Center-Level Portfolio: Colorado State 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 **Colorado State University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Colorado State University	2019	2020	2021	2022	2023	2024
	Muon detection and analysis					
	I expect to use the Top Quark Collision and What Heisenberg Knew activities...			Conservation properties. Calculate boson Z mass.	Mass of Top Quark	Mass of z and top quark
	Shuffling the Particle deck to introduce the standard model and make parallels to pattern recognition, periodic table arrangement, etc. This allowed students to make connections with what is familiar to this new unfamiliar material.					
	Mystery Neutron, Rolling with Rutherford, Top Quark		Using terminology in many practice problems and hoping to use Rolling with Rutherford this coming year. Examples: Rolling with Rutherford, Minerva Activity	I currently use to top-antitop collision investigation for conservation of momentum as well as the MINERvA masterclass each year. Examples: Top antitop collision and MINERvA	Top/AntiTop Quark Collisions, Rolling with Rutherford, finding the missing neutrino, shuffle the deck.	
	Mass of Z boson, Rolling with Rutherford, Totem Express					
	Rolling with Rutherford, Quark Workbench, Mass of Z, I look forward to QuarkNet trainings every year. Atomic, Nuclear, and Particle Physics are now my favorite unit to teach in physics.	I will continue to use many QuarkNet resources. Examples: Rolling with Rutherford, Mass of Z, Quark Workbench	Continue to use the activities that I have been using. Determine what activities will fit into our freshman physics course. Examples: Quark workbench, Rolling with Rutherford, Mass of the Z	Most years I have one or two students that use the cosmic ray detector for a student designed physics project in my advanced physics classes. I regularly use many of the activities. Examples: Quark Workbench, Mass of Z, Rolling with Rutherford. Additionally, the chemistry teachers at my school are using a version of Rolling with Rutherford in their classes.	Quark workbench, mass of the Z, rolling with Rutherford. QuarkNet keeps me teaching every year	Quark workbench, Rolling with Rutherford, etc. I look forward to my Quarknet meeting every summer

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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 Colorado State University Center**

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Colorado State University	Program Year (Year of Full Survey)	Subsequent Program Year		
	2020	2021		
	This is my first one, but I think the STEP-UP workshop will indeed be beneficial in helping my students gain some context.			
	Mass of a penny			
	Program Year (Year of Full Survey)	Subsequent Program Year		
	2021	2022		
	Mass of Z			
	Have yet to have a chance to use them.			
	I have extensively used Shuffling the Particle Deck and Rolling with Rutherford in various classes. Sometimes I have used these as explicit ways of teaching content, but more often I use them as ways to show students what it is like thinking and problem solving like a scientist while using science content that they might not see normally. A lot of the pattern recognition and graphing skills involved help make these activities useful in many subject areas outside of physics (and in physics too!).	Using cosmic ray data, neutrinos, and particle physics deck to help students explore "strange" content but still form meaning from the unknown inquiry-focused instruction. Examples: Particle deck, Rolling with Rutherford, LHC data interpretation.		
	Program Year (Year of Full Survey)			
	2023			
	I use the deck of particles and Rolling with Rutherford regularly to expose students to particle physics while also teaching about pattern recognition and the nature of science/discovery.			
	Mass of Z			

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. (Out of a total of 15 teachers.)

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 **Colorado State University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year
Colorado State University	2021	2022
	Mass of Z	
	Have yet to have a chance to use them.	
	I have extensively used Shuffling the Particle Deck and Rolling with Rutherford in various classes. Sometimes I have used these as explicit ways of teaching content, but more often I use them as ways to show students what it is like thinking and problem solving like a scientist while using science content that they might not see normally. A lot of the pattern recognition and graphing skills involved help make these activities useful in many subject areas outside of physics (and in physics too!).	Using cosmic ray data, neutrinos, and particle physics deck to help students explore "strange" content but still form meaning from the unknown inquiry-focused instruction. Examples: Particle deck, Rolling with Rutherford, LHC data interpretation.

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. (Out of a total of 12 teachers.)

Excerpt (direct quote) from Colorado State University 2023 Annual Report (QuarkNet Center Annual Report 2023.docx):

Quarknet@CSU Workshop: The Colorado State QuarkNet Center hit the road for a 4-day trip to Los Alamos, NM to align with the annular solar eclipse passing overhead on October 14th, 2023! We set up a cosmic ray flux study which ran the duration of the eclipse, 2 telescopes with different filters, and had plenty of eclipse glasses on hand to give to the general public in attendance. We had many conversations with people from all over the world about the eclipse, cosmic rays, and science in general. On our trip we also toured Los Alamos National Lab; where we got to visit both the LANSCE lab and the MagLab.

The majority of teachers at our center also serve as board members of the CO/WY AAPT section, so we are looking for ways to share what we learned at LANL, and recruit more QN teachers, at our upcoming section meeting on November 4th, 2023. Slides available for three presentations: *Neutrinos, Iron Chef Physics, and Harry Potter Physics.*

Excerpt (direct quote) from Colorado State University 2024 Annual Report (QuarkNet Center Annual Report 2024.docx)
The majority of teachers at our center also serve as board members of the CO/WY AAPT section, so we are looking for ways to share QN resources, and recruit more QN teachers, at our upcoming section meeting in the Spring

American Association of Physics Teachers Colorado/Wyoming Section Meeting
Colorado State University, Natural and Environmental Sciences Building
November 4, 2023

Time	Event	Presenter	Room
8:30-9:00 a.m.	Registration and Coffee		A-302/304
9:00-9:45 a.m.	*What is Mass – Really? From Democritus to Higgs*	Bob Wilson, Colorado State University	B-302
9:45-10:15 a.m.	*Cosmology and High Energy Physics*	Joshua Berger, Colorado State University	B-302
10:15-10:30 a.m.	Break		
10:30-11:00 a.m.	*Neutrinos*	Julia Gehrlein, Colorado State University	B-302
11:00-11:30 a.m.	*Iron Chef Physics*	Cecilia Dauer, Little Shop of Physics	B-322
11:30-12:00 a.m.	Business meeting and drawing for NSTA prize	Cherie Bornhorst, Section President	
12:00-1:00 p.m.	Lunch and explore Little Shop of Physics Engagement Spaces		A-302/304, B-323/325/329
1:00-1:45 p.m.	Denver Area Physics Teachers Circular Motion Workshop	Cherie Bornhorst and Matt Leach, DAPT	B-322
1:45-2:30 p.m.	*QuarkNet: Bringing 21st Century Physics Into the Classroom*	Shane Wood, QuarkNet	B-302
2:30-2:45 p.m.	Break		
2:45-3:15 p.m.	*Harry Potter Physics*	Carolyn Crapo, Grandview High School	B-302
3:15-4:00 p.m.	*Building Bridges to Interdisciplinary Collaboration*	Nadene Klein and Joe Schneiderwind, DC Oakes High School	B-302
4:00 p.m.	Adjourn; social gathering at Black Bottle Brewery		