

QuarkNet and COVID-19

May 1, 2020

Introduction

The COVID-19 crisis has profoundly affected QuarkNet and the teachers in the program. Summer workshops at centers and other opportunities that benefit them have been cast in doubt, re-imagined, or postponed. And almost all of the teachers have had to cope with a shift to teaching their students remotely online. The QuarkNet staff quickly realized that it would be important to maintain contact with and support QuarkNet teachers. Working from home, as the teachers and their students are, the staff adjusted and sometimes invented QuarkNet offerings to help teachers keep students engaged with meaningful learning in physics. This report will show what was done and how.

Before addressing the many issues and initiatives related to the crisis, it should be pointed out that the staff have maintained contact with each other and the routine aspects of QuarkNet. Tuesday staff conferences and Wednesday technical conferences were done remotely before and have continued unabated. The weekly newsletter, the *Friday Flyer*, has continued unabated and has, if anything, taken on a stronger role in connecting QuarkNet members. Staff have continued to field questions from and check in with mentors and teachers. Next week, Shane and Ken will systematically contact all mentors to get some updates from them on summer plans in light of the crisis and offer support. Staff still meet remotely with fellows - perhaps more than ever. For example, the monthly LHC and Neutrino fellows monthly videoconference has become weekly so that Ken and Shane can consult with them on the initiatives below. With the whole group mostly limited to home, it has become their virtual “night out”.

Support for teachers

As school facilities closed and schools moved to remote online learning in March, the QuarkNet staff quickly realized that teachers were entering a new world and needed support. The staff quickly built and continue to support online resources to assist teachers in switching to remote teaching and maintaining their use of QuarkNet content and practices:

- [Resources for Physics Teaching Online](#). This page has resources on remote online learning, physics simulations and online lessons, and more. It has been propagated outside QuarkNet and accessed over 900 times as of May 1 by QuarkNet and other physics teachers.
- [QuarkNet Zoom Channels for Videoconferencing](#). Six Zoom channels were opened on the Notre Dame Zoom account for QuarkNet teachers who might not otherwise have a robust way to communicate with students or colleagues.
- [Resources for Cosmic Ray Analyses Online](#). Using the Cosmic Ray e-Lab, teachers can engage students remotely in physics research projects with data from QuarkNet cosmic ray detectors. This “how to” guide includes instructions and pre-selected useful data files.

- [Using the CMS e-Lab](#). Using the CMS e-Lab, teachers can engage students remotely in physics research projects with data from the Large Hadron Collider at CERN. This “how to” guide includes instructions and suggestions for meaningful studies.
- [Comments on Adapting Data Activities to Teaching Online](#). QuarkNet staff and LHC fellow Jeremy Wegner added comments to the Data Activities Portfolio to explain how 16 different Data Activities can be done remotely by students at home in collaboration with their teachers and often their peers. To see such comments, one must log into the QuarkNet website. This page was added to make these comments available to all teachers, logged in or not. Mr. Wegner also contributed a Visual Python simulation online so the popular Rolling with Rutherford activity could be included.

The weekly QuarkNet newsletter, the *Friday Flyer*, also adapted to the current crisis. While the sections are familiar, much of the content shifted to making teachers aware of the support and new activities that have become available. *FF* has kept up with particle physics news, opportunities for teachers, and even a little humor throughout the crisis while being a conveyor of information QuarkNet teachers need. (Read the [May 1 issue](#).)

The next project to support teachers and students was announced on May 1: the [QuarkNet Wednesday Webinars](#) (QW2). QuarkNet staff have arranged for five webinars on particle physics-related topics between May 6 and June 10 given by experts. Teachers and students will be able to connect from home to learn new things about particle and contemporary physics. Like all of the Zoom webinars mentioned above, these will be recorded to widen their usefulness.

Cosmic Ray Studies

With many cosmic ray detectors inaccessible while teachers and students work from home, the total number of cosmic ray data file uploads is down. The number of cosmic ray analyses on the e-Lab, however, has increased as several teachers have challenged their remote-learning students to perform measurements with existing data. The page containing resources for cosmic ray analyses online (see section above) was created to help support teachers and students during this time of distance learning. Additionally, a few detectors continue to upload data. One of the detectors at Fermilab was moved to a QuarkNet staff member's home in order to provide an updated standard data set for the e-Lab.

Masterclasses

International Masterclasses (IMC) run each year in and around March; they were just starting as the COVID-19 crisis set in. Masterclasses began to shut down and by March 18, further IMC videoconferences were canceled, effectively ending IMC 2020. One of the last masterclasses in the U.S. was done remotely by QuarkNet LHC fellow Jeremy Wegner and his students in rural Indiana. A few other groups also attempted remote masterclasses with varying success.

QuarkNet took the next step by modifying the current CMS masterclass for remote learning. The measurement was simplified by focusing on muon tracks and new online support was built so that students could learn what to do via four screencasts and successfully complete the measurement with some coaching from their teachers. The result was a new remote learning masterclass, the Big Analysis of Muons in CMS (BAMC). QuarkNet built a support infrastructure

with student and teacher pages on the QuarkNet website, Zoom Q&A sessions for teachers, an April 15 webinar talk on the Standard Model and CMS by a Kansas State University particle physicist, ample tables for recording results online in the CMS Instrument for Masterclass Analysis (CIMA), and an April 17 webinar to discuss the data with three particle physicists. About 180 teachers and students attended each of the webinars and an estimated 240 students analyzed over 11,000 CMS events, one-by-one in the iSpy event display. BAMC provided a robust stress test for CIMA (which it passed), an opportunity for teachers to do a meaningful project with their students remotely, and the chance for hundreds of students to be “particle physicists for a day” at home. Along the way, QuarkNet developed capacities with webinars and designing remote learning experiences. And it all worked very well, with ample compliments from teachers and students.

With the success of BAMC in April 2020, QuarkNet has started another round for May, opening it up to more international participation. There are still details to sort but the masterclass talk will take place on May 19 with the videoconference to follow later that same week.

Fellows Workshop

In previous years, meetings of QuarkNet fellows have been vital to their development and communication with each other. These meetings have also maintained the coherence of their work. An in-person workshop for eight QuarkNet fellows who present our national workshops was planned for May 15-17 at Fermilab. QuarkNet staff is now planning to go ahead with the workshop virtually. The primary goal will be to enable select QuarkNet fellows to create remote online workshops that will be offered to teachers through our centers in summer 2020. The fellows virtual meeting will also provide the opportunity to share ideas between groups of fellows and continue the focus on research-based best practices in offering professional development.

Data Camp

Each year, Data Camp brings 24 QuarkNet teachers from around the country to Fermilab for a week-long, multi-faceted workshop that includes tours, talks, particle physics data analyses, and the exploration of data activities to bring back to the classroom. This “classic” Data Camp will not be offered in 2020; instead, the Teaching and Learning fellows will conduct a virtual/remote workshop that emphasizes the use of coding skills as they pertain to physics in general and particle physics in particular. Another goal of this virtual workshop, still under development, is to give teachers some comfort and confidence that, if remote learning is continued in the fall, they will have the skills and resources to implement something interesting, challenging, and useful with their students.

Summer 2020 Workshops at Centers

Summer workshops at many centers are among the QuarkNet highlights each year for teachers, mentors and staff. These meetings are the primary pathway to offer teachers at QuarkNet centers opportunities to develop professionally, build community, learn new physics, and improve their teaching. At this point, there is much uncertainty regarding these workshops in

2020. QuarkNet staff, mentors, and lead teachers are discussing the possibilities, which so far include:

- Rescheduling the workshop for late summer and/or fall of 2020 in hopes that face-to-face meetings will be possible then.
- Offering a virtual workshop, in which centers would meet for at least a portion of their workshop time remotely.
- Cancelling the 2020 workshop, with a plan to meet again in 2021.
- Other creative solutions.

QuarkNet staff is working with fellows to re-tool some of our national workshops in order for them to be offered remotely. Virtual summer meetings could also allow teachers to share successful strategies and tools with each other for teaching in a virtual setting, as the possibility of teaching this way may extend into the next academic year for at least some teachers.

STEP UP

In 2019, QuarkNet began a partnership with [STEP UP](#), a program that supports teachers in encouraging more women and minorities to pursue physics as a career. As part of this partnership, nine QuarkNet leaders, including staff, educational specialists, fellows and teachers, attended the 2019 STEP UP summer institute to become ambassadors for the program. Deborah Roudebush, QuarkNet Educational Specialist and STEP UP ambassador, has taken the lead in coordinating work that is beneficial to both organizations. As part of this work, several STEP UP classroom activities have been edited to be placed in QuarkNet Data Activities format. These activities will soon be posted in the Data Activities Portfolio. The 2020 STEP UP Summer Institute will be virtual, and Deborah is helping STEP UP leaders plan for this event. Several QuarkNet STEP UP ambassadors from 2019 plan to attend the 2020 institute as well. In addition, Deborah and QuarkNet staff are coordinating QuarkNet STEP UP ambassador efforts to arrange virtual STEP UP workshops open to all QuarkNet teachers.

IT Infrastructure:

Support for remote teaching and learning and carrying out new initiatives online only work if the IT infrastructure is strong. Fortunately, QuarkNet has been in a very good position in this regard. The QuarkNet servers at Notre Dame were not significantly affected by the COVID-10 crisis. The IT staff were already working remotely and Notre Dame has provided ongoing support. ND Studios assisted the staff in setting up webinars and exploring the capabilities of Zoom. The IT staff continues to work on development and maintenance of QuarkNet resources such as e-Labs and masterclass tools. One area of concern as International Masterclasses was the response of the CMS Instrument for Masterclass Analysis (CIMA) to large numbers of students in a CMS masterclass; this eased when IMC 2020 was canceled and gave IT staff time to fix problems. The first BAMC masterclass in April served as a stress test for CIMA: it passed and the few non-critical issues that remained were identified.

The current situation did delay the installation of new QuarkNet servers to improve capacity and performance. As the old servers are still working well, this has not been a problem.