Center-Level Portfolio: Vanderbilt 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 **Vanderbilt University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Vanderbilt University	2019	2020	2021	2024
	The astronomy information was cool, and getting to meet some professors who could guest speak to my students was useful. Haven't use DAP activities. I enjoyed the community of teachers that gathered for the Vanderbilt workshop			
	This will be my first year to implement activities. Students deserve the opportunity to interact with new technology and relevant content. I was totally engaged during the program. The other participants were extremely helpful. This program will allow me to enhance my teaching and instructional planning.	I would like to support and assist teachers during the school year. Assist teacher during this process. I became a Dean of Students after the workshop. My teachers were not exposed to the program last year; assist teacher during this process. I want to use this program to encourage students to review and or select career paths in science.	Muon Absorption Rates. Examples: Coding CMS Data Analysis Python/Jupyter notebooks. We have to add a component for practical application in content distribution.	
	We researched the correlation between lightning strikes and Muon count. Because (DA) it's authentic, it's collaborative, it's cutting edge physics, and it's fun. I'm working toward bettering my understanding of particle physics. I believe my students benefit as I do from the collegial support I receive as a result of being able to participate in QuarkNet.	.		I liked the Penny mass activity, Rolling with Rutherford, and Dice Decay (as modified by QN staff).
	My students have participated in International Muon Week. They completed most of the steps of the online map; however, we ran out of time and could not complete the entire activity. We have to add a component for practical application in content distribution. Participation in QuarkNet has rekindled my fascination with particle physics and inspired me to develop developmentally-appropriate lessons for my teenaged students. Big-picture strategies are important, of course. However, we must not lose sight of the fact that most of our students are still finding their way through the details. It takes time for them to become competent with enough small details to string together into a big picture. The QuarkNet eLab materials provide student access to current scientific data with all its inherent uncertainties. I've been forced to re-think my own approach to data analysis as well. I finally understand what is meant by a scientific "model" of data and why models are necessary to predictions and hypotheses in science. I had been developing a rigorous and developmentally-appropriate curriculum, using materials from QuarkNet, CERN, the Perimeter Institute, and other sources, for a semester-long Physics 2 class. Topics included Basic Electric Circuits; Physics of Waves; Introduction to Quantum Mechanics (including a little Bra-Ket Algebra); Introduction to Particle Physics, and Introduction to Special Relativity. The Commonwealth of Kentucky has made the regrettable decision to remove Physics 2 from the high school science curriculum. On a "block schedule," only a few days are allotted to topics in modern physics in the Physics 1 curriculum.			

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 **Vanderbilt University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Vanderbilt University	2020	2021	2022	2023	2024
	The Quark Workbench activity: my Physics 2 students really enjoyed it! I recommend the Quark Workbench activity because students enjoy using it to learn about how quarks make up other particles. They have lots of questions about the anti-matter particles! I have not succeeded using the Rolling with Rutherford activity. There are limited opportunities to teach modern physics topics at my school. I would like to work more of the activities into the curriculum, for example, as exercises in data analysis. Modern physics topics must now be inserted into classroom instruction as time permits. Nonetheless, the approach to data-analysis and interpretation, especially graphical analysis, is useful in all physics topics. Spending time with other science teachers is always refreshing and inspiring! Spending time in the student role has been most helpful for me as well.	I would like to try incorporating coding in a Google Notebook into my Honors Physics curriculum. I would use the data from this year's QuarkNet workshop and provide a brief introduction to Particle Physics. DAP Examples: None. Opportunities to teach modern physics topics in any meaningful way are extremely limited to nonexistent.	I have incorporated CRMD activities into the Physics 2 course. Students practice the skills of taking data, analyzing data, and interpreting the physical meaning of the analysis. This is especially challenging for high school students because there is physical to see: numbers appeared on the computer screen but there was no other indication that anything was happening as muons were being counted. Examples: Quark Workbench 2D/3D, Particle Transformation, Cosmic Ray e-Lab. During our annual QuarkNet workshops, I ask questions about modern physics that can only be answered by practicing physicists and other physics teachers. In order to teach this material, I need to understand it myself! I love being a "student" in this way each year!	The documentation for the cosmic ray e-lab is difficult to understand; sometimes it's not really clear what all of the different quantities measure or why they are important.	
		Exploring hardware design and implementation within both small classroom detectors and larger research detectors. I have transitioned over to teaching an engineering focused curriculum.			
	Showing how to collect data and the importance. Helps to understand yourself before teaching kids. What is helpful and how used. having sources to turn too if needed				

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 **Vanderbilt University Center**

Center	Program Year (Year of Full Survey)	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year	Subsequent Program Year
Vanderbilt University	2020	2021	2022	2023	2024
	They (DAP) contain helpful instructions and can get students to interact fairly easy. I am extremely grateful for the opportunity to engage in the QuarkNet experience. It allows me to connect with other teachers in my area outside of my building and to build relationships with the faculty at our host campus.	Exploring hardware design and implementation within both small classroom detectors and larger research detectors. I have transitioned over to teaching an introductory engineering focused curriculum.	Participating in QuarkNet has helped me feel that I am maintaining a connection with engaging in scientific processes. I have continuously enjoyed the opportunities QuarkNet has provided during our meetings in interact with teachers from other schools, districts and states.		Material & Equipment Engineering discussions. I try to reference information and practices that I have been exposed to through QuarkNet to describe and link to classroom experiences for my courses in engineering. I do not currently have plans to implement items from the DAP this year. My classroom focus has shifted from when I began participating in QuarkNet (general education physics) to introductory engineering. I do work to reference QuarkNet (particle physics) principles, equipment, and ideas as it links to my current courses.
	I have not used them yet, but I plan to in the future. It is well organized, covers a lot of topics of various levels, and offers interesting activities for the students to really engage in.				

Program Year (Year of Full Survey)
2022
I haven't had the opportunity to use them yet but look forward to it in the coming school year. I would recommend them because they help to give quantifiable data to students on things that are not otherwise seen. Not only did I get to learn but I learned about things my students have asked me about that previously I couldn't answer. Since this was my first year, I haven't had the opportunity to involve students in the QuarkNet material yet. However, I do plan to implement it in the upcoming school year. I have enjoyed learning and being part of QuarkNet and hope to return next year!

Program Year (Year of Full Survey)
2023
I will be able to use a number of the topics discussed this week in my physics classes: (a) discussion of quantum atomic model and gravity (b) use of generative artificial intelligence like ChatGPT (c) use of a downloadable version of Tracker software for analysis of motion in videos of everyday items (d) use of freely available tools to edit videos and create YouTube-like videos of physics demonstrations (e) I hope to borrow a set of cosmic ray detectors to use in my classes this year so that they can measure data and perform analysis
Learning about how to use ChatGPT in a constructive manner for education purposes.

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.