Center-Level Portfolio: Virtual 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 **Virtual Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virtual Center	2019	2020	2021	2022	2023	2024
	CERN was fantastic as it helped me better make the connections between what I teach and current physics research (DAP) Have not used yet. I want to try them myself.			After learning more about the Cosmic Ray detector and some ideas on how to use it, I want to incorporate data collection and data analysis in my computational physics course. This is a new course for me to teach so I have a lot of open opportunities and I want to try to incorporate a variety of QuarkNet activities. One of my colleagues in the group set a great goal that I want to copy. Having really only done level 0 and 1 activities in the past, my goal will be to add in at least level 2 activity into my course. Examples: What Heisenberg knew Step Up: Careers in physics Calculate the Z mass Muon mass - calculating the mass of the muon using LHC data. QuarkNet keeps me excited about physics which definitely translates to my students analyzing LHC data to explore 2D momentum and conservation of energy, momentum at relativistic speeds		
	No response	Modify "sequim science.com	When discussing "the world" with students, friends and family (retired)			
	I did masterclass with my students. They enjoyed doing research and meeting with other students on the internet. (Now retired.) Examples: Rolling with Rutherford. It gives better incite to the theories and problems the students encounter.					

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 **Virtual Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virtual Center	2019	2020	2021	2022	2023	2024
	No response.		I have incorporated a variety of activities when teaching conservation laws. Examples: StepUp, Rolling for Rutherford, Particle Cards.	I will use many of the activities from the data portfolio as after school projects. Some of which will be used through while teaching conservation and quantum mechanics. Examples: Neutrino masterclass, Z mass, the case of the hidden neutrino. They are fantastic to use to make direct connections to contemporary physics		I will bring students to Masterclass, have them participate in W2D2, and complete some of the data portfolio activities. In addition they will continue to use the CRMD. Examples: Missing Neutrino Z-Mass Rolling for Rutherford. It's an outstanding vehicle
	CERN - as much for the collegial nature and sharing of ideas, methods, and course structure. Examples: Rolling with Rutherford and Quark Workbench have been used consistently in introducing statistics and the structure of matter. I think the use of these materials in a somewhat structured manner is important in setting up whole courses, or parts thereof. And my students were highly engaged. I've been building a regional learning community, and QuarkNet has provided me with many resources to share in this endeavor. QuarkNet has enabled me to interact with other teachers in a larger community...	I've already incorporated the Cosmic Ray and e-lab activities as well as Masterclasses, and will add in what I've learned and developed in the Data Camp. These included lessons on CERN, conservation. Examples: Shuffling the Particle Deck Rolling with Rutherford Quark Workbench. The activities have been used in many ways, and some, such as Shuffling the Particle Deck, have been highly successful in a remote (virtual) session.	I'll use particle collision materials for Conservation on Momentum and Energy. Examples: Shuffling the Particle Deck, STEPUP Lessons. These have been great activities to reinforce, introduce, and pique interest.	I use the Data Activities Portfolio regularly for areas such as histograms (Mass of Pennies) to Conservation Laws and vectors products (Calculate the Top Quark). I also provide a masterclass. Examples: Mass of Pennies, Calculate the Top Quark Mass, Shuffling the Particle Deck (and more). These activities offer experiences that are beyond most curricula while bolstering and enhancing knowledge that is required by the State or LEA.	I'll use data from the CRD in class for programming. I'll also look over and use the wave materials. Examples: Quark Workbench, Penny Mass, Dice Histogram, Signal and Noise, Shuffling the Particle Deck, Calculate the Z-Mass, Calculate the Mass of the Top Quark, Rolling with Rutherford, Angles and Dimuons, Making it 'Round the Bend. This experience enriches many parts of the curricula for the various classes I teach,	

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 **Virtual Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virtual Center	2019	2020	2021	2022	2023	2024
	I used Rolling with Rutherford, Quark Workbench, and Calculate Mass of the Z when doing Masterclass for the past 8 years or so. All seemed to be helpful in teaching various aspects of physics. There are several activities that could be useful. A teacher can look through an activity and decide whether it fits what they are doing. The things I know about are useful and helpful. There are some that I have not been aware of. I'm not sure if that's my fault or if they haven't been communicated loudly enough to overcome background noise common to teachers. Most of QuarkNet's help has been towards me, and thus indirectly to my students. Without QuarkNet I would have known virtually nothing about particle physics. My students would not have participated in masterclass, visited Fermilab or participated in the Fermilab Open House. I would not have been in the CERN summer program. QuarkNet enriched my career as a teacher (and learner) and it enriched my students' learning probably more than they realized or appreciated when they were in the classroom.	I've used CRMD for learning, also for Science Fair and Illinois Junior Science and Humanities Symposium presentations, I have had students participate in International Physics Masterclass. Examples: Rolling with Rutherford; Quark workbench; Calculating the mass of the Z particle. (*retired)*				
	The structure of discovery and analysis of activities. Rolling for Rutherford is my favorite. Would recommend (DP) wealth of hands on Critical thinking that allows for group data plots.	Rolling with Rutherford, and dice decay				

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 **Virtual Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virtual Center	2019	2020	2021	2022	2023	2024
	CMS Masterclass. Many of my students have completed it so it provides a common reference and vocabulary when discussing momenta, energy, relativity, and energy-mass conservation. I do not believe that I am familiar with the 'Data Activities Portfolio' so I am unable to answer this question with any certainty.		I use the Heisenberg Uncertainly lab when I introduce graphing and the concept of uncertainty. I use both WWDD and the CMS Masterclass when discussing Energy and Momentum conservation and as an intro. Examples: What Heisenberg knew, Quark Workbench, Rolling with Rutherford	I've used them for conservation of energy and momentum as well as special relativity. I just moved to a new school with a new curriculum, and I need to find places to use them this year. I just moved to a new school with a new curriculum and I need to find places to use them this year. It is always a positive experience for the students who often recall their time doing the activities	CMS e-Lab, Cosmic Ray e-Lab. Easy extension activities for motivated students	Conservation Laws (momentum and energy), Uncertainty. Examples: Quark Workbench, Dice Probability, Mass of the Z-Boson.
	Rolling with Rutherford and Quark Workbench have been used consistently in introducing statistics and the structure of matter.					
	While I haven't used any yet, I love the activities like Workbench that make abstract concepts concrete and manipulative for the students, these really help deep understanding.	Being a part of Virtual QuarkNet has been one of the very best professional development opportunities I have experienced in my 10 years of teaching. The cohort is amazingly supportive and knowledgeable.	I will offer a Coding with Python enrichment for students, and I will mentor a STEM student's OSEF Science Fair Project using the Cosmic Ray Detector. Example: Cosmic Ray E-lab will be an introduction used in STEM class to build student knowledge and engagement to develop the science fair project; using all coding activities will be offering a coding workshop		I have tried with Masterclass but my Physics classes tend to be very small, 3-5 students, which is why I want to offer one to our schools. The resources as amazing for small schools like where I teach, we have no budget for labs, so this provides us with the opportunity to explore data manipulation, plus the kids think its really cool that they're using real data from CERN.	

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 **Virtual Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virtual Center	2020	2021	2022	2023	2024
	Masterclass showed my students that real science is not cookbook. Examples: Rolling with Rutherford. It gives chances to practice skills like graphing while learning other principles.				
	All! My main goal currently is to incorporate modern physics into the general physics curriculum to increase student engagement and enjoyment of the subject. All is new to me and all is helpful. N/A: to be used this year! Even if all we do is use the data for graphing practice, it will expose students at some level to topics in modern physics. I just haven't been with QN long enough to implement any of the data-based activities.				Cosmic ray detector for discussions about signal and noise, general data issues, histograms lots of the data portfolio activities for histograms, probability, conservation laws, standard model. Examples: Rolling with Rutheford, dice histograms and probability, histograms the basics, QuarkNet change the culture, calculate the Z mass, cosmic ray elab. The data portfolio activities, cosmic ray labs, and the idea for slipping the data portfolio activities in all through the year have really helped my teaching be more interesting and engaging.
	Although I haven't used them (at least I don't think I have). The QuarkNet materials I have used were good and I am sure these materials are also useful.				
	Rolling for Rutherford, quark workbench, both great for explaining basic particle physics and collecting data. Good activities, versatile. All are well tested and produce good results and discussions. Very worthwhile interactions with other teachers in the field. Collaborations are excellent, QuarkNet has been an invaluable addition to my teaching practices. The collaboration with other cutting edge teachers is very useful. That alone makes the whole system worthwhile. Students have really enjoyed doing the masterclasses in the past and have benefited from them. Looking forward to continued interaction with the Virtual QuarkNet program.				Uncertainty. I am teaching astronomy at the college level, so I don't have many opportunities to use most of the standard activities. My QuarkNet experience is always fabulous. I gain much insight into particle physics and get more comfortable with interactions with students. There are always applications to my work in astronomy.
	Program Year (Year of Full Survey) Subsequent Program Years				
	2024				
	New to program.				
	New to program				
	The quark workbench, a modified signal vs noise. I am a member of the virtual group, I would really like a local group to start in the Orlando area so there would be a regional community.				

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 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.

Implementation Plans

Virtual QuarkNet Center 2024

Name: Teacher #1

Ideas:

- **Calliper light diffraction experiment with heisenberg**
- **Millikan work function activity**

When and where in school year:

- **Optics lesson in honors physics and modern in AP 2**
- **AP 2 Modern Unit and Honors modern unit**

Teacher #2

Ideas:

Using the Quantum Activities

When and where in school year:

At the end of the school year after studying waves as a way for students to experimentally experience Quantum

Teacher #3

Ideas: I want to do the lab where they determine the wavelength of the laser

When and where in school year: Use at wave interference in the spring of the year

Teacher #4

Ideas:

Using data from the Cosmic Watches to analyze changes in Cosmic Ray detection based on altitude.

When and where in school year:

Computational Physics - graphing and analysis, Online Week 2

Teacher #5

Ideas:	When and where in school year:
How Speedy are These Muons? (QN Activity)	Semester two for my kinematics unit. Probably an intro activity to introduct particle physics and the questions it brings up
Energy, Momentum, and Mass (QN Activity)	Conservation Unit to compliment how large and tiny physics follow many of the same rules
Wave/Particle Duality and interference patterns	Waves in interference unit semester 1 around Christmas (as it stands now)