Center-Level Portfolio: University of Oklahoma/Oklahoma 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 **Oklahoma State University/University of Oklahoma Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
Oklahoma State University/ University of Oklahoma	2019	2020	2022
	The general information to help students and given them ideas of things that might interest them. I have really only pulled information to help/work with individual students. Lots of good information for students that have an aptitude or interest in more advanced information. It gives me information of what I have/have not been exposed to, and resources for my kids. Getting resources and ideas to pass along to students. Physics is not my background, and this has given me a pool of resources. It has exposed me to material and resources to pass along my students.		
	Personally, I have only participated in a Cosmic Ray e-Lab workshop. It was a bit overwhelming at first, but after a day I felt much more comfortable. I enjoyed learning about particle physics, and the various Cosmic Ray studies and how they can broaden our understanding of particle physics. I have not used the Data Activities yet, but would like to learn more about how to integrate them into my classroom. I believe we utilized these at the workshop last year, and I agree that they could be beneficial resources for teachers to provide to their students.		
			I will definitely bring students to the Masterclass. I like the Polar Bear activity and the Rolling with Rutherford activity.
	Additional information and activities. None (DAP)	I use many QuarkNet activities already in my classroom. I will certainly use the Step Up activities this coming year. Examples: Card Game, Rolling with Rutherford, Calculating z particles	
	Dice, Histograms, and Probability Mass of US Pennies "Why reinvent the wheel?" is my motto. Everything about the Oklahoma State and OU QuarkNet summer programs are very good/excellent		
	I have taken students to a master class at Oklahoma state university I would recommend them (DAP) because they depend student understanding. I am very pleased with all things QuarkNet.		
	The teacher lesson plans that are appropriate for use in a general physics classroom or in a Pre AP Chemistry classroom Quark workbench, Rolling with Rutherford, Isotopes of Pentium, various games with dice. The students get understanding of the nature of science and help standards especially those regarding energy. The workshops are led by teachers or have a large input to give evaluation and improve the curriculum. Since we actually do the labs and activities as well as work with scientists give a real life scenario	I plan on using Step Up plans as a new item to work with as we move forward. I have used other lessons for years from the QuarkNet program.	

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 **Oklahoma State University/University of Oklahoma**

Center	Program Year (Year of Full Survey)	Subsequent Program Year
Oklahoma State University/ University of Oklahoma	2019	2020
	Data camp at Fermi Labs - a number of ideas for interactive lessons. The high school curricula do not cover the topics of focus for the Data Activities (that may have changed since I last looked at the available activities) I haven't used QuarkNet related activities because they are mostly associated with particle physics which is not really covered in the high school curriculum. Again, particle physics is, in general, outside the scope of high school physics. The relatively few students I have taken to Masterclasses have gained a lot from their participation. Not so much in my full classes in general.	
	Data Camp. Re-introduced me to the challenge of learning new material and partnering with a group to solve a problem. Also taught me a lot about data analysis and how to defend conclusions from data. Examples: Quark workbench, Rolling with Rutherford, Isotopes of Pennium, various games with dice. All the materials I use are excellent and have really helped kids grasp the concepts. They also initiate a lot of good discussions. I think we all struggle with particle physics concepts because they are still very far outside the realm of introductory or high school physics. QuarkNet provides a very good way to learn something about a subject that few of us would ever have an opportunity to otherwise explore. I use activities from QN both to reinforce some introductory concepts about particle physics, and to reinforce general concepts like data interpretation and teamwork skills. My biggest gain from QN has been the network of teachers and scientists we make in the program.	Use cosmic ray detector as example of real time data gathering and large data sets. Used top quark mass to introduce particle accelerator and reinforce vectors as an analysis tool. Use quark work. Examples: Quark workbench Penny mass Top Quark mass. QuarkNet has given me tools that make teaching advanced subject matter very easy
	I learned the most at Fermi lab data camp, but the summer program at my local university and the masterclass are more helpful in sharing content with students. Examples: Quark workbench, particle deck, calculating top quark mass, particle adventure website, z-path, phyching out the system. Activities are very inclusive, well written, available for different level of students. I have greatly enjoyed participating in QuarkNet. It has enhanced my teaching and my student learning greatly!	
	All three of them have been most helpful! Each has something different. I think the one with the students was most important for and introductory to QuarkNet. The summer workshop at OU was very good at helping me get started on how to put this into my classroom. The Fermi workshop stretched my learning curve - particularly the math, the coding, and being able to think and reason. It has helped me to feel more confident and put myself in my student's shoes. I have used these for chemistry not physics class. I think that QuarkNet needs to expand their thinking about just wanting physics teachers. It has helped me go deeper into my lessons with chemistry students when talking about the atom. Before, it was so superficial. I have a better understanding and therefore I think my kids will too. This can be the first step toward a better physics class that students take the following year. I have used the marbles and dice, mass of pennies, and particle deck. Please extend this to perhaps a chemistry teacher (no physics teachers) only workshop. It could be very enlightening for both.	

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 **Oklahoma State University/University of Oklahoma Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Oklahoma State University/ University of Oklahoma	2019	2022	2023	2024
	All of the programs have been very helpful. The week long summer programs that I went to at OU and OSU really helped me understand the material. The first year was a bit overwhelming, but being able to come back and hear the material again helped me understand it much better. Many of the activities were right at my students level, and they were related to topics that I already covered. So, getting to see those activities and then come back another year to be able to ask questions about them was very helpful. The masterclass for students was helpful. These students said that what we talked about in class clicked so much better after seeing it again at the masterclass. A few students also made a connection with one of the professors and decided to attend that university and do undergraduate research. Fermilab this week has been very helpful, and I feel like I understand the process better. Talking to other teachers who are doing different things has also been very helpful. Examples: Quark Workbench Determining the mass of the top quark Determining the mass of the Z boson Deck of Particle Cards Rolling with Rutherford. The activities actively engage the students, and they are related to real science. For example, I like using the quark workbench because it does a great job of having students recognize trends, make hypotheses, and test their hypotheses. In addition, it teaches them real science content. The same activity could have been done with naming the quarks anything and the students still could have found the patterns. However, the activity lets them ignore the names to focus on the patterns, but they are still getting used to seeing all of the names, colors, and fraction of charges. This makes it easier to talk about the zoo of particles later without them getting initially confused by all of the different names. It would be nice to have the data portfolio also be in a google doc so that teachers could more easily download a copy to make changes to for their classroom. Since it is related to real science the students are required to bring in many different concepts to accomplish the task. It goes beyond a unit into a cumulative task has them apply previous concepts to a new area, which is great for their growth. It is one of the best professional developments that I have done. The Fermilab teachers this year were very knowledgeable and open to feedback. Professor at OSU has been very helpful to me and my students over the last few years answering questions and encouraging us.	I use the quark workbench, particle physics deck, Rolling with Rutherford experiment, particle adventure website, and determining the mass of the Z boson, and top quark activities. I have gone to Masterclasses in the spring and I plan to go again. I also have done World Wide Data Day with students in the fall, and I was able to go to Fermilab for Data Camp. From this year I would like to begin introducing some coding to my students, but as of now my district has refused to allow Google Colab to be used on the district computers. So, I need to iron out issues with the district before I know what I will be able to do in the future in the classroom. Examples: I use the quark workbench, particle physics deck, Rutherford experiment, particle adventure website, and determining the mass of the Z boson and top quark activities. I have gone to masterclasses in the spring, and I plan to go again. I also have done the day of data with students in the fall, and I was able to go to Fermilab for the data camp. From this year I would like to begin introducing some coding to my students, but as of now my district has refused to allow Google Colab to be used on the district computers. I enjoyed the programing introduction, and I thought the material was geared very well towards an intro physics class. So, as long as I can get my district to allow me to use google colab I am interested in putting it into my curriculum.	Particle Deck Quark Puzzle Mass of Z Boson Mass of top quark Rutherford Experiment Dice Rolling. Connecting science process and real data to concepts we are already covering in the classroom. I have shared the curriculum with multiple teachers. Coding: cannot use google. This year another teacher showed me replit so that I can use it to run the curriculum.	Finding mass of top quark and z boson, quark puzzle, and particle deck are the ones that I use every year. (Students are) able to collect data themselves, or good data provided to make concepts more accessible. Able to collect data themselves, or good data provided to make concepts more accessible.

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 **Oklahoma State University/University of Oklahoma Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year
University of Oklahoma/ Oklahoma State	2020	2021
	Rolling with Rutherford. The teachers I know are always on the lookout for new ways to present materials	
	Honestly, they both were awesome. The data workshop was more advanced than I was ready for, but the presenters were amazing. Rolling with Rutherford.	
	Data Camp Data activities: Histograms, Quark WorkBench 2D/3D. Rolling with Rutherford. Materials relate to standards and current labs. Thank you QuarkNet for these opportunities for teachers and students.	
	Data Camp has provided a number of detailed activities usable immediately in a classroom setting I have used the Cosmic Ray activities in a school club setting. I simply haven't had much interaction with teachers from other schools, and I am the only teacher teaching physics in my school	
	Program Year (Year of Full Survey)	Subsequent Program Year
	2022	2023
	I plan to use the panda game and the Rutherford boards with my 5th grade science classes this year. I will definitely recommend them to my school. I wish there were more opportunities for the younger grade levels. (elementary and middle school. I had a great time going to QuarkNet! I am so excited for them to come to my classroom and continue to help my students!	
	Program Year (Year of Full Survey)	
	2023	
	Learning new activities that would better help students understand these concepts. Because I am a new teacher, my teaching style and resources available are still developing. Being able to talk with other teachers on these topics are very beneficial to me. The 'Shuffling the Particle Deck' and the 'Mean Lifetime' activities. I would because the Portfolio has a wide range of activities that a variety of teachers can use to teach their students. I like the differentiation of materials available so that classes of various levels (like on-level students, below-level, or even up to AP level) have options in terms of how difficult the activities are for them. Since this was my first QuarkNet, I have no previous experiences to compare this to. However, in terms of professional development, I have learned much in terms of the implementation of activities in my classroom and learning about particle physics. This gave me the opportunity to collaborate with other teachers who also teach my subjects in their school district. I teach in a very small school district, so being able to collaborate with other teachers is very attractive to me.	
	The data collection, graphing, and interpretation. My students will be exposed to different types of graphs while gaining skills for graph interpretation. I've taken a look at your lab activities on the QuarkNet website. I plan to definitely incorporate some of those activities within my class. For example: The Mass of U.S. Pennies and the Dice, Histograms, and Probability activities. There are many graph analysis activities within the data activities portfolio. Being that my school is focused on the ACT --and the science portion of the ACT is graph interpretation--the activities within the portfolio will support my students in finessing that skill. Very enlightening. A little overwhelming; however, I'm grateful for the opportunity.	
	Dice Probability. It (DAP) helps us to use real data and labs that are being used in real life to explain science concepts and how science learning progresses. I really appreciate being exposed to particle physics. I like the hands on activities. I plan on using QuarkNet materials in my classroom this year. This is my first exposure to particle physics.	
	Dice, Histograms, & Probability; Shuffling the Particle Deck; Calculating the Z Mass	
	Neutrino Masterclass-Using and synthesizing data. None (DAP). I would recommend because there is very rich content available with this program. Also, it will help students in a different content area than what they are accustomed to. I would like to have more hands on activities.	

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 **Oklahoma State University/University of Oklahoma Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year
	2023	2024	2025
University of Oklahoma/ Oklahoma State	First experience with neutrino. Shuffling particle deck will be excellent to introduce standard model. New to program, will be able to assess better after implementing this year. Activities for science skills beyond specific subjects. New to program, will be able to assess better after implementing this year.	Rolling with Rutherford, Histogram, quark workbench. Comprehensive, easy to use activities. Science must be hands on!	For my classroom/students, I have used my experiences with QuarkNet to expand and provide depth of knowledge regarding "real-world" research I have used Rolling with Rutherford and Shuffling Particle Deck with my diverse science club before attending a Masterclass. I plan on using more of the data portfolio activities in my physics class this year. Rolling with Rutherford, shuffle particle deck, quark workbench, momentum, dice 1 and dice 2. Thank you for this opportunity to collaborate and fellowship with other Physics teachers and research scientists!
	Finding the missing Neutrino, we've used this activity to demonstrate how particle physics works. I love that these activities give students access to real experimental data. The size of the data pools makes these activities stand out vs other data pools which are usually given to students. Letting us use equipment that was built by QuarkNet and share it with the surrounding teachers really helps us build a collaborative community.		I come every year to brush up on my knowledge of quantum physics. I think it's important to talk to researchers and get my terminology correct. There's a big divide between hearing popular scientists talk about QM and hearing scientists working in the field talking about the same subject. Examples: Rolling with Rutherford, Pennies (Massing), Muon Detector analysis, and I'm not sure of others. I had a wonderful time and I look forward to another 10 years.
	I haven't used this yet, but I think I will use the hidden neutrino activity and data. I think that students are much more interested in real-life data. I am very excited to utilize the new information that I have learned for my Physics classes next year.		There are several activities I have incorporated over the years, including the oil drop experiment, Rutherford gold foil experiment, conservation of energy and momentum with particle physics. Examples: Quark workbench, Making Tracks, several conservation Labs (Hidden Neutrino), Dice and Histograms. It was a great opportunity and I really enjoyed the chance to learn from experts within the field. I think one of the greatest benefits is that I am now able to share newer information with my students.

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 **Oklahoma State University/University of Oklahoma Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year
	2023	2024
University of Oklahoma/ Oklahoma State		
	In the past we have done the cosmic ray detectors and looked at data sets. The interactions between teachers are vitally important for building education networks. I feel this is the one of the most awesome events to learn how to implement particle physics into the classroom. I was so impressed with it, I shared with our district PD and some teachers who never heard of it did attend this year. No other place even comes close to what we learn during these workshops. The interactions between teachers is vitally important for building education networks. Best experience for any PD in my lifetime so I try to come every year I can.	Cosmic Ray Detectors. Good way to interest them (students) into particle physics. Good way to interest them into particle physics. **2025:** Finally understand the Muon Detector. This workshop this time was very needed!
	I think this neutrino workshop was a good one to try for my first QuarkNet because I teach Chemistry and address elementary particles. The "Dice, Histograms, and Probability" activity supports student data collection, graphing, and analysis skills in Chemistry. This can also be applied for radioactive decay. After introducing subatomic particles and quarks, the "Shuffling the Particle Deck" data activity is a great way to introduce the standard model. Other activities I'm interested in are "Rolling with Rutherford" and "Quark Workbench." I would recommend the instructional materials in the Data Activities because they support state and national science standards with a teacher guide and student handouts. It really helps us, the teacher, work smarter not harder to introduce a quality activity for students to make discoveries and connections. I really liked the structure of the workshop where day 1 was utilized for background information on neutrinos, day 2 was utilized for Data Activities and data collection leaving day 3 for reflection, implementation discussion, and resources available. Three days is a nice amount of time for this workshop. The instructors and guest speakers did a fantastic job answering all of our many questions to assist in our understanding of neutrinos and the experiments that are involved in this research. The Quark Net faculty at University of Oklahoma and Oklahoma State University are looking at facilitating virtual meetings on a monthly basis to support teachers.	
	I have only attended the neutrino data workshop, however I found the workshop extremely interesting, enjoyable and useful for implementing labs/instruction into my classes. I plan to definitely incorporate some of those activities within my class. For example: The Mass of U.S. Pennies and the Dice, Histograms, and Probability activities. N/A - I definitely would recommend this to other teachers. This is my first experience, so I am not necessarily familiar with all that is available for instructional and classroom support. However, what I have seen are extremely useful and will be incorporated into my current classes.	
	This one has introduced me to the Newer advances in Particle research I enjoyed the Fermilab Case of the Missing Neutrino and the dice roller and Shuffle the Particle Deck Yes, it's a great way to intro students to Particle Physics. Yes, its a great way to intro students to Particle Physics. I came into this workshop fully expecting to have everything go over my head and after the 1st day I was a bit worried that I was in too deep. Coming back to day 2 and 3 of the workshop really refined some of my understanding and misunderstandings of Particle 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 **Oklahoma State University/University of Oklahoma Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year
	2024	2025
University of Oklahoma/ Oklahoma State	They gave us several activities that we can implement in our classrooms. There was data and activities that I felt would supplement the content that I teach in my classes. I got some ideas that I had not thought of before! I met some great teachers for networking opportunities and discussion.	
	I do not currently teach physics and have not been to very many QuarkNet workshops.	
	Program Year (Year of Full Survey)	
	2025	
	I teach chemistry and there are a couple of spaces where we touch on the physics of things. Waves and the 2nd law of thermodynamics. I just need time to go through the portfolio.	
	It was introductory for me. It gave me some insight on how to introduce this content to my students. I have not implemented anything from the PD into my classroom yet.	
	First workshop not sure.	
	Only one. It has given me access to better explain particles to my students and activities to help my students within areas of weak skills. A variety of possible activities for weak skills. A good variety of options.	

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 are proposed implementation plans created by participating teachers during workshops held in 2023, 2024, and 2025.