Center-Level Portfolio: Kansas 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 on their use of QuarkNet content and materials in their classrooms (and in-after class events). We see the value of these qualitative reviews as expanding on the instructional practices measured quantitatively via Teacher Survey responses. The table presents answers to select open-ended questions providing narrative examples of implemented or planned instructional practices by teachers in their classrooms and school environments. This evaluation approach is consistent with the use of *authentic assessment* as a means 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.

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. Each row starts with the original responses to the first time a teacher completes his/her full survey. If a particular table box is blank, it likely means that that teacher did not participate in an event for that program year or skipped the question (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.

As 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 **Kansas State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Kansas State University	2019	2020	2021	2022
	Rolling with Rutherford and Quark Workbench			
	Quark Workbench, Mass of an Electron, Masterclass			
	I have used the Quark Workbench most often, but next year I plan to incorporate the Calculate the Z Mass/Top Quark mass activities when teaching vectors.	In the 2019-2020 school year, I had a student work independently on CRMD research. This student graduated, but I have another student scheduled to work independent study during the 2020-2021 school year. Examples: Rolling With Rutherford Quark Workbench Cosmic Ray e-lab.	I plan to use the following activities with my APP2 class. Some will also be used with a general physics class. Totem Data Express CMS Masterclass Human Tricks Mean Lifetime: Dice Rolling With Rutherford.	I have a Cosmic Ray detector in my classroom, and interested students have used the CRMD e-Labs to pursue independent study projects. Hopefully if the dates work out, my General Physics Class will participate in the Masterclass this spring. I am working to improve my AP Physics 2 modern physics unit with some QuarkNet materials this spring. Examples: I have used the QuarkNet Workbench and the Rolling with Rutherford activities previously in my classes. I plan to make use of the Making it Round the Bend (Quantitative) activity this year.
	Mass of Top Quark to use high energy physics concepts to practice vector addition.		Mass of Z to practice vector addition	Nature of Science and experiment. This involves most of the basic concepts of classical and modern physics. Examples: Mass of Z, Top Quark, Around the Bend.
	Quark Workbench, Rolling with Rutherford, Top Quark Mass, Z mass	Using a CRMD in my classroom to do research, We have used the data on the Cosmic Ray site to do research without our detector. I do Quark Workbench, Rolling with Rutherford, and Top Quark Mass. Examples: Quark workbench, Rolling With Rutherford, The case of the Hidden Neutrino	Totem activity- to bring out the wave particle duality in Chemistry. Examples: Rolling with Rutherford, Quark workbench, Making Tracks.	Conservation of momentum ties in with the mass of top quark, mass of Z. Will be teaching coding in my Chemistry and physics classes, do use Rolling with Rutherford, a Cosmic Ray muon detector, cosmic ray research, other data activities. Examples: Quark workbench, Rolling with Rutherford, Top Quark Mass, Mass of Z.

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 **Kansas State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Kansas State University	2019	2020	2021	2022	2024
	None yet, but I am very excited to do so now that I know about them.				
	I will be determined, but I like the possibilities for the Detector use in the classroom. Way of incorporating real time research	I plan to use the idea of probability to in radioactive decay. I am going to implement the Muon detector more in the class curriculum. Examples: Dice part 1 and 2, mass of top quark		When teaching particle physics, I use some of the activities. Examples: Rolling with Rutherford, conservation of momentum. I have enjoyed talking to other teachers and seeing how they use the activities	Rolling with Rutherford; helps to clarify ideas
	Rolling with Rutherford and calculating top mass. Good stuff to add to the modern physics unit in describing statistical analysis and how momentum works with quantum mechanics. g the muon detectors GPS. This way I can upload more accurate data. I also loved the quantum physics lectures this university gave.	I want to use the muon decay lesson with histogram analysis to help students understand error analysis. Examples: Intro to histograms, Error analysis with histograms, Cosmic ray e-lab. Error analysis applications are great for students to understand how physics is done. I would like to have more direct content that uses histograms in my classroom.			
	Many of the Masterclass activities and a few others for measurement, etc. Great fun ways to implement HEP / Particle Physics into science classrooms. QuarkNet had greatly contributed to my understanding of modern physics	Big Ideas in Physics - Include various QuarkNet activities to review of Conservation Laws, Measurement, Probability, etc at the beginning of the year. Examples: Used regularly: Mass of Penny, Quark Workbench, Mass of Top Quark, and Rolling with Rutherford. My physics students will continue to participate in Masterclass / BAMC events when they arise.	CRMD and Masterclass. Examples: Mass of top quark, Mass of z boson, quark workbench.	I would like to incorporate the following things into my physics classes and individual/small group projects the students would complete during the school year . CRMD and e-Lab, LHC and Neutrino Masterclasses. Examples: STEP UP Everyday Careers in Physics, and Women in Physics; Case of the Missing Neutrino; Mass of Top Quark; Mass of Z; Rolling with Rutherford; Mass of US Pennies; Quark Workbench.	DAP integrated into physics classes. Masterclass activities and CRMD projects. Examples: Mass of z, top quark, rolling with Rutherford
	I've used several but can't think of their exact names. In Kansas we have many small high schools. I think this Quark Net program has helped teachers in these small schools. Some have as few as 100 students in grades 9-12.	I have retired from classroom teaching. But I am a private tutor in physics. I do incorporate ideas which I glean from the workshop. With one-on-one interaction with each student, I find this helps. While I no longer use actual labs, I do work with each student on interpretation of data for the lab.			

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 **Kansas State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Kansas State University	2019	2020	2021	2022	2023	2024
	I've used several, but can't think of their exact names. In Kansas we have many small high schools. I think this Quark Net program has helped teachers in these small schools. Some have as few as 100 students in grades 9-12.	I have retired from classroom teaching. But I am a private tutor in physics. I do incorporate ideas which I glean from the workshop. With one on one interaction with each student, I find this helps, While I no longer use actual labs, I do work with each student on interpretation of data for the lab				
	My most used is the Top Quark Mass. I integrate this into my conservation of momentum unit.			Shuffling the Particle Deck is something I need to make a point of using. Examples: Rolling with Rutherford, Shuffling the Particle Deck, Top Quark Mass.	I use the Top Quark activity when we talk about conservation of momentum. It is a good tie in to particle physics	I have written several coding notebooks to use in my physics classes. I am working on integrating more particle physics into my curriculum. Examples: Rolling with Rutherford, Top Quark
	Histograms: The Basics & Mass of Pennies *(planned to use).* Each one is adaptable for any level.	The overall plan is to use the Penny Mass to show small quantities before talking about atoms and subatomic particles. Understanding histograms is the other point I need to make with students. Examples: Mass of Pennies & Dice, Histograms, &Probability			Mass of Pennies - 1 time a year to develop problem solving.(teaching 5ht-8th grades)	Penny roll for mass & measure precision. Dice roll for half-life. Examples: Dice Roll & coding variation. It was great to connect with other educators in the field.
	Great fun ways to implement HEP/Particle Physics into science classrooms.	Big Ideas in Physics - Include various QuarkNet activities to review of Conservation Laws, Measurement, Probability, etc at the beginning of the year Used regular: Mass of Penny, Quark Workbench, Mass of Top Quark, and Rolling with Rutherford	Mass of top quark, Mass of z boson, quark workbench.	I would like incorporate the following things into my physics classes and individual /sm group projects the students would complete during the school year: CRMD and elab, LHC and Neutrino Masterclasses. STEP UP Everyday Actions, Careers in Physics, and Women in Physics Case of Missing Neutrino / Mass of Top Quark Mass of Z Rolling w/ Rutherford Mass of Pennies Quark Workbench	Rolling with Rutherford, Quark workbench, and Mass of Z activities. Lots of great ideas for connecting the concepts learned in class to applications in modern physics research.	

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 **Kansas State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Kansas State University	2019	2020	2021	2022	2023	2024
	Examples: Rolling with Rutherford and Quark Workbench Still feel like I am at the tip of the iceberg with relation to the particle physics realm. A bit overwhelming right now. Enjoy the opportunity to interact with other science teachers which is some-thing I don't get a chance to do since I am the only science teacher at my school.					
	Quark Workbench, Rolling with Rutherford, Top Quark Mass, Z mass. They bring particle physics into the high school classroom in a fun and inviting way. It takes the stress or anxiety away from really difficult concepts. I layer in many other activities I've made on my own as a result of my experience with Quarknet. I also love that it connects me with other physics teachers when I was completely alone in building my own curriculum at my first teaching job. The QuarkNet program has helped me in more ways than I can communicate by building a community of teachers and professors.	Using a CRMD in my classroom to do research, We have used the data on the Cosmic Ray site to do research without our detector. I do Quark Workbench, Rolling with Rutherford, and Top Quark Mass. Examples: Quark workbench, Rolling With Rutherford, The case of the Hidden Neutrino	Totem activity- to bring out the wave particle duality in Chemistry. Examples: Rolling with Rutherford, Quark workbench, Making Tracks.	Conservation of momentum ties in with the mass of top quark, mass of Z. Will be teaching coding in my Chemistry and physics classes, do use Rolling with Rutherford, a Cosmic Ray muon detector, cosmic ray research, other data activities. Examples: Quark workbench, Rolling with Rutherford, Top Quark Mass, Mass of Z.	Quark workbench -very hands on. Wouldn't teach particle physics if I was not involved with QuarkNet	

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 **Kansas State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Kansas State University	2019	2020	2021	2022	2023	2024
	Examples: Quark Workbench, Rolling with Rutherford, Top Quark Mass, Z mass The quark workbench is so hands on and the one thing students know very well at the end of the year - that quarks make up other particles (esp protons and neutrons). Top quark was one my students really enjoyed doing and teaches them about vector addition. It has been very valuable for building community, to have other teachers as resources and see them at other science conventions and workshops.	Using a CRMD in my classroom to do research, We have used the data on the Cosmic Ray site to do research without our detector. I do Quark Workbench, Rolling with Rutherford, and Top Quark Mass. Examples: Quark workbench, Rolling With Rutherford, The case of the Hidden Neutrino	Totem activity- to bring out the wave particle duality in Chemistry. Examples: Rolling with Rutherford, Quark workbench, Making Tracks	Conservation of momentum ties in with the top quark mass, Z mass Will be teaching coding in my Chemistry and physics classes, do use Rolling with Rutherford, a Cosmic Ray muon detector, cosmic ray research, other data activities. Examples: Quark workbench, Rolling with Rutherford, Top Quark mass, Rolling with Rutherford, Quark workbench, Mass of Z	Quark workbench -very hands on. Teach students what modern physicists look at and ideas of how things are discovered	Cloud Chamber for proof for students of particles. Z Mass for conservation of momentum and energy. Cosmic ray detector to do research, Examples: Quark workbench, Rolling with Rutherford, Making Tracks I and II. Great inservice training. It increases my confidence in teaching tremendously.
	Mass of Top Quark to use high energy physics concepts to practice vector addition.		Mass of Z to practice vector addition	Nature of Science and experiment. This involves most of the basic concepts of classical and modern physics. Examples: Mass of Z, Top Quark, Around the bend		I use large data sets from QuarkNet sources to teach how science is done. Top Quark, Z mass, Cosmic ray activities

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 **Kansas State University**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Kansas State University	2020	2021	2022	2023
	I use Indirect Measurement Lab to have students calculate pi.			
	Planning to implement Histograms: The Basics, Rolling with Rutherford in fall 2020.			
	Program Year (Year of Full Survey)			
	2022			
	Rolling with Rutherford			
	Program Year (Year of Full Survey)			
	2023			
	In my case (teaching class to several small schools) it is tough to coordinate times that we can get everyone together. I teach students that may live 200 miles apart.			

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.

Kansas State University QuarkNet Center, 2022-2023 Annual Report (excerpt):

"Coordinated a research project with QuarkNet Fellow Jim Deane that involved our dozen CRMD teachers working with their students to correlate muon rates with atmospheric temperature and pressure changes (available from NASA) as weather fronts move through Kansas and Arkansas."

Example from Washburn Rural High School