Improving Teachers' Instruction: The Impact of Project EQuIPD

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Final External Evaluation Report

Submitted to Dr. Nancy Ruzycki, University of Florida

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IMPROVING TEACHERS' INSTRUCTION:

THE IMPACT OF PROJECT EQuIPD

FINAL EXTERNAL EVALUATION REPORT

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BACKGROUND INFORMATION ABOUT THE SERVE CENTER

The SERVE Center at the University of North Carolina at Greensboro (UNCG) is a university-based research, development, dissemination, evaluation, and technical assistance center. Its mission is to support and promote teaching and learning excellence in the education community.

Since its inception in 1990, SERVE has been awarded over $200 million in contracts and grants. It has successfully managed 15 major awards, including a current contract for the Regional Center serving North Carolina, South Carolina and Georgia, four consecutive contracts for the Regional Educational Laboratory for the Southeast (REL-SE) funded by the Institute of Education Sciences (IES) at the US Department of Education (USED) and four awards from USED for the National Center for Homeless Education (NCHE). In addition, past SERVE awards include a five-year Technology Grant for Coordinating Teaching and Learning in Migrant Communities, three consecutive contracts as the Eisenhower Consortium for Mathematics and Science Education for the Southeast, and two consecutive Regional Technology in Education Consortium grants.

SERVE also conducts research studies and evaluations under grants and contracts with federal, state, and local education agencies. Examples of SERVE's grant-funded research work include three federally funded studies of the impact of Early College High Schools, and a five-year IES grant to examine the impact of Career and College Promise in North Carolina. Samples of contract work include evaluations of five Investing in Innovation (i3) projects, evaluations of North Carolina's Race to the Top and Read to Achieve Initiatives, a randomized controlled trial of the impact of an online intervention at Wake Tech, among others. *The Program Evaluation Standards, Second Edition* (The Joint Committee on Standards for Educational Evaluation, 1994), the *Guiding Principles for Evaluators* (American Evaluation Association, 2004), and the *What Works Clearinghouse Standards* (Institute of Education Sciences, 2018) guide the evaluation work performed at the SERVE Center.

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IMPROVING TEACHERS' INSTRUCTION: THE IMPACT OF PROJECT EQuIPD FINAL EXTERNAL EVALUATION REPORT

Summary

Project EQuIPD—**E**ngaging **Qu**ality **I**nstruction through **P**rofessional **D**evelopment—provided two years of intensive professional development to help teachers learn to think more strategically about how to improve student outcomes using technology-based inquiry instruction. The project also prepared participating teachers to train their colleagues.

Led by the University of Florida, Project EQuIPD was a three-year grant awarded through the U.S. Department of Education's Supporting Effective Educator Development (SEED) Program. The project was implemented in 121 schools in ten counties in Florida: Hillsborough, Palm Beach, Sarasota, the Heartland Consortium (Hardee, Hendry, Okeechobee, Glades, DeSoto), St. Johns, and Manatee. The impact of the project was studied with a randomized controlled trial.

Key findings from the evaluation include:

- The program was able to implement all intended activities, modifying some of the delivery methods in response to the COVID-19 pandemic.
- On a survey, treatment teachers reported statistically significantly higher levels of knowledge and higher implementation of EQuIPD instructional practices than control teachers.
- Observations of teachers' instruction showed no statistically significant overall differences between treatment and control teachers, although treatment teachers scored higher on implementation of inquiry practices than control teachers.
- There was no significant difference in teacher retention or overall attendance between the treatment and control groups.
- There were no differences between treatment and control groups on overall measures of student achievement.

A special note about COVID-19: EQuIPD was being implemented amid the pandemic, which required the project to make continual pivots to respond to on-the-ground changes. Additionally, the participating teachers were experiencing substantial stress as they attempted to navigate personal and school challenges, while also providing as strong a learning experience as possible for their students. Although EQuIPD did not achieve all its desired impacts, it is impressive that the project was able to successfully implement its targeted activities. Given the context, the evaluation team acknowledges that this evaluation was likely not a fair test of the true impact of EQuIPD; it is possible that, if the pandemic had not happened, the impact findings might have been different.

PROJECT EQuIPD: FINAL EXTERNAL EVALUATION REPORT

Section I. Introduction and Overview

Project EQuIPD—**E**ngaging **Qu**ality **I**nstruction through **P**rofessional **D**evelopment—sought to "establish and test for efficacy a professional development model to produce highly qualified teachers in STEM practices for all children, especially for students who are in traditionally underserved schools and districts within the State of Florida" (project proposal). The project did this by providing two years of intensive professional development that helped teachers use system thinking to infuse technology-based inquiry into their regular instructional practices. The project also prepared the teachers, using a train-the-trainer model, such that they could train other teachers and sustain the work moving forward.

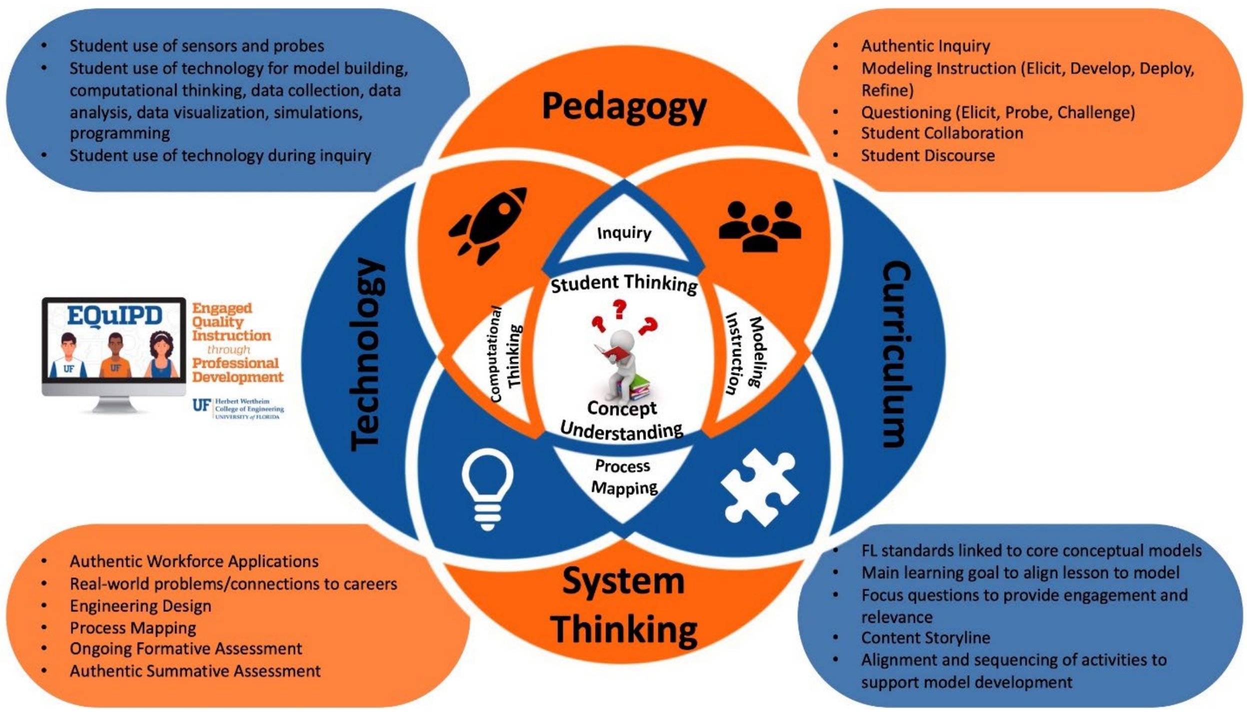
Led by the University of Florida (UF), Project EQuIPD was a three-year grant awarded through the U.S. Department of Education's Supporting Effective Educator Development (SEED) Program. The project was implemented in 121 schools in ten counties in Florida: Hillsborough, Palm Beach, Sarasota, the Heartland Consortium (Hardee, Hendry, Okeechobee, Glades, DeSoto), St. Johns and Manatee.

The program activities, or Key Components—supported by the grant, and described in more depth later in the report—included:

- two years of Summer Bootcamps, which provided five days of intensive training around system thinking, use of technology to support inquiry-based instruction and concept modeling;
- one summer of professional development provided by the participating teachers;
- Saturday workshops (also referred to as "follow-up workshops") that supported and expanded upon the summer training;
- online modules and web resources that included sample lessons and other materials for teachers to use and adapt in their classrooms;
- technology, both hardware and software, provided to teachers;
- instructional coaching provided onsite and virtually to participants;
- STEM-oriented field trips offered throughout the year;
- establishment of STEM-oriented industry-school partnerships; and
- financial and programmatic support for micro-credentials, STEM-related industry credentials, and teacher certifications.

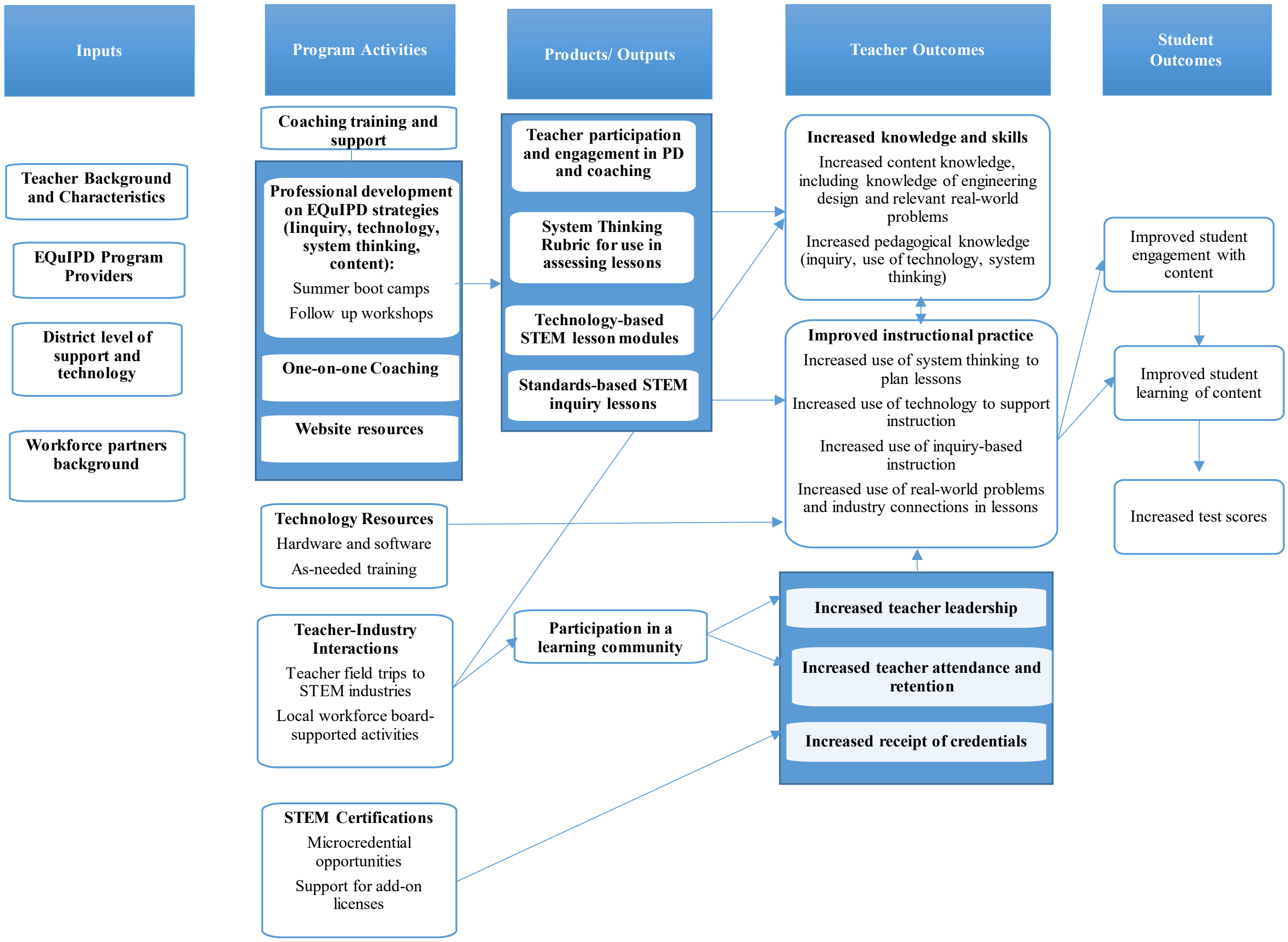
Effective implementation of these Key Components was expected to improve teachers' content and pedagogical knowledge around technology, inquiry, and system thinking. The expectation was that teachers would improve their instructional practice in four important ways. First, teachers would use a system thinking approach to design inquiry-based lessons such that students were better able to develop conceptual understanding. Second, teachers would embed more technology—such as the sensors and probes emphasized in the professional development—into their lessons. Third, teachers would increase their use of inquiry-based instruction that uses student teams to solve real-world problems. Fourth, teachers would make greater connections to real-world issues and industries throughout their instruction. Figure I-1 presents a conceptual overview of the way in which teachers were expected to change their practices.

Figure I-1. Project EQuIPD Conceptual Model



Changes in teachers' skills, knowledge, and instructional practice were also expected to have an impact on teachers' satisfaction with their job, which should have led to reduced teacher absences and increased teacher retention. As part of this project, teachers were also expected to earn additional credentials. The changes in instructional practice and teacher outcomes were then expected to lead to improved student outcomes (e.g., increased student engagement with content and improved student achievement). Figure I-2 is a logic model that represents an overview of the different program activities and how they related to the project's intended outcomes.

Figure I-2. Project EQuIPD Logic Model



The logic model is also the conceptual framework driving the project's evaluation. The evaluation used a randomized controlled trial supplemented by mixed methods to: (1) examine the implementation of the project activities and (2) assess whether the project was having the intended impact on the targeted teacher and student outcomes.

This final report presents results from the entire project, which began on October 1, 2018 through the end of summer 2021. Section II of this report describes the study's methodology. Section III provides key information about the program context, including an overview of how the project responded to the COVID-19 pandemic. Section IV presents the program's activities ("Key Components") and an assessment of the Fidelity of Implementation of those components. Section V describes the teacher-level impacts, and Section VI presents the impacts on student academic performance. Finally, Section VII includes a conclusion and discussion of lessons learned from the project.

Section II. Evaluation Methodology

The evaluation included four different components: (1) a study of the impact of EQuIPD on teachers, (2) a study of the impact of EQuIPD on students, (3) an assessment of the Fidelity of Implementation of the program activities, and (4) qualitative data collected around implementation and perceptions of impact. The methodology for each component is described below.

II.1. Impact on Teachers

A critical goal of the SEED program is to expand the knowledge base regarding what works in educator professional development. In fact, one of the SEED program's Government Performance Results Act (GPRA) indicators concerns the quality of the evaluation: "Number of planned evaluation studies that are likely to meet What Works Clearinghouse [WWC] standards." As a result, the evaluation used an experimental design to assess the impact of EQuIPD. Interested and eligible teachers were randomly assigned to either participate in the professional development or serve as a control teacher.

Impacts were assessed on teacher knowledge and their implementation of targeted instructional practices as well as their retention and attendance, their receipt of STEM credentials, and their teacher leadership activities. There were three primary sources of data: (1) surveys, (2) classroom observations, and (3) administrative data from the districts.

II.1.1. Teacher Sample

The professional development team was responsible for recruiting districts and teachers. The project had two primary goals that affected the selection of districts and teachers: (1) serve high-needs students and (2) test the professional development model in a diverse set of schools.

To develop their initial list of 10 districts that were included with the proposal, the professional development team identified districts serving students with high needs, including those who were low-income and had lower levels of achievement. Because these districts were predominantly urban and the team wanted to test the model in a variety of settings, they also identified more rural districts with high numbers of low-income students. Finally, they also considered districts with whom they had existing relationships. An initial district, one of the smaller districts, declined to participate after the grant was awarded and a larger, more urban district asked to join the project, keeping the total at 10 districts.

Each district was asked to identify a liaison who would serve as the grant's primary contact. The project staff worked with the liaison to negotiate a Memorandum of Understanding (MoU) with each district. The MoUs delineated the benefits and expectations of the grant, including district and teacher participation in both professional development and research activities. Because of initial delays in finalizing the language of the MoUs, the first MoU was not signed until March 26, 2019, and the final MoU was approved on June 11, 2019.

Teacher recruitment continued at the same time the MoUs were being negotiated. The district liaisons were asked to identify eligible schools for participation, targeting low-performing schools with large numbers of at-risk students. In two of the districts, the project was excluded from working with some of the lowest-performing schools because those schools were already participating in district-mandated turnaround activities. The professional development team disseminated information about participation to potential participants via e-mail and in-person presentations at individual schools. They also reached out to districts through individual contacts with principals or other school staff to encourage teachers to participate.

Interested teachers completed an online application. The initial plan was to primarily target STEM and CTE teachers in grades 3–9; however, it soon became clear that, in order to reach the target of 250 teachers in the study, the pool would have to be widened. The final screening criteria were as follows: (1) teachers who directly taught students, (2) teachers who taught students in grades K–9, and (3) teachers who taught in schools identified as eligible by the districts. A total of 305 eligible applicants[1] were then randomized as described below.

Four waves of recruitment were necessary to get the targeted number of teachers. The evaluation team conducted four rounds of randomization, one for each of the four recruitment efforts. In the first round, 220 teachers were randomized using a stratified random sampling procedure. To ensure that each district had both treatment and control teachers, the evaluation team randomized within district. Districts with many participants were then further stratified based on whether participants taught Grades 5–8, were CTE, or neither. Once strata were determined, the number of teachers assigned to the treatment within each stratum was calculated. This number was based on the overall proportion of teachers being assigned to the treatment. Because the number of teachers in each stratum differed, the exact proportion of slots allocated to the treatment also differed.

In the second round of randomization, 46 teachers were randomized using a modified stratified random sampling procedure. Because of the smaller sample, teachers were randomized within district for only the two largest districts, and all other districts were combined into a single stratum. In the final two rounds of randomization of seven and 32 teachers, there was no stratification. In sum, 134 teachers were randomly assigned to the treatment and 171 teachers were randomly assigned to the control, totaling 305 teachers. For all teachers, the evaluation

[1] One additional teacher, who was the only one from his district, was automatically accepted and participated in the treatment but was excluded from the final impact analyses.

team recorded teachers' probability of being selected into the treatment and control groups; these probabilities were incorporated into the impact analyses.

Teachers were notified of their status as a treatment or control teacher after their district had signed the MoU. Control teachers were able to participate in portions of the intervention starting in 2021–22. The professional development team reported that the MoU process was cumbersome and slower than expected. In some districts, the MoU had to be approved by the school board, which further delayed implementation. Because teachers could not be notified about their project participation until after the MoU had been signed, there was a gap between recruitment and teachers' receipt of an e-mail indicating whether they would be in the treatment group (and be expected to attend a summer training) or in the control group. For example, intervention teachers in one district had approximately two weeks' notice that they would be participating in a week-long training in the summer.

Approximately a quarter of the teachers in both treatment and control groups dropped out after notification but before the intervention began and these teachers were not included in any further data collection activities but were included in all attrition calculations. The specific samples differed by outcome measure and attrition is calculated separately for each outcome described below. The professional development team believed that the delay in notification contributed to those immediate 25% attrition rates. A total of 229 teachers have participated at least partially in the project in some way. The final analytic sample for each outcome measure—the surveys, observations, and student outcomes—is described under the appropriate section below.

II.1.2. Implementation Surveys

A survey was developed to gather information about teachers' implementation of instructional practices that were embedded in the EQuIPD professional development. The survey was primarily intended to measure: (1) characteristics of participating teachers (i.e., comfort with using technology, perceived importance of using technology); (2) availability of technology to teachers; and (3) measures of the knowledge and skills targeted by EQuIPD.

II.1.2.1. Survey Measures

The survey development process took place during November and December 2018. The evaluation team began by researching previously validated instruments and selecting items that were appropriate to measure constructs related to the outcomes targeted by EQuIPD. They shared a draft of the survey with the professional development team and revised the survey based on feedback. The updated draft version of the survey was piloted with four middle school teachers and then again with five elementary school teachers in two North Carolina districts.

Changes were made to the survey based on the teacher feedback and then approved by the professional development team.

The survey included scales measuring the constructs listed below. Appendix A includes a table with the detailed survey questions, response options, the sources of each scale, and the reliability for each scale. The evaluation team also tested the predictive validity of the different outcome scales, connecting scores on these scales to student outcomes. Scales with statistically significant positive associations with higher levels of student achievement ($p \leq .10$) are highlighted with an asterisk below and the results from the analysis are included in Appendix B.

Teacher background factors:

- Availability of technology in the classroom
- District and school support for technology use
- Perceived importance of technology
- Perceived importance of inquiry
- Teacher comfort with technology (intended as a covariate but also explored as an outcome measure)

Teacher outcomes:

- Overall knowledge scale (composite of scores below)
    - Knowledge and understanding of system thinking (two combined scales)
    - Knowledge of how to use technology in the class
    - Knowledge of engineering design
    - Knowledge of local STEM resources*
- Overall instructional practice (composite of scales below)*
    - Implementation of inquiry practices
    - Use of formative assessment strategies
    - Use of inquiry-based instruction integrating technology*
    - Implementation of project-based and engineering-based instruction
    - Use of real-world problems and EQuiPD-specific technology*
    - Connections to career and external STEM industries
- Teacher leadership activities

*Scales with statistically positive associations at p≤.10 with student achievement.

On the final administration of the survey only, questions were added about use of group work and student collaboration, teacher comfort with online instruction, and use of concept modeling. The evaluation team also asked about teachers' change in content knowledge and whether they had earned any credentials over the past two years.

II.1.2.2. Survey Data Collection

In the baseline year, the survey was distributed in April–May 2019, prior to teachers participating in any professional development. The survey distribution was similar in Year 1, with teachers receiving the survey between February and March 2020 (prior to the start of the pandemic). In Year 2 the survey was distributed between March and May 2021. For distribution in all three years, teachers were invited to participate via email. Teachers received a reminder to complete the survey approximately seven days after receiving the initial survey link; most teachers completed surveys within two weeks of the initial invitation. Teacher participation was tracked, and in some cases, the project's principal investigator (PI) reminded teachers to complete the survey (participation in the survey was a requirement for reimbursement).

II.1.2.3. Survey Sample

Teachers participated in the survey across the three years of the project. In the baseline year (2019), surveys were sent to all teachers who had been recruited into the project. Prior to analysis in the baseline year, SERVE staff worked with the professional development team to determine which teachers remained as participants; responses of teachers who had been removed from the study in the baseline year were removed as part of the data cleaning process. There were 146 teachers (60 treatment and 86 control) who completed surveys in 2019 and 2021 and their responses were included in the final analyses.[2] Survey responses were analyzed for changes between 2019 and 2021 and for differences between treatment and control teachers. Of the 146 teachers who completed the 2021 survey, 140 also had complete responses to the 2020 (Year 1) survey.

The overall attrition rate for the final analytic sample was 52.1%, with 55.2% attrition for the treatment group and 49.7% attrition for the control group. Because attrition rates differed in the treatment and control groups, the evaluation team conducted baseline equivalence analyses on the sample of teachers who responded to the survey in 2021; Table II-1 shows the baseline differences between the treatment and control groups for all outcomes of interest. The means for the teacher comfort with technology scale and knowledge and understanding of system thinking scale were lower for treatment teachers and differed from control teachers by more than 0.25 standard deviations, so these results should be interpreted with caution. All other scales satisfied the baseline equivalence requirement for analysis with differences of less than 0.25 standard deviations. Student body composition measures and baseline outcome measures were included as covariates in all the impact analyses.

[2] Responses from the one teacher who was not randomly assigned but still received at least part of the treatment were not included in the analyses.

Table II-1. Baseline Equivalence for the Survey Sample

	Treatment mean (N=60)	Control mean (N=86)	Treatment - Control difference	Effect size
Overall instructional practice	1.03	1.00	0.03	0.04
Overall knowledge scale	1.00	1.03	-0.03	-0.04
Teacher comfort with technology	4.72	4.91	-0.19	-0.27
Knowledge and understanding of system thinking	1.69	2.10	-0.41	-0.32
Knowledge of how to use technology in the class	4.21	4.16	0.05	0.05
Knowledge of engineering design	3.21	3.25	-0.04	-0.02
Knowledge of local STEM resources	2.81	2.73	0.08	0.06
Implementation of inquiry practices	2.90	3.03	-0.13	-0.15
Use of formative assessment strategies	4.26	4.21	0.05	0.09
Implementation of project-based/engineering-based inquiry instruction	3.01	3.05	-0.04	-0.04
Use of inquiry-based instruction integrating technology	2.27	2.28	-0.01	-0.01
Use of real-world problems and EQuIPD-specific technology	1.73	1.61	0.12	0.14
Connections to career and external STEM industries	1.57	1.47	0.10	0.14
Teacher leadership activities	2.48	2.57	-0.09	-0.13

II.1.2.4. Survey Analyses

The sample for the main impact analysis included the 146 teachers who responded to both the baseline and the final (2021) survey. Supplementary subgroup analyses were performed by grades taught. Some teachers reported serving as resource teachers across multiple grades in elementary schools (K–5) or multiple grades in elementary through middle schools (K–8). For example, teachers who served multiple grades reported their position as *Science Coach, STEM Lab Resource Teacher,* or *ESE Contact.* Teachers that reported teaching K–5 or K–8 in a resource capacity were included in a subgroup called *Resource Teachers.* Teachers who reported teaching only one grade in K–5 (there were no non-resource teachers teaching multi-grade classrooms) were placed into a subgroup called *K–5*. Teachers who taught any middle school grade, or grades, were included in the subgroup called *6–8*.

On the survey, teachers were also asked to identify the subject they taught, and teachers could select as many as applied. In supplemental subgroup analyses by subject, teachers were placed in the following mutually exclusive categories:

- *STEM.* Teachers who reported teaching only STEM subjects (science, math, technology, or engineering) or teaching both STEM and humanities subjects (most frequently, elementary teachers teaching all subjects) were placed in the STEM category. Because of small numbers in each category, this category was not further broken down by STEM subject.
- *Non-STEM.* Teachers who reported teaching only ELA, social studies, art, or any non-STEM course were included in a category called *Non-STEM.*

The items for each core scale were averaged to create a scale score, which was used in all of the analyses.

Differences between the treatment and control groups were determined using the following regression model:

$$y_j = \beta_0 + \beta_T T_j + \sum_{p=1}^{P} \beta_p COV_{pj} + e_j$$

where

y_j = outcome of interest for teacher j.

T_j = the indicator variable showing whether teacher *j* was a treatment (1) or control teacher (0).

COV_{pj} = p-th teacher-level covariate included in the final model. As specified before, these covariates included:

- perceived importance of inquiry-based instruction and comfort with technology from the baseline survey,
- the baseline measure of the outcome,
- the baseline share of minority students at the teacher's school,
- the baseline share of economically disadvantaged students at the teacher's school, and
- an indicator for teaching STEM subjects.

β_0 = adjusted mean outcome of control teachers after controlling for the teacher level covariates.

β_p = the association between the p-th teacher-level covariate and outcome of interest.

e_j= the error term of teacher *j* assumed to be distributed with a mean of zero and variance of σ_e^2.

For the subgroup analyses, separate models were estimated that included interactions of the treatment indicator with dummy variables indicating the grades or subjects taught:

$$y_j = \beta_0 + \beta_{X1}X_{1j} + \beta_{X2}X_{2j} + \beta_T T_j + \beta_{X1T}(X_{1j} * T_j) + \beta_{X2T}(X_{2j} * T_j) + \sum_{p=1}^{P} \beta_p COV_{pj} + e_j,$$

where

X_j =A dummy variable indicating whether teacher j is a middle school teacher (1) or an elementary or resource teacher (0) or a dummy variable indicating whether teacher j teaches STEM subjects (1) or non-STEM subjects (0).

X_{2j} =A dummy variable indicating whether teacher j is a resource teacher (1) or an elementary or middle school teacher (0); this variable was not included in the subgroup analyses by subject.

β_{X1} and β_{X2} = the adjusted differences between subgroups after controlling for the treatment effect and the P additional covariates for the outcome of interest.

β_{X1T} and β_{X2T} = the differences of the treatment effect of interest between middle school and elementary teachers and between resource and elementary teachers or between STEM and non-STEM teachers after controlling for the P additional covariates for the outcome of interest.

All other variables included are as described as above.

Finally, weights were used to adjust for the fact that that not all teachers had an equal probability of being selected for the treatment. These weights, w_j^* were initially computed based on the probability of being assigned to their specific group. For teachers in the treatment group, their weights were computed as the inverse of the probability of being selected for the treatment. For those teachers in the control, the weight was then computed as the inverse of the probability of being in the control group.

$$w_j^* = \begin{cases} \dfrac{1}{p_j}, & \text{in treatment} \\ \dfrac{1}{(1 - p_j)}, & \text{in control} \end{cases}$$

where p_j is the probability of being assigned to the treatment for the j^{th} teacher.

After having computed the initial weights, w_j^* for each teacher, the weights were rescaled so that the sum of the weights equaled the sample size. Thus, the final weights for each observation are computed as

$$w_j = w_j^* * \left(\frac{N}{\sum_j w_j^*}\right)$$

where *N* is the number of teachers in the analytic sample and w_j^* is the initial weights specified previously.

II.1.3. Observations

Improvement of instructional practices was the major target of this project and the measurement of instruction served as an outcome variable in the study. Classroom observations by independent observers were one of the ways this research project measured teacher instructional practices along with the surveys. The focus of observations was on the quality of implementation of targeted instructional practices, while the survey focused more on teacher self-reported frequency of implementation. Observations were conducted for both treatment and control teachers at baseline (spring 2019) and again at the end of the teachers' second year of participation in the professional development (spring 2021).

The following section describes the methodology of conducting the observations detailing: (1) the process of selecting and developing the observational tool, (2) recruitment and training of observers, (3) procedures for conducting classroom observations, (4) the teacher sample, (5) calculations of inter-rater reliability, and (6) the observation analyses.

II.1.3.1. Observation Measures

This section first describes the instrument that was used for observations and then the development process for this tool.

The observation protocol. The EQuIPD observation protocol, based on *The Electronic Quality of Inquiry Protocol* (EQUIP, described later in this section), was designed to rate the quality of the four main instructional practices of interest to this project: (1) inquiry instruction, (2) use of technology, (3) use of real-world problems, and (4) group collaboration. In addition to ratings, observers entered descriptive information for the observed classroom (e.g., the subject, topic, context, grade level, and the number of students and associated demographics). As part of the observation, observers were asked to record information on the lesson structure (e.g., non-inquiry, engage, explore, or explain); group organization (e.g., whole class, small group, individual work); specific technology tools used by both students and teachers (using a list of 12 tools); and the level of student engagement. Observers were asked to document these activities in 10-minute segments to allow for analysis of the duration of these various classroom activities. A copy of the observation protocol is provided in Appendix C.

The measures for the quality of technology use (recorded separately for teachers and for students), incorporation of real-world problems, and group collaboration had two indicators each. The quality of inquiry was measured by 14 indicators divided into four factors: instruction, discourse, assessment, and curriculum. Each of these factors also received a summary rating. The final rating was for the overall quality of inquiry instruction. The summary ratings and the overall quality ratings were scored holistically by the observer; these higher-level ratings were informed by the scores given on the individual indicators but were not necessarily calculated as an average of the indicator scores.

In 2021, the same protocol was used to conduct virtual observations, with items added to capture the delivery method of the lesson (e.g., completely in person, completely online, hybrid), which is discussed in greater detail below.

The protocol development process. The observation protocol was developed by the evaluation team in consultation with the professional development team between November 2018 and March 2019. The current protocol was adapted from *The Electronic Quality of Inquiry Protocol* (EQUIP) developed by the *Inquiry in Motion Institute* at Clemson University (Marshall, Horton, Smart, & Llewellyn, 2008) designed for use in science and math classrooms. The original EQUIP protocol went through a rigorous development process, and demonstrated content, construct, and concurrent validity, and good inter-rater reliability (Marshall & Horton, 2011; Marshall, Smart, & Horton, 2009). The original EQUIP protocol was developed to measure the quality of inquiry instruction, and all 14 indicators, four summary ratings, and the overall inquiry quality rubrics were adopted without changes.

Because the existing protocol did not include scales in some areas of interest to the EQuIPD project (i.e., use of real-world problems, technology, and group work) the evaluation and professional development teams developed a set of six new indicators to measure these three areas. Additionally, the lesson structure table from the original protocol was modified to include a list of technology tools used by the teacher as well as the students.

II.1.3.2. Observer Recruitment and Training

Observer recruitment. The evaluation team developed a set of criteria for initial observer selection, in consultation with the EQUIP designer, who was hired as a consultant for the project. The criteria included: (1) prior teaching experience, preferably in math and science, (2) the ability to look at the classroom teaching through the lens of a common observational protocol, and (3) preferably, prior observation experience.

In December 2018 – January 2019, the recruitment announcement was circulated through different educational organizations in Florida, with targeted distribution to retired teachers and current graduate students. Applications and resumes were reviewed by the evaluation team. Fifteen applicants were selected for the face-to-face observation protocol training in February 2019, and then two additional applicants were selected to participate in an online version of the observation protocol training. In addition, three members of the evaluation team were trained as observers.

In fall 2020, in addition to the three members of the evaluation team who previously observed, six of the original observers from 2019 also agreed to participate in the final round of observations.

Observer training. The initial two-day face-to-face observer training was conducted in Lake Placid, Florida in February 2019. The EQUIP designer was lead facilitator for the training related to the original EQUIP instrument. The evaluation team led the training related to the six additional indicators specific to real-world problems, technology use, and group collaboration. During the training, participants received instructions on how to interpret indicators, watched and rated four training tapes that had been previously rated by master observers, and discussed justifications for master ratings as well as discrepancies between master ratings and individual coder ratings. Observer ratings data were collected for each training video using an online survey so that inter-rater reliability between individual observers and the master code could be calculated in real-time; this information would then be shared back to the program trainers before moving on to the next training video. For purposes of the training, Cohen's Kappa was used to calculate inter-rater reliability. Based on these results, using an acceptable Kappa range suggested by the instrument developer, select observers were either approved to move forward as an observer or were recommended to participate in additional online training. The face-to-face training also covered all logistical and technology information related to conducting live observations in the classrooms.

Additional, asynchronous online training for approved observers took place by watching and discussing two more videotapes. Two observers received online training only. As a result, three evaluation team members and seven consultant observers achieved satisfactory inter-rater reliability and were approved to conduct live classroom observations for the project. Mid-way through the live observation window, one additional online training was conducted to discuss any "real-life" classroom scenarios that may have been hard to interpret and clarify how they should be rated.

Prior to the face-to-face observation protocol training, the evaluation team drafted an observation manual for the adapted EQUIP instrument to facilitate interpretation of the descriptions in the instrument. This manual was updated throughout the observation period to address difficulties observers encountered when using the instrument in the classrooms. All observers had access to a Virtual Binder in Google Docs, created by the evaluation team. The Virtual Binder provided readily available access to resources on inquiry, an observer checklist, the observation instrument, and observation manual.

Before the second round of observations, four refresher trainings were offered to observers via Zoom in January of 2021. During these trainings, participants watched exemplars and received instructions on how to interpret indicators. They watched and rated four training videos and agreed on their ratings and discussed justifications for, as well as discrepancies between, individual coder ratings. These trainings also addressed the variety of instructional delivery modes due to COVID, such as all in person, all online, and hybrid classroom instruction. The observation manual was updated during the training to clarify interpretations of indicators.

At the end of these trainings, all observers achieved satisfactory inter-rater reliability based on intraclass correlation (ICC) scores and percentage of absolute agreement. An additional re-calibration meeting was conducted in the beginning of March 2021 to discuss paired ratings of classroom observations conducted to date and address areas of disagreement. Additional trainings were conducted, as needed, to familiarize observers with technology used to remotely observe classroom instruction. Inter-rater reliability was calculated for the Year 2 observations and is discussed below.

II.1.3.3. Observation Data Collection

Classroom observations of both treatment and control teachers occurred during the baseline year (2019) before treatment teachers began participating in EQuIPD professional development activities. The observations used to calculate the impact estimates were conducted in the spring of 2021.

Baseline observations. Live observations were conducted in the classrooms of all participating treatment and control teachers from April 3–May 28, 2019. Before each observation was scheduled, teachers received an introduction letter informing them about the observation procedure and the focus of observation on inquiry and use of technology. Because the goal of observation was to evaluate the quality of inquiry instruction and technology use, teachers were asked to purposefully schedule the observation such that observers were present during a time when teachers were implementing inquiry instruction and using technology. The following definition of inquiry instruction was provided to teachers:

> Inquiry-based instruction is the development of understanding through investigation, that is, asking questions, determining appropriate methods, gathering data, thinking critically about relationships between evidence and explanation, and formulating and communicating logical arguments. (Adapted from the National Science Education Standards, 1996).

Teachers were specifically asked to avoid scheduling their observation at times they would be testing students, reviewing for tests, or engaging students in practicing skills. Observers were instructed to reschedule observations in cases when: testing was taking place, there was substitute teacher, or there were any interruptions that interfered with more than 40% of lesson time. Each observation covered the entire class period during which the observed subject was taught. Observers were not told the treatment status of the teachers and were also instructed not to discuss the treatment status with teachers. Only the three evaluation team members had access to data about treatment status, but they were instructed not to look at teachers' status prior to the observations.

Observers had a brief conversation with the teacher about standards covered and the specific inquiry model teachers used, if any. If it was not possible to collect this information during the observation, observers sent a follow-up e-mail to the teacher. During the live observation, observers completed a lesson structure table that described the activities happening and wrote narrative notes. After the observation, observers completed their ratings and entered the data into an online Qualtrics survey developed by the evaluation team as a central hub for all observation data collected.

Year 2 observations. The original intent was that the Year 2 observations would replicate the process used for the baseline observations, and some components of the process did remain the same. For instance, as in Year 1, teachers were sent an introduction letter introducing them to the Year 2 observation process, the description of inquiry instruction, and a request to not schedule the observations during review, testing, or skills practice. However, the Year 2 observation process had to be modified from in person to virtual in order to comply with UNCG Risk Mitigation guidelines, and the different districts' rules in place due to Covid-19.

For the Year 2 observations, it was necessary to consider how students attended class. Teachers were teaching students online, in person, and sometimes via a combination of the two. In some cases, students joined classrooms online from home over a web-conferencing program (e.g., Zoom, Google Meet, Microsoft TEAMS). In other cases, students attended school physically in the classroom. Frequently, however, teachers taught students attending in person along with other students joining online simultaneously; this was considered this a "hybrid" class. Students who attended class in person were required to be socially distanced, with minimal contact with the teacher or other students. In the classroom, teachers and students wore masks and were often separated by panels of plexiglass or other types of dividers. To comply with UNCG Risk Mitigation guidelines and the individual districts' rules, observations were designed so that no observer would be physically located in schools and classrooms. For completely online classes, teachers invited the observer to join the class using the same platform as the students. Although platforms differed in functionality, observers could see the online classroom, access the chat function, and in some cases, could access breakout rooms —the evaluation team termed these "online observations." For classes that were held in person, the evaluation team devised a "virtual observation" method using an array of iPads that were connected through Zoom to observe the classroom from multiple perspectives (described below). For hybrid classrooms, when the majority of students were online, the observation was conducted using the school's learning platform. When the majority of students were in-person, the observation was conducted via Zoom with the iPads placed at various locations in the classroom. Prior to scheduling an observation and assigning an observer, the number of students and the method of observation (online or virtual) were determined so that arrangements could be made to either allow the observer access to the classroom platform, or send iPads to the school to be set in place prior to the lesson.

When a teacher had a hybrid class, the observation was conducted in a manner that was consistent with the attendance of the majority of students; the evaluation team considered a majority anything over 50%. For example, if a teacher had 30% of students joining the class online and 70% in person, the observation was conducted using the iPads.

It is important to note that the observation tool was not validated for online or remote learning. The research team did an extensive review of the tool and did not believe it needed to be modified; although the directions on using the tool were modified to account for the virtual nature of the observations. It is possible, however, that the tool was not fully appropriate for looking at remote or online learning.

Prior to scheduling an observation and assigning an observer, the number of students and the method of observation (online or virtual) were determined. When observations were conducted by joining the teachers' online classrooms, arrangements were made for teachers to invite the observer assigned to observe the lesson. In this format, the observers had a view of the teacher's online classroom and typically saw the teacher and students each in small windows on the screen. Interactions between teacher and students was limited to onscreen discussion, use of a chat function, and in some cases, breakout rooms.

For virtual observations of classrooms where students attended in person, evaluation staff worked with teachers to set up the six iPads with optimal views of students (or groups of students) and the classroom. The teacher then "joined" the observation using a Zoom link provided by the evaluation team. Observers were able to hear and see the classroom interactions during the lessons. The iPads were not used by the teacher as part of instruction or by the students as part of the lesson; instead, iPads were used as cameras and microphones so that the observers could see and hear most of the class activities. The observer had the ability to mute and unmute iPads as needed to see and hear class-wide and student group activities as needed. Some observers reported having trouble hearing classroom activities from time to time, particularly when listening to student group activities. As a result, observers were instructed to discontinue and reschedule the observation if they could not substantively hear the classroom conversations. Views of the classroom were limited to what could be seen through each of the iPad cameras, which were stationary. All of the iPads provided live views of students and the teacher to the observers. An observer could hear and see the classroom interactions during the lessons. Observers were instructed to mute all of the iPads except the one that focused on the teacher at the beginning of the lesson. Observers would then unmute groups that appeared to be collaborating, and rotate muting and unmuting all of the iPads to hear group interactions.

Ten sets of equipment were used during the observation period and shipped to teachers in different districts in order to complete the observations within the given timeframe. Table II-2 provides an overview of the method of observation by treatment condition. Forty-six teachers were observed online, and 99 teachers were observed virtually via the iPad arrays. As the table shows, treatment teachers were slightly more likely to be observed teaching virtually than control teachers and control teachers were slightly more likely to be observed using the iPad method. Because of concerns that this might impact the outcomes, the observation method was included as a covariate in the analyses.

Table II-2. Method of Observation by Treatment Condition

Outcome	Treatment Status	
	Treatment	**Control**
Online	22 (35%)	24 (29%)
Virtual (iPads)	41 (65%)	58 (71%)
Total	63	82

Otherwise, we used similar procedures to the ones in 2019. Each observation covered the entire class period during which the observed subject was taught. Observers were not told the treatment status of the teachers and were also instructed not to discuss the treatment status with teachers; as a result, most observers did not know teachers' treatment status. Prior to the observations, teachers were asked to respond to a questionnaire about their planned lesson and provide information about the lesson (e.g., standards that would be covered and the specific inquiry model teachers used, if any). All teachers that were observed completed the questionnaire. The observers used this information to complete the observation protocol and completed their ratings and submitted the data into the Qualtrics observation data hub.

Challenges. There were several challenges to the Year 2 observations that likely affected the level of participation by teachers. There were instances of teachers postponing or cancelling their observation on short notice due to illness or required quarantine after exposure to the virus.

Also, there were some difficulties contacting teachers because some had changed schools, districts, or positions in the past year, and the evaluation team did not know of those changes until attempts were made to reach out to the teachers. The evaluation team worked with EQuIPD instructional specialists (hereafter referred to as "instructional coaches" or "coaches") to update contact information for as many teachers as possible. One significant challenge was a change in the Hillsborough County School District email service. The district switched to a new email provider in spring 2021 that included newly formatted email addresses for the teachers and staff in the district. The evaluation team had sent introductory emails to those teachers in early March 2021 and found, in April, that many teachers had not received the introductory email and had not been receiving scheduling emails. The evaluation team worked with the coaches and district to get the new addresses and the emails forwarded, but many of the emails never went through to the teachers.

In Palm Beach County Schools, teachers used Google Meet to hold online classes. There were initial difficulties for teachers who would send a link when they should have sent a specific invitation to the observer. Fewer than five observations needed to be rescheduled because of the confusion. SERVE staff worked with Palm Beach teachers to develop a process for district teachers to invite observers to their online classroom. This process eliminated difficulties that Palm Beach teachers had inviting observers to their classrooms.

II.1.3.4. Observation Sample

The sample for the observation analyses consisted of the 145 teachers (63 treatment and 82 control) with complete observations in 2019 and 2021.[3] Overall, attrition was 52.5% with 53.0% in the treatment group and 52.0% in the control group. The 1% of differential attrition falls between the cautious and the optimistic attrition boundary recommended by the WWC, which indicates that this can still be treated as a randomized controlled trial. However, to ensure that the two groups were equivalent, the evaluation team assessed baseline equivalence for the analytic sample on the observation scores. As shown in Table II-3, the samples were equivalent at baseline with differences on all scales or relevant indicators below the 0.25 level, which meets WWC standards for equivalence.

Table II-3. Baseline Equivalence for the Observation Sample

Indicator	Treatment mean (N=63)	Control mean (N=82)	Treatment - Control difference	Effect size
Observation Score (weighted composite)	1.06	1.00	0.06	0.08
Implementation of inquiry (Average of EQUIP scales)	2.23	2.27	-0.04	-0.06
Group work	2.20	2.21	-0.01	-0.01
Distribution of work among students in a group	2.19	2.20	-0.01	-0.01
Percentage of time engaged in large or small group activities	50.9%	49.4%	1.50	0.04
Discourse summative score	2.12	2.19	-0.07	-0.09
Student discourse quality within groups	2.21	2.22	-0.01	-0.01
Assessment summative score	2.05	2.16	-0.11	-0.15
Instruction summative score	2.48	2.50	-0.02	-0.02
Curriculum summative score	2.27	2.25	0.02	0.03
Use of real-world problems	1.72	1.58	0.14	0.24
Real life examples and authentic tasks	2.23	2.04	0.19	0.19
Incorporation of workforce skills/knowledge	1.20	1.12	0.08	0.20
Appropriateness of student technology use	2.11	1.94	0.17	0.17
Distribution of student technology use	2.92	2.64	0.28	0.21
Percentage of time student observed using any technology	53.6%	46.9%	6.70	0.17

Note. No differences were statistically significant.

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[3] The one non-randomly assigned teacher was excluded from the analyses.

II.1.3.5. Inter-rater Reliability and Validity

Approximately 19% of all Year 2 observations (27/145) were conducted by pairs of observers, and the rest were conducted by single observers. A lead observer was identified prior to the observation and was typically either a senior member of the evaluation team or a rater who was primarily responsible for leading the observation. During paired observations, each observer entered their ratings independently, and these data were used to calculate inter-rater reliability. In the cases of paired observations, both observers entered ratings for the same classroom, and the lead observer's scores were selected for analyses. Both sets of ratings were used to calibrate and evaluate reliabilities.

After observers entered their data on their individual observation scoring sheet, they discussed their ratings and justifications, which helped them to be more consistent in their future observational ratings. The data and reflections from initial paired observations provided basis for additional observation calibration meetings throughout the data collection window. These calibration meetings were necessary given that the observations were conducted online/virtually and involved various instructional formats (e.g., fully online, in person, and hybrid instruction). The calibration meetings allowed the observation team to discuss and come to consensus on how to handle any unanticipated issues with the virtual observations.

Inter-rater reliability for the 27 paired observations was calculated using the percentage of absolute agreement and the intraclass correlation coefficient (ICC). In terms of the ICC, the evaluation team used a one-way mixed model, which is most appropriate for observational designs that are not fully crossed. A fully crossed observational design is defined as one in which all available observers rate all available participants. However, such a design was not practical for this study. Instead, different pairs of observers were selected to jointly observe a subset of classroom teachers. Every effort was made to maximize diversity in coder pairs, and classrooms selected for joint observation were based solely on issues of scheduling. Given that the design was not fully crossed, and the observers were not randomly selected for joint observations, the one-way mixed model was the most appropriate ICC model for statistical analysis (Hallgren, 2012). In addition, ICCs were calculated to assess reliability in terms of absolute agreement in ratings instead of consistency of responses.

Because observational ratings for outcome analysis was based on a single observer for most observations, the evaluation of the quality of observer reliability is based on the single-measures (ICC). The average ICC across all items was 0.55, which is considered "fair" using commonly established ICC cutoff ranges (see Cicchetti, 1994), indicating that observers had a high degree of agreement across items in general. We also report percentage absolute agreement, which was 58.4% across all ratings. When raters disagreed on ratings, the majority of these disagreements were only off by one rating level, evidenced by a one-off percentage agreement of 93.2%. Table II-4 show the percentage of absolute agreement for the individual scales/indicators, all of which were above 50%.

Table II-4. Inter-rater reliability

Scale	Indicator	Percentage Absolute Agreement
EQUIP Inquiry	Instruction—summative score	64.9
	Discourse—summative score	69.4
	Assessment—summative score	54.1
	Curriculum—summative score	62.2
	Lesson—overall summative inquiry score	64.9
Group Work	Distribution of work among students in a group	73.0
	Student discourse quality within groups	81.1
Use of Real-world Problems	Real life examples and authentic tasks	51.4
	Incorporation of workforce skills/knowledge	75.7
Technology	Appropriateness of student technology use	54.1
	Distribution of student technology use	67.6

We assessed the predictive validity of the observation scales by determining the extent to which the different outcome measures were associated with positive student outcomes (see Appendix B). The overall composite observation measure as well as all the individual scales had positive and statistically significant associations with student achievement ($p \leq .05$).

II.1.3.6. Observation Analyses

This section describes the analytic approaches used for the observations. For teachers who were observed multiple times in a given year, one of the observers was designated as primary, and only this observation was used in the analyses.

Creation of subgroups. Analyses were also conducted separately by subgroups. Regarding subgroup analyses by subject area, the subject area was identified by the observer during the observation process and was recorded in the subject/course data entry field. In a few cases, when subject/course entry was ambiguous in terms of subject area, the lesson topic was also taken into account to code the subject/course.

Each subject was grouped into one of the following areas:

- Science
- Math
- Technology
- Engineering
- Humanities (English, foreign languages, social studies, art)

Because of small sample sizes, all STEM subjects were grouped together for the subgroup analyses. Finally, subgroup analyses were conducted by grade level, broken into: *K–5*, and *6–9*.

Note that these groupings varied slightly from the groupings done for the survey. This is because observations were done on a very specific classroom taught in a specific subject for a specific grade while, on the surveys, teachers were expected to indicate all of the grades and subjects that they taught. The survey thus required grouping that allowed for multiple subjects or grades while the observation subgroup analyses did not. Additionally, the observation recorded the specific grade that students in the observed class were in, so resource teachers serving multiple grades were not identified as a separate group.

Impacts were also analyzed separately for classrooms that were observed online and classrooms that were observed using iPads.

Analyses of the lesson structure table. In terms of the lesson structure, observers recorded, using a sliding scale, the approximate average percentage of students engaged behaviorally and cognitively during each of the 10-minute segments of the lesson.

The lesson structure table also allowed for recording whether certain events occurred for three minutes or longer, or multiple times during each 10-minute segment of the lesson. Within each of the four categories of events, multiple events could be recorded for each segment. These events included:

- Activity (non-instructional time, non-inquiry, engage, explore, explain)
- Organization (whole class, large group, small group or pairs, individual work)
- Use of specified technology tools by teacher
- Use of specified technology tools by students

Technology lists for teacher and students included the following items:

1. No technology was used
2. Database (Matweb)
3. Desktop or Laptop Computer
4. Video/computer/ overhead projector
5. Calculator
6. Digital Sensors
7. Handheld/Smartphone/Tablet
8. Simulation/Visualization
9. Interactive White Board
10. Office software (Word or Google)
11. Other Digital Device
12. Other Tech (see note)

First, a dichotomous variable capturing any technology used during each 10-minute segment was created for teacher and students. Then, to analyze the extent of event occurrence during the lessons for all four types of events, the ratio of segments in which the event occurred to all segments in the lesson was calculated, creating a variable capturing the portion of lesson time that the event occurred. For example, if a classroom teacher was observed for five 10-minute segments, in two of which the teacher was observed using any form of technology (for at least three minutes or multiple times), teacher technology-use duration would be reported as 40% for this teacher.

Impact analyses of the ratings and lesson structure. Differences between the treatment and control groups were determined using the same regression model as for the survey measures. Impacts were analyzed for the following scales:

- A composite score that was constructed as an average of the standardized inquiry, group and real world scales, and the average of the two technology indicators, with the inquiry scale assigned double weight,
- An inquiry scale constructed as the average of the instruction, discourse, assessment, and curriculum summative measures,
- The collaborative group work score, which was an average of two measures: distribution of work among students in a group score and student discourse quality within groups score,
- The percent of class segments involving small or large group activities,
- Discourse summative measure,
- Assessment summative measure,
- Instruction summative measure,
- Curriculum summative measure,
- Use of real-world problems scale, which combined two measures: use of real-life examples and authentic tasks and incorporation of workforce skills/knowledge,
- A measure of appropriateness of student technology use and a measure of the distribution of student technology use (these two indicators were kept separate and not combined into a single scale), and
- The percent of class segments when students were observed using any technology.

Covariates for the observation impact analyses included:

- baseline measure of the outcome,
- subject of the observed class (STEM versus non-STEM),
- the baseline share of minority students at the teacher's school,
- the observation mode (online or virtual/iPad), and
- the baseline share of economically disadvantaged students at the teacher's school.

Weights were used to adjust for the fact that not all teachers had an equal probability of being selected for the treatment based on a teacher's the probability of being assigned to treatment or control group. Weights were computed similarly to those for the survey analyses, but were rescaled so that their sum equaled the sample size for the observation analyses.

II.1.4. Administrative Data

One of the goals of the project was to improve teacher retention and attendance. Both of these outcomes were assessed using data provided by the districts.

II.1.4.1. Teacher Measures and Data Collection

The evaluation team requested teacher demographic, effectiveness, retention, and attendance data from all participating districts for all teachers who started the professional development or who started as control teachers. The evaluation team did not request data for teachers who were originally randomized but who dropped prior to the project starting. The districts were asked, annually, to provide data for participating teachers for school years 2018–19, 2019–20, and 2020–21. The focus of the initial data request was to collect demographic (gender, race/ethnicity, years of teaching experience) and baseline teacher-level assessment results for participating teachers. Across all three years, the districts were asked to provide teacher effectiveness, retention, and attendance data. In terms of effectiveness data, the state suspended state assessments in 2019–20 due to COVID-19; thus, no effectiveness data were available for that year across all districts. In addition, in 2020–21, only four districts were able to provide teacher effectiveness data due to modifications to the administration of student assessments that created reporting delays. As such, several districts were unable to provide effectiveness results in time for this report.

In terms of retention data, districts were asked annually to report on the employment status of each participating teacher, including whether the teacher was employed full- or part-time during the school year immediately preceding the request (e.g., July 2021 request asked districts to report on teachers' employment status for 2020–21 school year). Districts were provided with a list of participating teachers to ensure that teachers who were no longer employed by the district were accounted for in the annual reporting. Districts were given the same list of teachers every year even if they reported a teacher had left in a previous data collection. For retention analysis, teachers who were no longer employed with the district were coded as 0 and current employees were coded as 1. Teachers who were reported as being on leave were coded as unemployed (=0). In terms of attendance data, districts were asked to report on the number of days that participating teachers were absent. Absences reported in total hours were converted to days when necessary.

The impact analyses used retention and absences data for the 2020–21 school year.

II.1.4.2. Administrative Data Sample

Eight of the nine districts[4] included in the impact study sample provided information about teacher retention and attendance.

The sample for teacher retention included the 223 teachers (102 treatment and 121 control) in the eight districts that provided data. The overall attrition rate was 26.9% (23.9% in the treatment group and 29.2% in the control group). This attrition rate falls below the optimistic boundaries in the WWC Standards Handbook, which is the boundary used for teacher training programs (What Works Clearinghouse, 2019).

Regarding teacher attendance, the evaluation team excluded two teachers who were reported as not employed by the district in the 2020–21 year but who had attendance data. Of the 134 treatment and 171 control teachers who were randomized, attendance data for Year 2 was available for 85 treatment and 107 control teachers, for attrition rates of 36.6% in the treatment group and 37.4% in the control group. The overall attrition rate was 37.0%, which meets WWC attrition standards, so baseline equivalence is assumed to hold.

Because subjects taught were available only for teachers who completed the Year 2 survey, the samples for the subject subgroup analysis are smaller than the full sample for the confirmatory analysis.

II.1.4.3. Administrative Analysis

The administrative analysis used the model described under the survey analyses, with the following covariates included for the attendance analysis: the number of days absent at baseline, the number of years of teaching experience at baseline, and the baseline school-level percentage of minority and percentage of economically disadvantaged students. The evaluation team used dummy variable adjustment for missing baseline attendance and experience data.

For the retention data, the models included controls for years of teaching experience at baseline and the baseline school-level percentage of minority and percentage of economically disadvantaged students. The evaluation team used dummy variable adjustment for missing baseline experience.

For the subgroup analyses, the evaluation team estimated separate models that include interactions of the treatment indicator with dummy variables indicating the grades or subjects taught by a teacher. All specifications use weights equal to the inverse of the teacher's probability of being assigned to their respective treatment or control condition.

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[4] One county, Glades, had one teacher who participated in part of the professional development but was not part of the analytic sample for the impact study. As a result, only nine districts are included in the impact study.

II.2. Impact on Students

The second study looked at the impact of the project on student achievement and was designed to answer the following research question: Does achievement on state standardized tests improve for students whose teachers participate in EQuIPD?

II.2.1. Student Measures and Data Collection

The evaluation team requested student achievement data from all participating districts for all teachers who started the professional development. Data were not requested for teachers who were originally randomized but who dropped prior to the project starting (although those teachers are included in the attrition calculations below). The districts were asked to provide test score and demographic data for students in teachers' classrooms for the 2020–21 school year. They were also asked to provide baseline test score data for those same students from the 2018–19 school year, if available. Florida did not administer the standardized assessments in 2019–20 because of the pandemic.

All but one district provided student test scores for 2018–19 and 2020–21. The evaluation team used standardized state assessment scores from the ELA reading and math assessment for students in Grades 3 and up and iReady math and reading scores from the end-of-year assessment period for students in Grades K–2, who do not take state assessments in Florida due to the grade level. Five of the districts provided iReady scores. Thus, the evaluation team used state assessments at baseline and in Year 2 for students who were in grades 5–8 in the 2020–21 school year. For students in Grades 3 and 4, the evaluation team used iReady at baseline and the state assessment in Year 2. For students in Grade 2, the evaluation team used iReady in both years. Students who had not started kindergarten by the 2018–19 school year were not included in the sample because baseline scores are not available for these students on any assessment. For the main analysis, the evaluation team constructed a composite score by averaging the students' math and reading scores (standardized by grade level), if both were available, or using whichever one was available if one score is missing in a given year. Students in Grades 5 and 8 also took state assessments in science. Science scores were standardized by grade level as well and the students' composite score in 2018–19 was used as baseline.

II.2.2. Student Sample

II.2.2.1. Sample Construction and Attrition Rates

A total of 501 students who were in Grade 9 or higher in Year 2 were excluded from the sample. Also excluded were eight additional students with complete baseline and outcome scores who were assigned to two teachers who taught online in Year 2 because very small subsets of their classes took the standardized tests in 2021.

The final sample includes only students with valid baseline achievement measures and valid outcome test scores; no achievement data were imputed. As Tables II-5 and II-6 show, attrition rates were virtually identical between the treatment and control groups at both the teacher and student levels.

Table II-5. Attrition Rates: Number of Teachers with Usable Student Data

	Treatment group			Control group			Attrition rate		
	Assigned	Started study	With students in sample	Assigned	Started study	With students in sample	Treatment	Control	Overall
Total	134	108	70	171	128	87	48%	49%	49%

Table II-6. Attrition Rates: Student Sample

	Treatment group		Control group		Attrition rate		
	Students in the data	Students with valid math or reading scores	Students in the data	Students with valid math or reading scores	Treatment	Control	Overall
Total	8,253	5,684	9,769	6,839	31%	30%	31%

II.2.2.2. Baseline Equivalence

The evaluation team assessed baseline equivalence on achievement for the student analytic sample, as shown in Tables II-7 through II-10. Baseline equivalence was calculated for (1) the full sample, (2) the sample of students with baseline and outcome reading scores, (3) the sample of students with baseline and outcome math scores, and (4) the sample of students with a baseline reading or math score and outcome science score. As a reminder, none of the achievement data were imputed. The adjusted differences between the treatment and control groups were calculated using the multi-level model with teacher random intercepts used for the impact analyses but excluding all covariates other than the treatment group indicator. The evaluation team used weights at the teacher level equal to the inverse of the teacher's probability of assignment to their respective treatment or control condition. As the table below shows, all the samples were equivalent on baseline measures of the relevant student achievement measures.

Table II-7. Baseline Equivalence: Student Achievement

Outcome/Baseline Measure	N (Treatment)	N (Control)	Treatment mean (unadjusted)	Control mean (unadjusted)	Adjusted Treatment - Control difference	Effect size
Composite Sample/ Baseline composite assessment score	5,684	6,839	0.06	-0.01	-0.06	-0.06
Reading/ Baseline reading score	5,575	6,678	0.07	-0.02	-0.03	-0.03
Math/ Baseline math score	5,337	6,532	0.06	0.00	-0.07	-0.07
Science/Baseline composite score	1,986	1,889	0.06	0.02	-0.08	-0.08

II.2.3. Analyses

The teacher-level covariates included in the models were:

- number of years of teaching experience at baseline,
- subject taught at baseline (STEM vs. non-STEM),
- perceived comfort with inquiry-based instruction and technology from the baseline teacher survey, and
- the baseline school-level percentage of minority students, percentage economically disadvantaged students, and passing rates in English and Math.

The student-level covariates included in the models were:

- baseline score on the test that is analyzed as outcome (composite, reading, or math),
- indicator for underrepresented minority,
- indicator for female,
- indicator for ELL status at baseline,
- indicator for disability status,
- indicator for economically disadvantaged status, and
- indicator for gifted status.

Dummy variable imputation was used to impute other missing covariates (e.g. socioeconomics and demographics) besides the baseline test scores. The high- and low-performing groups were identified based on whether a student's standardized baseline score on the test analyzed in the respective specification is above or below zero. That is, the baseline composite score was used to identify (1) high- and low-performing students in the composite score and science score specifications, (2) the baseline reading score in the specifications where the outcome of interest is the Year 2 reading score, and (3) baseline math in the math score specifications.

For the subgroup analyses, the evaluation team estimated separate models that included interactions of the treatment indicator with dummy variables indicating the subgroup to which a student belonged. Imputed values were not used to infer subgroup membership, so the subgroup analyses were restricted to students for whom there were data on the relevant covariates. Multilevel models were estimated with teacher random effects. All specifications used weights at the teacher level equal to the inverse of the teacher's probability of being assigned to their respective treatment or control condition.

The evaluation team used the following multi-level model.

Level 1 (student level):

$$y_{ij} = \beta_{0j} + \sum_{p=1}^{P} \beta_{pj} COV_{pij} + e_{ij}$$

where

y_{ij} = outcome of interest for student *i* with teacher *j*.

COV_{pij} = p-th student-level covariate included in the final model.

β_{0j} = adjusted mean outcome of interest for teacher *j* controlling for differences in student-level covariates.

β_{pj} = the association between the *p*-th student-level covariate and outcome of interest;

e_{ij}= random effect of student *i* with teacher *j* assumed to be distributed with a mean of zero and variance of σ_e^2.

Level 2 (teacher level):

$$\beta_{0j} = \gamma_{00} + \gamma_{01} T_j + \sum_{k=1}^{K} \gamma_{0(k+1)} COV_j^k + u_{0j}$$

$$\beta_{pj} = \gamma_{p0}$$

where

T_j

COV_j^k= k-th (k=1,2,…,K) teacher-level covariates.

γ_{00}

γ_{01} = overall fixed treatment effect adjusted for the covariates.

$\gamma_{0(k+1)}$ = association between teacher-level covariate *k* and the outcome measure controlling for other covariates in the model.

u_{0j} = random effect of teacher *j*, assumed to be distributed with a mean of zero and variance of σ_u^2. Note that this term is also assumed to be independent of the student-level error term, e_{ij}.

II.3. Fidelity of Implementation

These program activities were expected to result in instructional changes at the classroom level that are intended to lead to improved student outcomes. The classroom-level changes were examined as part of the implementation and impact studies but were not included in the FOI measures.

To assess FOI, the evaluation team worked with the professional development team to identify levels for specific indicators for each of the program activities: (1) professional development, (2) technical assistance/professional development resources, (3) technology, (4) instructional coaching/instructional coaches, (5) teacher/industry interactions, and (6) industry and state credentials. Most program activities were examined relative to the number of days/sessions anticipated to be provided. A copy of the FOI matrix is included in Appendix D.

Data on service delivery and participation were collected from project records. Records included coaches' reports and professional development electronic sign-in sheets. These were supplemented with data from interviews conducted by the evaluation team.

II.4. Qualitative Data Collection

Throughout the project, the evaluation team collected data on implementation and perceived impact through interviews and professional development observations.

II.4.1. Interviews

II.4.1.1. Sample

In summer 2020, the evaluation team interviewed 26 teachers and all six coaches. Teachers were selected for interviews based on specific criteria. Four teachers were interviewed for the first time; they were from districts from which teachers were not previously interviewed. The remaining teachers had been interviewed at least once before and were selected to represent a range of grade levels and subjects. The sample also included a total of nine teachers from across Palm Beach, Hillsborough, and Sarasota (interviewed during the February 2020 site visit) and three coaches (interviewed in November 2019 and February 2020).

In summer 2021, the evaluation team interviewed 12 teachers and all six coaches. All the teachers had been interviewed one to three times prior to the final interview. Of the 12 teachers, five were elementary, teaching all subjects, and seven were middle school. Six of the middle school teachers were teaching STEM or CTE subjects, and one taught humanities.

II.4.1.2. Measures

Interview protocols were designed to gain participants' perspectives on (1) professional development, coaching, and other services provided by the project; (2) their evolving understanding of inquiry and other components of the program; (3) resulting changes in the classroom; and (4) recommendations for program improvement. To keep the interviews brief, not all participants received all the questions. Some questions were presented only as they applied to specific subgroups. A sample interview protocol is provided in Appendix E.

II.4.1.3. Data Collection

In February 2020, four in-person interviews were conducted in teachers' schools, and five interviews took place during the Saturday workshop. During the six weeks of the Summer Bootcamps in 2020 and 2021, all interviews were conducted using Zoom during the asynchronous work time. All teachers were interviewed individually for approximately 15–20 minutes. Coaches were interviewed in two groups.

II.4.1.4. Analyses

All interviews were recorded, transcribed, de-identified, coded, and analyzed using Atlas.ti software. The interviews were coded and summarized around themes related to program implementation and program impact.

II.4.2. Professional Development Observations

The intent of professional development observations was to: (1) document project activities, and (2) inform program improvement work throughout the project.

II.4.2.1. Observation Sample

All six coaches and the project principal investigator (PI) led the 2020 Bootcamp professional development. During the two weeks of Summer Bootcamp observed by the evaluation team, 16 elementary and 19 middle school teachers participated in the professional development activities. In summer 2021, most professional development sessions were led by treatment teachers, and some were led by the coaches and the project PI. Evaluators observed seven sessions conducted by intervention teachers, distributed among teachers of different grades and subject areas. Additionally, the evaluation team observed all four follow-up workshops during the 2020–21 school year.

II.4.2.2. Observational Measure

The professional development observation protocol was developed to record the content and structure of activities, use of technology, interactions among facilitators and participants, teacher engagement in activities, and to evaluate indicators of quality professional development. The protocol used time sampling, ratings, and descriptive narrative notes techniques.

II.4.2.3. Data Collection

The 2020 Bootcamp was conducted over Zoom, for six cohorts of teachers, each attending one week of professional development. Each week's session consisted of ten synchronous and ten asynchronous lessons. The evaluation team observed five randomly selected synchronous sessions during one week attended by elementary teachers and five additional synchronous sessions over the course of another week attended by middle school teachers; thus, evaluators were able to observe all content covered by this professional development. The evaluation team observers attended all activities conducted by the entire cohort and one breakout room activity during each session. Attendees' videos were turned off during the main sessions, which made it challenging to gauge teacher engagement. Instead, teacher engagement was judged based on teachers' responding to questions in chat; as such, this measure should be considered approximate and limited in scope. In 2021, the evaluation team randomly selected seven sessions led by teachers who were also interviewed that summer.

II.4.2.4. Observation Analyses

In summer 2020, all ten observed sessions were treated as a single professional development event. All ratings for individual indicators and summary ratings were analyzed using descriptive statistics including mean, standard deviation, and range across ten sessions. In summer 2021, observed sessions were treated as separate workshops, using the same descriptive statistics.

During each of the 10-minute segments of the sessions, observers recorded its content and activity structure, using pre-determined categories. With each session's length of 150 minutes, 150 episodes were coded. Then, the evaluation team calculated the percentage of episodes in which specific activity or content were recorded. Teacher engagement was recorded on a sliding scale, but it was judged only for a subset of the 150 episodes, and the descriptive statistics were calculated only for those episodes. Interactions and use of technology were recorded as narrative notes and were summarized descriptively.

Section III. Program Context

Project EQuIPD was implemented in 10 districts across central and northern Florida. This section of the report describes the characteristics of the participating districts, schools, and teachers. It also includes an overview of how the COVID-19 pandemic impacted the project.

III.1. District and School Characteristics

EQuIPD was implemented in 10 districts: De Soto, Glades, Hardee, Hendry, Hillsborough, Manatee, Palm Beach, Okeechobee, Sarasota, and St. Johns. Nine of the districts are clustered in the middle part of Florida, with one district (St. Johns) in the northeast section of state. Within the 10 participating districts, a total of 121 schools had at least one teacher participating in the project for at least some of the time, 78 schools had at least one treatment teacher in their school at least some of the time, and the remainder had only control teachers (who received the professional development starting in the final project year).

When looking at the characteristics of participating schools, almost all had over 50% minority students and more than 50% economically disadvantaged students. Across the districts, the math pass rates in participating schools ranged from a low of 40.5% to a high of 72.7%. The science pass rates ranged from 38.0% to 67.3%. Despite this, there were very few schools that were among the most academically disadvantaged in the state. For example, six districts had no schools that were identified as persistently low performing. Table III-1 shows the characteristics of participating schools and districts. The top number in each cell represents the data for the program schools. The data in the parentheses in each cell are for all the schools in the district; the final row includes data for all schools in the state.

Table III-1. Characteristics of Participating Schools and Districts

District	# Schools	% Minority	% Econ. Disadv.	% ELL	% Passing Math	% Passing Science	% of Schools Pers. Low Perf.	% of Schools in Lowest 300	% of Schools with Failing Grade
DeSoto	2 (5)	54.3% (61.4)	100% (98.8)	5.4% (8.7)	40.5% (41.0)	38.0% (38.8)	0% (20.0)	50.0% (60.0)	0% (0)
Glades	1 (5)	55.9% (72.1)	75.2% (49.7)	8.1% (3.0)	57.0% (61.4)	44.0% (45.2)	0% (0)	0% (0)	0% (0)
Hardee	3 (7)	70.6% (72.9)	94.9% (97.2)	8.6% (10.9)	60.3% (65.4)	52.3% (45.7)	0% (0)	0% (0)	0% (0)
Hendry	4 (10)	82.3% (81.5)	97.0% (98.6)	12.9% (14.4)	49.5% (49.0)	57.0% (48.7)	0% (0)	0% (10.0)	25.0% (10.0)
Hillsborough	39 (261)	69.3% (70.5)	65.3% (65.4)	12.0% (12.7)	53.1% (54.0)	51.0% (51.5)	25.6% (14.9)	23.1% (16.5)	20.5% (13.4)
Manatee	22 (60)	53.1% (56.3)	61.2% (67.5)	14.0% (14.8)	63.0% (61.1)	50.8% (50.3)	18.2% (8.3)	18.2% (18.3)	9.1% (3.3)

District	# Schools	% Minority	% Econ. Disadv.	% ELL	% Passing Math	% Passing Science	% of Schools Pers. Low Perf.	% of Schools in Lowest 300	% of Schools with Failing Grade
Okeechobee	6 (8)	51.0% (54.7)	89.9% (92.4)	11.4% (14.8)	57.8% (58.5)	46.7% (46.5)	0% (0)	0% (12.5)	0% (0)
Palm Beach	30 (197)	76.7% (72.3)	73.7% (76.7)	14.4% (14.8)	61.7% (63.3)	51.4% (53.6)	0% (2.0)	3.3% (9.6)	0% (2.0)
Sarasota	7 (49)	57.1% (38.6)	63.9% (50.1)	10.8% (6.7)	63.9% (71.3)	57.4% (65.1)	0% (0)	0% (2.0)	0% (2.0)
St. Johns	7 (40)	23.4% (23.9)	39.8% (27.7)	0.5% (0.8)	72.7% (77.7)	67.3% (74.3)	0% (0)	0% (0)	0% (2.5)
All Program Districts	**121 (642)**	**63.9% (64.3)**	**68.8% (64.1)**	**12.0% (12.3)**	**58.9% (60.4)**	**52.1% (54.2)**	**11.6% (7.6)**	**12.4% (12.3)**	**9.1% (6.9)**
Statewide	**3,337**	**63.1%**	**69.2%**	**11.1%**	**60.3%**	**55.1%**	**5.4%**	**9.0%**	**5.1%**

Note. Values not in parentheses represent schools with EQuIPD teachers. Values in in parentheses are for all schools within the district to allow for comparisons between program schools and all schools within a district. The statewide numbers are for all schools in the state.

III.2. Teacher Characteristics

A total of 229 teachers started participation in the project; 228 of whom were randomized. The summary of the characteristics of the teachers served includes findings from 227 survey respondents which also included the individual who participated in the project but was not part of the randomized study. The survey data provided background information about the teachers engaged in the professional development. In the baseline year, 13% of participating teachers were male, and 87 % were female. Nineteen percent (19%) identified as people of color, with 81% identifying as White. When looking by grade level, (Table III-2), more teachers reported teaching middle school than elementary (112 vs. 83), and thirty-two teachers were considered as resource teachers with multiple grade levels. The vast majority of teachers taught at least one STEM-related subject, with 27 teachers teaching humanities only. Between baseline and the end of the project, some teachers dropped out or left teaching while others changed their teaching position, either moving to new districts or schools, or changing grades. In one case, a teacher switched from teaching ninth grade to teaching second grade; other teachers became resource teachers after teaching a single grade level. In Table III-2, the Year 2 numbers show that the percentage of teachers in K–5 and 6–9 each decreased slightly although the proportion of resource teachers increased (from 14% in the baseline year to 20% in Year 2).

Table III-2. Number of Teachers, by Subject Taught and Grade Level

Subject Area	K–8 teachers (resource)	K–5 teachers	6–9 teachers	Total
Baseline				
Teach STEM subjects	30	76	94	200
Teach non-STEM	2	7	18	27
Total	32	83	112	227

Subject Area	K–8 teachers (resource)	K–5 teachers	6–9 teachers	Total
Percentage of total	14.1%	36.6%	49.3%	
Year 2				
Teach STEM subjects	27	47	59	133
Teach non-STEM	2	2	9	13
Total	29	49	68	146
Percentage of total	19.9%	33.6%	46.6%	

The project placed particular emphasis on reaching teachers in Florida's lowest-performing schools and on serving high-need students. As Table III-3 shows, less than 10% of the teachers started at schools with significant academic issues. As the district table shows, this is primarily because most of the districts have no low-performing schools. However, 70% of the participants started at schools where over half of the student body was economically disadvantaged. Taken across the different criteria, 70% of the teachers in the project came from schools meeting at least one high-needs criterion.

Table III-3. 2019 Percentage of Teachers Coming from High-Needs Schools, by Type of Need

Sample	N	Persistently Low Perf.	One of the Lowest Perf. 300 Elem. Schools	2019 Failing School Grade (Grade D or F)	At Least 50% Econ. Disadv.	25% or More of Enrolled Students Are ELL	Meeting at Least One of The Criteria
Control	127	9.4%	7.1%	7.9%	70.1%	12.6%	70.1%
Treatment	102	7.8%	8.8%	8.8%	70.6%	8.8%	70.6%
Total	229	8.7%	7.9%	8.3%	70.3%	10.9%	70.3%

Note. Data come from Florida Department of Education.

III.2.1. District Support for Technology

To inform the professional development and planning, and because the intervention was designed to improve teachers' use of technology, the evaluation team collected data about teachers' support from the district relative to technology. On the survey, teachers generally agreed that they had access to technology, reliable internet access, and support from their administration for technology-enriched lessons. They indicated that they had lower levels of support for more specific kinds of technology use and specialized technology professional development. Overall, the findings suggest that there was a solid base of technology upon which to build, although the teachers did need additional access to, and supports for, the more specialized pieces of equipment, such as the sensors and probes that were a target of this professional development.

III.3. COVID-19 Response

The COVID-19 pandemic impacted education across the state of Florida, and participants in the EQuIPD program were no exception. Every aspect of education was changed to accommodate the unknowns in spring 2020. Then, in fall 2020, teachers, parents, and students had to prepare to attend classes in one of three classroom settings (i.e., all virtual learning, all in-person learning, or hybrid). The mode of student attendance (how they received instruction), the physical environment of the classrooms and instruction, and assessment of student progress were developed with guidance from the Governor of Florida and the Superintendent of the Florida Department of Education (FLDOE).

On March 9, 2020, the governor declared a state of emergency in Florida—Executive Order 20-52–Emergency Management–COVID-19 Public Health Emergency (later extended several times through November 3, 2020)—and schools closed in March 2020 for an extended spring break. On March 17, 2020, the Florida Department of Education ordered public and private K–12 schools to remain closed through April 15, 2020, encouraging schools to provide online instruction or other methods of distance learning.[5] The Department of Education then extended online learning format on April 18, 2020 through the end of the 2019–20 school year (June 3, 2020).[6]

All EQuIPD districts provided three reopening plans based on a template provided by the FLDOE: (1) all schools open, brick-and-mortar five days a week; (2) students participate in synchronous learning online through their home school (most districts required a semester long commitment if parents chose this option); and (3) students enroll in virtual school, with asynchronous learning (this required students to unenroll in their home school). As the school year began, districts allowed parents/guardians to make an attendance choice based on their family's situation. All schools began the semester with plans for students to attend in person, with COVID-19 testing protocols and quarantine and remote learning options if students or teachers tested positive or were in contact with COVID-positive staff or students. Sick or quarantined students would learn remotely from home; teachers were expected to be able to transition between brick-and-mortar and e-learning as COVID-19 rates changed and attendance fluctuated. Several teachers in the EQuIPD project taught online through their district with synchronous classes and combined online and face-to-face classes. There were some EQuIPD teachers that resigned their positions with their districts and taught through the Florida State Virtual School program.

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[5] https://www.fldoe.org/newsroom/latest-news/florida-department-of-education-announces-additional-guidance-for-the-2019-20-school-year.stml

[6] https://www.fldoe.org/newsroom/latest-news/florida-extends-distance-learning-through-remainder-of-academic-year.stml

III.3.1. School Opening

For the majority of EQuIPD districts, students began the 2020-21 year in person or through their school's online learning platform. Hardee, Hendry, Okeechobee, and St. Johns Counties started in-person attendance and remained flexible, with students moving to hybrid or online as necessary. DeSoto County Schools began online and phased in the in-person learning as conditions improved. Manatee had a hybrid setting with students attending in person two days a week (Monday and Tuesday, or Thursday and Friday, Wednesday was online for all). Palm Beach began the 2020–21 school year fully virtual, opening two weeks later, and implemented in-person learning as conditions allowed.

In Hillsborough County, district schools started with students online, e-learning. Beginning January 19, 2021, schools were to be face-to-face. However, when classes resumed in January 2021, many students remained online, but all of the fifth-grade teachers were required to be in school.

In Sarasota County Schools, all teachers were expected to be able to transition from in-person instruction to online instruction as needed based on local conditions. Teacher schedules were determined by district needs and could be full-time remote (fully online with priority given to teachers who had medical needs, certification, and seniority), part-time remote (one or more full periods of remote, with other sections of face-to-face), or concurrent teachers (who would teach remote and face-to-face learners at the same time). When school did start, many teachers had classes with both online and in-person students (hybrid).

III.3.2. Assessments

In March 2020, the FLDOE announced that the spring 2020 assessments were cancelled.[7] For the 2020–21 school year, Florida resumed administering the Florida Standards Assessments (FSA) and the Next Generation Sunshine State Standards in Science Assessment (NGSSS). However, accommodations were granted to provide school districts with flexibility needed to safely administer all required assessments while minimizing the impact on instructional hours. These accommodations included extending the spring 2021 testing window for each assessment by two weeks (Emergency Order 2021-EO-01). In addition, school districts were granted greater flexibility in using state assessment results for student promotion and retention decisions (2021-EO-02). Finally, school districts were exempt from having to report 2020–21 school grades or other school improvement ratings based on student assessment data unless the district tested 90% or more of its eligible students and requested to opt in to have their

[7] https://www.fldoe.org/newsroom/latest-news/florida-department-of-education-announces-additional-guidance-for-the-2019-20-school-year.stml

school-level performance ratings officially recorded and reported (2021-EO-02). Due to the ongoing impacts of COVID-19, the state did not expect districts to achieve 95% assessment participation for eligible students. As a result of these emergency orders, release of the results from the statewide assessments were delayed until July 2021.

III.3.3. Additional Services or Benefits

Other changes made in response to COVID-19 benefitted EQuIPD teachers. Florida teachers were able to receive fee waivers for teacher certifications that resulted in almost 125,000 free teacher certification exams,[8] saving stakeholders more than $16 million to ease the financial and professional stress on Florida's teachers. EQuIPD teachers reported participating in the certification program and using the waivers to gain certifications. Additionally, the FLDOE delayed teacher certification test requirements and will provide teachers with the opportunity to take those tests at no cost, so far eliminating the test costs for more than 22,000 teachers.

[8] https://www.fldoe.org/newsroom/latest-news/governor-ron-desantis-proves-once-again-florida-is-the-education-state.stml

Section IV. Program Activities

Over the life of the project, the EQuIPD professional development team accomplished the activities described in their proposal while also pivoting to accommodate the teachers' transition to online instruction that occurred in response to the COVID-19 pandemic.

To accomplish its goals of building teachers' expertise in system thinking and technology-enhanced inquiry, EQuIPD includes a set of services, or Key Components, that are identified in Column 2 of the logic model. Because the project was conceptualized as a two-year intervention, the Key Components were rolled out across the two-year period. The following section includes a description of the implementation of each Key Component and a discussion of FOI for each. The section concludes with the overall FOI summary and consideration of the project's sustainability.

IV.1. Professional Development

The first Key Component, Professional Development, included two inter-related activities, (1) Summer Bootcamps, which provided key content relative to the intervention, and (2) follow-up workshops that occurred throughout the school year, which were designed to build upon and reinforce what was learned in the Bootcamp.

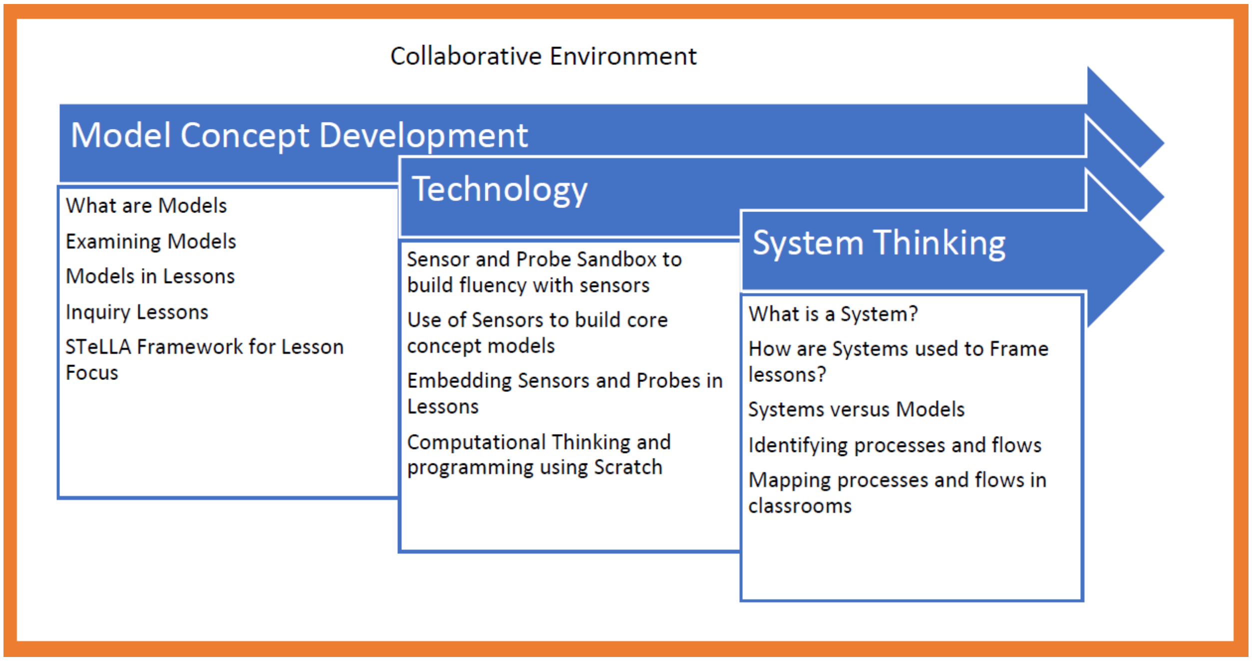
IV.1.1. Summer Bootcamp

A key part of the EQuIPD professional development was a Summer Bootcamp, which was offered to treatment teachers in summer 2019 and summer 2020. There was also a summer professional development for control and other non-participating teachers offered in the summer of 2021.

IV.1.1.1. 2019 Summer Bootcamp

Outside of a basic orientation and overview, the 2019 Summer Bootcamp was the first professional development activity for the teachers. There were six Bootcamps distributed across the various districts, and teachers could select the Bootcamp that worked best for their schedule. The 2019 Summer Bootcamps were intended to provide teachers with a high-level view of grant components and what they would be working on in follow-up sessions and with coaches throughout the year. The main components covered were system thinking, modeling instruction, process mapping, an introduction to sensors and probes, and authentic inquiry. Teachers participated in an open exploration time, entitled the "sensor sandbox," every day in order to build comfort and fluency with the sensors and probes. At the end of the week, teachers selected one probe manufacturer to work with for the semester. For modeling instruction, inquiry, and system thinking, teachers used lessons provided by partner BSCS Science Learning and then also assessed their own lessons for elements. Teachers were also introduced to a variety of software platforms used in this grant (e.g., TEAMS, Plectica, and Draw.io). Figure IV-1 presents the key elements covered during the Bootcamp.

Figure IV-1. Model Elements for Summer Training



In order to keep teachers engaged and in the building, breakfast snacks, lunch, and afternoon snacks were provided to teachers through funding from a grant partner. Teachers checked in at 8:30 a.m. and sessions ran until 4:30 p.m. Each teacher had a unique sign-in and sign-out process, and also had daily survey questions as to the quality of program and instructional practices delivered that day. Information collected was then analyzed in order to improve the quality of the trainings.

Exit surveys completed on the 2019 Bootcamp indicated that teachers, overall, believed that the content and materials were useful, relevant, and aligned to standards. They also reported that the quality of the instructional activities was very high; they saw a collaborative and respectful learning climate and believed that the instructors effectively modeled the targeted instructional practices. When asked about the perceived impact of the program, respondents, on average, agreed that they had increased their knowledge in the targeted areas and that they felt better prepared to integrate the targeted activities into their instructional practice.

IV.1.1.2. 2020 Summer Bootcamp

In 2020, because of the pandemic, the second Bootcamp moved from an in-person event to an online event hosted on Zoom. The virtual setting allowed the project staff to bring together people from different districts and allowed for grouping participants by grade level. There were five online Bootcamps that took place throughout the summer. Teachers could select the Bootcamp that aligned best with the grade level or content in which they taught. The sessions were divided into elementary, middle/high school, CTE, and an alternate for teachers that did not make the previous sessions. The elementary session was offered twice. The instructional coaches led the Bootcamps and took turns facilitating the various sessions.

The driving question for the 2020 Bootcamp was "How do we know a lesson is effective?" The teachers participated in both synchronous and asynchronous sessions from 9am to 5pm, Monday through Friday. As in Year 1, this was a five-day, 40-hour Summer Bootcamp, however, it was conducted entirely via the Zoom platform. Each day had a primary focus; areas of focus included: elements of effective lessons, inquiry, technology and data in effective lessons, video analysis to assess effective lessons, and workforce development in effective lessons. During the synchronous sessions, the teachers also participated in small group work and utilized Microsoft Teams for their Class Notebook. During their asynchronous work, teachers worked on assignments that often required them to use probes and/or sensors and other technology they had learned throughout the year. Teachers used probes and sensors throughout the academic year provided, via the initiative, from Pasco, Vernier, and Micro:bit.

The evaluation team conducted formal observations of this professional development. These observations indicated that sessions were well implemented, following principles for effective professional development. Across most sessions, there was time for reflection, small group discussions, and processing of key lessons. In interviews, teachers noted the value of reviewing videos to analyze instructional practice. For some teachers, the 2020 Bootcamp helped them bring the different pieces of the intervention together. As one teacher said,

> Last year, it was good. But I think I'm understanding more about the strategies like the model inquiry. I knew all about those and the types of questions to ask, because that's always in our evaluation. … But then, where we've actually broken down a lesson plan this time, and analyzed it day by day with each component, whether it was the STeLLA strategies or it was inquiry modeling, whether it was the use of technology. It's just bringing it all together now.

The virtual setting did pose some challenges for teachers as they found it difficult to be on the computer for so long. As one teacher said, "Earlier today, I thought, 'I just can't do this. I can't keep up.' It's just, I know we need that eight hours in every day, but eight hours in front of a computer is an extremely long time." The teachers reported they were learning a lot but felt overwhelmed with the amount of time spent on the assignments without a "real" break.

IV.1.1.3. 2021 Summer Bootcamp

The Summer Bootcamp in 2021 was very different from the first two years. In the final summer of the project, using a "train-the-trainer" model, intervention teachers provided professional development for the control teachers and other teachers in the districts served by the project. In groups of two to four, intervention teachers prepared and led a 2.5-hour session on one of the focus topics, typically incorporating instructional strategies they learned over the previous two years and used in their own classrooms. Intervention teachers were expected to facilitate this session four times during the summer, and attend four different sessions led by other teachers, all delivered over Zoom. Control teachers were expected to attend eight different sessions—one from each of the grant goals—with a total of 20 hours of synchronous instruction and additional assignments for asynchronous work. These sessions were not sequenced to create a coherent "program," but were stand-alone sessions. They covered all the focus areas targeted by the project. Some of the sessions were led by the project PI and coaches. Sessions provided during the 2021 Bootcamp are described in more depth at the end of Section IV, which focuses on sustainability.

Evaluators observed seven sessions conducted by intervention teachers, distributed among teachers of different grades and subject areas. The observed sessions were considered well implemented and of high quality. During the sessions, the instructors provided a good overview of the tools that teachers could use to enhance classroom discussions and used Zoom's various capabilities, like chat and breakout rooms, to increase participants' engagement, as well as Teams' affordances for collaborative work among participants. Overall, there was good modeling of using various kinds of technology for online instruction, as well as modeling of a variety of inquiry-based strategies, including independent reading and summarizing information, discussion of content with peers, and reflection on how to use new strategies in the classroom.

IV.1.2. Follow-Up Workshops

To reinforce and expand on the content learned in the Summer Bootcamps, the professional development team offered a total of four Saturday or evening follow-up sessions to each district annually.

IV.1.2.1. 2019–20 Follow-up Workshops

In the 2019–20 academic year, there were three rounds of five Saturday workshops offered to teachers, organized by district, and one round of five Saturday workshops offered to teachers by target audience. The first three Saturday sessions were held in person, and the last was held virtually due to the pandemic. Each teacher was expected to attend one workshop from each round.

Topics covered during the workshops for the first Saturday session included: (1) the elements of inquiry, (2) the definition of models and the process of model development in the classroom, and (3) sensors and probes. Topics and activities for the second set of Saturday sessions included: (1) model mapping (e.g., creating storylines); (2) model inquiry/5E model (e.g., examining the essential elements for inquiry); and (3) questioning and questioning ecology (e.g., determining when "probe, elicit and challenge questions" are using in lessons). Saturday session #3 topics included: (1) recap of inquiry model stages (e.g., Elicit, Develop, Deploy, Refine) and (2) the relationship of modeling instruction and STeLLA strategies (Science Teachers Learning through Lesson Analysis; Taylor et al., 2017). Participants were asked to rate the quality of the Saturday workshop after each session. Participants reported high levels of satisfaction with the workshops, with ratings increasing between the first and second round of workshops.

Because workshop #4 occurred after schools closed due to the pandemic, it differed from the first three sessions in terms of learning format and structure. Session #4 was offered online, via Microsoft Teams, in three one-hour blocks, with instruction grouped by grade level. All the sessions were guided by four overarching goals: (1) deepen understanding of model development within an inquiry-based lesson in any subject area; (2) enhance understanding of the essential elements of an inquiry-based lessons; (3) increase ability to use and incorporate technology to assist in supporting the model concept understanding; and (4) enhance ability to use questioning strategies to assist in supporting the concept model understanding.

During the interviews, teachers were asked about the follow-up workshops. Nine teachers shared that the workshops were beneficial for a variety of reasons: they were hands-on, teachers got a chance to work on grade-level specific curriculum, the sessions were relevant, and the sessions provided more depth into all aspects of EQuIPD. Six teachers spoke about the relevance. One teacher stated,

> We are divided into different areas, as far as skills that we need, it could be model development, it could be technology, it could be system thinking … we are exposed to different activities that will help us to better grip the concept and build our skills as teachers.

Teachers valued the professional development because they were able to focus on their needs and make immediate adjustments to their classroom instruction.

IV.1.2.2. 2020–21 Follow-up Workshops

In the 2020–21 school year, there were four online follow-up workshops, some conducted on Saturdays, and others on weekday nights, with the evening workshops consisting of two sessions. The 2020-21 follow-up workshops differed in that they were not a "single session" workshop where all the work was delivered and completed by teachers on the same day. These workshops were held in alternating asynchronous and synchronous sessions. One PD workshop was broken into two 2.5-hour "live" sessions via ZOOM where all participants were online together and three 1-hour asynchronous sessions for pre-, mid-, and post- PD workshop reflective and application work.

Two workshops were conducted in fall 2020, and two others took place in spring 2021. The fall sessions were focused on questioning as formative assessment and covered questioning strategies and concept modeling. The second session covered design thinking. One technique used in these sessions was watching pre-recorded lessons and critiquing them as a group to show teachers how to use the elements of EQuIPD, and then recording their own classroom lessons.

In spring 2021, the two follow-up workshops prepared teachers to lead their own professional development over the summer, as part of the grant's "Train the Trainer" model. The first session examined elements of effective professional development. According to a coach, it focused on understanding, "What made a good PD? What was engaging? What was strong? How do you get your learners focused and follow up with them?" The second spring session got teachers started on building their own professional development. Prior to each session, teachers had asynchronous assignments to complete. In interviews, several teachers remarked that the Year 2 follow-up workshops felt like a coordinated curriculum that set them up for the professional development that they provided over the summer. One teacher described the workshops as "baby steps" leading them to be professional development providers, and another said, "It progressed pretty naturally." Another teacher elaborated, saying that "The fall and the spring professional development, they went hand-in-hand. It prepared us in the fall and geared us up for spring." Not all teachers attended the follow-up workshops. In interviews, two teachers said that during the school year they were focused on teaching and didn't have time for extra activities.

Teachers who were interviewed were overwhelmingly positive about the Year 2 follow-up workshops. Several teachers noted the quick shift to a virtual format in spring 2020 and appreciated that, into the following year, trainings remained organized, engaging, and thorough, with minimal disruptions due to technology problems. As one teacher said of the EQuIPD workshops,

> Everything works. It's high quality, there're no issues. If there is, there's an immediate resolution. I think that's what impressed me the most. They've kept it fluid, in the pandemic, as if nothing changed, because we would be meeting in person and going to these workshops and doing all this, but it was like nothing changed. And I don't think the quality of what they did for us was affected.

Teachers also noted some positive changes in the professional development provided in Year 2. Some thought the content was more applicable the second year, either because they were getting more comfortable with the EQuIPD model or because the coaches had an improved understanding of what was realistic to do in a classroom. In addition, some teachers appreciated getting to do trainings with others from around the state who were teaching the same content or the same grades. One teacher explained that, "Meeting people from all over the state and [in] my content area and collaborating with them and getting to see what they do, I thought that, in some ways, that was more meaningful to me."

As a result of the program's professional development, several teachers reported improvements in their skills related to planning and preparing lessons based on curriculum standards and that facilitate deeper learning. One teacher explained learning the EQuIPD model as an iterative process, saying,

> Each time we went through a lesson, it was more to kind of add another layer or another leg on that model that is another way to essentially unpack the standards so I can understand in my own head, so that I can present, and present it in an easier-to-understand or a more student-focused or learner-focused method. … How can I design an assignment or an activity where the kids get that understanding?

IV.1.3. Fidelity of Implementation for Professional Development

To assess the FOI of Professional Development, the evaluation team examined two indicators of participation: attendance at the Summer Bootcamps and at the follow-up workshops.

Each teacher was expected to complete 85% of the Summer Bootcamp. In 2019, 102 teachers (all program participants) met this threshold. In 2020, 82 participants remained in the program and met this threshold. The Summer Bootcamp attendees were then used to identify the FOI participants for the academic year that immediately followed.

Regarding follow-up workshops, the expectation was that teachers would attend and complete all four sessions offered. Of the 102 treatment participants assessed for FOI in 2019–20, 76 (75% of participants) attended all four workshops. Participants were counted as "in attendance" for these in-person sessions if they attended the workshop; there were no asynchronous requirements for these workshops. For the 2020–21 school year, participants were only counted as "in attendance" if all associated session coursework (synchronous and asynchronous) was complete. Of the 82 treatment teachers assessed for FOI in 2020-21, 16 (20% of participants) attended and completed all parts of the four follow-up workshops and completed the asynchronous reflective work assignments. The asynchronous reflective work was added to the workshop expectations when the program moved to a virtual professional development delivery model during COVID-19. This change was made in an effort to reduce the number of hours the participants had to be online in a live, virtual workshop. A majority of the teachers attended the sessions, but many failed to complete one or more of the asynchronous reflective work assignments that followed the workshop; in these cases, the teachers were classified as not “completing” the workshop in full even though they attended the live session. Table IV-1 shows the number of participants and the percentage of teachers who attended at least four follow up workshops in both years of implementation.

Table IV-1. Teacher Participation in Follow Up Workshops, Year 1 and Year 2

District	2019–20		2020–21	
	N	% Attending & Completing all 4 Workshops	N	% Completing all 4 Workshops (Synch & Asynch)
Total	102	75%	82	20%

As the table shows, there was a significant decrease in the percentage of teachers attending all four sessions in 2020–21 school. This was primarily due to the format of the follow-up training in 2020–21 and the requirement to complete asynchronous work outside of the synchronous session. Analysis shows that nearly 70% of teachers attended 85% or more of the “live” portions of the professional development; however, many teachers did not complete one or more of the asynchronous assignments necessary for being considered as workshop completers.

IV.2. Professional Development Resources

Over the last two years, numerous resources have been made available to teachers in the project to support the use of inquiry and technology in their classroom practices. Microsoft Teams was introduced to teachers during the first Summer Bootcamp in 2019. This was a secure workspace where teachers could ask questions and get a response from anyone in the project online community, in a private space to allow teachers to speak freely. Resources available to teachers in Teams included sample lessons posted by teachers, descriptions of technology, examples of models, examples of students engaged with technology, photos from field trips, and additional outside training or grant opportunities. Generally, the instructional coaches posted the majority of the materials; in addition, coaches used Teams to document activities and share resources from all training sessions.

Initially, many teachers struggled with Teams. In some districts, Chromebooks were provided to teachers and students, which were not compatible with Microsoft products. Similarly, some districts had contractual obligations to Google, and teachers needed to circumvent their school technology in order to use Teams. Towards the end of Year 1, however, teachers described using Teams more than they had earlier in the project.

During Year 2, Microsoft Teams became an integral part of the training sessions. Teachers were able to find all their materials there; in addition, it was often used as a workspace during the professional development sessions. In interviews, teachers shared they were using the templates provided by the project. As teachers transitioned to online or hybrid classrooms, additional tools were shared, and the project PI and instructional coaches found more resources for those that needed them.

Overall, teachers report they found the professional development and resources useful. One teacher stated they now see the connections between the professional development and resources,

> Now that I'm in the second or third years of the program, I'm using them. I use a lot of their templates; I use everything that they gave me. Everything that we're doing [in] this program is becoming very, very useful. At the first year, you're understanding it, you're getting it, you're dealing with your school, and then you're doing this. But now, everything is starting to fall in place. And I use a lot of the resources. Everything that they provide me, I use in my class. … I use a lot of the inquiry and a lot of the model-based activities and things for my classes

IV.2.1. Fidelity of Implementation for Resources

To assess the FOI of Professional Development Resources, the evaluation team examined one indicator: whether the program developed and launched online resources. Across both years, the program shared resources and information via Microsoft Teams and developed and launched a project website. In the Teams platform, materials from all the professional development sessions were available, including PowerPoints, agendas, handouts, and participants reflection journals and individual/group activities. Given the activities completed in both years, this expectation was met at the project level.

IV.3. Technology Resources

Early in the grant, the program team discovered that many teachers did not have access to the technology needed for the grant, specifically sensors and probes. As a result, the project PI ordered a variety of hardware that teachers could check out and use. During Year 1, the grant provided temperature probes, motion sensors, light probes, gas probes, velocity cars, dongles, Spark Tablets, Pasco Sparks, Styrofoam balls, hulahoops, and calculators, providing access to products from Vernier, Pasco, Sparkview, Micro:bit, EZLink and Arduino. These products were highlighted during the Summer 2019 Bootcamp, which included visits from vendors and time to explore the technology. Based on project records, 99% of the participating teachers utilized the hardware during the first year.

COVID-19 precipitated a shift from an emphasis on hardware use, to also training teachers how to use various software and apps like Scratch, Flipgrid, Photoshop, Draw.io, Google Jamboard, Google Drawings, Micro:bits and Minecraft. Despite this shift in focus, approximately 75% of participating teachers checked out hardware during the 2020–21 academic year (Year 2). One teacher shared their experience with the shifting focus,

> Because we weren't necessarily going to be in class or we didn't know, so instead of having the technology that we have in the class, the Vernier Probe, to the Arduinos, or the micro bits, or what have you, it kind of became, what kind of virtual tools can we use to hold our classes for A, for the distance learners or B, for the students who are in quarantine but then also kind of have it incorporated into class. And I thought they did a really good job of their professional developments, just having us use the Jamboards or having us use the…MentiMeter.

The survey data looked at the extent to which teachers had technology available to them. As shown in Table IV-2, at baseline, almost all teachers reported having a computer for their own use, basic software, and projection hardware. Many also had easy access to computing devices for students and digital recording devices. The remaining types of technology were less frequently available. Regarding technologies targeted by the intervention, in Year 2, treatment teachers were much more likely to report access to sensors and probes, programming software, and electrical platform technology compared to control teachers. They were also slightly more likely to report having digital recording devices. There were no changes in access over time or between treatment and control for the remaining technologies, which were not targeted by the grant.

Table IV-2. Availability of Technology in Classroom

Question Stem: Describe the availability of different instruments and technologies you might use to teach your students.	**% Reporting Available or Always Available (Baseline) (N =146)**		**% Reporting Available or Always Available (Year 2) (N = 146)**	
	Treatment	**Control**	**Treatment**	**Control**
Sensors/Probes for collecting data (for example, temperature, pressure, motion, or biological probes and sensors).	37.7%	31.0%	80.0%***	28.6%
Programming software (for example, Scratch).	62.5%	52.4%	92.7%***	48.4%
Electrical platform technology (Arduino, Breadboard, capacitors).	20.0%	5.8%	40.0%	13.5%
Digital recording devices (camera, smartphones, iPad, etc.).	84.9%	80.2%	93.0%	80.8%
Computer for the teacher, for instructional purposes or administrative purposes.	100.0%	100.0%	98.3%	100.0%
Software for data collection and analysis (for example, Excel, Microsoft Word, or Google docs and spreadsheets).	100.0%	98.8%	98.3%	97.7%
Software for presentation (for example, Adobe, PowerPoint, or Google slides)	100.0%	100.0%	100.0%	100.0%
Programmable robots or devices.	42.1%	38.4%	45.7%	36.5%

Question Stem: Describe the availability of different instruments and technologies you might use to teach your students.	**% Reporting Available or Always Available (Baseline) (N =146)**		**% Reporting Available or Always Available (Year 2) (N = 146)**	
	Treatment	**Control**	**Treatment**	**Control**
Projection or presentation hardware, e.g., Smartboard, document camera, LCD projector.	98.3%	96.5%	93.2%	98.8%
Technology for visually enhancing phenomena (microscopes, telescopes, etc.).	65.1%	64.3%	56.0%	59.2%
Computing devices for student use, such as laptops, Chromebooks, or iPads *(at least one device for a group of 4 students up to one device for each student).*	89.8%	94.2%	94.8%	95.3%

Response options: 1=Always Available in My Classroom; 2=Available on Request; 3=Not Available or Don't Know

*** Difference between baseline and Year 2 significant at .001.

The project also provided optional training on the specific technologies targeted by the grant. For example, during summer 2020, participants received training on: e-portfolios, Canvas, LOOM, EDpuzzle, and Padlet among other topics. During the academic year, participants received additional training on Arduino, Vernier, Scratch, Scratch Junior, Micro:bit, and Pasco.

Some of the teachers believed that the technology and training they received from EQuIPD helped them to pivot during the pandemic because they had already gotten a good foundation in certain technologies. One teacher shared how they were able to provide technology hardware to students learning from home.

> What I used was Micro:bits this year. Before I was using the sensors and probes for my science room, but then I got these Micro:bit kits, and those were the ones that I use. … And [for] the few students [who] were at home, I was able to get [kits to] them. They were able to pick those up. They were able to use them at home. And so that worked out well. It was something all students could participate in because we were [a] hybrid classroom.

Another teacher shared how they had originally planned to use Photoshop for coding but switched to doing Scratch coding and Minecraft for Education because the students were home. Two teachers said they worked with their coach to introduce technology in their classroom. One teacher shared how the coach helped them introduce coding during online school using Scratch and Minecraft for Education. Another teacher stated,

> A lot of it was support. That emotional support too, with everything that happened this school year. Dealing with COVID on top of everything else … he would help me think of ideas of how to teach those standards and how to try to get technology involved. What I've used that I've learned through the grant, Scratch Jr and things like that. So just

trying to figure out how we could spice up those lessons and to make it more invigorating for the kids.

IV.3.1. Fidelity of Implementation for Technology Resources

FOI for Technology Resources was examined through three indicators: (1) assessing technology needs, (2) technology resources made available, and (3) training on educational technology, which was added for the 2020-21 school year. The technology needs were assessed during the first year of implementation. Regarding the second indicator—the availability of hardware and/or software technology resources—participants could check out hardware throughout the two years of the project. The instructional coaches maintained a sign-out sheet and made available technology, including temperature probes, motion sensors, TI calculators, and a range of Arduino Grove and Micro:bit STEM kits. The third indicator—training on educational technology—was defined as training made available on software and hardware (e.g., sensors and probes). During summer 2020, participants received training from the project coaches and a team of University of Florida graduate students. Participants received training on: eportfolios, Canvas, LOOM, EDpuzzle and Padlet among other topics. During the academic year, participants received additional training on Arduino, Vernier, Scratch, Scratch Junior, Micro:bit, and Pasco. For the third Key Component, FOI was met in both years of implementation.

IV.4. Instructional Coaching

As stated in the project design, the material presented in the Summer Bootcamps and Saturday (follow-up) workshops were intended to be reinforced by the EQuIPD instructional coaches. The instructional coaches were expected to provide one-on-one coaching and to "(a) work with teachers to … aid in implementation of the sample lesson modules, (b) [assess] student work products, and (c) [assess] effectiveness of system thinking-focused lessons" (SEED Grant Narrative, 2018, pg. 8). The coaches were expected to work with teachers at least twice a month during their school day and facilitate the follow-up sessions and Summer Bootcamps.

The original intent was to have coaches on board by the time of the first Summer Bootcamp in 2019. Although three coaches were hired in summer 2019, those positions were not in place by the start of Bootcamp. All remaining coaches were hired over the course of the fall. As of December 31, 2019, all seven coaches had been hired. These coaches came from a variety of backgrounds, with five hired as full-time employees and two hired as part-time coaches. Two of the seven were district employees (one for Hillsborough and one for Palm Beach), while the remaining five were University of Florida employees. The coaches and their areas of expertise are shown in Table IV-3.

Table IV-3. Coaches

Coach	Expertise
CD (district employee)	Science
SK	Literacy/Reading
JC	Engineering
XR (part-time)	Career and Technical Education
MH (part-time)*	Gifted Education
KD	Engineering
LA (district employee)	Elementary, Middle Grades Math

*After the program coordinator left in January 2020, MH was moved to serve as facilitator for the coaches. This position was ended in June 2020 and six coaches remained in summer 2020.

From summer 2020 until the final summer of the project, six coaches continued to provide all services as described in the project design.

IV.4.1. Coaches' Preparation and Support

Coaches received extensive training and support to do their work. In summer 2019, the three newly hired coaches received training on the project technology and how to be coaches. New coaches were provided similar training in the fall as they were hired. All coaches participated in a book study of *The Art of Coaching* (Aguilar, 2013). Coaches also received in-depth training on STeLLA, a research-based professional development model in which teachers build their expertise in high-leverage instructional strategies through video-based lesson analyses. This WWC-reviewed model is one of the strategies used to support the professional development in this grant.

Through the end of the project, coaches also continued to receive ongoing, weekly support from project leaders—one meeting per week was devoted to the project PI strengthening coaches' knowledge of all project strategies (e.g., system thinking, modeling, inquiry, technology), and another meeting was devoted to logistical issues, sharing of resources, and solving problems coaches encountered in their day-to-day work.

In summer 2020, coaches praised the training they received, saying that they felt a lot more confident in their coaching abilities compared to in the beginning of the grant. For example, one coach said the training "helped me tremendously in strategically planning [professional development] and how to support the teachers and even supporting in my own coaching, like strategies to navigate some situations." Even after working for many years as a coach, another coach stated, "This is the most training I've had on coaching." A third coach described a book study they did as, "like a master's class in education" and added that "the book studies were super valuable in that they were retraining me about things that I thought I knew pretty well." Two coaches added that the tools coaches received were very helpful in their work. These tools included an implementation rubric, EQuIPD model, and a coach evaluation rubric.

At the same time, after the six-week-long 2020 Summer Bootcamp, when asked about their current state of program understanding, coaches indicated they “learned a lot and [are] still learning.” One of them characterized their knowledge as a “base of everything,” adding that they were learning how to apply it. Three coaches commented that their knowledge of system thinking was still shaky. Another coach said that their knowledge has been piecemeal so far, and facilitating professional development helped them to integrate pieces together. When asked about additional supports they needed to do their job effectively, coaches most frequently referred to two areas: (1) their understanding of certain program components and (2) logistical aspects of coaching.

During the second year, coaches did not receive as much formal professional development, although they did meet regularly. When asked about additional supports needed to do their job, three of the coaches expressed frustration with the amount of record-keeping and other paperwork required. One coach noted that with the turnover of project personnel over the course of the grant, the coaches ended up taking on more paperwork over time, which cut into their time available for coaching. Another noted that in order to scale the project, the coaches would need more support with things like emailing reminders to teachers and managing projects. Coaches also shared frustration about the developmental nature of the program, as it meant the expectations for their jobs changed over time and that communication with teachers was not always as clear as they would have liked. They believed several aspects of the program would run more smoothly once the project model was solidified.

IV.4.2. Coaching Teachers

The three coaches who were hired in the summer of 2019 began scheduling meetings with the teachers starting the last week of August 2019 and commenced classroom visits in September 2019. Other coaches started at various times throughout the fall. Due to the delay in hiring coaches, not all teachers were assigned a coach until late October 2019. As coaches were hired, loads were re-balanced to ensure that no one coach served more than 20 teachers.

Coaches reported spending fall 2019 (project Year 1) getting to know the teachers with whom they would be working, building rapport, and understanding what teachers wanted to achieve related to EQuIPD. One coach described how they set expectations about the coaching activities with teachers early on in the project,

> I'm not coming in here and giving [teachers] all the answers, I'm coming in here and finding out what [teachers] think and then [1] helping them see other perspectives and ways of doing it, [2] finding the way to other ideas and trying things, and [3] seeing if they can improve their practice. And that it's not something as simple as, "Oh, use wait time, count to five seconds every time and everything will be better." It’s little questionings…what can we learn about questioning? How can you try it? What

> resources do we have? Let's watch some videos and analyze [how] other teachers use questioning. All of that, I've learned that I can't go in and just give an easy fix. Teachers have to make the change, I can just guide them.

After those initial meetings, coaches began working one-on-one with teachers. Each coach had responsibility to work with approximately 20 teachers, meeting with each teacher every other week. Coaches reported spending 40 hours per month working with their teachers. During this time, the coaches would make sure the teachers were aware of program activities and then followed a work plan that would have the coaches and teachers focus together on one part of the grant. A teacher described the coaching session,

> We just kind of discuss what I've been doing, and then she just provides me with resources. We just talk about challenges and things that have worked well, things that haven't, things I need improvement on. And then she always has something for me that could help me out. She's been awesome. And then setting up field trips and all that stuff too. [My coach] provides instructional resources, resources like, on inquiry, whatever. The last time we met, we talked about discussion and questioning, and that's a big one for me. That's another area that I could use more improvement on. Just whatever area I need more help in, or whatever she came across, … she shares it with me. So, just cover a little bit of everything.

A substantial amount of the coaches' work focused on process mapping and system thinking, areas with which the teachers reported struggling. One teacher described how her coach supported her in both system thinking and technology,

> [We] organized some plans so we can incorporate [technology]; she helped me set up the laptops so I knew exactly what I was doing. When we went over the lesson plan, she went through that with me to make sure she helped explain the concept mapping and the system thinking. So, I mean, [we] would go back over what we had done on our Saturday session to make sure we understood it completely. And then if I need her during the week, and she's got a free day, she will come and stop by and help.

As teachers became more experienced with EQuIPD content, coaches described how teachers began to suggest EQuIPD content and knowledge that they would like to work on with coaches. While the majority of the time coaches spent with teachers was one-on-one, outside of class, teachers and coaches described opportunities for coaches to observe and provide feedback on their teaching. These observations were separate from the one-on-one coaching sessions. One coach said,

> I do have some times where [teachers] want me to come in. 'Can you observe this?' Or I say, 'Do you mind if I come in? I'm here. I've got an hour to just watch away. Can I just come in?' They're like, 'Sure.'"

As schools began to switch to online learning in March 2020, coaches assisted teachers in developing lessons to engage students and continue with the technology. They also offered supplemental workshops on virtual learning technologies, such as Flipgrid and Google classroom.

In the second year of the project, coaches met with teachers online due to the COVID-19 pandemic. While some teachers missed the in-person visits from their coaches, coaches and teachers found there were some advantages to the online meetings. One coach shared that without the distractions and delays that are inherent in visiting a school, their coaching meetings were more focused and efficient:

> I feel like it was even more focused because there were fewer distractions. The school distractions are what they are. So for example, my entire coaching time would be maximized versus you got to go to the school, wait for them to contact the teacher. They got to scan you in, let you jump through all those hoops. … As opposed to, we just log right in and got right to it. … It just seemed absolutely more focused when it was just doing it by virtual.

And as with the previous year, the coaches' goal was to meet with teachers two times per month; however, some teachers reported scheduling more frequent meeting with their coach to get additional support, which was more feasible with online meetings. Several teachers noted that having the support of the coaches was particularly valuable during an unusual and unpredictable year. As one teacher explained, many of her interactions with the coach were about "just checking in, making sure I was doing okay. Especially in this year, because we were wild, wild west."

Many teachers had to adapt their lessons for teaching during the pandemic, whether they were teaching classes online, in a hybrid format, or in person, but with COVID-19 protocols (e.g., prohibitions against students sharing science equipment). They often turned to the coaches for help with making the necessary adaptations, in particular, how they could integrate more technology (e.g., web and computer applications) into their lessons and make their lessons more engaging for online learners. One teacher shared about meetings with her coach,

> We would go over, and he would help me think of ideas of how to teach those standards and to try to get technology involved. … So just trying to figure out how we could spice up those lessons and to make it more invigorating for the kids.

For their part, coaches took different approaches to what to cover during the coaching sessions. Two coaches directed their coaching by asking teachers what their needs were, or what they wanted to focus on, relative to the EQuIPD grant goals. One coach explained that when coaching a teacher she "meets them where they're at," elaborating,

> I elicit a little bit and dig in, but oftentimes, more often than not, it's not like I come to the table with, “All right, this is what we're doing during coaching.” It's more, “If you're freaking out about this, or you're feeling like we're about to miss an opportunity for a great lesson, let's talk that through a bit.”

Two other coaches spoke of using coaching time to reinforce what was covered during the follow-up workshops, noting that teachers had a better understanding of the professional development material when the coaches helped them apply it to their own classroom.

IV.4.3. Feedback about Coaching

The evaluation team administered a survey to teachers each January to collect feedback about coaching and other project activities. The full results were provided to coaches and project staff; highlights are noted here. In Year 1 (January 2020 administration), 79 teachers responded to the survey. All but one reported working with a coach at least once so far that year (August 2019 to January 2020), and six had met with their coach more than 10 times at that point. In Year 2 (January–February 2021 administration), 62 teachers responded to the survey. Of the responding teachers, five (8%) had worked with a coach fewer than 10 times so far that year (August 2020–January 2021), 35 teachers (57%) worked with a coach 10–12 times (which was an approximate average of two times per month at that point in the school year), and 21 teachers (34%) worked with a coach more than 12 times. Several teachers noted that they had a regular meeting scheduled with their coach, usually twice monthly, but that they would have additional meetings as needed.

The survey asked teachers to rate the quality of the coaching they received through several multiple-choice questions about their impression of coaches’ knowledge, the skills and topics they have worked on with their coaches, and the impact of coaching. In Year 1, most teachers rated their coaches as sufficiently knowledgeable, with the lowest ratings occurring in core content knowledge in teachers’ subject areas. In Year 2, almost all teachers considered their coach to have strong knowledge of the skills and topics emphasized by EQuIPD, but also in their field’s core content knowledge.

Teachers were asked to indicate the extent to which they believed their coach was helping them improve in the areas targeted by the project. While the areas on which teachers believed coaches had the greatest and least impact were largely consistent from Year 1 to Year 2, the percentage of teachers choosing the most positive response option, *I am greatly improving because of my coach*, increased substantially from the first year to the second. Table IV-4 compares responses for Year 1 to Year 2. Inquiry-based instruction, concept modeling, and questioning and student discourse were all areas most frequently cited has being greatly impacted by coaches both years; lesson planning was also a frequent choice in Year 1, and use of technology in instruction and teaching in an online/virtual environment (new to the scale in Year 2) were also frequent choices in Year 2.

Table IV-4. Perceived Impact of Coaches on Areas Targeted by EQuIPD

Areas Targeted by EQuIPD	Year 1 (N = 75-76)			Year 2 (N = 60)		
	% of Respondents Choosing "Greatly Improving"	Mean	SD	% of Respondents Choosing "Greatly Improving"	Mean	SD
Inquiry-based instruction	25%	2.67	1.02	63%	3.52	0.72
Concept modeling	21%	2.57	1.04	62%	3.47	0.77
System thinking	17%	2.44	1.03	52%	3.35	0.80
Questioning and student discourse	20%	2.41	1.11	67%	3.57	0.70
Process mapping	18%	2.39	1.06	60%	3.43	0.79
Lesson planning	20%	2.39	1.10	60%	3.45	0.77
Integration of real-world problems	16%	2.32	1.06	55%	3.38	0.80
Student collaboration	19%	2.31	1.14	57%	3.38	0.85
Use of technology in instruction	17%	2.29	1.12	62%	3.45	0.81
Probes and sensors	11%	2.12	1.08	32%	2.85	1.01
The engineering design process	17%	2.08	1.15	42%	3.20	0.82
Teaching in an online/virtual environment	n/a	n/a	n/a	63%	3.42	0.89

Response Options: 1 = My coach has not yet helped me in this area, 2 = I am improving a little bit because of my coach, 3 = I am moderately improving because of my coach, 4 = I am greatly improving because of my coach

During interviews in winter and summer 2020, most teachers were very appreciative of the coaches and their work. One teacher described how the coach helped her make sense of everything she is learning in the workshops. Another teacher appreciated the focus that the coach brought to the sessions,

> I like that we choose to focus [on] a specific area of improvement rather than bounce between all areas and pretend like we have done a good job. By focusing on one area at a time, I can truly get good at it.

In the second year of the project, interview feedback about coaches was entirely positive. Teachers reported that the coaches were supportive and responsive to their requests. One teacher praised the coaches, saying,

> They've just been a constant source of support. … They [are] very easily accessible, very easy to contact, quick responses. [My coach], she's always checking in, she's very detail-oriented and provides a lot of resources and examples of models and whatever I need, they're there to provide it. They're there to provide the resources, and support. And to me, that's the most important thing.

Another teacher appreciated that his coach remained focused on his specific goals and valued the close relationship that they built.

In summary, despite the delayed start of coaching, over the project duration, coaches completed all their planned activities, including working with teachers individually twice a month, and facilitating the 2020 Summer Bootcamp and follow-up sessions both years of the project. Coaches played a crucial role in helping teachers during the pandemic, training them on providing online and hybrid lessons. According to both teachers and coaches, coaches' expertise in focus areas of the project grew substantially over two years. As a result, in Year 2, teachers reported coaches' significant contribution to teacher's growth in these focus areas, more so than in Year 1 of the project.

IV.4.4. Fidelity of Implementation for Instructional Coaching

To assess FOI for the Instructional Coaching, the evaluation team examined two indicators: training for instructional coaches and instructional coaching provided to participants.

There was an expectation that coaches receive at least 20 sessions annually in technology, inquiry, coaching, and lesson planning. This included the twice-monthly coaches' meetings for ongoing professional development. EQuIPD program staff, external consultants, and home districts provided professional development that included asynchronous sessions, synchronous sessions, and one-day and multi-day intensive professional development. In Year 1, the seven instructional coaches were provided an average of 60 sessions. Through May 2021, the instructional coaches were provided an average of 65 training or support sessions. For Years 1 and 2, the coaches received more than the expected number of sessions.

The second indicator was instructional coaching for participating teachers. Each coach was expected to provide at least two days of coaching for each teacher, for each month of the school year. Because the coaching did not start until after school began in Year 1, teachers were expected to participate in 15 sessions of approximately an hour each (85% of the anticipated 18 sessions). In 2019–20, 71% of the participating teachers received that level of coaching. During Year 2, the goal was to have teachers participate in at least 17 sessions (85% of the anticipated 20 coaching sessions). For the 2020–21 academic year, 67% of the participating teachers met the goal. Table IV-5 shows the participation in coaching for the two project years.

Table IV-5. Coaching Sessions, Year 1 and Year 2

		2019–20			2020–21	
District	**N**	**Average # of Coaching Sessions**	**% of Teachers Receiving at Least 15 Sessions**	**N**	**Average # of Coaching Sessions**	**% of Teachers Receiving at Least 17 Sessions**
Total	102	15	71%	82	15	67%

IV.5. Teacher/Industry Interactions

According to the EQuIPD logic model, the program was supposed to provide teachers an opportunity to engage with STEM-related industries and take field trips to explore these industries in action. The industry interactions were intended to bring teachers and local workforce boards together through face-to-face and online interactions, and the field trips were intended to help teachers make connections between their curriculum and the workplace. However, the pandemic forced the program to go from in-person to virtual field trips; that change also limited the interactions teachers had with the organizations they visited.

IV.5.1. Field Trips

The purpose of the field trips was to provide authentic workforce applications of the content teachers were learning. The expectation was that teachers would then be able to use what they learned to help make better connections for their students. One teacher described her hope for the field trips:

> Another thing that I really like about the grant is that we're supposed to be on these field trips, getting business relationships with the community. … Because a lot of kids want to know, "Where am I ever going to use this?" And then I can say, "Look at, we have Flower's Bakery right there, and they use this sensor. And if you're skilled in this sensor, you could get a job with the training when you graduate high school.

Project records indicated that teachers from all but one district (Hardee) participated in field trips in the first year of the project. By the end of the 2020–21 academic year, records indicated that teachers from all but Glades participated in field trips (Hardee was no longer in the sample assessed for FOI in Year 2). In both years of implementation, the instructional coaches were responsible for organizing the field trips. At the beginning, some of the coaches reported facing challenges in finding local industries to host field trips, therefore, the number of field trips available varied by district. In addition, businesses often set limits on the number of people who could be a part of a tour group, which limited the number of people who could attend.

At the outset of the 2019–20 school year, field trips took place in person; participation was onsite at the field trip destination. However, due to COVID-19 restrictions, fieldtrips planned during spring 2020 were conducted virtually. Subsequently, in Year 2, the virtual field trip format remained in place due to continued limitations associated with COVID-19. Although the field trips were originally supposed to be in person, the virtual method of delivery helped to mitigate some of the earlier challenges relative to planning and teacher participation. For example, the online format allowed teachers greater ease of access, thus, multiple districts were able to participate at one time (as opposed to different field trips being offered by district).

When looking at the level of teacher participation in field trips, in 2019–20, the range varied from a low of zero to a high of 10 field trips through May 31, 2020,[9] and in Year 2, a low of zero to a high of 13. The expectation was that teachers would participate in at least seven field trips per year.

During fall 2019, onsite field trips were conducted in Hillsborough, Sarasota, and Palm Beach. The field trip sites were in a range of locations, such as a cybersecurity firm, a steel manufacturing company, art centers, zoos, and other natural resource centers. In interviews, teachers who went on the field trips reported enjoying them and learning about how sensors and probes were used. For example, after a field trip to the Wishing Tree (an art installation including 10,000 LED lights), one teacher wrote, “Seeing the technology that went into creating the Wishing Tree was inspiring. I didn’t even consider the engineers being able to modify the program from anywhere.”

After spring 2020, the program shifted the field trips to an online format, which greatly expanded the number of field trips that could be offered as well as the kinds of sites that teachers could visit. Regarding the virtual field trips, attendance records were maintained via Qualtrics, which allowed for tracking specific counts of those who attended. Three virtual field trips took place in May 2020 to a 3-D engineering company, the Oster Shake Lab-River Center, and the WAIF Gopher Tortoise Tracking with South Florida Wildlife Center.

All field trips between June 1, 2020 and May 31, 2021 continued to be virtual. Records indicate that 34 virtual field trips were planned during the year; they are shown in Table IV-6, along with the total number of teachers in attendance. Field trips are sorted by total teachers in attendance. Across the 34 field trips offered in Year 2, the number of attendees in a single field trip session ranged from 3 (“ERM Visits Busch Wildlife”) to 46 (“Prescribed Fire Burns”).

Table IV-6. Field Trip Summary June 1, 2020 through May 31, 2021

Virtual Field Trip	Total Participants	Virtual Field Trip (cont.)	Total Participants
Prescribed Fire Burns	47	Sweetwater Organic Farm	17
Aquaco Farms	38	Electro Mechanical Solutions	15
SAFRAN	36	Kano	14
Altek and Minds-i	34	JBT	13
Ringling Museum	34	zSpace	12
Corteva Agriscience	31	Atlas Core of Engineers	11
Water Quality Sampling at Wild Pine Lab	30	Using Tech to Advance Reef Science	11

[9] Additional virtual field trips were already being offered as of June 1, 2020; these are in the Year 2 reporting.

Virtual Field Trip	Total Participants	Virtual Field Trip (cont.)	Total Participants
Aidmics Biotechnology - uHandy Microscopes	26	MasterCut Tools	11
Arnold Prints	25	Southern Manufacturing Technology	10
Mangrove Research and Conservation	23	ERM - Lake Worth Lagoon	9
Boca Raton Ocean Rescue	22	Amalie Arena	8
Sea Turtle Ecology	22	Amazon	7
Seal Dynamics	23	Advanced Manufacturing & Robotics Center	6
Pioneering Underwater Camera Systems	21	Angari: Sharks Off Our Shores	4
Ajax Paving	18	Carlisle IT	4
Clearwater Marine Aquarium	19	Cranial Technologies	4
Arthrex	17	ERM Visits Busch Wildlife	3

Note. Attendance counts include only the 82 teachers meeting the criteria for inclusion in FOI analyses. In many cases, the number of teachers in attendance for the various field trips is greater than what is reported in this table.

Participants recognized that the field trips helped build their expertise relative to EQuIPD grant goals around the use of technology and authentic workforce development. Additionally, most teachers noted that they had learned something new. Overall, participating teachers found the experiences enjoyable and of value, particularly in terms of how they might be able to bring what they learned to the classroom to highlight real-work workforce connections with their students. For example, one teacher said,

> I am teaching coding, and there was an automatic testing machine [demonstrated during the field trip] that needed to be programmed to test water. Students can see how precise a program/algorithm has to be in order to perform all of the tests.

And in regard to a field trip related specifically to the field of engineering, another teacher said,

> I think something like working on the defibrillators is an interesting concept to share with my students who want to work in [the] medical [field], but often do not want to deal with blood. It will be interesting to show them the alternative—that they can pursue engineering and still work in the medical field in some capacity.

Teachers also reported gaining a lot of knowledge themselves about how sensors and probes were used in the real work. One teacher said, “I didn’t realize how many sensors and probes were used to test water quality, and it was fascinating to know that I could view this data on their website.” A teacher who visited a hockey arena noted, “The more field trips we go on the more I realize sensors and probes are used all around us. It was interesting to hear about how they use them to upkeep ice.” Another teacher commented about a field trip to Amazon, “The whole way they store & pack packages, [I knew that] sensors were involved, but not to this extent; the science and use of sensors to keep track [and organize] was breathtaking."

The switch to a virtual format proved advantageous in terms of logistics, because it centralized planning and gave more equal access to teachers (when the field trips were in person, their scheduling depended on a district's coach, and not all coaches planned or scheduled the trips, which meant that not all teachers had access). Another benefit expressed regarding the virtual format was that students could more easily replicate the experiences that the teachers had. For example, as one teacher said,

> But the thing is that those virtual trips, they can be used in the classroom. You can just either do it live or some of them were recorded that I was able to just play back for the students, clips of it. So that provided opportunities for our students to see things, places that they wouldn't be able to go to normally. That was a positive thing.

That said, during interviews some teachers reported that, while more field trips were offered, there were drawbacks to the format. One teacher stated,

> Before COVID, … we got to tour the site and we got to just speak with … the PR person, or whoever was gave us a tour, but he was very knowledgeable. That was probably one of my most interesting tours. [One of] the other field trips … it was online. I can't remember the name of it. I think it was over on the West Coast, but like I said, they don't really stand out as much as the ones that we were able to go in person.

IV.5.2. STEM-Industry School Partnerships

Early in the project, the project PI engaged industry partners at the project level, particularly around technology. For example, partners specific to sensors and probes were present at the 2019 Summer Bootcamps. Technology partners included Pasco Scientific, Vernier Probeware, Arduino, Pitsco, Microsoft, NBCLearns, Bluegrasset, Texas Instruments, BSCS, Florida High Tech Corridor, and St. Johns River Community College. All these companies provided free training, facilities, curriculum materials, software, and equipment discounts to the grant. Other partners included Invention Convention, and the University of Florida Extension Stations.

During Year 1, the project PI met, in person and by phone, with local workforce agencies within each of the project regions that provided the professional development team with skills needs assessments that the agencies had conducted. Although the local workforce partnerships were not fully developed as of the end of Year 2, teachers had begun to explore new industries through the field trips. In January 2020, EQuIPD held a teacher Broader Impact Day with vendor partners, Texas Instruments, Arduino, Pitsco, Pasco and UF Innovation Station. Over 100 teachers attended multiple sessions on this Broader Impact Day. Additionally, STEM vendor partners held summer training sessions for teachers in Florida as part of the EQuIPD summer training plans. These training sessions included Microsoft sessions for both teachers and districts, and NearPod training for teachers and coaches. In addition, Vernier, Texas Instruments, and Pasco made resources and materials available to Florida teachers as part of their response to COVID-19 and support of the grant.

During Year 2, the partnership efforts were either led by the project PI or instructional coaches. The STEM Industry-school partnerships were primarily with the Florida Advanced Technological Education (FLATE) and UF Innovation Station. FLATE provided trainings, field trips, and best practices. UF Innovation Stations in Pensacola and Melbourne shared best practices. The EQuIPD professional development team also met with Sarasota Libraries and the Suncoast Science Center to share grant best practices related to industry connections. The project PI also met with Texas Instruments, Pitsco, and Intel about grant industry partnerships. In January 2021, EQuIPD held two more Broader Impact Days for teachers with Texas Instruments as a vendor partner for mathematics teachers in districts within driving distance of the University of Florida. Over 40 teachers participated in one of these two trainings, attending sessions on conceptual models and the use of technology in mathematics.

When teachers were asked about their interaction with any of the STEM industry partners, they often responded that this was an odd year that did not lend itself to connecting with additional organizations. Because of COVID-19, one teacher said she found it difficult,

> Because of COVID, because of everything being so crazy this year, I wasn't able to do that. I would like to in the future. I did actually partner with UF, their Biomechanics program, [name] who reached out to me. And we did a virtual thing with the kids that the university, the students from the university planned all that and did that. [I don't know] if it was like part of a college project or what, but it was a three-day thing that they planned activities.

The survey provided evidence that teachers did increase their use of guest speakers from outside of the community. Table IV-7 shows the percentage of treatment survey respondents who reported hosting guest speakers from community organizations. As the table shows, that percentage increased from 29% to 43% over the life of the grant.

Table IV-7. Percentage of Teachers who Hosted Guest Speakers from Community Organizations

Year	% of Treatment Teachers
2019	29%
2020	32%
2021	43%

Program records showed that 11 teachers had multiple STEM industry interactions outside of the field trips. For example, one teacher had their class take a field trip to the University of Tampa College of Engineering and then had virtual guest speakers from Amazon come to the class. Another teacher took his class on multiple virtual field trips to places like Florida Power and Light, Lockheed Martin, a local bank, Venture Tech Company, Fluorotek, and the Aerospace Center for Excellence, among others.

IV.5.3. Fidelity of Implementation for Teacher/Industry Interactions

To assess the FOI of Teacher/Industry Interactions, two indicators were examined: STEM field trips and STEM industry-school partnerships.

As described earlier, the field trips were under the purview of the instructional coaches. During the 2019–20 year, a total of 10 field trips were planned between June 2019 and May 2020 and the expectation was that teachers would attend at least seven of them. Records indicated that, of the 102 treatment participants assessed for FOI in 2019–20, 59 (58% of participants) attended at least seven field trips.[10] For 2020–21, teachers were also expected to participate in at least seven field trips over the course of the year. Records indicate that, of 82 participants assessed for FOI, 50 (61% of participants) met that expectation. Additionally, there were nine teachers who did not participate in any field trips during the 2020–21 implementation year. Table IV-8 shows participation rates for the two years.

Table IV-8. Teacher Participation in Field Trips, Year 1 and Year 2

District	2019–20		2020–21	
	N	% Attending at least 7	N	% Attending at least 7
Overall	102	58%	82	61%

Note. One district did not have any treatment participants in the study as of the 2020–21 year.

The second indicator for FOI was whether teachers had at least two interactions with a STEM industry in their classroom in the second year of the project. This could have included an activity such as inviting a guest speaker or taking the students on a virtual field trip. The survey provided data showing that 43% of respondents had at least one external guest speaker. The professional development team also collected data about whether the teachers had interactions with industry outside of the field trips; according to their records, 11 teachers reported two STEM industry interactions. That said, at the program level, the professional development team engaged in a substantial number of partnerships with various STEM industries, as described above.

[10] Additional virtual field trips were already being offered as of June 1, 2020; these are included in 2020–21 reporting.

IV.6. Certification and Credentials

EQuIPD supported teachers' attainment of credentials in four areas: (1) internal micro-credentials, (2) STEM-related micro-credentials, (3) CTE industry credentials/industry tests, and (4) State STEM Certifications.

At the beginning of the grant, the EQuIPD professional development team worked on providing teachers with a set of project-specific micro-credentials that recognized teachers' skill in specific project areas, such as engineering design, sensors and probes, and system thinking. According to the professional development team, each topic had three mini credentials that combined to give teachers a micro-credential. The project developed a total of four micro-credentials that were made available to teachers in Teams. However, as of the end of the project, no teachers had completed a micro-credential. The professional development team was not sure why this was the case, whether teachers had no interest in completing these or if the pandemic prevented teachers from participating because of the level of work in which they were already engaged.

The other opportunities to earn credentials were external activities that were financially supported by the grant. The STEM-related industry credentials and certifications are designed to provide teachers with opportunities to earn additional STEM credentials. This activity was only available to teachers who had completed at least one year in EQuIPD. Teachers determined the credentials they wanted, and the opportunities were provided by Microsoft, Arduino, and Vernier among other organizations. In addition, coaches supported their efforts in identifying those credentials.

During the last academic year, there were several study groups formed to prepare teachers for certification exams. In June 2020, the Middle Grades General Science study group began meeting almost weekly and reviewed exam content (e.g., Earth, matter, and forces). There was also a math certification study group. One teacher stated, "I know that the study group we had, it was fantastic … we started with five people, and four out of the five ended up passing." Two coaches shared that their study groups were not well attended and turned into one-on-one sessions.

In addition to study groups, the coaches provided teachers with access to resources that might help them pass their exams. One teacher shared, "There were study groups and resources on our Microsoft Teams page. They were always posting resources for everything." Three teachers noted that they were provided a subscription to Study.com, and they used it to help them prepare for their exams. One teacher stated that Study.com was helpful,

> I didn't get to do a study group. They did have one offered, just wasn't a good time for me, but I did get a program through the grant, a Study.com membership. That was very

> helpful, and I used that to get credentials for my 6 through 12 certification through the grant.

The project PI also developed study materials in areas where none existed. One teacher explained,

> Engineering technology. That was a big one that the grant helped me with because there is not a study guide for it. There weren't any study materials. Study.com didn't have anything for it so [the project PI] basically got some materials together and held a study group for that. And I feel I'm pretty sure that I know I wouldn't have passed that test without that study group.

IV.6.1. Fidelity of Implementation for Certification and Credentials

FOI for Certification and Credentials includes the program providing support for four different types of credentials: (1) internal micro-credentials, (2) STEM-related micro-credentials, (3) CTE industry credentials/industry tests, and (4) State STEM Certifications. Project staff created a total of four micro-credentials, which were housed in Teams for teachers to access. The project provided connections to teachers around STEM-related and CTE-industry-related micro-credentials that were provided by industry partners. The project also supported teachers who wanted to earn additional STEM certifications by providing study guides, facilitating study groups, and paying for the state exams. FOI was met for the sixth Key Component.

IV.7. FOI Summary for Years 1 and 2

During each of the two Implementation Years, the evaluation team conducted a formal assessment of FOI of the project. Initial expectations were set during the spring of 2019 as the program was being designed. During the July 30, 2020 meeting with the PI, FOI was further refined due to key programmatic changes surrounding COVID-19, and an additional construct and indicator were added around Technology Resources.

This two-year review examines aspects of all six Key Components (14 of 14 indicators). Table IV-9 presents the FOI results for the 2019–20 (Year 1) and 2020–21 (Year 2) academic years. During the 2019–20 academic year, FOI was met for three of the five components that were assessed, Professional Development Resources, Technology Resources and Industry Credentials (which only had one indicator measured that year). During the 2020–21 academic year, FOI was met for the same three components, Professional Development Resources, Technology Resources, and Industry Credentials.

Table IV-9. Fidelity of Implementation Summary Reporting Table

Key Components	Expected Level of Implementation	FOI Status 2019–20	FOI Status 2020–21
1. Professional Development			
Summer Bootcamp Participation	100 % of teachers completed at least 85% of training	100% of teachers attended at least 85% of the training	100% of teachers attended at least 85% of the training
Follow-up Workshops Participation	100% of teachers completed at least 4 sessions	75% of teachers attended all 4 sessions	20% of teachers completed all 4 sessions and accompanying assignments
2. Professional Development Resources			
Creation of Online Modules and Website Resources	Modules and online resources provided	Modules and online resources were provided	Modules and online resources were provided
3. Technology Resources			
Assessing Technology Needs	Needs assessment conducted	Technology needs were assessed	NA
Technology Resources (hardware/software)	Technology resources made available through a variety of platforms	Technology resources were made available	Technology resources have been made available
Training on Educational Technology	Technology training provided	NA (Indicator added after Year 1)	Technology training has been provided
4. Instructional Coaching			
Training for Instructional Coaches	Coaches receive at least 20 training sessions	Coaches received an average of 60 training and support sessions	Coaches received an average of 65 training and support sessions
Instructional Coaching to Participants	100% of teachers receive 85% of sessions	71% of teachers received targeted # of coaching sessions	67% of teachers received targeted # of coaching sessions
5. Teacher/Industry Interactions			
STEM Field Trips	100% of teachers attended 85% or more of the 8 field trips originally proposed= 1	58% of teachers attended at least 85% field trips	61% of teachers completed at least 7 field trips
STEM Industry-School Partnership	Teacher had 2 or more documented interactions outside of field trips = 1	NA (Was not measured in Year 1)	11 teachers had 2 or more documented interactions
6. Industry Credentials			
Internal Micro-Credentials	3 or more modules developed and available for teachers	NA (Was not measured in Year 1)	EQuIPD modules have been developed and made available to teachers
STEM-Related Micro-Credentials	1 or more external trainings made available to teachers = 1	Micro-credentials were made available to teachers	One or more external trainings was made available to teachers
CTE Industry Credential/Industry Tests	Supports or scholarships provided for industry tests	NA (Not measured in Year 1)	Supports have been provided for industry tests
State STEM Certifications	Supports or scholarships provided for STEM certifications = 1	NA (Not measured in Year 1)	Supports have been provided for STEM certifications

IV.8. Plans for Sustainability

There were two primary ways in which the project attempted to sustain the work including using a train-the-trainer model and piloting a Professional Learning Communities (PLC) model.

IV.8.1. Train-the-Trainer

As part of the targeted goal of the EQuIPD project, a train-the-trainer model was used to scale-up and sustain project practices and pedagogy, enhancing local capacity. As teachers enrolled in the project in 2019, those assigned to the treatment condition agreed to act as professional development resources and train control teachers and other interested teachers during a Summer Bootcamp in 2021.

During two spring follow-up workshops in the 2020–21 school year, treatment teachers prepared to provide professional development at the 2021 Summer Bootcamp. As noted in the professional development section above, the first workshop covered the components of effective professional development, and the second workshop scaffolded the process of creating professional development. Teachers were asked to (1) survey their colleagues at their school to learn about the topics on which they wanted additional training, and (2) reflect on their own strengths and what they would be interested in creating a training about related to the EQuIPD model. Based on the results of their survey and their reflection, in the second follow-up session, teachers were placed into groups with other teachers interested in related topics. Teachers had to work with their group members to narrow down their interests to a single topic and then create a training about that topic. Coaches provided templates for slides and handouts that the teachers were encouraged to use.

Coaches planned to do office hours with each group to help them finalize their presentations, however, they found that most groups needed much more time and assistance from coaches than was expected. In interviews, coaches estimated that groups needed, on average, four to six hours of office hours with coaches, plus individual work time in between meetings, to fully prepare their session.

In describing the amount of preparation required, one teacher said,

> They originally … over-projected what we were capable of. Because we originally signed up for two sessions with our coach. We [expected we] would knock out that training and get it ready. [However,] I mean, I lost count. I think we met five or six times with two hours to an hour a piece.

Coaches noted that the groups that were able to prepare the quickest typically were (1) groups that were able to compromise and build consensus easily and (2) groups in which one or more members had previous experience delivering professional development. Many teachers did not have experience either creating or leading professional development, and some groups had interpersonal dynamics that slowed progress. One coach found that, "The easier groups for us to work with were the ones that had a natural leader step up and keep everything organized." One teacher said that they were "stretched a lot in terms of working collaboratively in a group" because not everyone in the group came with the same levels of knowledge and skills related to their topic; in addition, coordinating their schedules was a challenge. Coaches also reported that some teachers quit the program because they did not want to lead professional development.

One coach described the improvement they observed over time as teachers presented their professional development over the summer and also noted the potential interest in future presentations, saying,

> Every time they presented, it got better. Finally, by the last time they presented it, it was where it should have started, I think. Yeah. It took awhile. I have a few who are now interested in possibly taking on district [professional development] in the future who [originally] weren't [interested].

A total of 51 treatment teachers from eight districts led 95 two-and-a-half-hour sessions between June 1 and July 31, 2021. Treatment teachers were expected to attend four sessions in addition to the four sessions they led with their group. Control teachers were expected to attend eight sessions – one from each grant goal. There were 136 teachers who participated in the Bootcamp. A total of 22 attendees were teachers that were from outside the district or teachers in the districts that had not participated in the EQuIPD training prior to the 2021 Bootcamp. Five teachers attended between 10 and 15 sessions (two non-participant and three control teachers); 55 teachers attended eight sessions (49 control and five non-participant teachers); three control teachers attended seven sessions; three control and one intervention teacher attended five sessions; 39 teachers attended four sessions (34 intervention, four control, one non-participant); and 30 teachers participated in three or fewer sessions. Table IV-10 shows the participation levels by topic.

Table IV-10. 2021 Professional Development Sessions

Professional Development Session	Treatment	Control	Non-program	Total Attendees
Authentic Student Use of Technology**	3	12	2	17
Birds of a Feather Inquiry Together	16	23	2	51
Breaking It Down - Process Mapping***	3	17	-	20
CCI: Concept, Collaboration, and Inquiry Models	1	9	1	11
Classroom Discourse and Collaboration	2	20	2	24
Classroom Management with Process Mapping and System Thinking	5	27	8	40
Collaboration and Technology***	10	11	2	23
Collaborative Grouping***	5	17	2	24

Professional Development Session	Treatment	Control	Non-program	Total Attendees
Collaborative Grouping - Asynchronous	-	2	2	4
Concept Model Development***	1	4	2	7
Concept Modeling and Technology in a Small Group Setting	4	11	3	18
Conceptual Modeling	1	2	1	4
Design Thinking***	5	26	5	36
Design Thinking - Asynchronous	-	1	2	3
Differentiating Instruction with Technology***	7	11	3	21
Differentiating Instruction with Technology - Asynchronous	-	1	1	2
Eliciting Conceptual Models From Students***	3	7	3	13
Flipgrid and Literacy***	2	19	3	24
Fostering Collaboration through Design Thinking	10	29	4	43
How Can We Use Technology to Improve Student Learning?	3	9	2	14
How to Increase Student Engagement Using Technology	5	11	2	18
Implementing Inquiry Stages	3	9	2	13
Inquiry Based Lessons - Asynchronous	3	5	3	11
Inquiry Lesson Development	4	9	1	14
Inquiry Lesson Development - Asynchronous	1	2	-	3
Introduction to Draw.io and Concept Modeling	4	16	1	21
Literacy in Inquiry	2	2	3	7
Making Authentic Classroom Connections to the Workforce***	4	23	3	30
Making Authentic Classroom Connections to the Workforce - Asynchronous	-	3	1	4
Model Building to Increase Learner Comprehension	4	6	-	10
Mystery Solved! How to use Technology to Promote Student Collaboration and Discourse?	9	11	3	23
Planning Using Inquiry In All Content Areas	3	10	5	25
Planning with Conceptual Models	14	9	2	25
Preparing Students for the Future Workforce	7	19	4	30
Questioning and Video Analysis***	1	3	-	4
Small Group Strategies During Hybrid Learning	6	-	1	7
Social Emotional Learning (SEL) and How It Can Support Student Success***	6	14	22	42
Standards to Models***	3	6	3	13
Standards to Models - Asynchronous	-	2	1	3
The Four Elements of System Thinking***	3	13	5	21
The Four Elements of System Thinking - Asynchronous	-	5	-	5
Using Nearpod to Drive Collaboration***	8	16	1	25
Using Technology to Engage Students	10	7	-	17
Writing is More Than an Exit Ticket***	1	13	2	16
Writing is More Than an Exit Ticket - Asynchronous	1	4	3	8

*Totals include all attendees who participated in a session (teachers signed up for > 1 session).
**Some topics had up to 5 sessions scheduled during the summer.
***Led by project PI or instructional coach.

The presenters modeled classroom practices, and overall, the teachers responded positively to the ideas for student engagement, with one teacher reporting, “I loved the modeling techniques we talked about when teaching students how to listen and negotiate.” Other teachers described how they would facilitate student talk when school started again. Several participants wrote that, not only would they use concept models to build their own lessons, they would also incorporate concept models into student work. For example, one teacher stated, “I think the concept models would be a great activity to have my students complete in small groups after a standard has been taught as a way to determine their understanding and mastery.” Participants also responded positively to sessions that suggested ways to engage students in discussions using Flipgrid, Jamboard, and Draw.io as a means for students to share ideas and collaborate.

Part of the intent of this effort was to develop teachers’ capacity to share what they had learned and provide professional development in the future. When asked about their plans for delivering additional professional development, treatment teachers’ responses were mixed, although one teacher had already arranged to provide workshops to their district,

> I got approval from [the project PI] and from my principal to take the online scientific inquiry and then mix it with face-to-face, because I wanted [my collegues] to have the opportunity to use the [technology]. So I’m going to be doing a training with the fifth-grade teachers [in my building] so that they can see how to utilize that piece of equipment in their rollercoaster lesson.

The scale-up/sustainability of the train-the-trainer model for the EQuIPD project may be challenging. In some of the districts that participated in the project, teachers were not utilized as trainers because there were already teams of coaches provided by the district. Additionally, the work involved in preparing for the Bootcamp was more extensive than expected, and teachers may find it difficult to set aside hours in an already full day. Finally, teachers needed to be willing to lead and, in some cases, treatment teachers were not willing to develop sessions for the summer Bootcamp. Despite these concerns, as described above, those teachers who did participate in the train-the-trainer model ended up producing high-quality trainings that they could share with staff in their own schools.

IV.8.2. Professional Learning Communities

In addition to the services provided to the treatment teachers who were part of the study, the coaches also worked with groups of teachers in schools who were not part of the study to test out a Professional Learning Community (PLC) model. Because the PLC model was not part of the original study design, and the teachers were not part of the impact study, the evaluation team collected very minimal data on this aspect of the work. Evaluators did, however, observe one PLC session in which a coach worked with two teachers who were developing a common lesson plan about animal adaptation using the EQuIPD framework of inquiry stages.

One of the goals of the PLC work was to create a potentially more sustainable model whereby coaches worked with small groups of teachers instead of doing the more resource-intensive one-on-one coaching. Coaches worked with teachers during their planning period to help them integrate EQuIPD strategies. As coaches were leading pilot PLC groups in the second year of the project, they were experimenting with ways to lead the group. Each coach was expected to develop their own approach to facilitating the PLC, which they found challenging. One coach facilitated a common lesson planning session for teachers of the same subject. Another coach delivered workshop-style professional development with content similar to what was studied in the main project. The third coach focused on common problems of practice identified by teachers. As one coach said in response to a question about the goal of PLCs,

> I think it was more experiment. I think we're looking at which types of PLCs work, what maybe doesn't work. What are some ways that this PLC model can be used? What are the PLC models? I think a lot of it is kind of figuring out what works and what doesn't work.

Multiple districts within Florida expressed interest in utilizing the EQuIPD PLC model to establish train-the-trainer systems for their district teachers. The EQuIPD professional development team has started conversations and planning with district leaders from Manatee, Hillsborough, and Sarasota school districts to identify potential PLCs. The EQuIPD professional development team will work with the districts to identify and design a PLC model that is tailored to meet the pedagogical needs of the teachers participating in the PLC. Few districts had existing PLC structures in place except for loosely defined PLCs that functioned more as collaborative planning time for teachers.

IV.8.3. Barriers to Sustainability

The EQuIPD professional development team identified the following issues as barriers to sustainability within the districts: staff turnover for district liaisons, which created a barrier to communication; lack of supporting district infrastructure for professional development (e.g., lack of staff, lack of PD programs; lack of funds to pay teachers for PD attendance); lack of a cohesive PD plan for district; lack of PLC programs in schools; lack of delegated PD time for anything other than state- or district-mandated training; lack of knowledge at the highest level of the district administrators about grant progress; and finally, COVID-related loss of time, funding, and technology from districts to support continuation of the grant using district monies.

IV.9. Dissemination and Broader Impact

In addition to the activities in which the teachers participated, the EQuIPD grant has contributed to the broader knowledge about changing technology-infused inquiry practices.

IV.9.1. Dissemination

The professional development team, coaches, and evaluation team have made numerous peer reviewed presentations over the past two years, including 10 during the 2020-2021 grant cycle. There are currently four papers in preparation for submission to peer-reviewed journals.

Conference Presentations:

National Science Teachers Association STEM 2021 "Creating Equity for Students Through Modeling-Based Pedagogical Practices" Ruzycki, N.

National Science Teachers Association STEM 2021 "EQuIPD Grant: Building Core Content Models with Real-Time Feedback from Micro:bit Sensors", Carter, J., Ruzycki, N.

National Harbor Area Conference 2021 "Forging Successful Collaborations Through Facilitative Instructional Coaching" Ruzycki N.

Presentation – American Physical Society March Meeting 2021, "Model Based Instructional Practices for K12 Teachers: EQuIPD Professional Development to Support Effective Teaching" Ruzycki, N.

American Chemical Society National Meeting 2021 "Balancing the Equation: Collaboration within classrooms for chemical concepts", Chemical Education Division Ruzycki, N., Imperial, L.

World Engineering Education Forum (WEEF) 2021 Conference, "Building Conceptual Models and Engineering Design Thinking in K12 Students" Ruzycki, N., Imperial, L., Dulany, K., Kerr, S.

2021 PoLS-T Exchange: Building a Global Network of High School Physics Teachers, "Using Modeling Instructional Practices to Support Conceptual Model Development in Students" Ruzycki, N., Dulany, K., Imperial, L.

Association for Education Finance and Policy, 2021 Conference, "Increasing Teachers' Use of Technology-infused Inquiry: The Impact of Project EQuIPD." Edmunds, J.A., Arshavsky, N., Coyle, V., Hutchins, B., Lewis, K., Williams, M., & Henson, R.A.

National Science Teachers Association STEM Forum 2020, "Creating Three-Dimensional Inquiry Lessons", Danger, C.A., Ruzycki, N.

National Science Teachers Association STEM Forum 2020, “Enhancing Inquiry Through Facilitative STEM Coaching”, Ruzycki, N., Dulany, K., Rozas, X., Edmunds, J.

National Science Teachers Association STEM Forum 2020, “Using Scratch Jr. to Develop Concept Models in Lower Elementary Students”, Ruzycki, N., Kerr, S., Arnold, L., Carter, J.

Eastern Educational Research Association (EERA), 2020 Conference, “Starting from Scratch: Developing a Survey Instrument to Support the Evaluation of a Program Designed to Increase Teachers’ STEM Content and Pedagogical Knowledge”, Coyle, V., Sunnassee, D., Moteane, M., Gomez, S., and Kim, S.

Eastern Educational Research Association (EERA), 2020 Conference, “10 Districts, 100+ schools, and 225+ teachers in 6 weeks: Adventures in Scheduling Live Observations to Collect Baseline Measures of Teacher Instruction”, Coyle, V.

Poster Presentation:

2021 PhysTEC Conference “EQuIPD Grant Teacher Professional Development for Modeling Pedagogical Practices: Application to Preservice Teachers” Ruzycki N., Imperial L.

Video Presentations

2021 STEM For All Video Showcase: COVID, Equity and Social Justice, Working Together Alone: The EQuIPD Grant, Dulany, K., Arnold, L., Carter, J., Danger, C.A., Kerr, S., Rozas, X., Imperial, L., N. Ruzycki

2020 STEM For All Video Showcase, EQuIPD Grant: A Model Love Story, Dulany, K., Arnold, L., Carter, J., Danger, C.A., Hersey, M., Kerr, S., Rozas, X., Ruzycki, N.

IV.9.2. Other Impacts

The grant has also held multiple Broader Impact Days (see section on industry partnerships) with over 140 unique teachers attending who were not part of the existing grant. In response to COVID, the grant also held trainings in the summer of 2020 that were open to all teachers in Florida and Mississippi. Nearly 300 teachers attended over 60 offered sessions on everything from grant-related content (e.g., System Thinking, Process Mapping) to technology (e.g., using cell phones to record data, Scratch) to best practices in social-emotional learning and educational technology to support student inquiry in new learning environments (e.g., Jamboard, Whiteboarding). In addition, the project published an 18-page Remote Learning Resource Guide that put together pedagogically and content sound web-based resources for teachers in multiple subject areas. It also included resources for Socio-Emotional Learning during the pandemic and in remote and hybrid learning environments. EQuIPD was one of the first University of Florida entities to provide a resource guide to teachers, and the resource was hosted on the UF College of Engineering website.

Section V. Teacher Impacts

As described in the proposal, Project EQuIPD was intended to "increase STEM (science, technology, engineering, and math) pedagogical content knowledge of teachers in: System Thinking … [and] standards-based lesson design incorporating inquiry, computational thinking, technology integration, and engineering design." As a result, the evaluation measured changes in teachers' knowledge, their implementation of targeted instructional practices, teachers' leadership behaviors, and their retention and attendance. This section presents findings relative to each of these areas.

Key findings from this section include:

- **Treatment teachers reported substantially higher levels of knowledge than control teachers on all areas targeted by the project.**
- **Treatment teachers reported significantly higher use of EQuIPD instructional practices than control teachers.**
- **Overall, there were no differences between treatment and control teachers on the observations. Observations did show higher levels of inquiry-related practices for treatment teachers than for control teachers, although the difference was not statistically significant.**
- **There were no impacts on teachers' attendance or retention.**

V.1. Impact on Teacher Knowledge

The program intended to impact teachers' knowledge and understanding in a variety of different areas: (1) their knowledge of system thinking, (2) their knowledge of and comfort with technology, (3) their knowledge of engineering design, and (4) their knowledge of career-readiness practices. The evaluation team captured changes in these areas through the survey and through interviews with teachers.

V.1.1. Survey Results

The survey included questions about teachers' level of knowledge of the specific targeted content areas. The evaluation team created an overall measure of teachers' knowledge by combining results for all the knowledge-related scales (Knowledge and understanding of system thinking; knowledge of how to use technology in the class; knowledge of engineering design; and knowledge of local STEM resources). Teacher comfort with technology was analyzed separately.

Treatment teachers reported higher levels on the overall knowledge measure than the control teachers, with a very large and statistically significant effect size of 1.60 for Year 2. Additionally, there were large and positive impacts on four out of the five individual knowledge scales (Table

V-1), including system thinking, technology, engineering design, and local STEM resources. The only scale that did not have a significant impact was teacher comfort with technology; this scale asked teachers to comment on their comfort learning new technologies, how frequently they explored new technology, and if they had increased the use of technology in their classroom (see Appendix A, *Comfort with Technology*). In interviews, teachers reported that they were learning new technologies, which gave them less comfort with technology.

Table V-1. Impact on Teacher Knowledge

Outcome	Treatment (N =60) Adjusted mean (SD)	Control (N=86) Mean (SD)	Effect Size
Overall knowledge scale (composite)	1.63 (0.50)	0.59 (0.74)	1.60***
Knowledge and understanding of system thinking (two combined scales)	4.55 (0.98)	2.42 (1.47)	1.64***
Knowledge of how to use technology in the class	4.98 (0.71)	4.05 (0.99)	1.05***
Knowledge of engineering design	4.50 (1.38)	3.33 (1.85)	0.70***
Knowledge of local STEM resources	4.40 (0.95)	2.95 (1.23)	1.30***
Teacher comfort with technology[a]	4.94 (1.21)	4.83 (0.69)	0.11

***$p \leq .001$;

[a]This measure was not included in the overall composite knowledge scale but was used as a covariate in the analyses. We report it separately here.

We also looked at the impacts across the two years for the sample of teachers that had survey results in both years. Table V-2 shows that the impacts were larger in Year 2 than they were in Year 1, suggesting that treatment teachers learned more about the targeted areas the longer they were in the program. As the table also shows, the mean scale scores for treatment teachers increased from Year 1 to Year 2, while the mean scale scores remained essentially the same for control teachers.

Table V-2. Impact on Teacher Knowledge, by Year (Longitudinal Sample)

Outcome	Year 1			Year 2		
	Treatment (N = 59) Adjusted mean (SD)	Control (N=81) Mean (SD)	Effect size	Treatment (N = 59) Adjusted mean (SD)	Control (N=81) Mean (SD)	Effect Size
Overall knowledge scale (composite)	1.43 (0.69)	0.71 (0.70)	1.02***	1.63 (0.48)	0.60 (0.74)	1.60***
Knowledge and understanding of system thinking (two combined scales)	3.92 (1.21)	2.27 (1.45)	1.22***	4.59 (0.93)	2.48 (1.50)	1.64***

Outcome	Year 1			Year 2		
	Treatment (N = 59)	Control (N=81)		Treatment (N = 59)	Control (N=81)	
	Adjusted mean (SD)	Mean (SD)	Effect size	Adjusted mean (SD)	Mean (SD)	Effect Size
Knowledge of how to use technology in the class	4.69 (0.86)	4.11 (1.00)	0.61***	4.98 (0.69)	4.06 (0.99)	1.06***
Knowledge of engineering design	3.90 (1.59)	3.33 (1.89)	0.32**	4.47 (1.37)	3.30 (1.85)	0.70***
Knowledge of local STEM resources	3.77 (1.25)	2.87 (1.21)	0.73***	4.39 (0.96)	2.94 (1.22)	1.30***
Teacher comfort with technology	4.81 (0.97)	4.88 (0.73)	-0.08	4.95 (1.22)	4.88 (0.68)	0.08

**p≤.01; ****p* ≤ .001

We also looked at the results for two sets of teacher subgroups, (1) by grade and (2) by whether they taught a STEM subject or not. Table V-3 presents the results for the overall knowledge scale (composite) by the subgroups. As shown, all groups demonstrated positive impacts, with the largest impacts for elementary teachers.

Table V-3. Impact on Year 2 Overall Knowledge Scale, by Subgroup

Group	Treatment		Control		Impact estimate	Effect size
	N	Adjusted mean (SD)	N	Mean (SD)		
Overall means	60	1.63 (0.50)	86	0.59 (0.74)	1.04	1.60***
Teach K–5	22	1.54 (0.45)	27	0.22 (0.69)	1.32	2.21***
Teach 6–9	29	1.67 (0.50)	39	0.85 (0.73)	0.82	1.28***
Teach K–8 (resource)	9	1.64 (0.64)	20	0.60 (0.64)	1.04	1.62***
Teach STEM subjects	55	1.67 (0.50)	78	0.63 (0.72)	1.04	1.62***
Teach non-STEM subjects	5	1.20 (0.56)	8	0.09 (0.84)	1.11	1.47***

****p* ≤ .001

V.1.2. Insights from Interviews

In interviews conducted in spring and summer 2021, teachers were asked about what they learned as a result of their participation in the EQuIPD program. Across the interviews, each of the knowledge areas targeted by the program (system thinking/concept modeling, technology, engineering design, and career-readiness practices) were mentioned, with technology and system thinking/concept modeling brought up most frequently.

Regarding technology, many teachers mentioned specific programs or websites that they were able to incorporate into their lessons. Many also explained that they were now more comfortable with technology in general, with some emphasizing their increased use of instructional tools and some mentioning greater familiarity with the various platforms used for online instruction this past school year. Some also noted that they were better prepared for teaching online this year than their colleagues, which they credited to EQuIPD. One teacher explained, "I think I was better prepared for [not being in person with students] this year than other teachers, because I knew, 'Okay, I could use this, this, and this to bridge that gap.'" Coaches confirmed seeing an increased use of, and comfort with, technology, with one coach reporting,

> They started using a whole lot more instructional technology than they had ever used. And, I mean, I think that their technology understanding, usage, growth, being able to use technology for students to collaborate—a lot of those things just grew exponentially this year.

Coaches also observed that overall, teachers gained a better understanding of system thinking and concept modeling during Year 2, which was reflected in the number of teachers who mentioned each as something they learned from the program. Both coaches and some teachers noted that this was an area that was previously unfamiliar to many teachers and required a lot of work to get comfortable with. One teacher, who taught STEM for the first time that year, described making use of concept modeling to create lessons from a new curriculum, saying,

> That's what I really leaned on this year, building that conceptual model of the knowledge. … What do the kids need to know? And kind of start building almost a mental map … [of] how that knowledge, how the concepts and the vocabulary interact, [so] that I can essentially just survive the school year.

Another teacher described learning about concept modeling as an "eye opening" tool to use with students.

Many teachers also described how concept modeling and system thinking, and the EQuIPD project more broadly, impacted their approach to lesson planning. One teacher spoke of learning about the "interconnectivity of stuff" so that their lessons now had a progression and through line, explaining that with concept modeling, she was,

> Building a model that I can attach to another model or building a lesson I can attach to another lesson … [so that I am] able to have a little more intentionality to my lessons where one leads into the next, and I can cycle back to the stuff we covered in the previous lesson and bring it forward into this lesson in a meaningful way and build on to it.

Other teachers also spoke of learning how to be more intentional or strategic in their approach to creating lessons. Coaches also noticed this change. One coach explained,

> I definitely saw a lot more intentionality in planning. That was one of the biggest changes I saw. They were saying that by using the EQuIPD type of planning—deciding on what the conceptual model was, what that looks like, that using the model stages to plan to get there, and then having an idea before they started on what the students should be able to explain at the end—they all felt that that helped them to be more effective and helped their kids score a lot higher on the little unit tests and things, the check-ins. So that was a really big difference.

V.2. Changes in Instructional Practices

Changes in teacher knowledge were expected to precede changes in teachers' instructional practice. The project expected teachers to use technology-infused inquiry practices that integrated real-world experiences. This section includes results from three primary sources of data around the implementation of instructional practices: (1) the survey, (2) observations, and (3) interviews with teachers. First, overall findings are presented on instructional practice from the survey and the observations. Then findings are then broken out by the specific areas of project emphasis.

V.2.1. Overall Impacts

There were two primary measures for instructional practice. One was the composite score on the survey (including the following scales: implementation of inquiry practices; use of formative assessment strategies; implementation of project-based and engineering-based inquiry instruction; use of inquiry-based instruction integrating technology; use of real-world problems and EQuiPD-specific technology; and connections to career and external STEM industries). The other was the weighted composite score for the observant (the average inquiry scale, which was weighted twice, group work, real-world problems and technology). As shown in Table V-4, there were large positive impacts on the instructional strategies survey scale and no significant impacts on the observation scale.

Table V-4. Impact on Implementation of Instructional Practices

Outcome	Year 2		
	Treatment Adjusted mean (SD)	Control mean (SD)	Effect size
Survey	N=60	N=86	
Overall instructional practice (composite)	1.34 (0.85)	0.77 (0.63)	0.78***

Outcome	Year 2 Treatment Adjusted mean (SD)	Control mean (SD)	Effect size
Observations	N=63	N=82	
Observation score (weighted composite)	1.03 (0.80)	0.97 (0.79)	0.08

***$p \leq .001$

Table V-5 shows the findings for the survey measure by subgroup. All subgroups had statistically significant and large impacts (even those groups that were very small).

Table V-5. Impact on Overall Instructional Practice Survey Score, by Subgroup

Group	Treatment		Control		Impact estimate	Effect size
	N	Adjusted mean (SD)	N	Mean (SD)		
Overall means	60	1.34 (0.85)	86	0.77 (0.63)	0.57	0.78***
Teach K–5	22	1.11 (0.71)	27	0.56 (0.55)	0.56	0.88***
Teach 6–9	29	1.34 (0.91)	39	0.80 (0.67)	0.54	0.69***
Teach K–8 (resource)	9	1.74 (1.02)	20	1.01 (0.58)	0.73	0.99***
Teach STEM subjects	55	1.36 (0.85)	78	0.82 (0.63)	0.53	0.73***
Teach only non-STEM subjects	5	1.04 (0.92)	8	0.15 (0.23)	0.88	1.51***

***$p \leq .001$

Similar analyses were conducted for the overall observation score with larger impacts for elementary and non-STEM teachers, but none of the differences were statistically significant.

Table V-6. Impact on Weighted Overall Observation Score, by Subgroup

Group	Treatment		Control		Impact estimate	Effect size
	N	Adjusted mean (SD)	N	Mean (SD)		
Overall means	63	1.03 (0.80)	82	0.97 (0.79)	0.06	0.08
Teach K–5	29	1.19 (0.87)	40	1.01 (0.83)	0.18	0.22
Teach 6–9	34	0.90 (0.70)	42	0.93 (0.77)	-0.03	-0.04
Teach STEM subjects	50	1.08 (0.79)	72	1.00 (0.80)	0.09	0.08

Group	Treatment		Control		Impact estimate	Effect size
	N	Adjusted mean (SD)	N	Mean (SD)		
Teach non-STEM subjects	13	0.91 (0.80)	10	0.75 (0.71)	0.16	0.21

Note. No differences were statistically significant.

In terms of why there are positive impacts on instructional practices from the surveys and null results from the observations, one obvious difference between the two is that the survey was self-report and the observations were done by external observers. It is possible that treatment teachers had become familiar with the expectations of the grant and were therefore more likely to report that they were doing activities that were a focus of the grant. The evaluation team tried to minimize that likelihood by including questions whereby they were simply asked to describe their instructional practices (see survey questions in Appendix A), but it is still possible that treatment teachers were primed to respond in a certain way.

It is important to note that there were positive impacts on the inquiry-related measures of the observation scale (see further discussion below). These positive impacts are close to 0.20 standard deviations, which are not large enough to be statistically significant, given the sample size. It is reasonable to expect that effect sizes may be larger for survey results than observation results, given that teachers might overestimate their implementation of specific strategies.

Another reason could be related to the observation data collection techniques used, which faced several challenges due to the pandemic. As described in the methods section, the evaluation team had to switch to online/virtual observations, which meant that observers could not as easily see the full room as if observing instruction in person. Thus, it is possible that the observers missed group work or hands-on activities that they would have been able to see if they had been in person. Additionally, it was challenging to capture student engagement and student interactions in the online/virtual setting.

A second COVID-related reason for larger effect sizes for the survey results compared to the observation results is that teachers could have found it more challenging to implement the EQuIPD instructional activities in an online or hybrid setting. Even in person, COVID-19 safety protocols, such as social distancing and not allowing students to share materials, could have made it much more difficult for teachers to implement inquiry activities. Teachers may have believed that they were doing more activities, but it might have been challenging to see that given these issues.

V.2.1.1. Observations of Exemplary Classrooms

To provide a picture of what instruction looked like in the classrooms not fully in person, the following is a description of two classrooms—one online and one hybrid—that received the top ratings from observers.

The first class was an online fourth-grade science class attended by 14 students aimed at building students' understanding for "how the flow of energy is transferred along the food chain through producers and consumers," according to the teacher. The teacher started with warm up questions, with students' answers displayed on the Google white board on the teacher's screen and discussed by the teacher and students. For the main topic, the teacher presented a concept map depicting the food web of a shark. After students asked and answered one another's questions, they explored the food webs of different animals and fish, finding and explaining the information to each other. Then students worked individually on an assignment to create a food chain for an animal of their choice, which included the energy from the sun and predators of this animal. The teacher helped individual students in breakout rooms on Zoom. After students finished this assignment, they were asked to take a screen shot and create a short video about what they learned from the activity.

According to the observer, students were actively engaged in exploration, discussion, and explanation throughout the entire class, demonstrating critical thinking, answering higher order questions, and connecting what they learned to a bigger picture.

The second exemplar class was a hybrid seventh-grade science class attended by 18 students in person and four students online. According to the teacher, the goal of that day's lesson was to develop students' understanding of "why there [are] genetic variations with sexual reproduction and not with asexual reproduction." After assessing students' prior knowledge, the teacher divided students in pairs and assigned a project. The project was to determine the traits and draw a picture of a school mascot given the recessive and dominant genes of the mother and father. The description of these genetically determined traits (eye color, legs, face) was given to pairs of students in "Mother" and "Father" paper bags. As students worked on this hands-on project, they also had to answer four "check for understanding" questions in writing about the independent and dependent variables, observations, evidence, and students' reasoning. During the discussion, students explained their reasoning about sexual and asexual reproduction to the whole class.

The observer noted that the students were consistently active and very interested in class activities and discussion. They were challenged by each other and by the teacher and regularly explained and justified their investigation results. The teacher consistently acted as a facilitator, assessed the students formally and informally throughout the lesson, and encouraged openness and student inquiry, leading towards connection to a big picture.

V.2.1.2. Insights from Interviews

During interviews with twelve teachers and six coaches in summer 2021, the evaluation team asked how instruction was affected by the project. All coaches and two teachers commented that teachers' lesson planning became more intentional and strategic, focused on a specific learning goal. As one coach said, "I would say that they took more time to be more strategic with what their activities were focused on, and how they were deploying them." And one teacher noted, "It has changed the way I think about my lessons. I do think of them more like the model, … what is my end goal? So, I think about my lessons a lot more strategically than I used to." Two teachers also shared that they were thinking more about how to refine their lessons, and one of them reported being much more open to trying and mastering new teaching strategies. As one of them shared,

> I would say refinement is part of the stages that we learn about, where you take feedback, and you can go in and you can make your model better. I think that applies to everything in life and looking at even old lesson plans, how could I refine that? How could I look at that with what I know now and make it even better by adding in … maybe a technology piece or a field trip or a group work or some hands-on project?

The remainder of the instructional practice sections are organized by the targeted areas of instructional change: (1) inquiry practices, (2) use of technology, (3) system thinking and concept mapping, (4) use of real-world problems, and (5) collaboration and group work. Results for each of these instructional practices are included for both the survey and observations (as available); the discussion explores any differences between the two and looks for insights from the interviews.

V.2.2. Impact on Implementation of Inquiry Practices

Integrating high-quality inquiry instruction into the classroom was a key goal of the grant. The impact of the project on teachers' use of inquiry practices was examined using three different data sources: (1) the survey; (2) the observations; and (3) interviews with participating teachers.

Results from the different data sources show a generally consistent pattern with treatment teachers implementing inquiry at higher levels than control teachers. Table V-7 shows the results from inquiry-related measures on the survey and the observations. The impacts show large positive results on inquiry-related scales on the survey, and positively trending results on the observations, although the latter differences were not statistically significant. The lack of statistical significance for the observations is likely due to the size of the sample, which has insufficient power to detect effects of less than 0.30 standard deviations.

Table V-7. Impact on Implementation of Inquiry Instruction

Outcome	Year 2		
	Treatment Adjusted mean (SD)	**Control Mean (SD)**	**Effect size**
Survey	N=60	N=86	
Implementation of inquiry practices	3.49 (0.94)	2.99 (0.85)	0.56***
Project-based/Engineering Inquiry Instruction	3.38 (1.13)	2.66 (1.04)	0.67***
Use of formative assessment strategies	4.44 (0.55)	4.30 (0.51)	0.26 ^{T}
Observations	N=63	N=82	
Implementation of inquiry (Average of four scales: instruction, curriculum, assessment, discourse)	2.53 (0.80)	2.37 (0.77)	0.20
Instruction—summative score	2.58 (0.98)	2.49 (0.94)	0.10
Curriculum—summative score	2.54 (0.71)	2.38 (0.86)	0.20
Assessment—summative score	2.45 (0.89)	2.33 (0.82)	0.14
Discourse—summative score	2.51 (0.97)	2.29 (0.85)	0.25

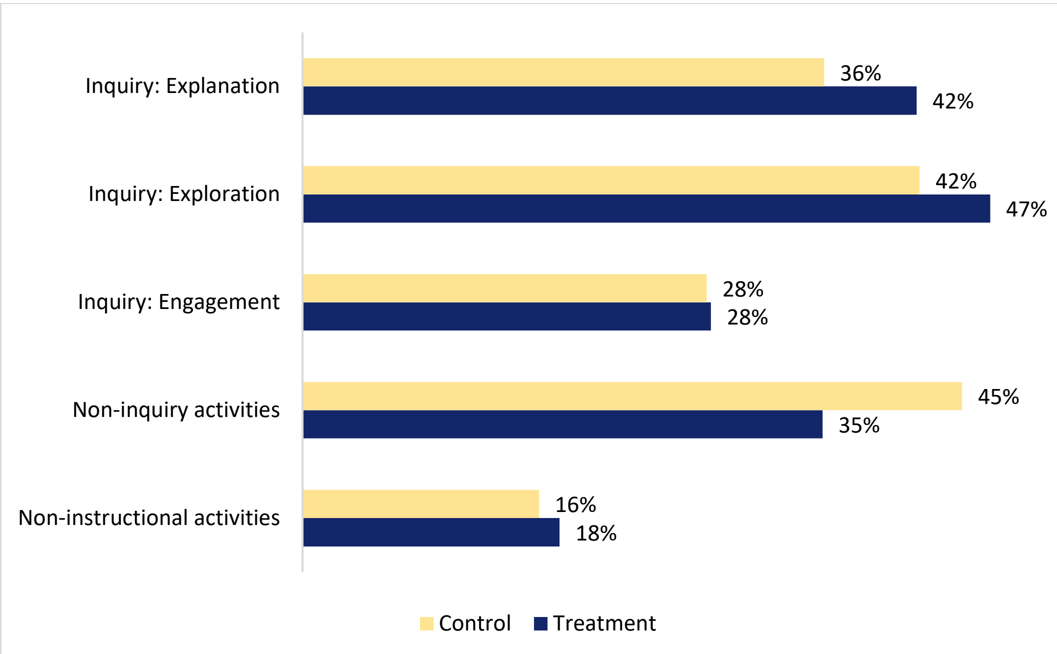
***$p \leq .001$; $^{T}p \leq .1$

The observations provided additional data about implementation of inquiry. Every 10 minutes, observers recorded whether students were engaged in one of five activities, three of which were parts of an inquiry cycle, and two that were not. The observation protocol described these activities in the following way:

- *Non-Instructional Time*—administrative tasks, handing back/collecting papers, general announcements, time away from instruction.
- *Non-Inquiry*—activities with the purpose of skill automation; rote memorization of facts; drill and practice; checking answers on homework, quizzes, or classwork with little or no explanation.
- *Engagement*—typically situated at the beginning of the lesson, assessing student prior knowledge and misconceptions, stimulating student interest.
- *Exploration*—students investigate a new idea or concept.
- *Explanation*—teacher or students making sense of an idea or concept.

Figure V-1 shows how time was distributed among these activities across treatment and control classrooms. It is important to remember that percentage of segments was not the same as percentage of classroom time. Each activity was recorded if it occurred for three minutes or longer or multiple times during each 10-minute segment, which was then divided by the total number of 10-minute segments observed. It is possible that, even if an activity was recorded in 100% of the lesson segments, it may not have been implemented 100% of the time in the lesson.

Figure V-1. Percentage of Time Segments Spent on Different Activities



The most frequently observed activities in treatment classrooms were both inquiry-related activities: exploration (average of 47% of segments) and explanation activities (42% of segments). This contrasts with the control teachers, for whom the most frequent activities were non-inquiry activities (45% of segments). This indicates that treatment teachers were spending more of their time on inquiry-related activities than control teachers.

When comparing results from the surveys and observations, both showed positive impacts, although the effect sizes for the survey are larger than the effect sizes for the observations. This is not unexpected given that the surveys are self-report; it is possible that treatment teachers had become familiar with the expectations of the program and might have tended to rate themselves higher.

Results from the interviews provided additional context about the extent to which teachers were able to implement inquiry-related activities in their classroom. Eight teachers and one coach reflected on changes they made related to inquiry. Teachers commented that they prepared and implemented deeper-level questions in order to develop a conceptual model. Further, they connected concepts from different lessons, implemented open-ended hands-on projects, and gave students more time to work on problems and figure out the answers; students had to think more on their own. As one teacher noted,

> Having more open-ended projects, having them work things out, definitely having them [be] more persistent with things and working through the problems. … I had to learn to give them more wait time, I realized that and not give them the answers.

V.2.3. Impact on Use of Technology

Teachers were expected to embed technology into their instructional practice, emphasizing technologies such as sensors and probes. The survey, observations, and interviews provided data around the extent to which teachers were able to use this technology effectively.

On the survey, teachers were asked to describe the extent to which they used technology for inquiry-related purposes. The impact on this question was positive, large, and statistically significant. On the other hand, there were no differences as measured by the observations in any of the three ways technology was examined: frequency of use by students, use by students to enhance learning, and distribution of time segments spent using technology by the students. (For context: Use of online technology, such as Zoom, for virtual or hybrid classrooms was not coded as technology use by the observers.)

Table V-8. Impact on Use of Technology

Outcome	Year 2		
	Treatment Adjusted mean (SD)	**Control Mean (SD)**	**Effect size**
Survey	N=60	N=86	
Use of inquiry-based instruction integrating technology	2.87 (1.10)	2.24 (0.80)	0.68***
Observations	N=63	N=82	
Appropriateness of student technology use (extent to which it was integral to the inquiry task)	1.93 (1.17)	1.83 (0.96)	0.09
Distribution of student technology use	3.12 (1.39)	3.13 (1.25)	-0.01
Percentage of time student was observed using any technology	68.7% (42.32)	73.0% (36.64)	-0.11

***$p \leq .001$

Why are there different conclusions from the surveys and the observations? First, as noted earlier, the surveys were self-report and thus, it is reasonable to expect that the effect sizes for the surveys were higher than for the observations. However, unlike with the inquiry questions, there were no apparent differences between treatment and control groups on the different measures of technology use. It is likely that COVID-19 safety protocols, which prohibited students from sharing technology, inhibited students' sharing of many of the technologies emphasized by the project.

In interviews, ten teachers and two coaches talked about changes teachers made around technology use. As one coach shared,

> [Teachers] started using a whole lot more instructional technology than they had ever used. And, I mean, I think that their technology understanding, usage, growth, being able to use technology for students to collaborate, a lot of those things just grew exponentially this year.

Teachers also appreciated gaining better grasp on how to use technology to increase students' understanding, engagement, and to teach standards. As another coach noted, "Some [teachers] can definitely now tell the difference when the use of technology is enhancing the lesson … for student comprehension rather than just using a computer to use a computer." Most teachers confirmed that the project helped them to change or increase their use of technology. As one of them commented, "I think the technology piece has been really, really, really helpful … I've seen that I have an upper hand and I think that the EQuIPD grant might be the reason for that."

Teachers described how they taught coding to their elementary students and how they used probes and sensors. One teacher noted, "I've never done coding before. So, I definitely learned a lot about coding. So, I feel pretty confident in how to do that now. That was a big game changer." Another commented,

> I did a training with one of [the teacher's] students on how to use the code.Node, and that was awesome too, because that was one of the first ones we did, where the kids had to build their tallest tower and what could withstand an earthquake. And then the code.Node measured seismic activity, our pretend seismic activity. But it turned out great. And so, it just kind of opened my eyes, working with her and her students on how to be able to do inquiry online.

Teachers also commented that the project was very helpful in supporting the transition to online instruction during the COVID-19 pandemic.

V.2.4. Impact on Use of System Thinking and Concept Modeling

As shown earlier, the project has had a very large and positive impact on teachers' knowledge and understanding of system thinking and process mapping. The Year 2 survey included additional items that examined teachers' implementation of concept modeling; however, concept modeling was not included in the observation protocol. As shown in Table V-9, survey results showed a large and positive impact on treatment teachers' reported use of concept modeling in their instruction.

Table V-9. Impact on Use of System Thinking through Concept Modeling

Outcome	Year 2 Treatment Adjusted mean (SD)	Control Mean (SD)	Effect size
Survey	N=60	N=86	
Concept modeling frequency	2.88 (1.27)	2.15 (1.19)	0.60***
Concept modeling implementation	4.12 (0.55)	3.71 (0.81)	0.55***

***$p \leq .001$

In the interviews, five teachers commented on their increased focus on system thinking and four teachers commented on their use of concept modeling and mapping. As one teacher shared,

> So now I can take all of my big ideas in physical science, and I can now connect them all to transportation and movement. Now I know how to go to those standards, and now I have to create my skeleton.

Another added,

> I'd say that the biggest thing overall for me would be just the interconnectivity of stuff, building a model that I can attach to another model or building a lesson I can attach to another lesson. But being able to have a little more intentionality to my lessons where one leads into the next, and I can cycle back to the stuff we covered in the previous lesson and bring it forward into this lesson in a meaningful way and build on to it.

Teachers used process maps for classroom management, lesson planning, and for students to articulate their processes. Coaches confirmed that, for many teachers, focusing on concept modeling affected their teaching the most and helped give their planning more intentionality.

V.2.5. Impact on Use of Real-World Problems

One of the project expectations was that teachers would incorporate real-world problems and an emphasis on careers into their inquiry activities. This was measured by both the survey and the observations. The survey measured the extent to which teachers made connections to careers in their classroom instruction using two different scales. As shown in Table V-10, treatment teachers reported making more connections to careers and external STEM industries in their instructional practice (effect size of 0.81) than control teachers and using real-world problems and the project-specific technology. On the other hand, observations showed lower integration of real-world problems and career information among treatment teachers with effect sizes of close to -0.20, although the differences were not statistically significant.

Table V-10. Impact on Use of Real-World Problems

Outcome	Year 2		
	Treatment Adjusted mean (SD)	Control Mean (SD)	Effect size
Survey	N=60	N=86	
Connections to career and external STEM industries	2.23 (1.10)	1.53 (0.63)	0.81***
Use of real-world problems and EQuIPD-specific technology	2.32 (1.11)	1.72 (0.71)	0.66***
Observations	N=63	N=82	
Use of real-world problems (scale)	1.52 (0.72)	1.65 (0.71)	-0.17
Real life examples and authentic tasks	1.84 (1.08)	2.00 (0.95)	-0.16
Incorporation of workforce skills/knowledge	1.20 (0.63)	1.29 (0.65)	-0.14

***$p \leq .001$

This outcome had the largest difference between the results from the survey and the results from the observations. It is not clear why those differences occurred, although both groups scored relatively low on the observation scale (2.0 or less out of 4).

Seven teachers said during interviews that they used knowledge received during field trips in their classrooms to help make the connection to real-world problems. As one of them commented,

> I think it was really beneficial just to see the different fields that are out there in different companies and businesses and everything that I've never really heard of or didn't know about. And then they go and try to explain what it's about. So then, in turn, you could go in and explain and introduce it to your students or kids.

And another added, "So, the field trips help me also as a teacher, see how I can relate a real-world experience to my classroom. It was hard this year because everything was online, but it definitely sparked conversations in my classroom." One teacher noted that virtual tours were easier to share with students because, "they can be used in the classroom."

V.2.6. Impact on Use of Collaboration and Group Work

Teachers were expected to have students engage in collaboration and group work. The level of collaboration and group work was assessed using data from the survey, observations, and interviews. As shown in Table V-11, treatment teachers reported using higher levels of collaborative activities than control teachers[11]; however, there were no significant differences between the treatment and control groups in the observations. The largest impact on the observations was on the quality of student discourse within a group, which was a practice emphasized by the professional development.

Table V-11. Impact on Use of Collaboration and Group Work

Outcome	Year 2		
	Treatment Adjusted mean (SD)	**Control Mean (SD)**	**Effect size**
Survey	N=60	N=86	
Engagement during collaborative activities	2.95 (1.15)	2.45 (0.96)	0.42*
Student collaboration on assignments	3.20 (0.80)	2.81 (0.72)	0.54***
Observations	N=63	N=82	
Group work (scale)	2.07 (1.28)	1.98 (1.10)	0.08
Distribution of work among students in a group	2.06 (1.28)	2.03 (1.12)	0.03
Student discourse quality within groups	2.08 (1.32)	1.94 (1.12)	0.12
Percentage of time engaged in large or small group activities	40.94 (40.30)	40.50 (35.61)	0.01

$^{*}p \le .05$; $^{***}p \le .001$

During interviews, six teachers and two coaches commented on how teachers improved their collaborative group work due to the project. As one teacher shared, "So, it's definitely something I had never done before as far as partner reading. And then … trying to figure out how to do it online as well, grouping and stuff like that." Another teacher noted,

> And one thing that I added was, if we're doing a project, they would get feedback from a peer, and then they have to go back. And from that feedback, go and make changes to their project. And having more reflection at the end and reflecting what and seeing how they can improve what they're doing and the work.

One coach noted how the project helped teachers to organize groups for inquiry learning online,

> So, instead of reverting to lecture-based instruction, still doing inquiry, but using online simulations and using collaborative documents to have a group experience, or close of an approximation to that as well. Just working with them to develop the collaborative

[11] A new collaboration scale was added at the end of Year 2.

worksheets and develop the activities and structure the right questions really, really empowered some teachers.

V.3. Impact on Teacher Professional Growth

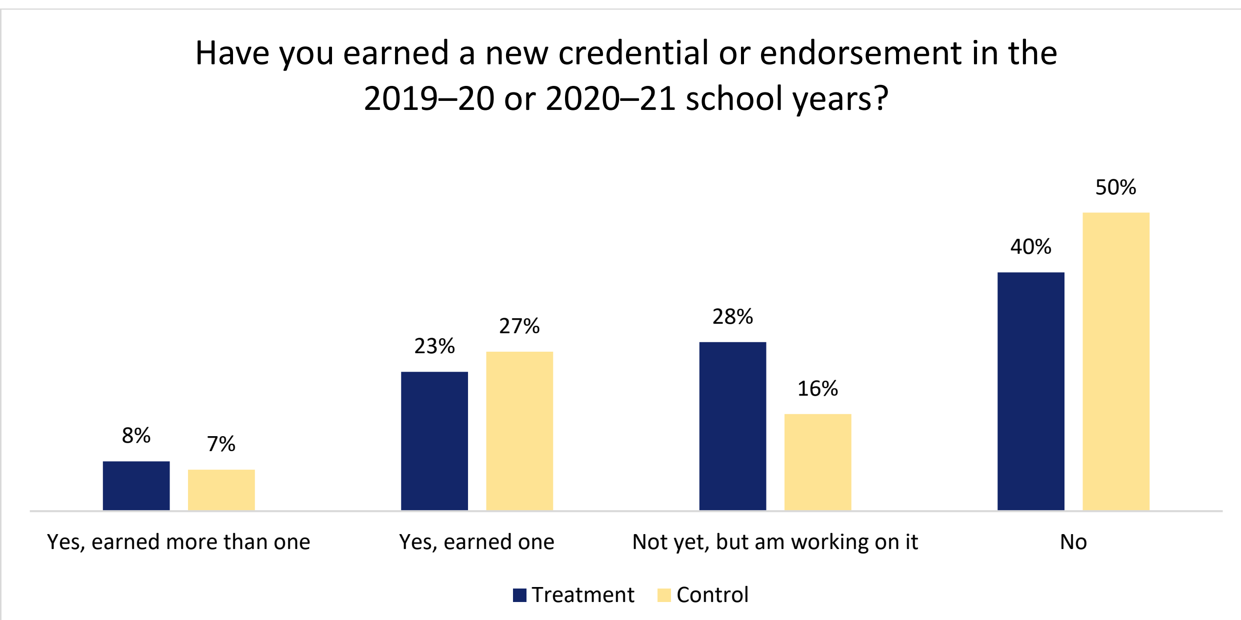
The evaluation looked at two measures of teacher professional growth: their earning of postsecondary credentials and their engagement in teacher leadership activities. Data on both came from the survey.

V.3.1. Earning of Credentials

On the survey, teachers were asked whether they had earned a new credential or endorsement in either of the project years. As shown in Figure V-2, descriptive analyses indicate that 60% of treatment teachers reported either earning or working on a credential compared to 50% of control teachers (the difference was not statistically significant).

Project records showed that a small number of teachers earned multiple credentials. For example, one teacher (1) earned certifications in Apple Swift, X code, Minecraft for Education, Code.org certification, (2) participated in and provided professional development, and (3) became (along with other participants) a Google-certified trainer.

Figure V-2. Earning of Credentials, by Treatment Status



V.3.2. Teacher Leadership Activities

In addition to changing behaviors in the classroom, Project EQuIPD expected that teachers would increase their leadership outside of the classroom (e.g., working with other teachers and sharing their knowledge with the broader educational community). As shown in Table V-12, there was no significant impact on teacher leadership from the survey, although there were descriptively positive trends. It is important to note that this survey was administered prior to treatment teachers providing the summer professional development in the summer; the results might have been different if the survey had been administered after teachers had provided the workshops for the control teachers.

Table V-12. Impact on Teacher Leadership Activities

Outcome	Adjusted Treatment mean (SD)	Control Mean (SD)	Effect Size
Survey	**(N =60)**	**(N=86)**	
Teacher leadership activities	2.62 (0.81)	2.50 (0.66)	0.17

Note. Impact was not statistically significant

Project records showed that some of the participating teachers had extensive leadership responsibilities in their school, and at least two of the teachers received grants. One teacher received $2,000 in Arduino Grove Tech, and another teacher was awarded a STEM4All grant, which provided 10 drones.

Of the teachers interviewed in summer 2021, over half expressed a willingness to provide professional development to their school and district, or to serve as a mentor, or in another leadership role, after participating in EQuIPD. Two other teachers had already scheduled professional development sessions at their schools for the fall. Several of these teachers were excited to present the session they had developed for the 2021 Summer Bootcamp or on other EQuIPD topics. Others were interested in training teachers on technology (i.e., websites, software/apps) in which they had developed expertise.

In addition, two teachers had already been selected by their principal for other leadership positions, one as a mentor and one as a liaison to the district for science; the latter noted that EQuIPD participation led to being asked to take the position. Two other teachers said that they had already been informally supporting other teachers in their school. For example, one teacher, who had to coordinate their science lesson plans with others teaching the same course, ended up teaching colleagues about the EQuIPD concepts so they could be incorporated into their instruction as well.

Opportunities for leadership varied by school and district—for instance, an instructional coach explained that one district already had professional trainers in place, so teachers were rarely given the opportunity to provide training. And some teachers were uncertain about their leadership options due to changing circumstances such as a new principal or moving to a new district. One teacher explained that no professional development was offered at their school the previous year because of the pandemic, but was hopeful that opportunities would resume, saying,

> If things get back to normal this year, I'd like to run our design thinking program that we made with the people at my school … I think they would get something out of it, no matter what subject [they] teach."

Finally, two teachers noted that preparing and presenting professional development for EQuIPD gave them greater confidence in their ability to train and lead their colleagues. As one teacher explained, "

> [I had] never put myself out there to be, like, a teacher for teachers. Something about being a teacher for the students, that's one thing. But teaching your peers, that's kind of a whole other level. So, I definitely gained confidence in my ability to do that.

V.4. Impact on Teacher Retention and Attendance

Another goal of EQuIPD was to increase the likelihood that teachers would remain in the profession. The evaluation team examined two measures, the percentage of teachers who were still employed in 2021–22 in the districts where they were at the beginning of the project and the number of days that a teacher was absent from school. As shown in Table V-13, there were no statistically significant differences in teachers' likelihood of being retained. The benchmark two-year retention rate in the control group was already fairly high at 91%.

Table V-13. Impact Estimates for Retention

Group	Treatment		Control		Impact estimate	Effect size	p-value
	N	Adjusted mean (SD)	N	Mean (SD)			
Overall means	102	0.88 (0.32)	121	0.91 (0.28)	-0.04	-0.12	0.35
Teach elementary	43	1.00 (0.00)	54	1.00 0.00			
Teach middle	59	0.78 (0.40)	67	0.84 (0.37)	-0.06	-0.16	0.34
Teach STEM subjects	54	0.96 (0.19)	73	1.00 0.00	-0.04	-0.31	0.16
Teach non-STEM subjects	4	1.00 0.00	6	1.00 0.00			

Note. Impact estimates are not reported for groups when retention was 100% in the treatment and control group.

Table V-14 shows that there were no statistically significant differences in absences overall or at the subgroup level, with the exception of treatment elementary teachers having higher levels of absences (significance level of 0.10). The evaluation team conducted a sensitivity analysis that excluded one teacher with an abnormally high level of absences (49.3). Under these analyses, the overall effect size was reduced to 0.02 and the impact on elementary teachers was not statistically significant at any accepted level. As a result, the primary conclusion is that there was no impact of the project on teacher absences.

Table V-14. Impacts on Teacher Absences

Group	Treatment N	Treatment Adjusted mean (SD)	Control N	Control Mean (SD)	Impact estimate	Effect size	p-value
Overall means	85	7.11 (7.05)	107	6.50 (6.36)	0.61	0.09	0.50
Teach elementary	39	8.47 (9.23)	52	5.61 (5.40)	2.86	0.39	0.09
Teach middle	46	5.97 (4.57)	55	7.34 (7.10)	-1.37	-0.22	0.18
Teach STEM subjects	48	6.07 (5.84)	69	6.48 (6.20)	-0.41	-0.07	0.71
Teach non-STEM subjects	4	8.21 (1.18)	6	8.24 (11.58)	-0.03	-0.003	1.00

It is not surprising that there were no findings on absences and retentions given the overwhelming impact of the COVID-19 pandemic. There was one teacher, however, who shared that participating in the EQuIPD program kept her from leaving the profession as it helped remind her of her motivation for teaching. As she explained,

> There were plenty of times throughout this course where I wanted to give up and leave the field, but just being a part of this cohort kept me grounded and reminded me of my why and my purpose … Even through the pandemic, [being worried about] losing a job. … I definitely appreciate having the support of the program to one, continue to grow, and then just being a part of my why.

Section VI. Student Impacts

Changes in teachers' instruction were expected to lead to improved impacts on student achievement. As described in the context section, the pandemic had an impact on student assessments, with no statewide assessments administered in spring 2020. Florida did administer tests in spring 2021, however, with some modifications. The evaluation team analyzed data from these 2021 assessments.

Key findings from this section include:

- **There were no differences between treatment and control classes on composite scores (combined reading and math), reading scores, math scores or science scores.**
- **There were statistically significant positive impacts on science scores for students in two subgroups; however, it is possible that these differences occurred by chance given the number of different comparisons that were made.**

VI.1. Impacts on Student Achievement

The tables below show impact estimates for the combined assessment scores, reading scores, and math scores. Table VI-1 shows the impacts on composite scores. Results show no statistically significant impact overall and for none of the subgroups.

Table VI-1. Impact Estimates for Composite Scores

Group	Treatment		Control		Impact estimate	Effect size	p-value
	N	Adjusted mean (SD)	N	Mean (SD)			
Overall means	5,684	-0.01 (0.91)	6,839	0.01 (0.92)	-0.02	-0.02	0.57
Underrepresented minority	2,736	-0.31 (0.86)	3,602	-0.30 (0.89)	-0.01	-0.01	0.82
White	2,948	0.32 (0.82)	3,237	0.35 (0.83)	-0.03	-0.03	0.39
Economically disadvantaged	2,389	-0.29 (0.85)	2,828	-0.27 (0.88)	-0.02	-0.02	0.53
Not economically disadvantaged	1,943	0.41 (0.79)	2,407	0.44 (0.83)	-0.03	-0.04	0.32
Female	2,760	0.02 (0.89)	3,292	0.03 (0.90)	-0.01	-0.01	0.66
Male	2,924	-0.03 (0.92)	3,547	-0.01 (0.93)	-0.02	-0.02	0.53
ELL	621	-0.54 (0.82)	855	-0.55 (0.87)	0.02	0.02	0.73
Not ELL	3,711	0.15 (0.90)	4,380	0.18 (0.89)	-0.03	-0.04	0.27

Group	Treatment		Control		Impact estimate	Effect size	p-value
	N	Adjusted mean (SD)	N	Mean (SD)			
Low-performing	2,553	-0.65 (0.71)	3,328	-0.62 (0.71)	-0.03	-0.04	0.38
High-performing	3131	0.60 (0.64)	3,511	0.61 (0.65)	-0.01	-0.01	0.86

Table VI-2 shows the impact on reading scores. The results were similar to the composite scores.

Table VI-2. Impact Estimates for Reading Scores

Group	Treatment		Control		Impact estimate	Effect size	p-value
	N	Adjusted mean (SD)	N	Mean (SD)			
Overall means	5,575	-0.02 (0.96)	6,678	-0.01 (0.99)	-0.01	-0.01	0.69
Underrepresented minority	2,674	-0.31 (0.93)	3,501	-0.32 (0.96)	0.01	0.02	0.59
White	2,901	0.29 (0.90)	3,177	0.33 (0.90)	-0.04	-0.04	0.14
Economically disadvantaged	2,325	-0.28 (0.93)	2,732	-0.27 (0.94)	-0.01	-0.01	0.82
Not economically disadvantaged	1,918	0.41 (0.85)	2,376	0.45 (0.90)	-0.04	-0.05	0.14
Female	2,710	0.07 (0.94)	3,228	0.07 (0.96)	0.00	0.00	0.99
Male	2,865	-0.11 (0.97)	3,450	-0.09 (1.02)	-0.02	-0.02	0.49
ELL	608	-0.62 (0.88)	819	-0.60 (0.95)	-0.02	-0.02	0.62
Not ELL	3635	0.17 (0.94)	4,289	0.19 (0.95)	-0.02	-0.02	0.38
Low-performing	2,492	-0.70 (0.79)	3,294	-0.68 (0.79)	-0.02	-0.02	0.56
High-performing	3,083	0.65 (0.67)	3,384	0.65 (0.68)	-0.01	-0.01	0.85

Table VI-3 below shows the impact on math scores. There were no statistically significant differences in math performance overall or for any of the subgroups.

Table VI-3. Impact Estimates for Math Scores

Group	Treatment N	Treatment Adjusted mean (SD)	Control N	Control Mean (SD)	Impact estimate	Effect size	p-value
Overall means	5,337	0.03 (0.96)	6,532	0.04 (0.98)	-0.01	-0.01	0.79
Underrepresented minority	2,618	-0.29 (0.92)	3,449	-0.27 (0.96)	-0.02	-0.02	0.71
White	2,719	0.38 (0.85)	3,083	0.38 (0.87)	-0.00	-0.01	0.92
Economically disadvantaged	2,286	-0.29 (0.91)	2,697	-0.26 (0.97)	-0.03	-0.03	0.53
Not economically disadvantaged	1,906	0.43 (0.85)	2,367	0.45 (0.88)	-0.02	-0.02	0.64
Female	2,601	-0.03 (0.94)	3,149	-0.01 (0.97)	-0.02	-0.02	0.72
Male	2,736	0.07 (0.98)	3,383	0.08 (0.99)	-0.01	-0.01	0.88
ELL	596	-0.43 (0.89)	836	-0.48 (0.96)	0.05	0.05	0.45
Not ELL	3,596	0.14 (0.97)	4,228	0.18 (0.96)	-0.04	-0.04	0.35
Low-performing	2,415	-0.56 (0.82)	3,124	-0.54 (0.82)	-0.02	-0.02	0.65
High-performing	2,922	0.58 (0.77)	3,408	0.58 (0.79)	-0.00	-0.00	0.97

The final analysis looked at the impact on science scores. Results showed generally no differences, although there were statistically significant positive impacts on students who were not economically disadvantaged and higher achieving students. However, given the number of comparisons that we completed in these analyses, it is possible that these positive findings occurred by chance.

Table VI-4. Impact Estimates for Science Scores

Group	Treatment N	Treatment Adjusted mean (SD)	Control N	Control Mean (SD)	Impact estimate	Effect size	p-value
Overall means	1,986	0.01 (1.03)	1,889	-0.04 (0.95)	0.05	0.05	0.20
Underrepresented minority	1,130	-0.32 (0.95)	983	-0.38 (0.89)	0.06	0.06	0.21
White	856	0.39 (0.90)	906	0.34 (0.86)	0.05	0.05	0.35

Group	Treatment		Control		Impact estimate	Effect size	p-value
	N	Adjusted mean (SD)	N	Mean (SD)			
Economically disadvantaged	1,049	-0.25 (0.93)	683	-0.27 (0.91)	0.02	0.02	0.67
Not economically disadvantaged	827	0.44 (0.87)	834	0.34 (0.86)	0.10	0.11*	0.05
Female	1,005	-0.02 (0.99)	915	-0.05 (0.88)	0.03	0.04	0.46
Male	981	0.04 (1.07)	974	-0.03 (1.00)	0.07	0.07	0.15
ELL	255	-0.49 (0.87)	242	-0.51 (0.78)	0.02	0.03	0.73
Not ELL	1,621	0.24 (1.00)	1,275	0.17 (0.92)	0.06	0.07	0.16
Low-performing	905	-0.64 (0.76)	853	-0.64 (0.76)	0.00	0.00	0.94
High-performing	1,076	0.58 (0.77)	1,010	0.49 (0.76)	0.09	0.11^{t}	0.07

*p≤.05; ^{t} p≤.1

Overall, the analyses show no significant changes in student performance. This is not surprising given that EQuIPD was implemented in the middle of a pandemic, which was accompanied by many changes and stresses, including shifts between virtual and in-person instruction. Additionally, the 2020–21 state assessments were not used for accountability purposes, which might have affected student participation and performance.

Section VII. Conclusions and Implications

VII.1. Conclusions

Project EQuIPD provided all planned professional development activities without being derailed by the pandemic. Teachers participated in one week of a Summer Bootcamp in 2019 and an online Bootcamp in summer 2020. Throughout the two years, the professional development team provided both in-person and virtual follow-up workshops. By the end of 2019, all the instructional coaches had been hired and worked with teachers in person and virtually over the next 18 months. The professional development team also provided extensive training on the technologies used in the grant as well as the online technologies that were used when teachers had to make the shift from in-person to virtual instruction. The professional development team provided teachers with opportunities over the course of the project for both in-person and virtual fields trips to a range of businesses.

The FOI expectations for teachers did not change—and remained very high—across the two years, even in the middle of the pandemic. Although FOI was not met across all activities, teachers, on average, still received a substantial amount of support. These supports led to treatment teachers reporting much higher levels of knowledge of EQuIPD instructional practices than the control teachers. Teachers also reported much higher levels of implementation of the instructional practices targeted by EQuIPD. Observations also provided suggestive evidence that teachers were changing their practices related to inquiry.

There were no statistically significant differences in student achievement, which is not necessarily surprising given the overall context. EQuIPD was being implemented during COVID-19, which required the project to make continual pivots to respond to on-the-ground changes. Additionally, the participating teachers were experiencing substantial stress as they attempted to navigate personal and school challenges, while also providing as strong a learning experience as possible for their students. Although EQuIPD did not have all if its desired impacts, it is impressive that the project was able to successfully implement its targeted activities. Given the context, the evaluation team acknowledges that this evaluation was likely not a fair test of the true impact of EQuIPD; it is possible that, if the pandemic had not happened, the evaluation results might have been different.

Nevertheless, the project did learn some key lessons that have led to some recommendations for considering how to move this work forward and potentially replicate it.

VII.2. Lessons Learned and Recommendations

The data collected and the feedback from teachers and project staff have led to several lessons learned for people to consider as they look at scaling up the work.

VII.2.1. For complex interventions, it is critical to make the connections clear.

The EQuIPD model is a complex model with many different parts. Throughout the project, coaches and many teachers noted that it was challenging to understand how all the parts related to each other. The concept of system thinking, in particular, was a difficult concept for many people to fully operationalize, although many teachers appreciated the more specific application of process mapping.

The project used a variety of strategies to clarify the intervention components, including creating a graphical representation (Figure I-1) and rubric that laid out a picture of successful implementation of the different components. The coaches used this rubric in their work with the teachers.

Alternately, it is worth considering whether it may be easier for teachers to understand if the model streamlined discussion of the model's four primary components: Pedagogy, Curriculum, Technology, and System Thinking. The concepts of other pieces—such as engineering design, computational thinking, etc.—could be embedded throughout but not necessarily explicitly called out. This may help teachers focus more effectively.

VII.2.2. An intensive, aligned system of supports is necessary to support real change but can be challenging to sustain.

Project EQuIPD provided a variety of professional development opportunities (e.g., intensive Summer Bootcamps, follow-up workshops, and instructional coaching) that were all intended to build upon and reinforce each other. The Bootcamps gave an in-depth overview of the model, and the workshops predominantly built teachers' expertise in specific areas introduced during the Bootcamp. The coaches then provided on-the-ground assistance with implementing specific strategies.

The intensity of the professional development supports does pose challenges for sustainability given that it is difficult for districts to provide that level of support. The project sought to support sustainability by preparing teachers to share what they had learned with other teachers (i.e., using a train-the-trainer model). While this approach can provide some level of support, teachers, by themselves, will not be able to provide the same intensity of support; this must come from districts and should be planned for at the beginning of the project.

VII.2.3. When using specialized technologies, projects need to plan for providing those technologies.

Project EQuIPD focused on sensors and probes, technologies that are widespread but not always present in schools. During an initial needs assessment, schools indicated that they had these tools but, in reality, there were very few available. As a result, the project had to shift gears to purchase and make these technologies available to teachers.

When projects used specialized technologies, it would be useful to start with the assumption that these technologies will need to be purchased and made available to the teachers using a checkout system similar to the one used by Project EQuIPD.

VII.2.4. Projects should plan for management and monitoring systems.

As mentioned above, EQuIPD was a complex project with lots of pieces, including treatment and control teachers who were involved in different activities and coaches who provided extensive on-site and virtual training and who facilitated many different professional development opportunities for the teachers (e.g., field trips, certifications). Over the course of the project, the professional development team recognized the importance of having clear tracking systems that could be used for project management, monitoring, and evaluation. The lack of systems, particularly for tracking coaches and their work, appears to be a common challenge in educational practice. As the project PI commented, "One of the things, when I look at literature, is almost nobody has these plans for managing coaches, and they don't know what they do." Going into Year 2, the project PI noted that "creating these kind of tracking systems, in a way, is almost like a side product of the grant." Conceptualizing these systems from the beginning will help similar projects.

VII.2.5. EQuIPD was able to effectively pivot to respond to COVID-19.

As is likely the case with almost every intervention implemented in 2020–21, EQuIPD was substantially impacted by the COVID-19 pandemic. Schools were closed, and teachers had to navigate moving to online instruction. Similarly, the program had to switch from providing in-person professional development to an entirely virtual experience. From the service provision angle, the transition was fairly seamless with workshops, coaching, field trips, and other support activities moving online. All planned activities were implemented. Most teachers were fine with the shift to online opportunities as they appreciated the increased flexibility it gave them with scheduling and working with other teachers or accessing resources that might not be in their geographic area. This suggests that online delivery might be a viable option for the EQuIPD services. Offering hybrid options—with some in person and some online—might be the best way of meeting diverse needs.

Although the project was able to meet service delivery challenges head on, it is important to recognize that teachers were under a tremendous amount of stress, trying to do their best job at teaching in an ever-changing environment accompanied by potential health challenges for them and their families. This stress likely made it difficult for teachers to fully engage with the program. Additionally, COVID-19 safety protocols meant that it was challenging, if not impossible, to implement some of the targeted instructional practices (e.g., group work and hands-on inquiry activities that involved sharing materials). As such, the 2020–21 school year was a difficult time to assess teachers' implementation of the targeted instructional strategies. Despite these challenges, however, the treatment teachers reported a higher level of implementation of instructional practices than the control teachers, and the observations provided suggestive evidence that teachers may have modified their instructional practice in areas related to inquiry. All of this suggests that, in a non-pandemic situation, the program is likely to result in substantial changes in practice.

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Appendix A: Project EQuIPD Implementation Survey Scales

Survey scales: EQuIPD—Year 2 Survey 2021

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Availability of Technology in the Classroom **Source:** Adapted from 2018 NSSME+ (Banilower, et al., 2018)	*This question asks you to describe the availability of different instruments and technologies you might use to teach your students.* ➢ Sensors/Probes for collecting data (for example, temperature, pressure, motion, or biological probes and sensors) ➢ Computer for the teacher, for instructional purposes or administrative purposes. ➢ Software for data collection and analysis (for example, Excel, Microsoft Word, or Google docs and spreadsheets) ➢ Software for presentation (for example, Adobe, PowerPoint, or Google slides) ➢ Programmable robots or devices ➢ Programming software (for example, Scratch) ➢ Projection or presentation hardware, e.g., Smartboard, document camera, LCD projector. ➢ Digital recording devices (camera, smartphones, iPad, etc.) ➢ Electrical platform technology (Arduino, Breadboard, capacitors) ➢ Technology for visually enhancing phenomena (microscopes, telescopes, etc.) ➢ Computing devices for student use, such as laptops, Chromebooks, or iPads (*at least one device for a group of 4 students up to one device for each student*)	1 - Always available in my classroom 2 - Available on Request 3 - Not available or don't know	Used for baseline needs assessment and to track changes over time
Comfort with Technology **Cronbach's α = 0.92** **Source:** Technology Knowledge (TK) Scale from TPACK (Schmidt, et al., 2009) and Vannatta & Banister 2009	*This question asks you to think more broadly about how comfortable you feel using technology in your classroom. As you think about your own use of technology, indicate your level of agreement with the statement.* ➢ I can learn technology easily. ➢ I keep up with important new technologies that relate to my content area. ➢ I know a lot about different technologies. ➢ I frequently explore new technology. ➢ I have the technical skills I need to incorporate technology into my lessons. ➢ I have attended professional development sessions intended to increase technology usage. ➢ I have increased the use of technology in my classroom in the past year.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Baseline measure used as covariate in the survey analysis, also analyzed as individual outcome

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Perceived Importance of Technology **Cronbach's α = 0.88** **Source:** Based on Teacher Belief in Technology Use (Alghamdi & Prestridge, 2015)	*This question is about the integration of technology in student learning. It asks you to think about how important you think it is to include various technologies in your students' learning. As you think about the importance of integrating technology in your lessons, indicate your level of agreement with the statement.* I believe that… ➢ technology accommodates the different ways that students learn. ➢ technology converts teacher-centered approaches to student-centered learning approaches. ➢ technology improves students' research skills. ➢ technology makes it harder to manage classroom behavior. ➢ technology enhances in-class collaboration among students. ➢ incorporating technology into lessons helps to improve student learning. ➢ technology allows me to add visual and interactive components to lessons. ➢ incorporating technology into lessons improves student achievement of state standards.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Teacher background factor used for baseline needs assessment

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
District and School Support for Technology Use **Cronbach's α = 0.85** **Source:** Based on STNA Information and Communication Technologies Scale (Corn, 2007)	*The following statements ask about the extent to which your district and school supports the integration of technology into your classroom. As you think about the support provided by your district and school, indicate your level of agreement to the following statements.* ➢ My classroom has internet access that is sufficiently reliable and fast enough to complete instructional activities. ➢ My school or district has timely and reliable access to technology support and repair. ➢ My district and school provide technology (including laptops and calculators) for teachers to use in classrooms. ➢ My district and school provide technology (including laptops and calculators) for students to use in classrooms. ➢ My district and school provide other types of technology (such as sensors, probes, programming equipment, and recording devices) that can be implemented in my lessons. ➢ Professional development is provided at the local level to teachers and staff to implement technology into curriculum. ➢ I can ask for and receive specialized technology professional development. ➢ I am supported by the administration in developing technology-enriched lessons. ➢ My administration encourages staff to collaborate to create lessons or units that integrate technology as part of the learning process.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Used for baseline needs assessment

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Teacher Comfort with Online Instruction **Cronbach's α = 0.93** **Source:** Developed with project development team	*This question asks you about your comfort with aspects of online or virtual instruction (any situation in which some or all students are accessing instruction remotely via technology).* ➢ Engaging students when teaching online ➢ Facilitating learning remotely using technology and online tools ➢ Facilitating student collaboration using digital tools ➢ Using different teaching methods in the online environment (e.g., brainstorming, collaborative activities, discussions, presentations) ➢ Using synchronous web-conferencing tools (e.g., Google Meet, Zoom, Google Hangout) to teach online ➢ Managing student behavior in an online classroom ➢ Making digital materials and online lessons accessible to accommodate varying student needs ➢ Adapting lessons and assignments for online instruction ➢ Using inquiry instruction in an online setting	1 - Very uncomfortable 2 – Somewhat uncomfortable 3 – Somewhat comfortable 4 – Very comfortable	Used in Year 2 only as individual outcome; no baseline available.
Importance of Inquiry and Use of Real-World Problems **Cronbach's α = 0.94** **Source:** Adapted from TBEST, Horizon Research (Smith, et al., 2014)	*The following statements ask you to assess the importance of various aspects of teaching inquiry learning. Please indicate your level of agreement to the following statements.* I believe it is important for students to… ➢ generate their own questions or predictions related to a core concept. ➢ select variables to investigate as part of inquiry lessons. ➢ develop models or representations to investigate and understand real-world problems. ➢ have the opportunity to collect and organize their own data. ➢ make predictions based on evidence that they have gathered. ➢ have the opportunity to use technology themselves to collect data as part of inquiry ➢ draw conclusions from their experimentation. ➢ be able to make arguments based on evidence. ➢ present their own research to the class (either formally or informally) ➢ develop a conceptual model based on their own data or observations. ➢ make connections between what they learn in the classroom to what they experience outside of school.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Used for baseline needs assessment and as covariate in outcome analysis

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Understanding of System Thinking **Cronbach's α = 0.98** **Source:** Based on Effectiveness of System Thinking in the Classroom (Hopper & Stave 2008)	*The following statements have to do with your understanding of specific applications of System Thinking within your classroom.* ➢ I can define and explain system thinking to others. ➢ I understand how a system thinking approach can be applied to lesson development, deployment, and assessment of lessons in a classroom. ➢ I can list examples of low-level system thinking versus high-level system thinking. ➢ I use a system thinking approach to plan complex learning units. ➢ I build my students' expertise in applying system thinking to real-world problems. ➢ I use system thinking to map and understand complexity in the classroom. ➢ I recognize interconnections in a system and can explain how the parts of the system are related to the whole. ➢ I understand the changing [or fluctuating] relationship between feedback and behavior. ➢ I use general system principles to explain an observation or phenomena. ➢ I support my students as they purposefully develop simulation models to test their hypotheses.	If you are not yet aware of *system thinking,* please select <u>strongly disagree.</u> 1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Combined with Knowledge of System Thinking to create a single measure; used as an individual outcome and as part of the Knowledge scale.
Knowledge of System Thinking **Cronbach's α = 0.99** **Source:** Developed with project development team	*The following statements have to do with your knowledge of specific aspects of System Thinking. Please indicate your level of agreement to the following statements.* I can… ➢ identify components and processes within a system. ➢ identify relationships between and/or among system components. ➢ identify dynamic relationships within a system. ➢ organize system components, processes, and interactions within a relationship framework. ➢ recognize cyclical behavior within system. ➢ discern patterns and interrelationships within a system. ➢ draw conclusions to solve problems based on system understanding. ➢ I solve problems by using reflection and prediction.	If you are not yet aware of *system thinking,* please select <u>strongly disagree.</u> 1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Combined with Understanding of System Thinking to create a single measure; used as an individual outcome and as part of the Knowledge scale.

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Knowledge of Technology (Sensors & Probes) **Cronbach's α = 0.82** **Source:** Technology Knowledge (TK) Scale from TPACK (Schmidt, et al., 2009)	*The following statements have to do with your knowledge of specific technologies and how they can support student learning. Please indicate the degree to which you agree with each statement.* I can… ➢ design lessons that incorporate technology and are aligned to state learning standards. ➢ choose technologies that will enhance students' core content learning for an inquiry lesson. ➢ teach my students to use sensors and probes to solve real-world problems. ➢ program sensors and probes to support inquiry lessons ➢ teach my students to understand the use and impact of technology in solving real-world problems.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Individual outcome and part of Knowledge Scale
Knowledge of Engineering Design **Cronbach's α = 0.99** **Source:** Based on DET (Yasar et al., 2006) and TPK/TPACK, (Schmidt et al., 2009)	*The following statements have to do with your knowledge of engineering design and how it can be implemented in your lessons to model real-world problems. As you think about your own knowledge of engineering design, indicate your level of agreement with the statement.* As a **teacher,** I know how to… ➢ integrate engineering design into my inquiry lessons. ➢ guide my students' use of engineering design in their work. ➢ develop lessons that require students to use an engineering design process and solve real-world problems. ➢ implement all steps of the engineering design process as part of an inquiry lesson or unit.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Individual outcome and part of Knowledge Scale
Knowledge of Local STEM Resources **Cronbach's α = 0.93** **Source:** Developed with project developers	*The following statements have to do with your own knowledge of your local STEM industries and the resources that they have.* As a **teacher**… ➢ I know the STEM industries that are in my community and surrounding areas. ➢ I have toured STEM industries in my community. ➢ I know how to develop connections with industry partners in our area. ➢ I have had speakers from STEM industries present to my classes. ➢ I understand specialized skills that STEM employers require. ➢ I can embed STEM employment skills into my instruction. ➢ I can inform students of local STEM careers and the education those careers require.	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Individual outcome and part of Knowledge Scale

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Implementation of Inquiry Instruction **Cronbach's α = 0.93** **Source:** Based on Inquiry Beliefs and Practices (Jeanpierre, 2006)	*The following question asks you to reflect on the frequency of your implementation of specific instructional practices in your classroom.* In my classes… ➢ I encourage students to seek answers to their own questions. ➢ students develop their own hypotheses. ➢ students use resources other than the textbook. ➢ students design their own experiments. ➢ students analyze data from their own research. ➢ students develop conceptual models as part of inquiry learning. ➢ students use their data to support their arguments or conclusions. ➢ students working on different research questions during a class period. ➢ students communicate their research results to their peers. ➢ I provide students with inquiry experiences that develop their research skills. ➢ I provide students with inquiry experiences that build their conceptual understanding.	1 - Not yet 2 - Less than four times a year 3 - Monthly 4 - Weekly 5 - Daily	Individual outcome and part of Instructional Practices scale
Formative Assessment Strategies **Cronbach's α = 0.83** **Source:** Developed with project development team	*The following question asks you to reflect on the extent to which you incorporate formative assessment strategies in your classroom.* During a class period… ➢ I assess students' prior knowledge and adjust or modify instruction based on this knowledge. ➢ I assess individual student needs and differentiate instruction accordingly. ➢ I continuously monitor the students' level of understanding of the concepts or content they are working on. ➢ I provide descriptive feedback or specific information to students on their work to help them move towards their learning goals. ➢ I adjust instruction when I notice students' misunderstandings or misconceptions.	1 - Not yet 2 - Rarely 3 - Occasionally 4 - Regularly, but not every class period 5 - Every class period	Individual outcome and part of Instructional Practices scale
Use of Concept Modeling (Year 2 only) **Source:** Developed with project development team	*The following questions ask you to reflect on the use of concept modeling and related activities in your instruction and their impact on your instruction.* ➢ This school year, how frequently have you used concept modeling in your instruction?	1 - Not yet 2 - Four times or less a year 3 - Monthly 4 - Weekly 5 - Daily	Used in Year 2 only as individual outcome; no baseline available.

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Change in content knowledge **(Year 2 only)** **Cronbach's α = 0.97** **Source:** Developed with project development team	*The following questions asks you to reflect on the extent to which your understanding of the content that you teach has changed.* ➢ My understanding of the content I teach has improved over the past two years. ➢ Over the past two years, I have improved my ability to identify the core concepts in the state content standards. ➢ Over the past two years, I have improved my understanding of the core concepts underlying the content I teach	1 - Strongly Disagree 2 - Disagree 3 - Disagree Somewhat 4 - Somewhat Agree 5 - Agree 6 - Strongly Agree	Used in Year 2 only as individual outcome; no baseline available.
Implementation of concept modeling **(Year 2 only)** **Cronbach's α = 0.88** **Source:** Developed with project development team	*The following question asks you to reflect on your lessons. Indicate how often the following statements are true about your instruction this year.* ➢ My instructional strategies and activities are designed to allow students to use their prior knowledge to explain or predict phenomena and then resolve any results or answers that are surprising to them ➢ My lesson plans, and the questions I pose, encourage students to seek and value different ways to investigate or solve a problem ➢ My lessons focus on the fundamental concepts of a subject ➢ In my lessons, the activities focus on developing conceptual understanding of the subject ➢ In my lessons, elements of abstraction (i.e., symbolic representations, theory building) are encouraged when it is important to do so ➢ In my lessons, students use a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, lab materials, process maps, etc.) to represent phenomena. ➢ My students are presented with conceptual models (in words, pictures, or graphical representations) that they build and refine over the course of a lesson/series of lessons.	1 - Not yet 2 - Rarely 3 - Occasionally 4 - Regularly, but not every class period 5 - Every class period	Used in Year 2 only as individual outcome; no baseline available.

Construct **Reliability Estimate** **Source**	**Question**	**Response Options**	**Purpose in the Analysis**
Implementation of Project-based and Engineering-Based Inquiry Instruction **Cronbach's α = 0.97** **Source:** Based on Inquiry Beliefs and Practices (Jeanpierre, 2006)	*During a design or hands-on project, your students may engage in the following steps. Please indicate how often your students do the following steps.* When your students are doing a project, they… ➢ Work in teams to conduct inquiry or engineering projects. ➢ Collaborate to define the problem to solve or to identify the final product. ➢ Do background research before beginning work on a problem or design. ➢ Work together to brainstorm solutions and select one to move forward. ➢ Design the experiment or create a prototype for testing ➢ Collaborate to test their design for the product/ problem solution and collect data on how well it performs. ➢ Assess whether the hypothesis or prototype was correct based on the data. ➢ Work together to refine the design/solution based on the data collected. ➢ Write a report or present the results of the project as a learning team.	1 - I do not design hands-on projects 2 - My students never do this as part of a project 3 - My students do this as part of some projects 4 - My students do this as part of most projects 5 - My students do this as part of all projects	Individual outcome and part of Instructional Practices scale
Use of Inquiry-based Instruction Integrating Technology **Cronbach's α = 0.92** **Source:** Based on STNA Information and Communication Technologies Scale (Corn, 2007)	*The items below ask about how frequently technology is integrated into inquiry-based instruction and how technology is used to build student knowledge.* In my class students… ➢ work on inquiry lessons that contain real-world problems with no known solutions. ➢ use a variety of technologies as part of a full inquiry or engineering design project. ➢ use technology to access online resources and information as a part of classroom activities. ➢ use the same kinds of tools that professional researchers use, such as, probes and sensors. ➢ program sensors and probes to perform experiments they have designed. ➢ use technology to help solve problems as part of the investigative process. ➢ use technology to collect and analyze data individually and in learning teams. ➢ use technology to support higher-order thinking, e.g., analysis, synthesis, and evaluation of ideas and information. ➢ use technology to conduct research and model representations of the information (using Google slides, PowerPoint, etc.).	1 - Not yet 2 - Less than four times a year 3 - Monthly 4 - Weekly 5 - Daily	Individual outcome and part of Instructional Practices scale

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Use of Real-World Problems and EQuIPD-Specific Technology **Cronbach's α = 0.81** **Source:** Developed with project development team	*This question asks you to think about how frequently **your students** participate in specific activities in your classroom.* Students in my class… ➢ Grapple with real-world situations to solve inquiry problems related to local conditions. ➢ Experience engineering design as full cycles. ➢ Use sensors and probes to support inquiry lesson to build conceptual models. ➢ Use technology incorporating coding to analyze, model or predict as part of an inquiry learning process.	1 - Not yet 2 - Less than four times a year 3 - Monthly 4 - Weekly 5 - Daily	Individual outcome and part of Instructional Practices scale
Connections to Career and External STEM Industries **Cronbach's α = 0.87** **Source:** Developed with Project Development Team	*This question asks about **your students**' participation in STEM-related activities over the past year.* Students in my class… ➢ Receive information about STEM careers and STEM job opportunities in our area. ➢ Are asked to solve problems similar to those experienced by local industries. ➢ Explore STEM opportunities through guest speakers from community organizations. ➢ Use technology that is similar to technology used in the area industries. ➢ Have opportunities to develop STEM skills aligned with local employers' needs.	1 - Not yet 2 - Less than four times a year 3 - Monthly 4 - Weekly 5 - Daily	Individual outcome and part of Instructional Practices scale
Student Engagement during Collaborative Activities (Year 2 only) **Source:** Developed with Project Development Team	*This question asks how frequently students in your class collaborate.* ➢ This school year, how frequently have you had students work with each on projects or assignments?	1 - Not yet 2 - Less than four times a year 3 - Monthly 4 - Weekly 5 - Daily	Used in Year 2 only as individual outcome; no baseline available.
Quality of Student Collaboration (Year 2 only) **Cronbach's α = 0.92** **Source:** Developed with Project Development Team	*This question asks how often you observe students doing the following during collaborative projects or assignments:* ➢ Negotiating their roles within their group ➢ Dividing up the work so that everyone in the group contributes to completing the task ➢ Providing peer feedback, assistance, and/or redirection within their group ➢ Respecting each others' ideas ➢ Listening and taking turns speaking ➢ Sharing connections to relevant knowledge ➢ Negotiating the method or materials relevant to completing the task ➢ Using tools collaboratively to complete a task	*My students…* 1 - never do this as part of their collaborative assignments 2 - do this as part of some collaborative assignments 3 - do this as part of most collaborative assignments 4 - do this as part of all collaborative assignments	Used in Year 2 only as individual outcome; no baseline available.

Construct Reliability Estimate Source	Question	Response Options	Purpose in the Analysis
Teacher Leadership Behaviors **Cronbach's α = 0.83** **Source:** Based on Teacher Leadership Program Readiness Surveys (Finster 2014)	*This question asks about your participation in teacher leadership activities in your school and district over the past year. As you reflect on your own experience, think about how often you are involved in the situations described in the statements.* ➢ I collaborate with other teachers on instructional and student-related matters. ➢ I mentor new or struggling teachers. ➢ I model instruction to other teachers. ➢ I lead professional development at my school or in my district. ➢ I share my teaching expertise at state or national conferences. ➢ I seek out professional and leadership roles within my school and district.	1 - Not yet 2 - Rarely 3 - Sometimes 4 - Frequently	Used as outcome
Credentials **(Year 2 only)** **Source:** Developed with Project Development Team	*Have you earned a new credential or endorsement in the 2019-2020 or 2020-2021 school years?*	1 – Yes, more than one 2 – Yes, one 3 – Not yet, but working on it 4 - No	Used in descriptive analyses for outcome
EQuIPD Support for Credentials **(Year 2 only)** **Source:** Developed with Project Development Team	*Did the EQuIPD project support you in earning that credential, either through funding or training?*	1 – Yes 2 - Now	For formative purposes only

Appendix B: Predictive Validity of Survey and Observation Scales

Predictive validity describes the extent to which a particular score is related to some other measure. The stronger the relationship, the better the prediction. Typically, a correlation index between the score and some other measure would be used to assess the predictive validity although regression models can also be used. Because these data were nested, the evaluation team estimated separate multilevel models of the student composite score at Year 2 for all students who had a score as a function of each survey and observation scale, also measured at Year 2. The models used probability weights equal to the inverse of teachers' probability of being assigned to the treatment or control group. No other covariates were included in the models. The estimated effect was then transformed into an effect size to provide a standardized measure of the relationship, which was used as evidence for predictive validity. These effect sizes are included in the two tables below; associations that were significant at the p≤.10 level are bolded.

Table B-1. Validity of the Survey Measures

	Effect size [p-value]
Overall instructional practice	**0.16 [0.061]**
Overall knowledge scale	0.03 [0.738]
Comfort with technology (Q11)	0.06 [0.428]
Knowledge and understanding of system thinking (Q20 and Q21)	0.17 [0.178]
Knowledge of how to use technology in the class(Q24)	-0.02 [0.670]
Knowledge of engineering design (Q25)	0.05 [0.434]
Knowledge of local STEM resources (Q26)	**0.08 [0.020]**
Implementation of inquiry strategies (Q30)	0.004 [0.932]
Formative assessment strategies (Q32)	0.11 [0.116]
Implementation of Project-Based/Engineering-Based Inquiry Instruction (Q35)	-0.07 [0.572]
Use of inquiry-based instruction integrating technology (Q37)	**0.23 [0.000]**
Use of real-world problems and EQuIPD-specific technology (Q38)	**0.13 [0.060]**
Connections to career and external STEM industries (Q39)	0.10 [0.172]
Teacher leadership activities (Q41)	0.02 [0.736]

Table B-2. Validity of the Observation Measures

	Effect size [p-value]
Observation Score (Weighted overall measure)	**0.33 [0.000]**
Implementation of inquiry (Average of four scales from EQuIP)	**0.27 [0.000]**
Collaborative group work scale	**0.20 [0.000]**
Use of real-world problems scale	**0.31 [0.000]**
Technology scale	**0.14 [0.026]**
Instruction summative measure	**0.22 [0.000]**
Discourse summative measure	**0.18 [0.008]**
Assessment summative measure	**0.17 [0.021]**
Curriculum summative measure	**0.28 [0.000]**

Appendix C: EQUIPD Observation Protocol

EQUIP: Adapted with Permission from Authors for EQuIPD Project: 2021
(Electronic Quality of Inquiry Protocol)

Complete Section I before and during observation, Section II during the observation, and Sections III-VII immediately after the observation. If a construct in Sections III-VII absolutely cannot be coded based on the observation, then it is to be left blank.

Observer: ______________________________

School: ______________________________ District: ______________________________

Teacher ID: __________ Teacher Initials: __________ Subject/Course: __________ Grade Level(s): __________

Date: __________ Time Start: __________ Time End: __________ __________

I. *Descriptive Information*

A. Teacher Descriptive Information:

1. Teacher gender: ____ Male (M) ____ Female (F)
2. Teacher ethnicity: ____ Caucasian (C) ____ African-American (A) ____ Latino (L) ____ Other (O)

B. Student/Class Descriptive Information

1. Number of Students in Class: ____________ Number of Students on Zoom: ______________________________

C. Lesson Descriptive Information

1. Working Title for Lesson: ______________________________
2. Objectives/Purpose of Lesson: (Please list Objectives/Purpose if they were written or explicitly discussed by the teacher during the lesson) _ ______________________________ ______________________________

II. Lesson Structure

In the space below, take narrative notes about activities happening in the classroom and check codes for each of the five categories. Check the code if it occurred for more than 3 minutes or multiple times during a 10-min interval. In your notes, please pay attention to the following features of the lesson: (1) Concept Model/Core Idea explicit presence and development; (2) Alignment and explicit connections among Concept Model/Core Idea and learning goal, lesson activities and content representations.

II. Time Usage Table						
Time	*Classroom Notes of Observation* *(what teacher was doing; what students were doing)*	*Activity Codes*	*Organization Codes*	*Student Engagement*	*Teacher Technology Use*	*Student Technology Use*
0-10						
11-20						
21-30						
31-40						
41-50						
51-60						
61-70						
71-80						
81-90						

Activity Codes

- **0** **Non-Instructional Time**—administrative tasks, handing back/collecting papers, general announcements, time away from instruction
- **1** **Non-Inquiry**— lecture; activities with the purpose of skill automation; rote memorization of facts; drill and practice; checking answers on homework, quizzes, or classwork with little or no explanation
- **2** **Engage**—typically situated at the beginning of the lesson; assessing student prior knowledge and misconceptions; stimulating student interest
- **3** **Explore**—students investigate a new idea or concept
- **4** **Explain**—teacher or students making sense of an idea or concept

Organization Codes

- **W** **Whole Class**
- **L** **Large Group**—5-8 students
- **S** **Small Group or Pairs**—2-4 students
- **I** **Individual Work**

Student Engagement Code (Displayed by Students)

Record approximate percent of students who were engaged with the lesson content as described below:

High engagement—students are behaviorally and cognitively engaged with the lesson content and tasks. They are taking notes or looking at the teacher and listening during lecture, writing on the worksheet, are volunteering ideas during a discussion, engaged in collaborative group work, engaged in small group discussions even without the presence of the teacher. Students volunteer to solve a problem or demonstrate an experiment in front of the class. Students on Zoom actively participate in chat or orally.

Technology Use

Note: Any electronic equipment or software would count as technology. Examples include probes and sensors, computers, calculators, cell phones, SMART boards and clickers, computer projectors with access to internet, video equipment, GPS, programming software, etc.

Technology list:

1. No technology was used
2. Calculator
3. Handheld/Smartphone/Tablet
4. Database (Matweb)
5. Digital Sensors
6. Simulation/Visualization
7. Desktop or Laptop Computer
8. Interactive White Board
9. Other Digital Device
10. Video/computer/overhead projector
11. Office software (Word or Google)
12. Other Tech (see note)

In the space below, provide notes about any unusual circumstances, the teacher, the lesson or activities happening in the classroom which you think are important to know but which were not captured by the observation protocol. [Optional]

III-G. Group Collaboration					
Construct Measured		*Emerging Practice (1)*	*Developing Practice (2)*	*Proficient Practice (3)*	*Exemplary Practice (4)*
G1.	**Distribution of Work** Among Students in a Group	**No** student groups, separate assignments, or the groups' tasks **did not** focus on **inquiry or design**.	Inquiry/Design task present, but work on task was **not distributed** among students in group.	Inquiry/Design task present and students in the group divided the work, but **inequities and inefficiencies** were present in the distributions.	Inquiry/Design task present and students in the group **equitably** divided the work. Group monitored completion of individual tasks and provided assistance, if needed.
G2.	Student **Discourse Quality** within Groups	**No** student groups or student conversations in groups **did not** focus on the **inquiry or design task.**	Students discussed the inquiry/design task in groups; the talk **was not** distributed equally. Multiple perspectives **were not** introduced or considered.	**All students** had opportunities to contribute to discussion of the inquiry/design task in groups. The discussion **rarely or never** considered **multiple perspectives** or approaches to the task/problem.	**All students** discussed the inquiry/design task in groups. Group **considered and incorporated multiple perspectives** or approaches into designing solutions/products.

III-R. Real World Examples					
Construct Measured		*Emerging Practice (1)*	*Developing Practice (2)*	*Proficient Practice (3)*	*Exemplary Practice (4)*
R1.	Real-Life Examples and Authentic Tasks	Teacher did not use any real-life examples that were authentically related to the inquiry **task or no inquiry task was introduced.**	Inquiry task present; **context for the task was authentic** to real world (simulated a real world situation, related to everyday life, society, or workplace). Task was **not complex or interdisciplinary** or had a **single correct solution**. Task was completely structured by the teacher.	Inquiry task present; context for the task was **authentic** to real world. Task was complex and **had no one right answer.** Task's relevancy to students, or content standards, or real life was missing in some segments.	Inquiry task present; context for the task was **authentic** to real world. **All processes** for developing and presenting solution were authentic to the context and mirrored **real world workplace processes**.
R2.	Incorporation of Workforce Skills/Knowledge	**No** workforce information **authentic** to the inquiry task was provided.	**Employability skills** related to the inquiry task were **not explicitly discussed**, but **some incomplete career** information was provided (i.e., level of education, competition for the career, compensation, etc., but not all).	Information concerning e**ither employability skills or careers** which were authentic to the inquiry task were covered **comprehensively**, but not both.	Information concerning **both employability skills and careers** which were authentic to the inquiry task were covered comprehensively,

III-T. Technology Integration					
Construct Measured		*Emerging Practice (1)*	*Developing Practice (2)*	*Proficient Practice (3)*	*Exemplary Practice (4)*
T1.	**Appropriateness** of Student Technology Use	Students either did **not use** technology or used it for purposes other than the inquiry/design task (drill and practice, note-taking, simple calculations, etc.).	Students used technology in the **context of an inquiry/design task**, but its use helped the task **only indirectly** by increasing efficiency or providing access to resources. Technology use was **structured and prescribed** by the teacher.	Students used **technology** that **was central and essential** for completing inquiry/design task. Technology use was **structured and prescribed** by the teacher.	Students used **technology** that **was central and essential** for completing inquiry/design task. **Students determined** how, when, and what technology to use and utilized it to locate, organize, analyze, evaluate, synthesize, process, and report data and results.
T2.	**Distribution** of Student Technology Use	**None or fewer than 25%** of students in class had an opportunity to work or learn with technology throughout the lesson.	Between **25% and 50%** of students in class had an opportunity to work or learn with technology throughout the lesson.	Between **51% and 90%** of students in class had an opportunity to work or learn with technology throughout the lesson.	**More than 90%** of students in class had an opportunity to work or learn with technology throughout the lesson.

IV. Instructional Factors					
Construct Measured		Pre-Inquiry (Level 1)	Developing Inquiry (2)	Proficient Inquiry (3)	Exemplary Inquiry (4)
I1.	Instructional Strategies	Teacher predominantly lectured to cover content.	Teacher **frequently lectured** and/or used demonstrations to explain content. Activities were **verification only**.	Teacher **occasionally lectured**, but **students were engaged in activities** that helped develop conceptual understanding.	Teacher occasionally lectured, but students were engaged in investigations that **promoted strong conceptual understanding**.
I2.	Order of Instruction	Teacher explained concepts. Students either did not explore concepts or did so only after explanation.	Teacher asked **students to explore concept before receiving explanation**. Teacher explained.	Teacher asked students to **explore before explanation**. **Teacher and students explained**.	Teacher asked students to explore concept before explanation occurred. Though perhaps prompted by the teacher, **students provided the explanation**.
I3.	Teacher Role	Teacher was center of lesson; rarely acted as facilitator.	**Teacher was center** of lesson; **occasionally** acted as f**acilitator**.	Teacher **frequently** acted as facilitator.	Teacher **consistently and effectively** acted as a facilitator.
I4.	Student Role	Students were consistently passive as learners (taking notes, practicing on their own).	**Students were active to a small extent** as learners (highly engaged for very brief moments or to a small extent throughout lesson).	**Students were active as learners** (involved in discussions, investigations, or activities, but not consistently and clearly focused).	Students were **consistently and effectively active as learners** (highly engaged at multiple points during lesson and clearly focused on the task).
I5.	Knowledge Acquisition	Student learning focused solely on mastery of facts, information, and/or rote processes.	Student learning focused on **mastery of facts** and process skills without much focus on understanding of content.	Student learning required **application of concepts** and process skills in new situations.	Student learning required **depth of understanding** to be demonstrated relating to content and process skills.

V. Discourse Factors				
Construct Measured	*Pre-Inquiry (Level 1)*	*Developing Inquiry (2)*	*Proficient Inquiry (3)*	*Exemplary Inquiry (4)*
D1. Questioning Level	Questioning rarely challenged students above the remembering level.	Questioning rarely challenged students above the **understanding level**.	Questioning challenged students **up to application or analysis levels**.	Questioning challenged students at various levels, **including at the analysis level or higher; level was varied to scaffold learning.**
D2. Complexity of Questions	Questions focused on one correct answer; typically, short answer responses.	Questions focused **mostly on one correct answer;** some open response opportunities.	Questions **challenged students to explain, reason, and/or justify**.	Questions required students to explain, reason, and/or justify. **Students were expected to critique others' responses**.
D3. Questioning Ecology	Teacher lectured or engaged students in oral questioning that did not lead to discussion.	Teacher occasionally **attempted to engage students in discussions ~~or investigations~~** but was not successful.	Teacher **successfully engaged students** in **open-ended questions, discussions,** and/or ~~**investigations**~~.	Teacher **consistently and effectively engaged students** in **open-ended questions, discussions,** ~~investigations~~, and/or reflections.
D4. Communication Pattern	Communication was controlled and directed by teacher and followed a didactic pattern.	Communication was **typically controlled and directed by teacher** with occasional input from other students; mostly didactic pattern.	**Communication was often conversational** with some student questions guiding the discussion.	Communication was **consistently conversational with student questions often guiding the discussion**.
D5. Classroom Interactions	Teacher accepted answers, correcting when necessary, but rarely followed-up with further probing.	Teacher or another student **occasionally followed-up student response** with further low-level probe.	Teacher or another student **often followed-up response** with engaging probe that required student to **justify reasoning or evidence**.	Teacher **consistently and effectively facilitated rich classroom dialogue** where evidence, assumptions, and reasoning were challenged by teacher or other students.

VI. Assessment Factors					
Construct Measured		*Pre-Inquiry (Level 1)*	*Developing Inquiry (2)*	*Proficient Inquiry (3)*	*Exemplary Inquiry (4)*
A1.	Prior Knowledge	Teacher did not assess student prior knowledge.	Teacher **assessed student prior knowledge but did not modify instruction** based on this knowledge.	Teacher assessed student prior knowledge and then **partially modified instruction** based on this knowledge.	Teacher assessed student prior knowledge and then **modified instruction** based on this knowledge.
A2.	Conceptual Development	Teacher encouraged learning by memorization and repetition.	Teacher encouraged **product-or answer-focused learning activities** that **lacked critical thinking.**	Teacher encouraged **process-focused learning activities** that **required critical thinking**.	Teacher encouraged process-focused **learning activities** that involved **critical thinking that connected learning with other concepts**.
A3.	Student Reflection	Teacher did not explicitly encourage students to reflect on their own learning.	Teacher explicitly encouraged students to **reflect** on their learning but only at a minimal **knowledge level**.	Teacher explicitly encouraged students to **reflect** on their learning at an **understanding level**.	Teacher consistently encouraged students to reflect on their learning at multiple times throughout the lesson; **encouraged students to think at higher levels**.
A4.	Assessment Type	Formal and informal assessments measured only factual, discrete knowledge.	Formal and informal assessments **measured mostly factual, discrete knowledge**.	Formal and informal assessments **used both factual, discrete knowledge and authentic measures**.	Formal and informal assessment methods **consistently and effectively used authentic measures**.
A5.	Role of Assessing	Teacher solicited predetermined answers from students requiring little explanation or justification.	Teacher **solicited information from students to assess understanding**.	Teacher solicited explanations from students to **assess understanding and then adjusted instruction accordingly**.	Teacher frequently and effectively assessed student understanding and adjusted instruction accordingly; **challenged evidence and claims made; encouraged curiosity and openness**.

VII. Curriculum Factors					
Construct Measured		*Pre-Inquiry (Level 1)*	*Developing Inquiry (2)*	*Proficient Inquiry (3)*	*Exemplary Inquiry (4)*
C1.	Content Depth	Lesson provided only superficial coverage of content.	Lesson provided **some depth** of content but with **no connections made to the big picture.**	Lesson provided depth of content with **some significant connection** to the big picture.	Lesson provided depth of content with **significant, clear, and explicit connections** made to the big picture.
C2.	Learner Centrality	Lesson did not engage learner in activities or investigations.	Lesson provided **prescribed activities** with anticipated results.	Lesson allowed for **some flexibility during investigation** for student- designed exploration.	Lesson provided **flexibility for students to design and carry out** their own investigations.
C3.	Integration of Content and Investigation	Lesson either content-focused or activity-focused but not both.	Lesson provided poor integration of content with activity or investigation.	Lesson **incorporated student investigation that linked well with content**.	Lesson **seamlessly integrated the content and the student investigation**.
C4.	Organizing & Recording Information	Students organized and recorded information in prescriptive ways.	**Students had only minor input as to how to organize and record information**.	Students regularly organized and recorded information in **non-prescriptive ways.**	Students organized and recorded information in **non-prescriptive** ways that allowed them to **effectively communicate their learning.**

*VIII. Summative Overviews**		*Comprehensive Score***
Summative view of Instruction		
Summative view of Discourse		
Summative view of Assessment		
Summative view of Curriculum		
Overall view of Lesson		

*Provide brief descriptive comments to justify score.
**Score for each component should be an integer from 1-4 that corresponds with the appropriate level of inquiry. Scores should reflect the essence of the lesson relative to that component, so they need not be an exact average of all sub-scores in a category.

Marshall, J. C., Horton, B., Smart, J., & Llewellyn, D. (2008). *EQUIP: Electronic Quality of Inquiry Protocol*: Retrieved from Clemson University's Inquiry in Motion Institute, www.clemson.edu/iim.

Appendix D: Fidelity of Implementation Matrix (Final)

Fidelity of Implementation: EQuIPD Key Components—Annually

Construct 1: Professional Development					
Indicators	**Operational Definition**	**Range**	**Data Source**	**Fidelity at Teacher-level***	**Sample and Data Collection**
Summer Boot Camps	**Summer training received by teachers**	**0–5 days**	**Records kept by University of Florida** • **Sign-in Sheets/Online sign in**	**1= completed 85% of the training** **0= completed less than 85% of the training**	**All teachers**
Saturday Workshops	**Training sessions received by teachers**	**0–4 sessions**	**Records kept by University of Florida** • **Sign-in Sheets/Online sign in**	**1= completed at least 4 sessions** **0= completed less than 4 sessions**	**All teachers**
Program-level Fidelity of Implementation Total Score				**Implemented with fidelity:** **1 = 100% of teachers with score of 2** **0= less than 100% of teachers with score of 2**	**Fidelity will be measured annually for 3 years of implementation**

Construct 2: Professional Development Resources					
Indicators	Operational Definition	Range	Data Source	Fidelity at Program-level	Sample and Data Collection
Online modules and website resources	Creation of online modules; website resources made available: developed lessons, handouts from training, training presentations, list of materials/supplied used, etc	0–5 modules	Learning Management System/Microsoft Teams—documentation, sample modules	1 = Modules and online resources provided 0 = Modules and online resources are not provided	
Program-level Fidelity of Implementation Total Score				Implemented with fidelity 1 = Full implementation = score of 1 0 = Incomplete implementation = score of < 1	Fidelity will be measured annually for 2 years of implementation

Construct 3: Technology Resources					
Indicators	Operational Definition	Range	Data Source	Fidelity at Program-level	Sample and Data Collection
Assessing Technology Needs	Needs assessment conducted to support the implementation of technology within the educational setting	0–1	Records kept by University of Florida • Technology annual plan	1 = needs assessment conducted 0 = needs assessment not conducted	
Technology resources (hardware/software)	Hardware and/or software technology resources made available through a variety of resources.	0–1	Records kept by University of Florida • Sign-in Sheets/Reservation System	1 = Technology resources made available through a variety of platforms. 0 = No technology resources made available	
Training on software and hardware	Training made available for teachers on technologies provided	0–1	Records kept by University of Florida • Sign-in Sheets/Reservation System	1 = Training made available through a variety of platforms. 0 = No training made available	
Program-level Fidelity of Implementation Total Score				Implemented with fidelity 1 = Full implementation = score of 3 0 = Incomplete implementation = score of < 3	Fidelity will be measured annually for 2 years of implementation

Construct 4: Instructional Coaching/(EQuIPD instructional specialists (EIS))					
Indicators	Operational Definition	Range	Data Source	Fidelity at Program-level	Sample and Data Collection
Training for instructional coaches/ EQuIPD instructional specialists (EIS)	Provide training to prepare/support coaches (i.e., Orientation webinar, trainings, etc.)	0–20 training sessions	Records kept by University of Florida • Online sign-in sheets • Agendas	1=Coaches receive at least 20 training sessions in technology, inquiry, coaching, lesson planning. This includes monthly meetings for ongoing professional development. 0=Coaches do not receive 20 sessions of training or ongoing support	All instructional coaches
Instructional coaching to participants	# sessions of instructional coaching provided to teachers (meet at least one planning period twice a month)	0–18 sessions totaling at least one hour a month	Coaching records/Online app kept by University of Florida	1= 100% of teachers receive 85% of sessions 0=Less than 100 of teachers receive less than 85% of sessions	All teachers
Program-level Fidelity of Implementation Total Score				Implemented with fidelity 1=Full Implementation—score of 2 0=Incomplete implementation, score of 0	Fidelity will be measured annually for 2 years of implementation

Construct 5: Teacher/Industry Interactions					
Indicators	Operational Definition	Range	Data Source	Fidelity at Teacher-level	Sample and Data Collection
STEM Field Trips	Field trips to STEM industries	0–8	Project documentation (i.e., flyers) Online sign-in sheets	1 = Teacher attended 85% or more of field trips 0 = Teacher attended less than 85% of field trips	All teachers
STEM Industry-school partnership	Teachers invite speakers from STEM industries into the classrooms; solicit information from STEM partners concerning real-world problems related to the industry; and, solicit career information from STEM partners	0–2	Project documentation/lesson plan (i.e., email trail, community event flyer, other artifacts that document the interactions, etc.)	1 = Teacher had 2 or more documented interactions outside of field trips 0 = Teacher had 0–1 documented interaction outside of field trips	All teachers (To be documented in Year 2)
Program-level Fidelity of Implementation Total Score				Implemented with fidelity 1 = 100% of teachers with score of 2 0= less than 100% of teachers with score of 2	Fidelity will be measured annually for 2 years of implementation

Construct 6: Certification and Credentials					
Indicators	Operational Definition	Range	Data Source	Fidelity at Program-level	Sample and Data Collection
Internal Micro-credentials	Opportunities for teachers to gain skill sets in specific project areas, as engineering design, sensors/probes, system thinking and receive a credential	0–3 credentials	Records kept by University of Florida • Credentials	1 = 3 or more credentials developed and available for teachers 0 = less than 3 credentials developed and available for teachers	
STEM related micro-credentials	Support for teachers preparing for microcredentials from external organizations (ex. CK-12, Digital Promise, NEA)	0–3 external trainings	Records kept by University of Florida • Documentation/flyer	1 = 1 or more micro-credentials made available to teachers 0 = No micro-credentials made available to teachers	
CTE industry credentials/ Industry Tests	Scholarships and support provided for industry tests (after one year of participation in EQuIPD)	0–1 supports	Records kept by University of Florida • Documentation/ Scholarship Recipients	1 = Supports or scholarships provided for industry tests 0 = No support or scholarships provided for industry tests	
State STEM Certifications	Support (e.g., study groups, study guides, payment for exam) for teachers preparing for additional STEM certifications from the state	0–1 supports	Records kept by University of Florida • Documentation/ Study Groups and Payment of Fees	1 = Supports or scholarships provided for STEM certifications 0 = No support or scholarships provided for STEM certifications	
Program-level Fidelity of Implementation Total Score				Implemented with fidelity 1 = Full implementation = score of 4 0 = Incomplete implementation = score of < 4	Fidelity will be measured annually for 3 years of implementation

Appendix E: Teacher Interview Protocol

Engaging Quality Instruction through Professional Development
Teacher Interview Protocol: Summer 2021

Background

1. Please confirm the grades and subjects that you taught this school year.

Professional Development

2. Please describe EQuIPD professional development EQuIPD activities in which you participated in since last summer.

Probes:

   a. (if not mentioned before) Did you participate in field trips since last summer?

   b. During the last school year, did you interact with STEM industry partners outside of field trips (e.g. guest speakers, getting information on real world problems, career information, etc.)?

   c. (if not mentioned before) Did you participate in workshops on technology since last summer?

   d. Did you use any of the technology resources or equipment offered by the program last school year?

   e. (if not mentioned before) Have you received support from the project for any credentials or microcredentials?

3. In which ways were these PD activities and resources useful for you?

4. Describe how your coach or other coaches helped you with changes in your classroom and in any other areas.

PD outcomes: Knowledge

5. EQuIPD is focusing on a number of instructional areas: inquiry, technology, concept modeling, systems thinking, design thinking, authentic workforce applications, collaborative learning, and classroom discourse.
   a. How have your knowledge and understanding in these areas changed since last summer?

PD outcomes: Changes in the classroom

6. Describe any significant changes you have made in your classroom this year as a result of the EQuIPD professional development.

    a. Do you feel more comfortable using technology in your classroom? Why or why not?
    b. How did COVID affect the instructional changes you wanted to make?

7. What changes have you seen in students or in student work this year that you can attribute to effects of EQuIPD program?

PD outcomes: Leadership

8. Please describe the process of preparation for and leading professional development this summer. What did you get out of this process?

9. (if not mentioned before) How helpful were Dr. R and coaches in preparing you to lead this PD?

10. Based on that process, do you plan to change your instruction next year in any way?

11. Do you have any plans for doing PD or coaching with teachers in your district after this summer?

12. Other than changes in your knowledge and instruction, what lessons have you learned from participation in EQuIPD program?

13. Did anything else happen in the project this year you'd like to tell us about?