
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 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 **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	2024
	None yet, but I am very excited to do so now that I know about them (DAP).			
	will be determined, but I like the possibilities for the Detector use in the classroom. (DAP) 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 use some of the activities. Examples: 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
	I guess the CRMD workshop, this is only my second year teaching physics, so I am kind of new to all of this. Rolling with Rutherford and Quark Workbench. I don't feel confident enough in them (DAP) to make a recommendation since I have so little experience with them. 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 something I don't get a chance to do since I am the only science teacher at my school. I don't know where else I would have the opportunity to learn about and develop student lessons on particle physics except with QuarkNet.			
Quark Workbench, Mass of an Electron, Masterclass. They (DAP) 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.				

Table (con't.)

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Kansas State University	2019	2021	2022	2024
	Mass of Top Quark to use high energy physics concepts to practice vector addition. Not being a High school teacher makes it challenging to use the same way I would use it with High School students. But it is very useful with just a few modifications. I wish we had more opportunities within QuarkNet to work with peers and mentors.	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. Examples: Top Quark, Z mass, Cosmic ray activities. QuarkNet is an incredible resource for physics teachers.

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	2019	2020	2021	2024	2025
Kansas State University	<p>I think that they have all been equally valuable. The primary thing that has been helpful is the ability to network with physics teachers throughout the state and nation. Each year, I am able to incorporate a few more activities in my teaching. 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. The activities are well thought out and help incorporate advanced physics topics into a busy curriculum. The structure of the QuarkNet teacher workshops requires me to put on a student hat to design experiments but then allows me to use the teacher hat to help plan ways to make the experiments work in the classroom. And again, the time to get to know my fellow HS physics teachers gives me a resource to lean on during the year to help with both QuarkNet and non-QuarkNet related lessons. QuarkNet is great and is making me a better physics teacher. (I still have lots of room for improvement).</p>	<p>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. This is the best professional development I am involved in because it has created a network of physics teachers that I see multiple times a year over the course of several years.</p>	<p>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. I have used the Quark Workbench and the Rolling with Rutherford activities previously in my class. I plan to use the Making it Around the Bend (Quantitative) activity this year. To me, one of the greatest benefits of QuarkNet is the collaboration with other physics teachers in learning how to better help students engage with physics concepts. Often, I am able to apply instructional techniques or philosophies I learned from QuarkNet teachers to lessons that are not specifically related to QuarkNet. So even if I might be slow to adopt specific QuarkNet lessons, QuarkNet activities still have a big influence on my classroom instruction.</p>	<p>I intend to build a physical cloud chamber and using the making tracks 1 and 2 activities with my AP Physics 2 class. I will attend coding camp 1 this summer and hope to learn enough coding to feel comfortable incorporating some coding into physics classes. I will use some of the ideas shared during the share-a-thon and the workshop, particularly new ways for students to collect, report, and analyze data. I hope to bring students to a Neutrino Masterclass next spring at the QuarkNet center. I plan to use Making tracks 1 and 2 to help students understand modern physics. I plan to use Making it around the Bend for magnetism. I will continue to use Rolling with Rutherford. QuarkNet has been the most influential professional development I have ever experienced. I have developed a group of professional peers that I see repeatedly who I can rely on for help and advice in the classroom. I get to learn new things at each meeting, which helps me step into the role of student. I can demonstrate life-long learning and my enthusiasm is greater for teaching.</p>	<p>CRMD Plans: Get both detectors up and plateaued over the summer Start uploading data Try to recruit some students interested in independent study Do a short introduction to APP 2 class using presentation created during QuarkNet https://docs.google.com/presentation/d/106AmaDmOP_-caVBI6nvVAXfo_DpWqIFXigUhwQQGK3E/edit?usp=sharing Email previous students Try to recruit some robotics students to be involved Fall Semester Week 5: General Physics Class How speedy are these muons? Activity- Canvas Commo. Examples: Shuffling the Particle Deck; Rolling With Rutherford; How Speedy are those muons?</p>

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Kansas State University	2019	2020	2021	2022	2024
	Fixing the muon detectors GPS. This way I can upload more accurate data. I also loved the quantum physics lectures this university gave. Examples: 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. They (DAP) are well designed and gets at the core concept of what quantum mechanics and modern physics means. It is applicable to the high school level. Seems good. Not all are working on particle physics though.	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.			I have used the cosmic ray detector, Rolling with Rutherford, and the Particle deck. They are useful for teaching concepts that are hard to conceptualize for students.
	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. QuarkNet had greatly contributed to my understanding of modern physics	CRMD and Masterclass. 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. I wish I had more time to dedicate to particle physics because they are great activities!	DAP integrated into physics classes. Masterclass activities and CRMD projects. Examples: Mass of z, top quark, rolling with Rutherford 2025: Cosmic Ray Muon Detector and Nova Masterclass Examples: Rolling with Rutherford, Mass of a Penny, Case of the missing Neutrino

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	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. Keeping abreast of new information in physics is very helpful to me so that I can relate to each student who I tutor.				
	Data Camp has been a huge learning experience. The presenters did a great job of balancing making everything challenging, but not make us all cry. The researchers and tours of the facilities were excellent, and the way things were explained really makes me feel like I have a much better understanding of, well, just everything. My most used is the Top Quark Mass. I integrate this into my conservation of momentum unit. I think it would be difficult for a teacher with little background to do most of them well. There is an entirely new set of vocabulary required to really do those activities justice.			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

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	Histograms: The Basics & Mass of Pennies. Each one is adaptable for any level. There are very few activities for middle school and the topic of sub-atomic particles is in the textbooks. There is a need for introductory activities for this level. Data Camp has allowed us to build a web of resources across the country and the hard part will be getting more regional activity.	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. 5th Grade can understand there are smaller particles than atoms, but the details escape them. It is helpful when they use real data to understand graphs.			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. 2025: Now retired. Used in previous years Rolling with Rutherford, Mass of U.S. Pennies. There's need to be more activities for younger students to start hearing about particle physics. Most of them already know about protons, neutrons, & electrons. So I tell them about the smaller particles to give them an introduction.

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	<p>Examples: Quark Workbench, Rolling with Rutherford, Top Quark Mass, Z mass</p> <p>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 (especially protons and neutrons). Top quark was one my students really enjoyed doing and teaches them about vector addition.</p> <p>It has been very valuable for building community, to have other teachers as resources and see them at other science conventions and workshops.</p>	<p>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. Love it! They are a great resource, the only trouble is deciding which ones to do because of lack of time!</p>	<p>Totem activity- to bring out the wave particle duality in Chemistry. Examples: Rolling with Rutherford, Quark workbench, Making Tracks.</p>	<p>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. Love it. I gain so much every time I have professional development with QuarkNet.</p>	<p>Quark workbench -very hands on. Teach students what modern physicists look at and ideas of how things are discovered</p>	<p>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.</p> <p>Great inservice training. It increases my confidence in teaching tremendously.</p> <p>2025: I include some of the Data Portfolio activities such as Shuffling the Particle Deck, Rolling with Rutherford, Quark Workbench. I use a cloud chamber so students can see the tracks of some of these mysterious particles during the unit. This year, I am adding "How speedy are these muons activity, early as we begin kinematics, such as Shuffling the Particle Deck, Rolling with Rutherford, Quark Workbench. I use a cloud chamber so students can see the tracks of some of these mysterious particles during the unit. This year, I am adding "How speedy are these muons activity, early as we begin kinematics. we do the Case of the Hidden Neutrino.</p>

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Kansas State University	2020	2021	2022	2023
	Planning to implement Histograms: The Basics, Rolling with Rutherford in fall 2020. Some activities are good to introduce certain topics. Thank you for the opportunity to participate in the QuarkNet Research group. It provided me good resources to implement in my classroom.			
	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
	2022	2023	2024	2025
	CMS workshop. Able to introduce the standard model, CMS data analysis in General Physics class. Rolling with Rutherford. Didn't get a chance to interact with other physics teachers. Looking for more ways and ideas to implement the knowledge gained in the workshop in the classroom.			I would like to use more data activities, which I am already using to prepare my students for the master class. I am planning to enroll some students who can work on the detector. Examples: Rolling with the Rutherford Shuffling the particle deck How speedy are these muons? (will use in the upcoming year)
	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.			
	Program Year (Year of Full Survey)			
	2024			
I think the data activities do a great job of bringing modern science into understandable analogies and applications. This was an incredible workshop, and though I am not sure how I will apply my learning specifically, I know that I will do so! I am pretty far away from this center (in Northwest Arkansas) but I feel like I am part of the community of teachers here already. This has also given me the confidence to bring real scientists and their research into my classroom.				

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Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
Kansas State University	2025		
	It is hard to pick something that has been the most helpful. Every event I have attended has been useful and allowed me to take new ideas to my classroom. Rolling with Rutherford. I actually use this in chemistry knowing I will have the same students in my physics course and can refer back to it. I have also used Top Quark Mass when teaching about momentum. I would recommend it because it provides insight into current research in physics. I think QuarkNet is great. The structure of the schedule at my school makes it more challenging to implement more aspects. Each year I try to add or change a little bit more.		
	The workshop helped me understand some technical details of the muon detectors, and possible experiments.		

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 presents results from a research project conducted by teachers and their students that was presented in the center's 2022-2023 annual report. In a supplemental document, posters and implementation plans created by teachers who participated in the 2025 KSU QuarkNet Workshop – Cosmic Ray and NOvA Update are presented.

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

The Correlation Between Cosmic Ray Muon Flux Rate and Low Pressure Regions During Stormfronts in Kansas.

