teachers on the University of Iowa/Iowa State Center’s webpage. These were posted during and based on their 2023 workshop experience.

Implementation Plan: Teacher #1 Dice, Histograms and Probability
I teach mathematic (taught physics in the past, hence the connection to QuarkNet).
I feel it is important that students understand the importance of mathematical concepts and skills that will be needed in science work either at the high school level or collegiate level. It is my plan to help them develop some skills and understanding how this can occur, while still meeting curriculum standards need for my math course.

Using pencil and paper, then moving to computer aided work I think is needed.

Dice, Histogram, and Probability Activity

A Have the students roll two die - record each die value on paper - record sum of roll
Complete this for 36 rolls
Make a histogram for the individual die rolls and a histogram for the sum
Compare the histograms
Discuss how their histograms compare to those around
Discuss similarities and differences

"*You might ask students questions such as:*

- *What conclusion can you draw about the histogram of how many times your number was rolled?*
- *What number appeared most often in the rolls? Discuss the reasons for this.*
- *What would happen to the histogram if there were twice as many dice rolls recorded on it?*
- *If you suspected that there was a "trick die" hidden in your materials, would you be able to infer this from your data? Why or why not?"*

B Have students enter their data on a shared google sheet - each student enters their data on their individual sheet (Pre-made google sheet that has a combining sheet that can take all the data entered and create the histogram of class data)
- Suggest entering student name in cell E1

C Using google sheets to repeat process A with random die rolls =RANDBETWEEN(1,6)
Scroll down to A50 to start the complete the new random, table.
After making the random set, copy the entire table and them in the top left cell of data
PASTE SPECIAL - VALUES ONLY - this will stop the automatic recalculations

D Discussion on probability and degree of freedom

Expanding the concept -

A Using the knowledge from the first portion of this activity - predict the results of a 3 dice rolling system for histograms look, to most probable sum, etc….
B Using the provided google sheet - make a random 3 dice roll
C Make the same scatter plots - (each die rolled and sum)
D Discuss what has happened

Rutherford Experiment
[Using the Rutherford Experiment - and Histograms]

Implementation Plan: Teacher #2

Course: Chemistry - Integration into current
Unit: **Nuclear Change** PS-HS-1-8
I plan to integrate QuarkNet activities into an existing unit in chemistry focusing on nuclear change.

Activity 1: “Build an Atom” (existing activity)
This is an activity where students utilize 16 atomic models represented by colored beads to determine relationships between protons, neutrons, electrons and the periodic table. This is then typically followed by background information and practice using simulations regarding atomic structure and the periodic table.

Activity 2: Making Tracks 1 (New QuarkNet integration)
I would like to use this activity as an intro phenomena leading into nuclear decay but also provides an opportunity to introduce particles of the standard model. I may try to build an example cloud chamber to take whole class observations or will use the videos provided to generate questions relating to what is happening.

Activity 3: Shuffling the Particle Deck (New QuarkNet integration)
I will use this activity as a way to introduce particles in the standard model and will be followed up by comparing organizations to the current standard model and discuss specifics about the general ideas and groupings of the standard model. Special emphasis will be toward quarks as they make up protons and neutrons to lead into the next activity.

Activity 4: Quark Workbench 2D (New QuarkNet integration)
I plan to use this activity slightly modified and paired down as a way to focus on the components of protons and neutrons.

Activity 5: “Nuclear Checkers” (existing activity)
This activity models the decay series of Uranium-238 to lead into learning about radioactive isotopes and the difference between alpha and beta decay. This is then followed by background information on radioactive decay which can be related back to observations within the cloud chamber.

<u>Note</u>: in the past I have greatly simplified the process of beta decay, but now by implementing the knowledge and activities of QuarkNet within this unit, I plan to incorporate more details of particle physics, neutrinos, etc into this nuclear change unit. In order to facilitate some of this I will be looking at the Particle Adventure website as a resource for students.

Implementation Plan: Teacher #3 Chemistry Connection

I would use information I have learned at QuarkNet for my chemistry classes. This would be a new part of my Introduction to the Atom Unit.

How we currently learn about Subatomic Particles

1. Our Friend the Atom - Watch and discuss
2. Filling in the blanks of history - after working on a timeline we will add other important information that was not in the movie.
3. Parts of the Atom - what and where are they located

Then we transition to the Quantum Mechanical Model. This is where I would use my new information.

1. I would like to use the Particle Deck Activity here for a starter activity. I picture just giving kids the deck in no order at all and discussing what they notice after analyzing the particles. They could try to find patterns and put it in some sort of order.

2. I would then show the movie "Fabric of the Cosmos -Quantum Leap". To learn more about electrons.

3. Then kind of debrief together what we have learned before talking about orbitals.

Also, for an extension or review activity, I would use the Particle Adventure for kids.

Lesson Ideas: Teacher #4

We begin our chemistry class with an introductory Measurement and Methods Unit. I would like to incorporate Histograms Basics into the first several days work to prepare them for the lesson below and for a lab to determine the composition of pennies. This is a required basic chemistry class usually taken at the junior level.

I am planning to use Rolling With Rutherford to familiarize students with indirect measurements used in research and practice collaboration in data collection and analysis early in the chemistry course. I will include this in the Periodic Table and the Atom as part of the development of the modern atom. It will include using histograms, data collection, solving for a variable, and statistics.

I am considering a short version of Quark Workbench to introduce the other subatomic particles and to reinforce that scientific discovery continues to discover more about the way the universe works.

I am also considering a version of the Discussion Guidelines at the beginning of the year to help students to comfortably collaborate.

Implementation Plan: Teacher #5 -- Physics Connection

When working on 2-D motion oftentimes students have very limited understanding of vectors. Because of this I normally will spend some time teaching/reteaching vectors.

This comes under the following math standards

Represent and model with vector quantities. (N-VM.A)

1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). (N-VM.A.1) (DOK 1)
2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. (N-VM.A.2) (DOK 1)
3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. (N-VM.A.3) (DOK 1,2)

The actively of MASS CALCULATION: Z

https://quarknet.org/data-portfolio/activity/calculate-z-mass

This gives some particle applications

This can then be followed up with CALCULATE THE TOP QUARK MASS

https://quarknet.org/data-portfolio/activity/calculate-top-quark-mass

The goal here is to help students be comfortable with working with vectors in 2D space and being able to add and subtract vectors. Understand what the direction of the line has to do with its vector properties.

Plan:

After introduction to 2-d motion. Introduction to Vectors. Spend a day doing Mass: Calculation: Z lab. This will give an opportunity to go talk about particle physics as well.

After having students digest this for a day we can then follow un with

CALCULATE THE TOP QUARK MASS

To look at some more interesting situations. This should help create a strong base for understanding vectors and serves as an introduction to particle physics.

Plan Summary: Freshman Earth and Earth Science

For all students:

DAY 1

1. Big Bang Story-Reading Annotation
2. Cloud chamber observation and questions
3. The Particle Adventure-Fundamental/Concept Map of Atoms and Subatomic particles

DAY 2

1. Class Stations:
    a. Diagram of Atoms
    b. Build a proton with quarks, Build a neutron with quarks (Quark Workbench)
    c. Card Sort Observation/Reasoning (Particle Deck Activity)
    d. Big idea Discussion Questions
    e. Accelerators and Detectors around the world Map
    f. Matter/Antimatter Particle Adventure
    g. Conservation of Mass and Conservation of Energy Notes
2. Check your note guide, share your takeaways.

DAY 3

1. CERN video and discussion
    a. Particle Physics research is expensive. Why should you do it?
    b. Value of inventions and value of exploration for exploration sake

Extension for advanced students:

1. Rolling with Rutherford
2. Calculate the Z Mass
3. Research Higgs Bosons and create a brief presentation on the importance of its discovery

Possible precursor activity:

Histogram pennies