Center-Level Portfolio: Syracuse 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 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 **Syracuse University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Syracuse University	2019	2020	2021	2022	2023	2024
	Muon detector activity		I will use the case of the missing neutrinos to show how particles are discovered from indirect evidence as well as the conservation of momentum. Examples: Shuffling the particle deck, the case of the missing neutrinos.	I intend to incorporate the mapping the poles activity as well as the data analysis techniques used in the workshop	The activities such as Rolling with Rutherford have been very useful to show how discrepant data can be used to make discoveries	I plan to use this to create activities for students to code with python to create graphs of data they have collected and also to have them download large data sets from actual experiments to sort through the data and be able to accurately interpret the data using current scientific principles. Examples: Shuffling the particle deck, rolling with Rutherford, mapping the poles, histograms, the basics
	Indicated that (s)he used DAP activities but gave no examples.	I have had a group of students work with my cosmic ray detector. I have also taken those students to do a masterclass. I have done the rolling with Rutherford activity with my students. Examples: Rolling with Rutherford, Quark Workbench, Calculate the Z Mass.	I have done quite a few activities on the QuarkNet website. Every year I do the quark workbench. I have done Rolling with Rutherford and conservation of momentum and other as well in the past. Examples: Quark workbench, rolling with Rutherford, dice histograms and probability	I will use data from CERN to talk about particle physics. I would like to try to use the activities from QuarkNet for circular motion and conservation of energy/ momentum. I will also use quark workbench. Examples: Quark Workbench, Rolling with Rutherford, STEP UP, Cosmic Ray.	Indicated that (s)he used DAP activities but gave no examples.	I have used the comic ray detector with an independent study group at my school. Each year I do the quark workbench with my students to learn about how to add quarks to make particles. Through other experiences through QuarkNet (going to CERN and Fermilab) I am able to relate my knowledge of the detectors and particle physics with my experiences. I would like to try to use the material we learned this week when teaching conservation of energy and momentum in the future. Examples: Quark workbench, rolling with Rutherford, conservation of momentum. QuarkNet gives an amazing opportunity for teachers and students to better understand particle physics.
	Rolling with Rutherford as well as the Hadron workbench. They (DAP activities))have already gone through many revisions and they are a polished product in itself thought of by many bright and talented educators and scientists..		Cosmic Ray Detector, Masterclass, more particle physics especially at the beginning of the year. Examples: Case of the missing neutrino, particle deck, hadron workbench, cosmic ray detector			Hadron workbench every year along with the Rolling for Rutherford. Also go through the Neutrino momentum activity with my AP C students we typically have 5 weeks of classes post AP exam in New York. DAP is an excellent repository of classroom activities and laboratories that can get students excited and interested in particle physics. Found QuarkNet shortly after starting to teach - that along with other physics education opportunities (modeling physics, STEP-UP, etc.) has shaped not only my own learning but my students every year. I typically teach 80 students a year and am halfway into my career (end date is always TBD) so the more I can excite my students the more future physicists I can help encourage.

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 **Syracuse University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Syracuse University	2019	2020	2021	2022
			I will use the case of the missing neutrinos to show how particles are discovered from indirect evidence as well as the conservation of momentum. Examples: Shuffling the particle deck, the case of the missing neutrinos	I intend to incorporate the mapping of the poles activity as well as the data analysis techniques used in the workshop. Examples: Mapping of the Poles.
		I'm not going to have enough time this year to cover all the topics that I usually do so I'm going to take that as an opportunity to try more of the activities in the QuarkNet experience. Examples: Particle Cards, Rutherford Marble Activity, BAMC.		
	Rolling with Rutherford			
	Indicated that (s)he used DAP activities but gave no examples.	I have had a group of students work with my cosmic ray detector. I have also taken those students to do a masterclass. I have done the rolling with Rutherford activity with my students. Examples: Rolling with Rutherford, Quark Workbench, Calculate the Z Mass.	I have done quite a few activities on the QuarkNet website. Every year I do the quark workbench. I have done Rolling with Rutherford and conservation of momentum and other as well in the past. Examples: Quark workbench, rolling with Rutherford, dice histograms and probability	I will use data from CERN to talk about particle physics. I would like to try to use the activities from QuarkNet for circular motion and conservation of energy/ momentum. I will also use quark workbench. Examples: Quark Workbench, Rolling with Rutherford, STEP UP, Cosmic Ray.

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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 **Syracuse University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Syracuse University	2019	2020	2021	2022	2023
	Getting students to analyze real data would be impactful for physics students.				I am not very familiar with the Data Activities, but I think the Rolling with Rutherford activity is full of potential for student learning. In New York, most of the Data Activities go beyond our standards and thus must be modified for each classroom.
	Rolling with Rutherford *(planned)*	I used the Cosmic Ray detector as an extension two years ago and have implemented Rolling with Rutherford and ideas of collecting whole-class data, histogram use, and sprinkling Standard Model facts. Examples: I don't plan on using them. They are too complex, and we are currently overwhelmed with lack of tech.	Conservation of momentum, standard model vocabulary, STEP-UP resources. Examples: Shuffling of Particle deck, the case of the missing neutrino		Penny Lab, Rolling for Rutherford. They are adaptable which is vital. Only opportunity to interact with scientists. Data Camp was a phenomenal experience for actually seeing application.

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 **Syracuse University**

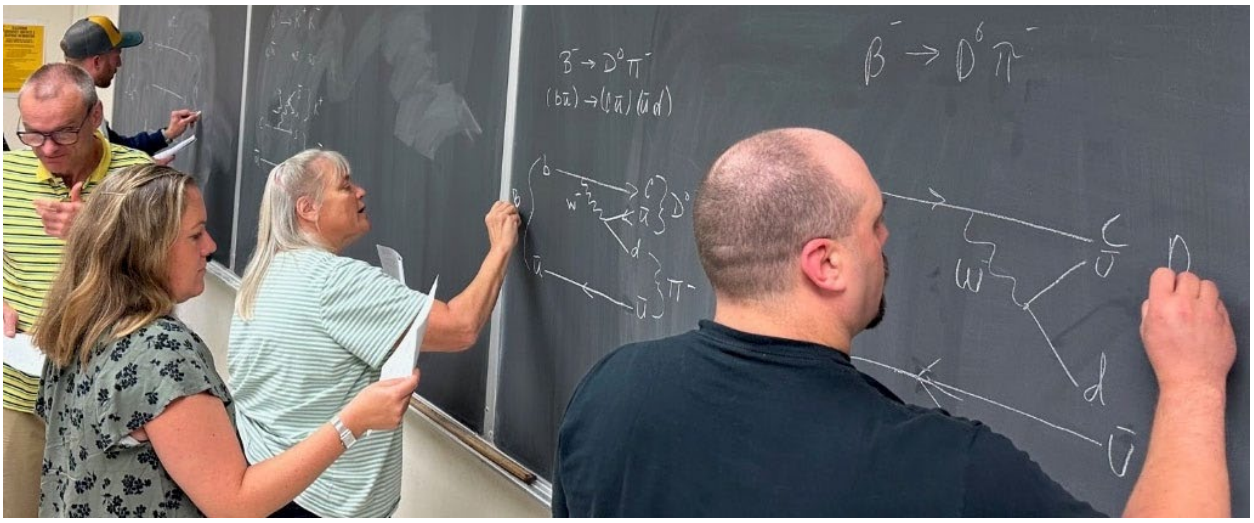
Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Syracuse University	2020	2021	2022	2023
	I am impressed by what I have seen so far and I think that it would be useful for other classes (chemistry in particular). (First year)		I like using the LHC examples to show real-life applications of conservation laws. I also like how the labs Data Activities Portfolio are tied to standards. Examples: (planned) Dice, Histograms & Probability, Mass of US Pennies, and Shuffling the Particle Deck. I really like the "Share-a-thon" between the teachers and learning other teachers' tips and tricks.	Mass of the Penny - great intro to histograms
	QuarkNet Workbench *(planned)* - Invaluable in letting students "discover" many aspects of The Standard Model on their own, and in getting them invested in exploring the topic further. I plan to use several others this year, too!	The summer workshop helped guide me toward asking questions to help students think through particle physics research procedures. (The lead modelled this extremely well.) Also, it was great to learn about ways that "standard topics" like momentum could be taught via particle physics, all the while creating a sense of wonder in the process. Examples: Shuffling the Particle, Workbench 2D, The Case of the Missing Neutrino.	This program definitely clarified several details which I was fuzzy or about which I was incorrect in my understanding. I have used Google forms to collect labs, but I have never used them to create classroom/ daily collections of data, which I really liked. One classmate suggested posting student reports in the hallway, which creates an authentic audience for student work (and likely will increase the effort students put into their posters). Examples: Quark Workbench 2D, CMS Masterclass J/PSIs (for those who participated) Cosmic Ray e-Lab.	
	I honestly did not know these activities were openly available on the site until this workshop. I will look through them and use some this coming year.			
	Program Year (Year of Full Survey)	Subsequent Program Year		
	2021	2022		
		I like using the LHC examples to show the real-life applications of conservation laws. I also like how the Data Activities Portfolio Activities are tied to standards. Examples: Ill use Dice, Histograms & Probability, Mass of U.S. Pennies, and Shuffling the Particle Deck.		
	I have not used any yet but will be soon.	I totally plan on using Shuffling the Particle Deck, with my class as an introduction to the particle physics of the standard model. Examples: Shuffling the Particle Deck, Rolling with Rutherford, mass of penny.		
	Rolling with Rutherford			

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 **Syracuse University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
Syracuse University	2022	2023	2024
	Rolling with Rutherford, the Quark Workbench		
	I haven't had a chance to use the DAP yet, but expect to use a version of the Rolling with Rutherford one next year. The ideas presented are creative and things I likely wouldn't think of myself. While I will probably modify them to be more concise (at least less words on the pages), I think the overall idea behind them, from what I have seen so far, is excellent.		I aim to incorporate some of the Data Activities Portfolio pieces as well as some of the Python Jupyter coding I have learned during this workshop. I like the mass of the pennies and rolling for Rutherford activities. I would like to add more to my repertoire. Very valuable knowledge and skills are shared. Great community building between high school teachers and professors. Please keep doing these!
	Hard to say. (First year)	I am considering using Rolling with Rutherford, and the mass of the penny one. They are well designed and effective.	
	Program Year (Year of Full Survey)		
	2023		
	I practiced the labs at the workshop and they work well		
	I think that I will use Rolling with Rutherford and Shuffling the Particle Deck. I am also thinking about using another activity either the signal to noise or making histograms activities. I have used the momentum part of the mass of the top quark data in the past.		
	I have gotten a lot of ideas which can be implemented in my classroom and enhance my lessons in particle physics.		
	This is my first introduction to QuarkNet and I am beginning to think about how it will be incorporated in my curriculum. I believe the resources will be valuable to my classroom for introducing students to modern scientific research practices in particle physics.		
	Discovered QuarkNet from a physics teacher email list; I am very happy that I joined this workshop. I am looking forward to doing more!		
	I've used and tweaked Shuffling the Particle Deck, Rolling with Rutherford and Quark Workbench a number of times. I do a different version of Penny Planck that I wrote.		
	Rolling with Rutherford, Shuffling the Deck (first year)		Shuffling the Particle Deck Introduction to Coding Using Jupyter Rolling with Rutherford. Lots of good ideas, that I can hopefully implement

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.)

The next page shows an exercise from the 2023 Syracuse University Center Workshop.



Prof. Blusk gave a second talk on Weak Decays," followed by an activity that had teachers drawing Feynman diagrams for weak decays of heavy quarks. (See photo.)

Photo and description extracted from the Syracuse University Center's Annual Report
Microsoft Word - Summer2023WorkshopReport (quarknet.org)
Summer 2023 QuarkNet Workshop hosted by Syracuse University group from Aug 14-16, 2023.