Center-Level Portfolio: University of Cincinnati Center

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 understanding 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 Cincinnati Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
University of Cincinnati	2019	2020	2021/2022	2023	2024
	Not as yet, but plan to when school resumes. Provides in-depth information. Provides more "college ready" physics applications and topics of study, other than the traditional kinematics. Looking forward to participating in this learning environment.			Have not used as yet but plan to implement. I think everything was covered well and is very applicable to my classroom	
	Rolling with Rutherford; helps collaborative problem solving. QuarkNet has been vital to my relationship with my students as a science educator	Analyzing J/Psi data with students		Penny Mass Activity: The idea that measurement effects, histogram construction, and drawing conclusions about material composition can be done with such simple equipment makes it an activity appropriate for all levels with lots of room for supplementation.	We (The Cosmic Club and the University of Cincinnati) will use activities from the data portfolio to warm up for WWDD, where we will video conference. We will then turn our focus to Cosmic Ray data using our detector to present at International Muon week. Finally we will participate in the masterclass being held at the University of Cincinnati.
	Have not had a chance to implement this into my teaching. I think after this year if I can use this in my classroom I would recommend it, but I would like to see the material have more of a storyline in how one thing leads to another.				
	None yet - just took the class. It's an area I haven't studied before, so it's useful from that perspective.				
	I have used Rolling with Rutherford to show the idea of indirect measurement and histograms. The materials are well thought out and often use data analysis techniques that the students are not familiar with.				
	I have used Rolling with Rutherford (to practice with histograms) and the Top Quark activity. The problem is always time. I feel like I have to do spend some time - can't just do the activity without much background. I like Rolling with Rutherford for practicing histograms				

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 Cincinnati Center**

Center					
University of Cincinnati	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year		Subsequent Program Year
	2020	2021	2022		2024
	I'm new to QuarkNet and haven't had a chance yet, If it's as good as what I've seen so far in the Workshop, then it's going to be useful both for me and for my colleagues.				
	I plan to use this year. I think this can be very helpful to teachers to help motivate the students and excite them more about learning physics.				
	I just haven't tried it yet due to time constraints in my curriculum		Currently using: Python activities learned in coding camp, data activities from QuarkNet, World Wide Data Day Plan to use the cosmic ray detector and explore the idea of doing a masterclass. I incorporate material into my curriculum via modern physics put into the units, coding for lab data analysis, coding to explore physics concepts (kinematics, momentum, etc.)		Cosmic ray detector, Shuffling Particle Deck, Rolling with Rutherford, Histograms, Calculating the Z Mass, Google Colab Notebooks, World Wide Data Day. Examples: Rolling with Rutherford, Coding exercises, Calculating Z Mass, Histograms: The Basics. QuarkNet has been the single most helpful PD in my teaching career and I have had students decide to pursue further studies/careers in physics based on the QuarkNet material I have used in class.
	I have yet to have had the opportunity to use these activities in my classroom, but perhaps I will this Fall. The portfolio has unique activities that may be difficult to find/create and will likely engage students in a manner that is unique and intriguing.				
	N/A I just haven't tried it yet due to time constraints in my curriculum.				
			Currently using Python activities learned in coding camp, data activities from QuarkNet, World Wide Data Day. Plan to use the cosmic ray detector and explore the idea of doing a Masterclass. I incorporate materials into the units, coding for lab data analysis, coding to explore physics concepts (kinematics, momentum, etc.) Examples:		

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 Cincinnati Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year
University of Cincinnati	2021	2022
		After attending a workshop at another center and Data Camp this year, I plan to bring students to a Masterclass and have and work with them on e-Labs. I also want to implement one of the advanced activities in my class, the mass of the top quarks activity. I plan for them to understand better and work more on conservation laws and Einstein's formula. Even though the curriculum does not have Modern Physics, I plan to implement the standard model. Examples: The mass of top quarks, Rolling with Rutherford.
		I use some of the particle games in the activities in my physics class last year and they really enjoyed them. Examples: We use the marble demonstration to describe the Rutherford experiment.
	Program Year (Year of Full Survey)	
	2022	
	Round the bend.	
	Program Year (Year of Full Survey)	
	2023	
	Z Mass. It incorporates particle physics while allowing students to practice their vector skills	
	I plan to use the roll a dice half-life activity.	
	Seem pretty good	
	I haven't, but I plan on in the future. (first year)	
	This was my first QuarkNet experience.	I will use a few of the activities on the quark net site with my freshmen to learn process. I will use finding the top quark with my physics class. Examples: Dice roll part A, Rolling with Rutherford (possibly) and intro to histograms for my freshman. Finding the top quark with my physics class.

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

UC QuarkNet Implementation Plans

June 2023

Group 1: Teacher #1

*I have a "short" list of what I will be using, but one of them that I will put to use right away is calculating the **Z Mass Activity**.*

- I'll use it in the first two weeks of AP Physics I during what I call "Unit 0."

- Introduces the concept of vectors, uses trig functions and relates conservation of mass (symmetry) in physics.

- Great way to get mathematical relationships incorporated and to use multiple equations to find final answers that require more than one step.

- Excellent way to incorporate advanced concepts that might not otherwise be covered in the curriculum

Group 2: Two Teachers

- In chem and physics, use something with the particle cards (in chem with quantum mechanics)
- Ivets with physics. I plan to use these throughout the year at the end of major units as additional resource for self assessment
- Make own ivets for dimensional analysis
- Data activities portfolio on quarknet site
- Physics continue to integrate colab notebooks into the course (one per unit) and create new notebooks for pre-calc courses (not sure of the timeline)
- World Data Day in Science department and make it a celebration
- Honors physics classes will begin using the Z mass activity as part of their unit on momentum
- Look into hosting a masterclass, probably after school or on a testing day

Group 3: Two Teachers

	Physical Science		
Activity	Mean Lifetime Part 1 Dice - rolling dice serve as a model for decaying particles	Use google sheets to create a graph from data	Make 1 IVET and post to LMS https://www.compadre.org/IVET/Tutorial.cfm?ID=KM1 Track student progress and analyze data regarding success rate
Time	January	1x per quarter at minimum	One IVET within the first 9 weeks of school.
Why?	Review isotopes, probability, and graphing. Could discuss nuclear forces and particle decay. Easy to obtain materials. Use of quantitative and qualitative data analysis	Builds skills required for "high-stakes" testing environments such as ACT and End of Course Science Testing. Continued analysis of quantitative data which is useful in all science content.	• Allows students to learn at their pace outside of the classroom. • Allows students who need more time/more visualization to access this material as often as needed. • The IVET approach allows all students to have the opportunity to review content with the ability to assess their progress.

Group 4: Two Teachers

“Cosmic Club Plan”: Club that meets once every two weeks for the entire year

- August-October: Making sure Cosmic Ray Detector is in working order and students have access to data. Activities to do during Cosmic Club meetings BEFORE World Wide Data Day: Histogram activities such as Rolling with Rutherford and Detector Measurement activities such as Z mass angle measurement.
- November: Participate in World Wide Data Day (pulling students out at convenient time to videoconference)
- November-December: Participate in International Cosmic Day. Compare Cosmic Detector results to Cosmic Watch results; possible videoconference with other schools
- January-February: Analyze events in CMS, Atlas, Minerva, possibly LHCb? For students to vote on which Masterclass they will do as a group.
- March: Prepare and Participate in Masterclass that was voted on by students
- April (meetings stop once AP exams start): analyzing muon, J/psi, or top quark mass from publicly available CERN data.

Group 5: Two Teachers

College Prep

Lesson 1 from Step Up for 1st day activity to introduce options for students who are still in the exploring phase.

Shuffling the deck at the of the year during AP exams as a sorting/critical thinking activity and coincides with the end of year topics.

AP Physics 1

Calculate the the *Zmass* after momentum unit before we introduce Energy as a scaffolding activity and review of spreadsheet skills.

Would like to try IVET after first unit on constant velocity before the unit test as a method of problem solving. To make at least one IVET before the end of the year.

8th graders

If I could get access, I would introduce one of the coding activities: Either probability or temperature during state testing in April as an introduction activity. It gives some students a chance to show off skills.

Honors Physics

During conservation of momentum, using the Z-Mass activity to show real world applications of conservation of mass and energy. So January or February.

Higgs activity to further spreadsheet skills. Could occur at any time of the year.

IVETs for students that need more assistance on particular problems.

Using python or some code to solve a variety of physics problems. Anytime throughout the year.

Physical Science (9th graders)

Shuffling the Deck as another way to organize something (Early in the school year when introducing periodic table)

Implementation Plans

QuarkNet, University of Cincinnati, July 2024

Name: School:

Ideas	When/Where in school year:
“How does the Universe Work?” pg 15 from Topics in Modern Physics	First day of school
Rolling with Rutherford	January - prior to discussing atomic structure in detail
Cloud chamber using instructions from CERN S’cool lab	February - during unit on radioactive decay
3D printed Quarks	January/February - after introducing nucleus of an atom

Name	School
Ideas: Cloud Chamber on Club Fair	**When and where in school year: 8/22**
WWDD with Cosmic Club	**Between 9:30-10 am**
International Muon Week (Using our Cosmic Ray Detector) elab	**Starting in January**
Cosmic Club participating in the Masterclass held at UC	**February-March depending on when Conor and/or Phil want to hold it**
Could we think of an experiment to present to the Test Beam at Fermi?	**April-May**

Ideas:	When and where in school year:
Rolling with Rutherford Mass of U.S. Pennies Signal and Noise: The Basics World Wide Data Day	Data Analysis Unit for Math Problem Solving Class 
Cloud Chamber Piano Tuner Question	Science Club build? Beginning of the year
How Speedy are These Muons?	Kinematics Unit in Physics
Calculate the Z Mass	Vector Intro/Conservation of Momentum

Ideas:	When / What Course:
World Wide Data Day Activities	Fall 2024 & Nov 14 / H. Physics 1
Rolling with Rutherford - To introduce data analysis and model refinement	Day 1 / Advanced Physics 2 & Fall 2024 prior to WWDD / H.Physics 1
“Large” Cloud Chamber - Intro to Atomic & Particle Physics Unit, Making Tracks 1 Fish Tank/Baking Pan IOP directions	Spring 2025 / Advanced Physics 2 (maybe start with small cloud chamber first)
Half-Life Lab with “Beer” Foam	Spring 2025 / Advanced Physics 2
FeynHex Activity	Spring 2025-after SM Intro / Adv Physics 2
Considering using Particle Physics/Accelerators as theme for course–spring trip to visit Fermilab	Advanced Physics 2

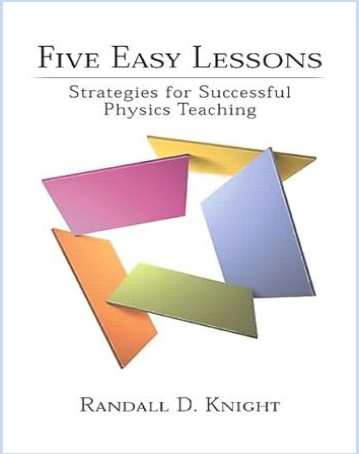
Ideas: Moving AP Physics/ Honors Physics into less of a lecture driven course and towards more active learning. This requires students to have more discussion. Class time is used to discuss ideas and clarify points of confusion, demonstrate process and practice doing physics with all members of the class being included. This is going to be a big change for them and for me as well, so some practice and flexibility will be required.

I want to use the "Quarknet: Changing the Culture" to help me get started with how to proceed appropriately with inclusive discussions.

When and where in school year: AP Physics throughout the year but the Quarknet activity would be in the first week.

Changing the Culture

Link to 5 Easy Lessons



Ideas: I want to have my students in Science Club help me build a cloud chamber. Then I want to use it with the and in my Nuclear Unit.

When and where in school year: In the Nuclear Unit of CCP Chemistry which should be near the end of October.

[Making Tracks]

Ideas: In advanced chemistry courses including the Mean Lifetime activity as part of half life decay. Currently I do a lab in which M&M's decay into Sweetarts, which decay into Skittles, which become Red Hots. (Keeping the number of particles straight can be difficult for even advanced students.) The activity does not actually calculate a ½ life time for any of the "Candy Isotopes." The Mean Lifetime activity could be modified and incorporated into the Candy decay lab.

(I couldn't find my link for the lab but when I do I will post it. Similar labs are on TPT teacherspayteachers.com)

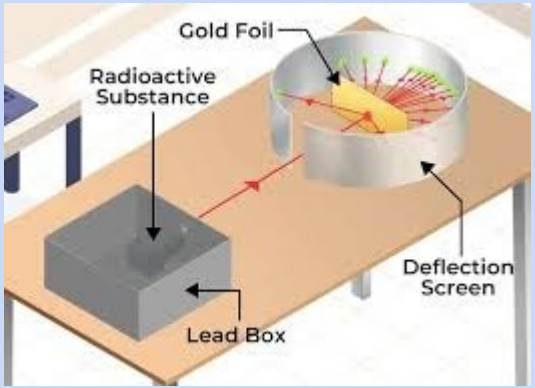
Mean Lifetime Part 1

When and where in school year: In the Nuclear Unit of CCP Chemistry which should be near the end of October.

Ideas: Incorporating the Rolling With Rutherford into our lecture on modeling the atom. I typically do a timeline diagram of the atom through history and this would be a perfect way to use inferences along with the use of calculations to determine what we can not see.

Rolling With Rutherford

When and where in school year: In the Fundamental of Chemistry unit of Honors Chemistry which should be near the end of October but it will be fun to get my lower and higher levels involved too.



Ideas: This activity is a great way to learn/review how to create and use histograms along with learning the concepts of isotopes.

When and where in school year: In the Atoms, Ions, and Isotopes unit taught in mid September in Chemistry

Mass of US Pennies

Ideas: Rolling with Rutherford from Data Activities Portfolio. This is a great activity that introduces a scientific breakthrough via mathematics

When and where in school year: Early in the year (Physics) when basic mathematics is reviewed/discussed

Ideas: Shuffling the particle deck. This is a great activity that introduces some of the elementary particles in the standard model while developing pattern recognition skills.

When and where in school year: (Chemistry) - 2nd quarter during the introduction of the atomic model

Ideas: Cloud chamber demonstration

When and where in school year: (Chemistry and Physics) - Early in year during discussion of topics/fields treated by chemists and physicists

Ideas: How many piano tuners are in Cincinnati question and subsequent discussion on assumptions and bias

When and where in school year: (Chemistry and Physics) - Early in year during discussion of mindset

Ideas: Mass of US Pennies

Students in small groups given random pennies from which they collect data (qualitative- date, design, corrosion and quantitative- mass) then create an individual histogram.

They then combine their data with the rest of the class, create the histogram and discuss what the data shows.

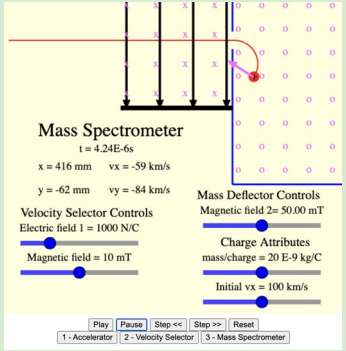
When and where in school year:

I have done a similar activity in my Chemistry classes with the objective to learn about density; I may enhance it with parts of this. When: first quarter.

I think this would make a great intro activity in my physics classes- reminding everyone about collecting data, graphing and analyzing at the start of the year- and then use it to refer back to when we explore particle physics second semester. (I have the students record all they do in a composition book/lab notebook, and I love a reason to have them reflect on what they have recorded in the past!)

Ideas: Making It 'Round the Bend

Qualitative Data collection from an online interactive. Students can explore the interactive and see how altering the parameters changes the trajectory of the particle.



When and where in school year:

This will be great to have as an inquiry activity to introduce how magnetic and electric fields are related, and how momentum can be qualitatively estimated from the angle of the particles curve.

Ideas: Number of Piano Tuners…

This is great for introducing what factors need to be known to set up an experiment/solve a problem.

This is a great way to practice dimensional analysis.

When and where in school year:

Astronomy and Physics classes early in the school year. (First week?)

Ideas: Citizen Science Research

World Wide Data Day, Master class, Zooniverse and the other opportunities that Coner put on our agenda. :)

I strive to make as much of my students' time be conducting meaningful research.

When and where in school year:

Astronomy and Physics classes; Second Quarter and onward throughout the year.

I have had my Astronomy students present their research at a poster session in the Spring, near the end of the school year.

Name

Ideas: **Mass of U.S. Pennies, Brassing Pennies & Rolling Pennies**

I would like my students to understand the reasons why the penny material has changed. In the past I have had my students change the color of “old” pennies into silver and gold. This can be done before we brass them. Also as part or experimenting with the mass, I will have my students roll the pennies into flat discs. The new pennies get a cool pattern as the different materials mix. Students will learn how to build histograms and it will help them with their other classes.

When and where in school year:

This is a two day project, I would do this right before a holiday where students are ready to get out of school. It is easy learning concepts that are fun to implement.

Ideas: Implement thinking and problem solving with questions such as, “How many hair salons are there in Cincinnati?” and sorting the Elementary Particles cards. The focus is on how the student comes up with their answer not the correct answer.

When and where in school year:

Name

School

Ideas: I want to have my students help me build a cloud chamber. I will actually do this with the chemistry teacher. Having my students witness the particles that are constantly falling will be a great experience for them.

I also believe most of the students at my school will be interested in seeing the cloud chamber therefore we will put it in the space next to the chemistry lab at my school.

When and where in school year:

Ideas	When and Where in School Year
How does the Universe Work Activity (from Marty's old QuarkNet resources)	First day of school, all physics and precalculus
Histogram the Basics to introduce the concept and some of the basic terminology (bins, frequency, etc) and review process of claim, evidence, reasoning	End of week 1 Honors Physics
Rolling with Rutherford to build on Histogram lesson, introduce science w/o direct measurement	Week 2 or 3 Honors Physics
Shuffling the Particle Deck followed by brief lesson introducing the Standard Model (use videos to support)	Week 4 of Honors Physics

Ideas	When and Where in School Year
Conservation of Momentum: Calculate the Z Mass to reinforce conservation laws, intro particle physics units, 2 dimensional p calcs	AP Physics week 6
Goal #1: Increase use of Google Colab notebooks throughout all courses, particularly importing and analyzing data from phyphox	Throughout course (AP Physics)
Goal #2: Require all students (in groups) to do a study and present results using the cosmic ray detector once during the school year.	Throughout course (H. Physics)
For students interested: FeynHex and Masterclass	