2016 CTI Summer Research Experience for Teachers: Connecting K-12 Teaching and the Study of Nanoscale Science

Kenia E. Rios, Department of Psychology

Mentor: Scott Gartlan, Executive Director, Charlotte Teachers Institute

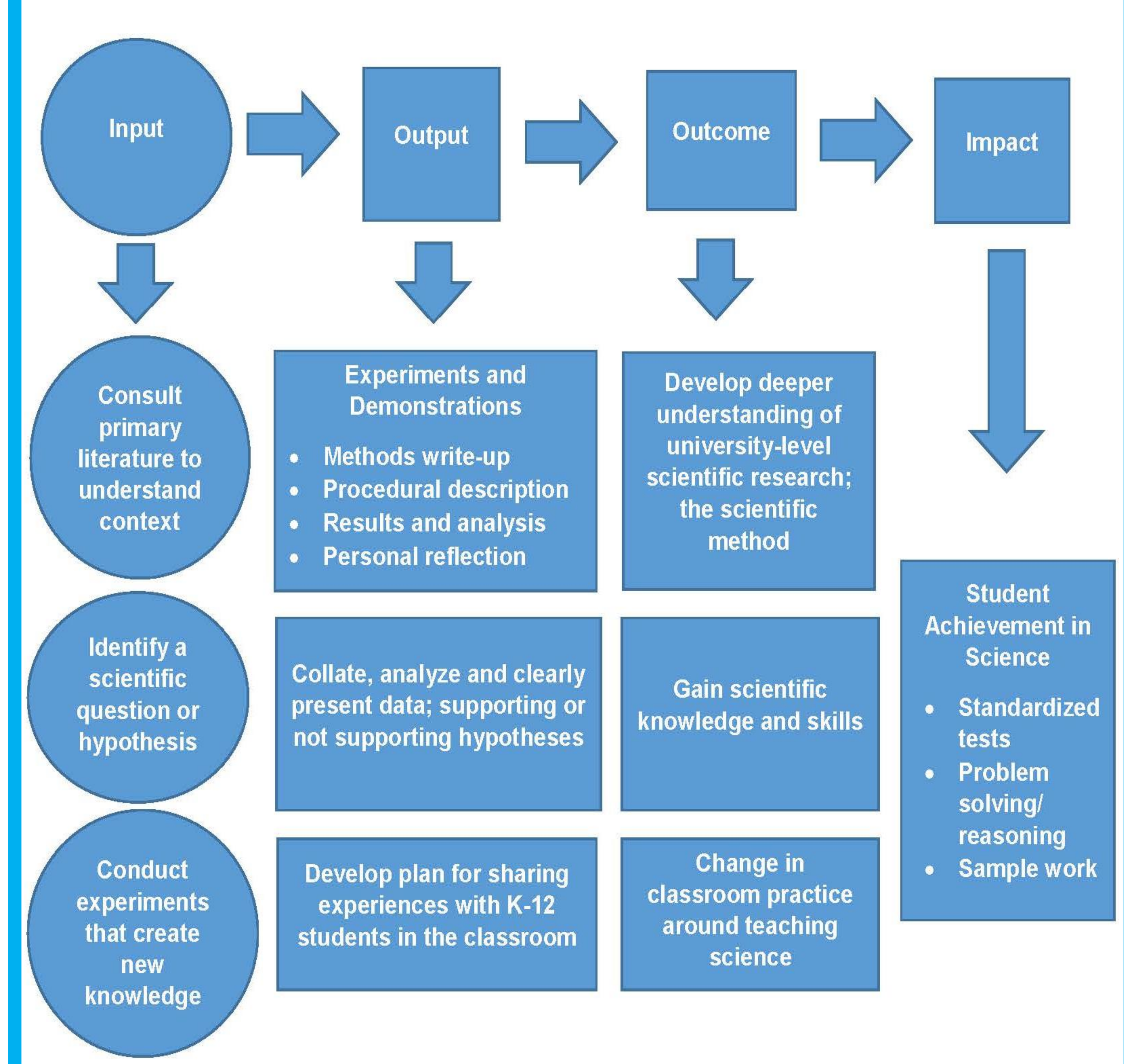
Introduction

The STEM fields have become increasingly prioritized within the K-12 curriculum. There is extensive research in the literature regarding science education and teacher professional development. However, there exists a gap between this research and documentation of scientist-teacher partnerships and their cooperation in creating science education curriculum for K-12 students.

This purpose of this process evaluation, as defined by Stufflebeam's CIPP Model (2003), of the Charlotte Teachers Institute (CTI) Summer Research Experience for Teachers pilot program was to document implementation.

There were two primary contributions of this evaluation. First, to contribute to underserved area of the literature by documenting and providing a detailed account of this program implementation regarding scientist-teacher collaboration. Second, through this process of collecting and analyzing data on implementation, important insight and recommendations helped to improve decision-making and increase the potential for positive impact in the K-12 classroom.

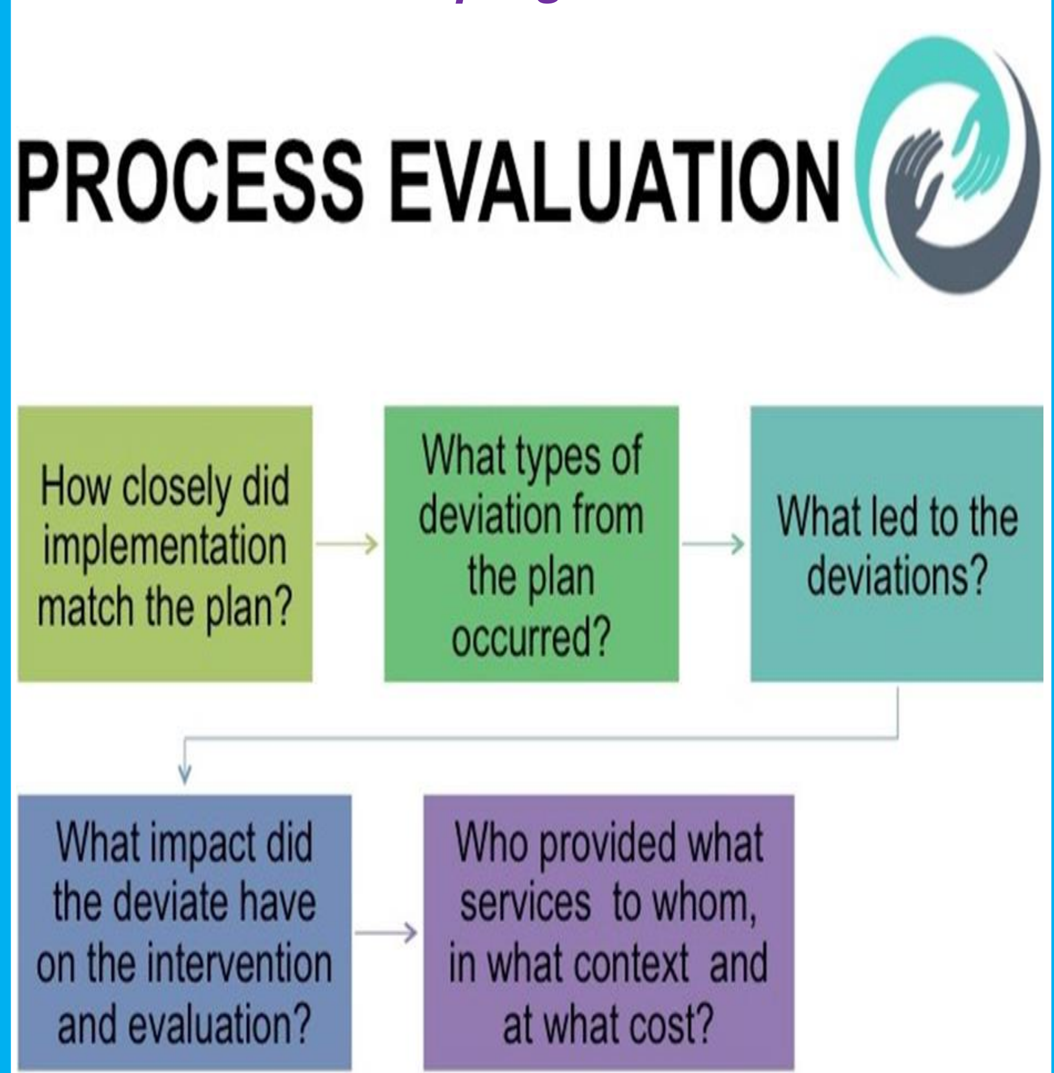
2016 Summer Research Experience Logic Model



CIPP Model of Process Evaluation

The process evaluation used for this project is part of the CIPP program evaluation model by Stufflebeam (2003). As defined by Stufflebeam, a process evaluation is based on plans and actions. It focuses on evaluating the implementation of a program. An essential guiding question is:

How was the program delivered?



Methods

The participants fell into three groups: scientists (N=1), graduate students (N=2) and classroom teachers (N=2). The methods used to conduct the process evaluation consisted of:

1. preliminary and post interviews,
2. naturalistic observation of lab work and weekly meetings
3.weekly reflection logs.

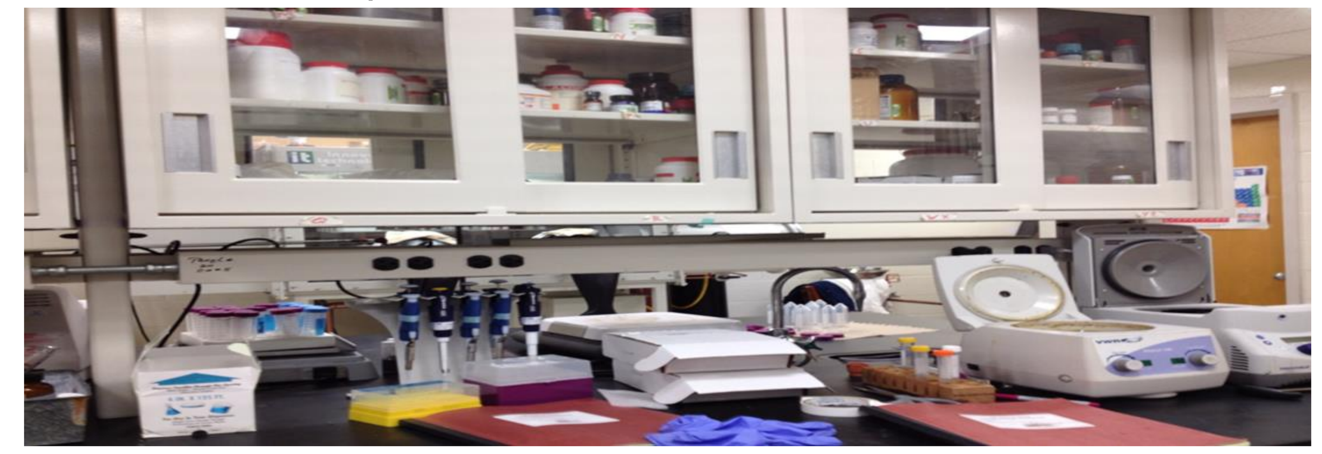
Interviews as well as observations were transcribed and analyzed along with reflection logs.

The evaluator spent 10 hours observing lab work and 3 hours observing weekly meetings. Reflection logs were administered online directly after these meetings through a link to a Google document with reflection questions. Lab observations consisted of alternating cycles of direct observation and non-direct observation on a ten-minute, per-person basis.

The evaluator structured each day's observation schedule beforehand to ensure that there were equal observation blocks allocated to each person in the lab. These intervals of ten minute direct observations were also supplemented with indirect general observations of lab activity. With the consent of lab participants, the evaluator also took photographs to provide further observation details.

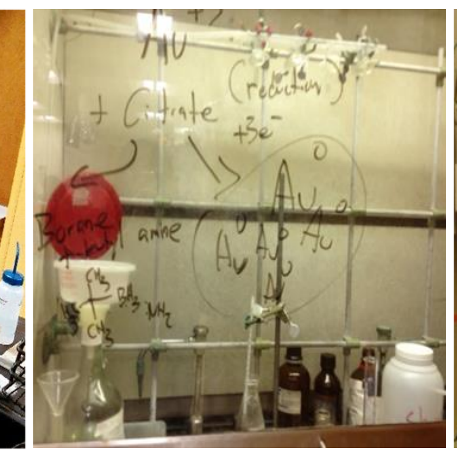
A Day in the Lab

Over the 3-week period through analyzing detailed observation field notes, interviews, and reflections logs, four major themes were discovered: Mentorship, Collaboration, Scientific Engagement, and Curriculum Development.

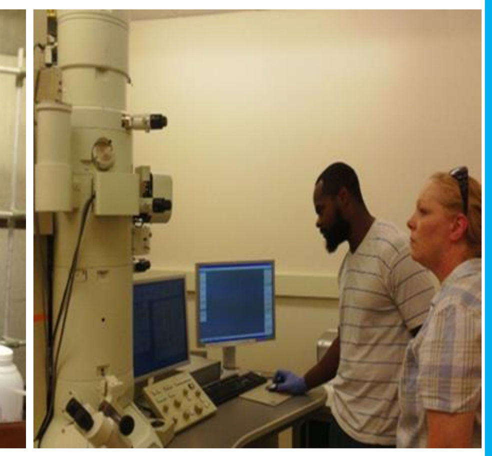


Mentorship: Graduate student mentorship of teachers was observed to be a critical factor in delivering this research experience for teachers. They fostered a positive learning environment in their approach to collaborating with teachers in the lab. They were friendly and open to questions and supported teachers' daily experiences regarding lab procedures.

Teacher and graduate student rinsing slides after working with piranha bath solution.

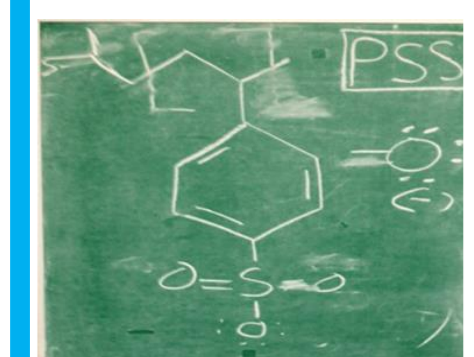


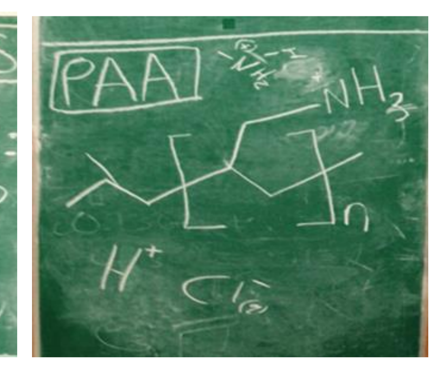
Reaction mechanism for gold nanoparticle growth sketched by graduate student.



Graduate student setting up the transmission electron microscope while a teacher observes.

Collaboration: The implementation of this program was based in collaboration between Ph.D. chemistry students, classroom teachers and a university scientist. Similar to previous research (Caton, Brewer, & Brown, 2000) teachers observed the importance of establishing a common vision for collaboration.





Molecular structure of two different polymers PSS and PAA sketched by one of the graduate students which was explained to the teachers by another graduate student.

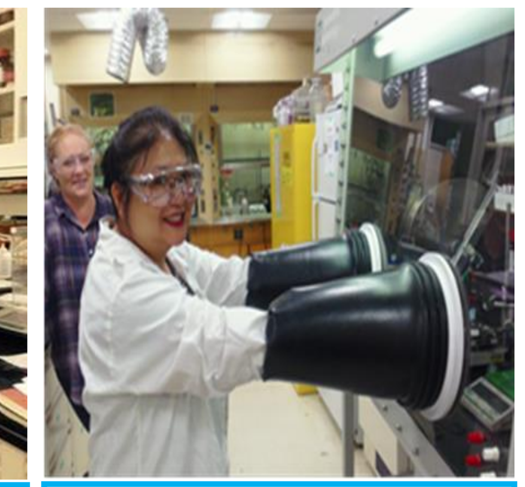
Graduate student works with the spin coater while a teacher documents the procedure by taking pictures.

Scientific Engagement: Key partners demonstrated different forms of scientific engagement in the lab: using university-level scientific equipment, attending weekly lab meetings, researching primary literature, posing scientific questions, and cultivating a scientific attitude around curiosity, skepticism, and humility.

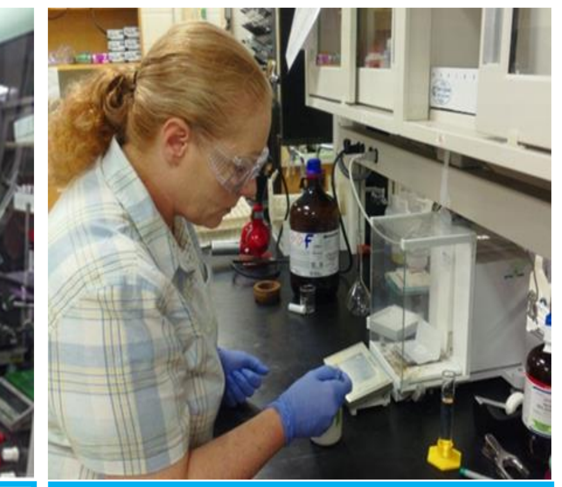
"It's questioning their actions, their data, thinking about things that could be happening, thinking about things to change for the next experiment. How does that lead us to something we can use that's useful for our research and maybe even the wider world?" –Lead Scientist

A Day in the Lab Cont…

A teacher pours gold solution into a tube.



A teacher as she works in the glove box.



A teacher weighs out PSS for polymer solution.

Curriculum Development: By the end of this program, teachers identified specific examples of how the university-level research could be translated to their students in the classroom. Teachers referred to their own research and time in the lab, as well as conversations with graduate students to further guide them with ideas for curriculum development.

"I want to capture their attention and make some connection to math because a lot of it has to do with supporting our sciences. I'm looking into how we can work that into my curriculum. That interdisciplinary connection between science and math."

"When I look at nanoscale science, I think more of the Geometry portion because you're talking about size and proportions, and scale factors. That's probably what I'd like to see kids understand."

"My intention is to have the students figure out what nanoscience is and find it in many disciplines and then we're going to come back around to medicine and biotech."

"[Graduate student A] is going to help me find the right nanoparticles to make in a middle school classroom and again making it as inquiry based as possible."

Recommendations for Replication

Brewer, Brown, and Caton (2000) suggest that the most important feature of scientist-teacher partnerships is **establishing an overall shared vision between program partners**. The following are also essential components for scientist-teacher collaboration:

1. In order to establish an effective partnership, it is necessary to have **scientists who are comfortable serving as mentors** to teachers.
2. **Emphasize collaboration** not only between scientists and teachers, but also within scientist and teacher groups.
3. **Equal partnership; therefore program roles should be structured in a way that is satisfactory to all partners** (Brewer et al., 2000).
4. Have teachers document the experience through pictures and videos that they can use to enrich their curriculum with a **"show and tell approach"** (Shein & Tsai, 2015).
5. Time built in for key partners to **reflect** on their program experience.
6. Ensure that all lab participants are required to **engage in different modes of scientific inquiry and practice**. The NRC's "Science as inquiry" model (2000) consists of five significant components of scientific inquiry and practice which may be used as a guide for ensuring scientific inquiry in the lab as well as the classroom.
7. **Time built into the program to discuss ideas about incorporating scientific inquiry and concepts into a suitable curriculum.**