Center-Level Portfolio: Virginia Center (GMU/Howard University/William & Mary)

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 **Virginia Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virginia Center	2019	2020	2021	2022	2024
	Z Boson Activity		I teach a "unit" of four class days to my AP Physics 1 students. Covering Standard Model, bubble chambers, and masterclass activities. Examples: Bubble chamber, Z Boson, J/psi masterclass	Use some of the activities in a mini-unit on particle physics in my AP physics 1 class. Attend Masterclass with students. Examples: Z Boson, Making Tracks, CMS e-Lab.	Z Boson, Bubble Chamber, Masterclass activities. Examples: Z boson, particle cards, rolling with Rutherford. Excellent experience as always!
	Calculate Mass of Z, Calculate the Top Quark Mass, Penny Lab, Dice Histogram	I will be using z mass, top quark, rolling with Rutherford, and standard model, and quark bench as part of the curriculum. Examples: Mass of Pennies, Histogram Basics.			
	The particle Workbench, Rolling with Rutherford, particularly for masterclass prep and IB Physics. It has a variety of useful materials that relate to standards we teach but with a particle physics additional topic to hopefully engage students. (DAP) activities keep getting better. Over the years, the variety has increased, the pedagogy more robust, including ability to use at different levels.	While I am not teaching in the 20-21 school year, I'll be back after 1 year. I did the masterclass with some students and used the Making it Round the Bend data portfolio activities. Examples: Making it Round the Bend, Totem Express. The ability to use data and make graphs, especially virtually as we head into this year, is really helpful.	I've taken students to masterclass, both virtually and in person, used many of the data activities, including StepUp, Making it Round the Bend, etc. Examples: StepUp careers in physics Making it round the bend.	I will try using coding in my particle physics unit to get a feeling for how we know about particles and in the magnetism unit with a phone app to collect magnetometer data and explore magnetic fields caused by currents. Examples: Makin' it Round the Bend, Quark Workbench, Step Up	Particle physics activities from the Data Portfolio for IB 2 HL Physics students-- Makin' It Round the Bend, Feynman diagrams, Quark Workbench. Examples: Makin' It Round the Bend, Particle Transformations, Quark Workbench
	Rolling with Rutherford: the students thoroughly enjoyed the activity, and it covered a broad range of laboratory skills (plotting data, importance of multiple trials, mathematical modeling, indirect measurements, etc.).	I use QuarkNet resources in class whenever I can. Our class has a "Physics Fun Friday" every few weeks, in which we explore a topic in modern physics. I often use QuarkNet data activities. Examples: Z mass activity, Rolling with Rutherford, Particle Deck			

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 **Virginia Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virginia Center	2019	2020	2021	2022	2024
	Mass of US Pennies, because it made the students think of different descriptors to measure, and as a great intro to histograms. Other examples: Penny lab, Making it Round the Bend, Energy Momentum & Mass, Top Quark	I'd like to use the Calculate the Top Quark Mass particle activity to show applications of vectors and vector addition and introduce basic idea of momentum. Examples: I have used the Mass of US pennies activity, Mapping the Poles, and Making it Round the Bend activities.	I prefer to sprinkle in modern physics where I can. For example, when I talk about sig figs tomorrow, I plan on mentioning/ doing a quick explanation of LIGO. I'd like to use some of the activities	I just wrote a Python-based lab activity where we use data from Earth's satellite to figure out what affects satellite period. I'd have also used activities from the Data Activities Portfolio like Penny Mass, Making it Round the Bend, and some of the STEP UP topics. Examples: Mass of U.S. Pennies, Making it Round the Bend, STEP UP Careers.	Mass of US Pennies- people assume that pennies are all the same, this is a cool opportunity to challenge assumptions and when we actually investigate and take data we can get surprising results. And of course it is a great introduction to histograms, which can be used throughout the rest of the year when interpreting data and analyses. Not many teachers are able to get to modern physics topics, so that means most don't have any labs to work on that incorporate modern physics. This gives them a chance to sprinkle in some modern along the way so it gives their students some exposure.

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 **Virginia Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
Virginia Center	2020	2021	2022
	Group analysis of data used to identify an unknown.	I use these concepts to unite topics in physics and to expand the understanding and depth of the understanding of these topics.	I have used cosmic ray data and particle interaction explanations. I have used LHC data to help students understand the Higgs boson was detected and explained why it was searched for, I have used statistical exercises to help students grasp how students grasp how testing results. And many other lessons. Examples: Much the activities from the Data Activities Portfolio was developed after I retired from teaching but I was using cosmic ray data with my students.
	Calculating the Z-mass. It's a great activity because it can be a competitive thing. It also reinforces some major math concepts.		
	Z-mass activity, Masterclass	I teach a "unit" of four class days to my AP Physics 1 students. Covering Standard Model, bubble chambers, and masterclass activities. Examples: Bubble chamber, Z boson, J/psi masterclass.	
	The DA portfolio activities currently are not quite user-friendly for Honors level courses and the AP curricula are packed. I do use the DA a bit for Masterclass preparation as the students are already motivated and interested in the content and usually are better equipped to use the activities. Examples: Masterclass and coding	Rolling w/ Rutherford, TQ etc. as Masterclass preparation.	AP Physics 2 – following or concurrent with Fluids and Thermo units or if hurricane affects the region. Examples: Rolling with Rutherford, Top Q, Hidden Neutrino – probably others but cannot think of titles right now.
	Program Year (Year of Full Survey)	Subsequent Program Year	
	2021	2022	
	Mass of pennies, dice-histograms-probabilities, histograms - the basics, rolling with Rutherford, mean lifetime, cosmic ray e-lab.	I used the Comic Ray detectors quite a bit. I've included many of the activities from the QuarkNet resources, specifically Rolling with Rutherford, Mass of U.S. Pennies, Dice Histograms and Probabilities, Mean Lifetime, Cosmic Ray, e-Lab, and some Jupyter Notebook Coding. Examples: Rolling with Rutherford, Mass of U.S. Pennies, Histograms.	
	Program Year (Year of Full Survey)	Subsequent Program Year	
	2022	2024	
		Conservation Laws, Uncertainty and Standard Model. Examples: Shuffling the Particle Deck, Dice, Histograms & Probability, Histograms: The Basics, Rolling with Rutherford, and What Heisenberg Knew	

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.

Results from CMS data analyzed by 20 students from Virginia and Maryland high schools who participated in a CMS Masterclass held on March 11, 2023.

Masterclass: FNAL-11Mar2023A
location: Williamsburg2023