Center-Level Portfolio: Virginia Center (Hampton University/College of William and Mary/George Mason 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 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 anonymously 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 (Hampton University/College of William and Mary/George Mason University)**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Virginia Center	2019	2020	2022	2024
	All of them. Calculate Mass of Z, Calculate the Top Quark Mass, Penny Lab, Dice Histogram. This could increase the particle physics literacy since there are a lot of changes going on. This workshop is great. I am looking forward to more. Is it possible to invite scientists for videoconferencing with our students or invite them to talk to our students through QuarkNet. How can we as teachers contribute in making QuarkNet popular among the schools.	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. Given that we are going into a complete distance learning environment, I will have more success in my team accepting some of the QuarkNet activities to become part of the curriculum. Change is difficult.		
	Neutrino Masterclass because the students needed to be prepared for the Masterclass, so it kept me accountable to my plan of introducing particle physics and detectors to my students. 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.). They are an accessible, developmentally appropriate way of introduced students to modern physics, which in my experience, is the content that makes students curious about physics to begin with (as opposed to mechanics). They also have fun hands-on activities, which get the students engaged. For 21c/d, I marked "good" rather than "excellent" because the data sets are pre-selected to be tidy and fit certain parameters. However, I'm sure this is necessary to make the projects more accessible and doable for teachers. I love QuarkNet because it is the main avenue for me to learn new physics with others and find ways to present particle physics to my students. I also LOVE being able to interact with physics faculty and researchers who value our contribution to the physics community instead of looking down on us as "just high school teachers."	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. QuarkNet has enriched my courses by providing activities that capture students' interest in the "big questions" of physics. It also helps students see why the concepts they're learning in classical physics.		

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	Subsequent Program Year
Virginia Center	2019	2020	2021	2022	2024	2025
	CERN and CMS Data Workshop, Z Boson Activity. They are a great resource and provide a way to introduce modern topics in physics to your students...this will give the students a sense that physics is not dead and that there is a lot left to be learned. I have found all the work that I have done with QuarkNet has been extremely helpful with my teaching...the collaboration with other professionals, the activities and the support have all been excellent. QuarkNet has been the single most beneficial professional development program that I have ever participated in. Love that I have access to professors and other professional teachers to discuss ideas with and to work on projects that I may not have access to on my own. Best professional decision that I have ever made was to join QuarkNet back in 2000.	I never took particle physics in college and I now teach a three week unit with my students...all thanks to QuarkNet!	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, Best professional development experience in my career.	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. It has been a terrific 20 years!	Z Boson, Bubble Chamber, Masterclass activities. Examples: Z boson, particle cards, rolling with Rutherford. Excellent experience as always!	Making Tracks, Masterclass, Cosmic Watches, Z Boson. I can not believe it has been over 25 years...amazing resource!
	Data Camp has given me a thorough background plus specific ideas for teaching, including some ready-made activities. 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 we clearly don't have the background needed to fully understand all the data, we now have tools to deepen our and our students' understanding. The data portfolio activities keep getting better. I look forward to implementing many of the activities that I have learned about in data camp this summer. My participation in QuarkNet center programs has helped me find like-minded teachers who want students to understand data, analysis, and supporting conclusions with evidence. After this summer, I have more tools available to fully use the portfolio.	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 careers in physics, Making it Round the Bend, etc.	Coding Camp. 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. Coding is challenging for me, so it will be challenging for me to bring to my students. It will take some time for me to develop the material and the knowledge to support students.	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.	

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	Subsequent Program Year
Virginia Center	2019	2020	2021	2022	2024	2025
	We were just doing the CMS workshop right now, and we went through a number of activities on the Activities Portfolio, including Round the Bend and Mass Spectrometer. Mass of US Pennies, because it made the students think of different descriptors to measure, and as a great intro to histograms. Other examples (would recommend): Penny lab, Making it Round the Bend, Energy Momentum & Mass, Top Quark. I really like having the lab/ activity resources available online without having to log in. Thanks! I end up changing the activities as I go, but they are still good. I like being in workshops because of the interactions with other teachers. I really like to share ideas!	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'd love to see videos of people using the QuarkNet activities in their classroom, or maybe just explanations of how they use it. It's nice to hear ideas from others and share out my own ideas.	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. Examples: Mass of Pennies, Calculating Z Mass. QuarkNet has some really cool activities, but this group is my only real resource for getting into Modern Physics (other physics teachers at my school and County don't really.	Coding Camp 1. 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. I really like in-person sessions where you can have little conversations about how teachers can use the QuarkNet activities in their classroom. Today's virtual session allowed us to work in small breakout rooms and that helped, but generally speaking, it is really important for QN participants to talk it out with teacher hats on.	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.	I would like to use some e-labs in my class to help reinforce conservation. I have done the penny activity and making it round the bend. I would also like to use the Z Mass or Top Quark activities. I enjoy doing the activities in my class, but sometimes I forget all that was presented to us in QN meetings so I am not sure I will be able to cover everything. And seeing as you are not right down the hall for me to watch you do the activity again (or ask questions from), I would benefit from you making some videos of how you use these activities in class, including how you introduce the idea and how you explain the concept in the end.

Table (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Reponses 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
	Data camp was the most useful. It presented a model that could be mimicked in parts and used in the classroom to stimulate and excite students. Group analysis of data used to identify an unknown. It (DAP) is a fine technique to stimulate creative problem solving using a group setting. The ratings are a result of my personal use and expected student responses. The QuarkNet program is centered around these concepts . The program is a fantastic way to learn about particle physics, develop strong and helpful connections with fellow teachers and make fascinating contacts in the real world of Physics research. The interaction with other teachers presenting the same topics is a fantastic help in anticipating problems but really more in developing a better way to accomplish a learning task.	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. They (DAP) are a great intro to particle physics research, math, etc.		
	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 2012 Data Camp at FermiLab and the current (coding) Data Camp 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. Yes (recommend DAP) w/a caveat if you have flexibility in the curriculum and higher level students. So magnet/independent school teachers. As stated previously the DA activities are a bit wonky for nonQNet physics teachers and Honors/Standard level students. Teachers might also be hesitant as it takes a bit to incorporate in to the curricula - especially if it is a new or out-of-field teacher. Excellent, relevant and inspirational professional development. QuarkNet is by far the best professional development program I've participated in and it has greatly improved my teaching.	Rolling w/ Rutherford, TQ etc. as Masterclass preparation. Excellent method to improve content knowledge, get current on research, and reminder on science works in the real world	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. Excellent PD.

Table (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Reponses 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	2021	2022	2022
	Oh my. I was so new at data camp, and coding camp is so much fresher. I think they were equally good. Examples: Mass of pennies, dice-histograms-probabilities, histograms - the basics, rolling with Rutherford, mean lifetime, cosmic ray e-lab. All of the ones identified are definitely worthwhile, with the cosmic ray e-lab the best. QuarkNet has been an outstanding program for me, and I'm honored to be part of the community. My only regret is that I wish I had more time to implement more of the opportunities. The biggest issue - again - is available time. I think QuarkNet does an outstanding job in connecting people. As an example: the Zoom sessions every other week during the past year (due to covid) were excellent and I wish I could've participated in more of them. QuarkNet has been a superb program. I learn much every time I engage with the community, and I hope to be able to participate much more in the post-covid era. I had a great relationship with the Wayne State University QuarkNet center, and I hope to better engage with the QuarkNet center I'll be associated with next (I'll be teaching in Bethesda, MD, so I'm thinking Johns Hopkins, but I need to think that through).	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. One powerful part of the QuarkNet community is forging a venue for scientific discourse among high school physics teachers that are very interested in particle physics. There really is no other forum (that I am aware of) where this takes place. The ongoing professional development led by the QuarkNet Team is especially helpful in our ability to stay engaged and help us develop this interest with our students.	
	Program Year (Year of Full Survey)		
	2022	2023	2024
	Coding Camp - it allows the students to see visually what I have taught. To get students into coding because it is the future		Conservation Laws, Uncertainty and Standard Model. Examples: Shuffling the Particle Deck, Dice, Histograms & Probability, Histograms: The Basics, Rolling with Rutherford, and What Heisenberg Knew

Table (con't.)
Self-reported Use of Data Activities Portfolio Activities: Based on Reponses 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	2023	2024	2025
	Since I mainly teach chemistry, biology, and biomedical science, I plan to make an effort to included QuarkNet in these subjects and describe for my students discoveries being made (ex CERN) but I don't plan to have a specific unit dedicated to sub atomic particles because of the nature of the subjects I teach. However, I have taught physics and if I were to teach physics again I would definitely make a unit dedicated to subatomic particles and inform my students on opportunities that are open to them.		
	Seeing and participating in student activities. Example: particle deck (part of DAP). Have not used yet (DAP).		
	Plenty of useful information easy to use in the class. Shuffling the particle Deck, Calculate the Z mass, Rolling with Rutherford. Easy to use (DAP), no special equipment required. I like everything about this workshop. Plenty of discussions, hands-on activities, learning.		
	Experience activities as a student. Rolling for Rutheford.		
	This workshop was my first that I have attended. I would recommend the ones (DAP) that I saw demonstrated in the class.		
	Learning how to use co-lab in the classroom. Examples: DICE, HISTOGRAMS & PROBABILITY. It (DAP) allows the students to see real life examples of expectations in the workplace.		
	Program Year (Year of Full Survey)		
	2024		
	Being a student working towards becoming a teacher, I learned so much about the world of teaching and how teachers collaborate and exchange ideas and lesson tips for their classrooms. I also liked learning about how 21st century physics is being integrated into high school curriculums. I haven't yet implemented QuarkNet resources in the classroom but I understand the potential success that they can bring. I am not yet a full physics teacher yet so I cannot fully answer this question at this time. I really enjoyed participating in the NOvA QuarkNet workshop and it taught me so much about being a physics teacher.		
	Teaching graphing and analyzing graphs - Rolling with Rutherford and DICE, HISTOGRAMS & PROBABILITY Histograms - Mass of U.S. Pennies. Good activities that could be used in any unit and connect it to the particle physics.		
	Don't know yet. I'm new to all this so presume Summer Mtgs are not the same as the designed classes, etc. I try to focus on PBL teaching if I can, and my 'spin' is entirely discovery and skill based. I don't give answers, I ask questions.		
	CMS Masterclass as a student because it helped in my decision to teach physics as well as attend William & Mary for undergraduate. I am not sure if data camp will be conducive for my teaching yet but I am hopeful. The data importing and graphing modules as that is likely what my students will use. I think it is useful if students do not have a way to demonstrate graphing ability with other software. My students use LoggerPro for graphing already so many of the functions we have covered are already available in LoggerPro. In addition, without teaching programing, many of the functions in coding camp are not possible. I have not seen instructional strategies or Big Science Ideas but I am also not sure if this was a big focus of the workshop I attended.		

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.

In a supplemental document to this portfolio an example of data analyzed by students during a Masterclass and implementation plans prepared by QuarkNet teachers are presented.