Evaluation of the QuarkNet Program:
Evaluation Report 2019-2020
Executive Summary

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The QuarkNet Collaboration, referred to as QuarkNet, "is a long-term, national program that partners high school science teachers with particle physicists working in experiments at the scientific frontier." QuarkNet is a professional development program that "immerses teachers in authentic physics research and seeks to engage them in the development of instructional strategies and best practices that facilitate the implementation of these principles in their classrooms; delivering its professional development (PD) program in partnership with local centers" (Program Theory Model, PTM, 2019). There are approximately 50 plus such centers across the United States.

Program Goals

The measurable program goals of QuarkNet (as articulated by the Principal Investigators, PIs of the program and as stated in the Program Theory Model) are:

1. To continue a PD program that prepares teachers to provide opportunities for students to engage in scientific practices and discourse and to show evidence that they understand how scientists develop knowledge. To help teachers translate their experiences into instructional strategies, which reflect guided inquiry and NGSS science and engineering practices.

2. To sustain a national network of independent centers working to achieve similar goals. To provide financial support, research internships, an instructional toolkit, student programs and professional development workshops. To investigate additional funding sources to strengthen the overall program.

3. To reenergize teachers and aid their contributions to the quality and practice of colleagues in the field of science education.

4. To provide particle physics research groups with an opportunity for a broader impact in their communities.

Overview of Report

This report is a prototype of the final evaluation report that will be submitted at the end of this award period; as such, it presents a draft of the final evaluation report (although it is final as an interim report). In serving as a prototype, the present report and its review demonstrate the shift in evaluation efforts that have occurred from formative (and summative) assessment to an outcomes-based evaluation. In providing this early look, it

is hoped that this will provide opportunities to help QuarkNet program staff members better understand this shift. It will also allow opportunities for staff to identify principal needs and concerns that the evaluation may be able to be responsive to; and to give the evaluator time to adjust to these needs and suggestions proposed by staff to aid in the usefulness of evaluation findings and recommendations.

With the onset of a new external evaluator, a new direction for the evaluation was undertaken focused on the following, that is, the: (1) Development of a Program Theory Model (PTM); (2) Assessment of program outcomes at the national and center levels through teacher-level outcomes; and, (3) Assessment of the sustainability of program centers, based on center-level and sustainability outcomes.

The fully-articulated PTM is complete. The process used to create the PTM has been described in this report and the model has been described in detailed. Ideally, a program theory model offers a cohesive and representative picture of the program, "an approximate fit" of the program as *designed*. We have sought consensus on the representativeness of this model with key stakeholders and will revisit the PTM over the course of the award period, as this is needed.

To a large extent the PTM elaborates on how change is expected to occur, based on the following QuarkNet Theory of Change:

By immersing teachers in doing authentic particle physics research and by engaging them in professional development that supports guided-inquiry and standards-aligned instructional practices and materials designed for the classroom, teachers become empowered to teach particle physics to their students in ways that model the actual practices of scientists and support instructional best practices suggested by the educational research literature. (Modified fom Beal & Young, QuarkNet Summative Evaluation Report 2012-2017).

The development of a PTM and a Theory of Change is consistent with common guidelines proffered by the Institute of Education Sciences, U.S. Department of Education and the National Science Foundation (2013). Weiss (1995) noted that grounding evaluation in theories of change means integrating theory with practice. She postulated further that making assumptions explicit and reaching consensus with stakeholders about what they are trying to do, and why, and how, may ultimately be more valuable than eventual findings (Weiss, 1995), having more influence on policy and popular opinion (Rallis, 2013).

We have used the PTM to direct the development of evaluation measures and methods designed to address the remaining two goals. A Teacher Survey and a Center Feedback Template have been designed to measure the teacher-level and center-level outcomes

articulated in the PTM, respectively. The first administration of the Teacher Survey coincided with the start of summer workshops that occurred in 2019; and the roll-out of the Center Feedback template began in September 2019. To coincide with the 2020-2021 program year, we have added an Update: Teacher Survey to continue to capture information from participating teachers and to focus on classroom implementation of QuarkNet content and instructional materials.

A total of 265 teachers (a response rate of 78%) participated in the Teacher Survey during the 2019-2020 program year. A profile of participating teachers has been provided in the narrative of this report. Our approach to analysis has been to explore teacher perspectives as to their exposure to core program strategies, perceived approach to teaching, student engagement, the potential influence QuarkNet has had on teachers' approach to teaching and student engagement as well as self-reported use of activities from the Data Activity Portfolio (DAP). When possible, outcomes will be assessed within the context of the degree of program engagement by participating teachers and the delivery of the program through participating centers.

In preliminary analyses ….

Regarding **Core Strategies**, program engagement and measurement of exposure to core program strategies were shown to be related in a meaningful way (that is, more engagement by type of event, the higher the perceived exposure to core strategies; and more reported use of activities from the Data Activities Portfolio in the classroom). This speaks to the fidelity of the *implemented* program as compared to the program as *designed* as perceived by participating teachers who completed the Teacher Survey.

Regarding, **Approach to Teaching,** teaching outcomes were shown to be related to *perceived* QuarkNet's Influence and the use of activities from the Data Activities Portfolio in the classroom as reported by participating teachers. **Use of DAP** activities was shown to be related to exposure to Core Strategies, Approach to Teaching, and all of the types of QuarkNet program events (Data Camp, Variety of Workshops, and Masterclass engagement).

Regarding, **Student Engagement,** QuarkNet's Influence on Student Engagement and Approach to Teaching were related to perceived student engagement in inquiry-based science based on the perceptions of their participating teachers.

Although preliminary, the weight of these analyses suggests that there is a positive relationship between teacher engagement in QuarkNet and exposure to core program strategies; and, that the type and degree of program engagement is related to teacher outcomes (Approach to Teaching), the use of activities from the Data Activities Portfolio in the classroom, and teachers' perceptions of Student Engagement in inquiry-based science.

In assessment of the process of conducting center-level information through the Center Feedback Template, results from the pilot test and a second round of outreach suggest that this process has been helpful for QuarkNet staff teachers, the centers themselves (mentors and lead teachers), and the evaluation. Based on review of very early results, centers (based on ten centers at this point) and teachers indicated that the program offers the opportunity for teachers to engage as active learners, as students, as part of their QuarkNet workshop participation. That is, these centers reported that *"all or most teachers"* engaged as active learners (as students); and, most teachers reported that the opportunity to engage as active learners (as students) was "excellent."

Also, analysis suggests that QuarkNet workshop participation aligns well with the NGSS Science and Engineering practices through engagement in activities in the DAP and through QuarkNet workshop and program participation.

Program Summary and Recommendations

The full impact that coronavirus (COVID-19) has had or will have on QuarkNet remains to be determined for the 2020-2021 program year and beyond. Currently, QuarkNet staff has actively sought to plan and conduct workshops, which previously were held face-to-face, in virtual environment(s). This has included modifying the content by focusing on core concepts as well as the delivery of the workshop or program, such as half-day sessions with small-group breakout sessions, separate off-line time to work on specific tasks, and breaks built into the agenda.

The following program summary and recommendations are proffered:

1. The program has had a long-standing practice of holding regularly-scheduled staff meetings. One of these is staff-wide; one is specific to IT concerns; and, one is specific to program content and development. The evaluator has been invited to attend these weekly meetings, and she has regularly attended the staff-wide meeting. Of importance, these weekly meetings have been especially helpful in discussing and planning program content and delivery modifications as a result of coronavirus, COVID-19. Continue to hold these meetings as determined by the feasibility of everyone's schedule.
2. During the 2019-2020 program year, there has been a concerted effort to help nationally- and center-led workshops document the content of their workshops through the development and use of agenda templates; which are posted on-line. This is a simple and pragmatic step that has been very valuable. First, these agendas can and have been modified and used by QuarkNet centers. In many cases, agenda are modified during the event which memorializes the program in a just-in-time fashion.
3. The documenting of program content through workshop agendas has improved our ability to identify which (and how) activities from the Data Activities Portfolio (DAP) have been incorporated into workshops, especially nationally-led workshops and to a lesser extent but still notable for center-led workshops. This (along with item 2) may help centers prepare their annual reports, which each participating center is asked to do.

4. DAP activities, collectively, have been shown to align well with Next Generation Science Standards Science and Engineering Practices. Of importance, these activities are a bridge for teachers to implement QuarkNet content and materials into their classrooms. Continue to maximize the use of Data Portfolio Activities by teachers at center-led and nationally-led QuarkNet workshops and meetings.

5. Starting with the 2020-2021 program year, staff created a guide to help teachers reflect on and develop implementation plans that can be incorporated into their classrooms using QuarkNet content and instructional materials. Staff members have mandated this discussion in nationally-led workshops and they have strongly encouraged its use in center-run 2020-2021 workshops.

6. As articulated in item 5, continue support of the development by teachers of implementation plans and the subsequent use of these plans by teachers, QuarkNet program staff, and the evaluator.

7. The number (and the quality) of activities in the DAP has increased dramatically from 2017 (the end of the past grant period) to the new program-award period. This has included applying the review and restructuring of previously developed activities, offering activities by graduated student skill-sets, and, separating activities by data strand and curriculum topics. As the number of these activities has grown so has the work-load for their development and eventual use.

8. Consider adding a Project Coordinator position to QuarkNet staff, if not now, in the future. This person could help the education specialist with DAP activity development as well as have other responsibilities such as helping to track participation related to registration, updating teacher profiles on the QuarkNet website; and subsequent stipend payment.

9. Reflect on ways in which the Program Theory Model may be used to inform others in the program, those participating in the program (including centers), and those external to program.

10. Continue to support the evaluation and its efforts as reasonable; and continue to work with the evaluator, as planned, to help embed evaluation efforts and requirements within the structure and delivery of the program.

Evaluation Summary and Recommendations

The following evaluation summary and recommendations are proffered:

1. The response rate for the Teacher Survey was 78% during the 2019-2020 program year. This successful return rate is due to the commitment of QuarkNet staff teachers, fellows and center mentors in allocating time during their workshops and meetings for this purpose. We acknowledge and are grateful for this commitment.

2. Working with QuarkNet staff, the Update Teacher Survey dovetails well with the guidelines for teachers in the development of classroom implementation plans. We think that this will facilitate a meaningful way for participating teachers to reflect and build these plans as well as, hopefully, provide a pathway for documenting and incorporating this information into the evaluation.

3. Initial efforts to distribute and collect center-level information through the Center Feedback Template suggest that this process has been helpful for QuarkNet staff, Center level mentors and lead teachers, and the evaluation.

4. Preliminary analyses from the Teacher Survey suggest that there is a meaningful link between exposure to program strategies and program engagement; and that this engagement is related to teacher outcomes, perceived student engagement, and use of activities from the Data Activities Portfolio in the classroom of participating teachers.

5. Very early data analyses suggest agreement between center-level perceptions and teacher-level perceptions on teachers experiencing activities as active learners (as students) and exposure to instructional materials (and their delivery) that align with the Next Generation Science Standards Engineering and Science Practices.

6. As more centers participate in the Center Feedback Template process, integrate these center-level outcomes data with analysis of teacher-level perceptions and outcomes. Add sustainability outcomes into the mix as the number of participating centers grows.

7. Work with program staff to help articulate ways in which the PTM can be used and how to facilitate this use. This includes seeing the PTM as representative of the program (as an "approximate fit") and the value of its Theory of Change.

8. As recommended by the Advisory Board in December 2019 and to the extent possible, extend external evaluation efforts to incorporate QuarkNet's international outreach efforts.

9. Continue to be mindful of the many responsibilities that program staff, mentors and teachers have. Work to ensure that evaluation requests are reasonable and doable in a timely manner. And to the extent possible, embed evaluation requests and efforts within the structure and delivery of the program.

10. Work to ensure that evaluation efforts and results are of value (or of potential value) to all those involved in the process. This includes QuarkNet staff and network of partners, participating teachers, NSF and others who may be interested in QuarkNet.