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RESEARCH IN MATHEMATICS EDUCATION

STEM Academy for Science Teachers and Leaders: 2019 Teacher Academy 2 Evaluation

Technical Report 19-10

STEM Academy for Science Teachers and Leaders: 2019 Teacher Academy 2 Evaluation

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Executive Summary

The need for graduates in STEM careers will increase over the next decade to meet the increasing industry demands in the United States (Smithsonian, 2018). The STEM Academy for Science Teachers and Leaders is an intervention designed to support middle school science teachers and leaders in the Dallas Independent School District (ISD). The goal of the project is to increase students' interest in STEM with the hopes that they pursue STEM career pathways.

The purpose of this report is to summarize the perceptions of the second cohort of teachers participating in the second of three STEM summer academy courses. The course is titled *STEM Academy for Science Teachers and Leaders: Engaging Students through Inquiry in STEM Education* (Academy 2 hereafter). Another purpose of the report is to examine the experiences of the first cohort of teacher in Academy 2 and the second cohort. The content of Academy 2 follows the first implementation of Academy 2 in 2018 and is described in a previous technical report (Pierce, Adams, Rhone, Hatfield, & Ketterlin-Geller, 2019). This report highlights changes made from the first iteration of Academy 2.

This report summarizes teachers' perceptions of their experiences in Academy 2 during summer 2019. These teachers were part of the second cohort of participating teachers who attended Academy 1 during the summer 2018 and received coaching during the 2018-19 academic year. The structure and content of Academy 2 built on teachers' experiences during the first year of participation in the program, including the previous summer academy in 2018. Academy 2 addressed pedagogical strategies that would help teachers develop the skills identified by and associated with four foundational pillars (i.e., inquiry-based instruction, scientific process standards, deep content knowledge, and differentiated support for all learners). Furthermore, feedback from teachers over the course of the academic year, including coach perceptions, helped guide what content would be most valuable to include and would achieve the STEM Academy goals.

In addition to summarizing the experiences and perceptions of cohort 2 teachers (n = 15) regarding Academy 2, a second purpose of this report is to describe changes from the previous implementation of Academy 2. We report the results from a teacher survey of cohort 2 teachers by categories of the four pillars and summarize teachers' open-ended responses on the survey for additional context.

Between 87% (13/15) and 93% (14/15) of cohort 2 teachers participating in Academy 2 indicated that they strongly agreed or agreed that the academy was valuable, interactive, and that they would share their knowledge gained through this experience with their colleagues. Furthermore, 93% (14/15) of teachers strongly agreed or agreed that the content of Academy 2 met their expectations, improved their science instruction, and deepened their understanding of inquiry strategies including project-based learning (PBL), maker-based instruction (MBI), and social and emotional learning (SEL).

For instructional planning and implementation, 93% (14/15) of teachers agreed of strongly agreed that Academy 2 provided them with the tools to implement inquiry in the classroom, influenced their content knowledge, and that field trips were relevant to the content they teach. Overall, the percentage of teachers who agreed with items decreased slightly across cohorts but the sample sizes for both were both relatively small (n = 12 for cohort 1; n = 15 for cohort 2) and the cohorts included different teachers, which limits comparisons across years.

Two recommendations for improving the Academy 2 for future iterations are suggested, based on the results and analyses within this report. First, the structure and activities within Academy 2 should continue with minor if any adjustment for future implementations. Second, we recommend evaluating the amount of time needed for teachers to complete the online materials and making adjustments as necessary. Evidence to support these recommendations are highlighted in the report.

Table of Contents

Background 1

Overview of Project 1

Purpose of this Report 2

Evaluation Question 2

Revisions to the Content and Structure of Academy 2 3

Maker-Based Instruction 3

The 5E Instructional Model 3

Project-Based Learning 3

Mursion 4

Community-Based STEM Educational Resources 4

Leveraging Technology for Informal Spaces 6

Participating Teachers 6

Academy 2 Evaluation Survey 10

Results 11

Overall 11

Inquiry 12

Instructional Planning and Implementation 15

Content Knowledge 17

Summary 20

Conclusions and Recommendations 20

References 22

Appendix A – Presenter Biographies 23

Appendix B – Academy 2 Evaluation Survey 25

STEM Academy for Science Teachers and Leaders: 2019 Teacher Academy 2 Evaluation

Background

The number of STEM-related jobs has grown faster than the number of non-STEM jobs between 2000 and 2010 (Smithsonian, 2018). Industry leaders in STEM fields continue to emphasize the growing needs for students interested in STEM, especially from underrepresented subgroups including Black and Hispanic students. Although situated within a large metropolitan area with numerous STEM job opportunities, the Dallas Independent School District (ISD) only had 16.9% of students in Grade 8 select STEM as an endorsement area.

To circumvent the lack of student interest in STEM careers, a partnership between the Texas Instruments Foundation, the O'Donnell Foundation, Southern Methodist University (SMU), and Dallas ISD was established. A primary goal of this partnership was to determine how students' interest and perseverance in STEM could by improved, and how this affects the STEM pipeline for technical fields. The partnership identified four key areas, including (a) inquiry-based instruction, (b) scientific process standards, (c) teacher content knowledge, and (d) differentiated support for all learners, with an emphasis on social and emotional learning (Perry, Reeder, Brattain, Hatfield, & Ketterlin-Geller, 2017). The primary desired outcomes for this 4-year project include (a) an increase in student achievement and engagement, and (b) an increase in teacher implementation of active learning experiences.

Overview of Project

The STEM Academy for Science Teachers and Leaders project includes two primary components: (a) intensive summer academies of 90 hours of professional development focused on inquiry-based instruction, scientific process standards, teacher content knowledge, and differentiated instruction for all learners; and (b) academic year support through periodic one-on-one coaching and collaboration within a professional learning community. Teachers engage in both components of the program each year of participation for up to three years. For additional details, please see previous evaluation reports (Adams, Hatfield, Cox, & Ketterlin-Geller, 2018; Adams, Hatfield, Cox, Mota, Sparks, & Ketterlin-Geller, 2018; Perry et al., 2017; Pierce et al., 2019).

The program follows a cohort model. At the time of this report, the first cohort of teachers was in their third year of participation (cohort 1), and a second cohort of teachers was in their second year of participation (cohort 2). Cohort 1 teachers began participation in summer 2017; cohort 2 teachers began participation in summer 2018.

During the second summer of participation, cohort 2 teachers enrolled in the *STEM Academy for Science Teachers and Leaders 2: Engaging Students through Inquiry in STEM Education*

(Academy 2 hereafter). Academy 2 content is structured around four main pillars that were identified during the development of the STEM Academy goals as being especially influential in fostering both student and teacher interest in success. These pillars are depicted in Figure 1.

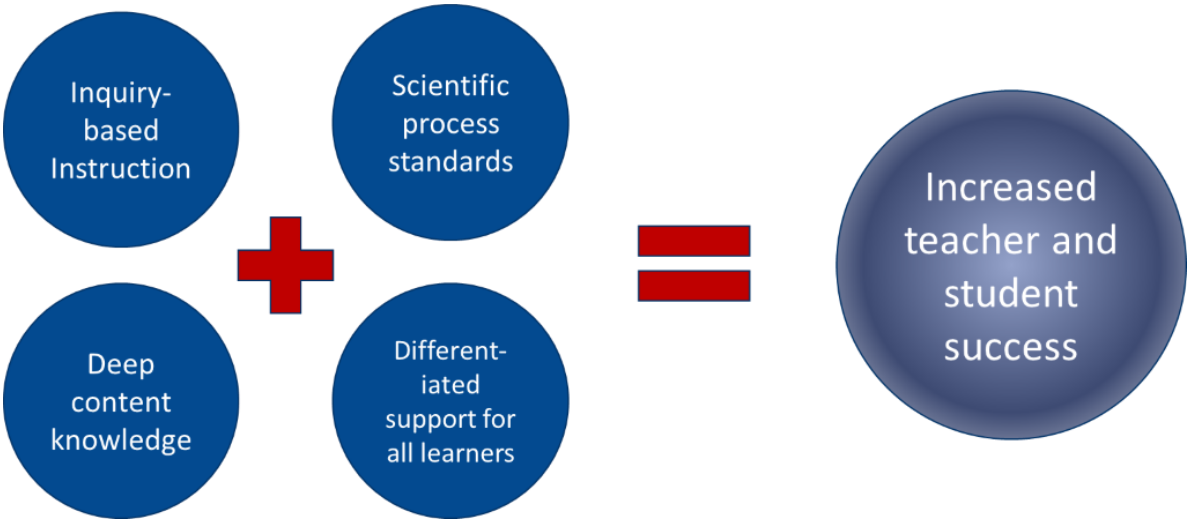

Figure 1. Foundational Pillars of the STEM Academy

Figure 1 highlights the relation between the pillars and the intended outcome for the project (i.e., increased teacher and student success). The complete description of the project components can be found in the previous year's Academy 2 evaluation report (Pierce et al., 2019). Continuing cohort 2 middle school teachers (n = 15) from 7 Dallas ISD schools participated in Academy 2 during summer 2019.

Purpose of this Report

The purpose of this report is to: (a) provide a summary of the revisions made to the components of Academy 2, and (b) summarize cohort 2 teachers' perceptions of the Academy 2 coursework, which occurred during the second year of participation in the STEM Academy for Science Teachers and Leaders.

This report includes information about revisions to the content and structure of Academy 2, demographic details about the participating teachers, and details the results from an evaluation survey completed by the teachers at the end of Academy 2.

Lastly, the results of this report are designed to inform future improvements to the design and structure of Academy 2.

Evaluation Question

This report focuses on the following evaluation question:

- What are cohort 2 teachers' perceptions of the STEM Academy 2 based on the academy evaluation survey? Do perceptions differ from cohort 1 teachers who participated the previous year?

Revisions to the Content and Structure of Academy 2

A full description of the content and activities of Academy 2 can be found in the previous Academy 2 evaluation report (Pierce et al., 2019). The following sections describe changes to the five main emphases of the Academy 2 content and activities, which included MBI, the 5E Model, PBL, SEL, and community-based STEM education resources.

Maker-Based Instruction

The instructor of the MBI followed the first implementation of Academy 2 in 2018 with some changes. The first implementation is outlined in the previous Academy 2 technical report (Pierce et al., 2019). Notable changes to the teaching are included below.

- The instructor made deliberate attempts to ask questions that focused on adjusting the activities to meet the specific needs of the students in the classrooms and the available resources; how to incorporate social and emotional learning throughout the activity; and explicitly connecting activities to the state content standards (TEKs) taught by the teachers.
- The instructor gave the participants additional copies of materials to support completing the activities. This facilitated teachers retaining copies to use in their classrooms during the school year.
- Teachers utilized a template to support the creation of a MBI unit, which teachers completed individually or with other teachers at their school. The instructor's rationale was that teachers were more likely to implement the plan if they designed the unit for their specific school context.

The 5E Instructional Model

The 5E content was consistent with the previous year with minor changes. The order of activities was adjusted such that teachers engaged in active learning more frequently during the 5E unit. The active learning experience was centered around making observations and developing inferences based on observations focused on natural selection using sunflowers seeds. Teachers then created models based on the information. The intent was to clarify for teachers that models are used in several ways in the classroom as a part of the 5E framework. Finally, teachers identified the process standards that were incorporated in the 5E unit.

Project-Based Learning

The first iteration of Academy 2 included project-based learning and a detailed explanation of activities included can be found in the previous technical report (Pierce et al., 2019). Changes

from the previous iteration of Academy 2 include changes to the end product required of teachers. Instead of revising their project from the previous year, teachers redesigned a portion of a water system PBL unit, created as a part of SMU's Infinity Project. This change was made to facilitate equal groupings of teachers with a smaller participating cohort relative to last year and share an example PBL unit with teachers, which teachers modified based on their students' needs. The instructor spent considerable time supporting teachers in understanding the components of 5E and how they related to the PBL design elements.

Mursion

Musion is a virtual reality-based stimulation exercise, which allows teachers to practice components of the STEM Academy in a low-stakes environment (i.e., not with actual children). During the 2019 academy, teachers practiced justifying the implementation of a PBL unit to an administrator, parent, and a community person. In preparation for the Mursion session, teachers wrote as many questions as possible that each stakeholder may ask. Participants formed groups of three; one member was an observer, and the other two assumed the role of administrator, community person, and/or parent. Teachers practiced articulating the value of PBL and active learning strategies for student learning. Following the Musion session, the teachers debriefed with the instructor. Debrief sessions focused on what went well and what additional questions they could have asked.

Community-Based STEM Educational Resources

L3Harris

L3Harris is an aerospace and defense contractor and engineering firm that has a large presence in the North Texas area. L3Harris employs over 50,000 people worldwide, 20,000 of whom are scientists and engineers. The staff have been awarded over 3,000 patents, have launched over 535 failure-free space missions, and boast over 1 million training hours of helicopter flight school.

Sue Barnes and Donny Blair, both VPs of Engineering introduced L3Harris to the teachers and explained their role in development of data-driven information systems that include aviation airborne systems, integrated missile systems, and communication systems that inform the development and manipulation of helicopters, airplanes, and undersea autonomous vehicles (UUMS), space launches, satellites, and cybersecurity. As problem-solvers, they described themselves as "solutioneers" working in the multitude of disciplines that fall within the engineering, such as software, hardware, aero, mechanical and electrical, to name a few.

L3Harris staff shared with teachers that becoming an engineer is not usually a clear path. Often students who start with interest in music or other disciplines find their way to engineering. They emphasized that the skills they look for not only encompass math skills, but are also team working, problem solving, critical thinking, and innovating, while focusing on customer needs and design synthesis. The presentation ended with an opportunity to ask questions and conversations about how to engage the engineers at L3Harris with the teachers and their students to support more students engaging in science and engineering careers.

Hilti North America

Hilti North America is a privately-owned international construction company that develops systems solutions for the construction industry. Hilti was founded in 1941 and employs more than 29,000 employees in 120 countries. The company leads the engineering construction industry in engineering, measuring and aligning, drilling and demolition, cutting and grinding, fastening and installation, and chemical firestops.

During the experience at the Hilti Test Lab, teachers were introduced to Hilti through a presentation that focused on the many types of engineers who are employed by Hilti, including their roles and backgrounds. Teacher engaged in hands-on demonstrations related to the 6-8th grade science TEKS. In particular, at the outset of the day, two engineers demonstrated Newton's laws of motion using balls while describing the 1st, 2nd, and 3rd laws of motion. Teachers were then given their own challenge to break into teams to participate in a design competition to build the highest skyscraper using only straws, spaghetti, large and mini-marshmallows. The goal was to collaborate and plan as a team, and build the highest structure in under 10 minutes. This competition exemplified the communication and collaboration required to be an engineer. The presentation included a facility tour which included a demonstration where staff lifted a full size truck with that single bolt. In addition, teachers watched engineers test force on bolted down objects, measure force, and test fire retardant.

Teachers engaged in an application experience where each one explored tools designed with ergonomics and efficiencies to promote safety and speed in the construction domains. The teachers drilled holes in concrete and used specially designed nail guns to adhere sheetrock to studs in walls. Both endeavors provided lab-like, hands-on experiences, reminding teachers of the importance of project-based, solution-oriented thinking and experiences to their students.

Trinity River Audubon Center (TRAC)

The Trinity River Audubon Center sits on 120 acres within the 6,000-acre Great Trinity Forest. This reclaimed sanctuary is home to a tremendously diverse population of birds and other wildlife within a unique environment of bottomland hardwoods, wetlands, and grasslands. The mission of the organization is "conserve and restore natural ecosystems, focusing on birds, and other wildlife, and their habitats for the benefit of humanity and the Earth's biological diversity." By preserving this open space and protecting wildlife, the TRAC engages people in conservation through learning and exploration.

During this field experience, teacher hiked through the trails to discover and identify wildlife and marshes, explored water quality and conservation, performed a pond investigation, identified macro-organisms in a local body of water, and engaged in an animal encounter with a turtle and snails. A wide variety of organisms and environment TEKS were covered, including those involving biotic and abiotic factors, variation within a population or species, adaptations, heredity, relationships in an ecosystem, and environmental changes and impacts on the environment.

Leveraging Technology for Informal Spaces

During the information spaces session, the teachers considered the affordances of technology outside of the classroom. Teachers engaged with a web-based resource (i.e., Skype in the Classroom and practiced implementing virtual field trips in their classroom. Teachers earn a certificate using the web-based resource. This activity supported teachers in understanding ways to interact with STEM professionals without leaving the classroom. Finally, the web-based resource offers on-demand field trips, some of which teachers were able to explore and connect to their classroom content.

As a second example of a technology resources, teachers used Flipgrid (an app-based resource) to respond to a prompt about informal learning spaces. The intention of the session was two-fold. Teachers used the technology-based response system to encourage responses from all students. Second, teachers generated their own virtual field trip experiences for their students. The teachers were given an example of how to set up a virtual field trip using the Trinity River Audubon Center as the setting. Using Flipgrid, the teachers created an outside experience lesson to share with their students and could be replicated in any setting.

Collectively, these revised components of Academy 2 strengthened the connection between the academy and teachers' needs, including stronger alignment to the TEKS and more frequent, intensive, and relevant active learning experiences for participating teachers.

Participating Teachers

Overall, 15 cohort 2 teachers participated in Academy 2 in summer 2019. Of those participating teachers, 15 completed the academy evaluation survey, resulting in a response rate to the teacher survey of 100%. Table 1 shows the demographic characteristics of the cohort 2 teachers who participated in Academy 2 in summer 2019, relative to cohort 1 teachers who participated in summer 2018.

Table 1. *Teacher Demographic Information*

	Characteristic	Cohort 1 (Summer 2018)		Cohort 2 (Summer 2019)	
		# of Teachers	% of Teachers	# of Teachers	% of Teachers
Gender	Male	3	25%	5	33%
	Female	9	75%	10	67%
Race	Alaska Native	0	0%	0	0%
	Asian	0	0%	0	0%
	Black	7	58%	9	60%
	Native Hawaiian	0	0%	0	0%
	Other/Pacific Islander	0	0%	1	7%
	White	5	42%	4	26%
	Two or More Races	0	0%	1	7%
Ethnicity	Hispanic or Latino	3	25%	2	13%
	Not Hispanic or Latino	9	75%	13	87%
Total		12	100%	15	100%

Table 2 shows cohort 2 teachers' average years of experience in education, teaching, teaching science, in other careers, and at their current school, relative to cohort 1 teachers' years of experience. On average, participating cohort 2 teachers had nine years of teacher experience and five years of experience in careers other than education.

Table 2. *Teachers' Work Experience*

	2018-19 (n = 12)	2019-20 (n = 15)
	Mean # of Years (SD)	Mean # of Years (SD)
Years in education	5.7 (3.3)	9.9 (6.1)
Years teaching	5.6 (3.4)	8.7 (5.7)
Years teaching science	5.2 (3.0)	7.4 (5.6)
Years in other careers	8.9 (6.1)	5.1 (4.4)
Years at current school	4.8 (3.4)	5.3 (3.2)

Table 3 shows the number of teacher certifications for cohort 2 teachers, relative to cohort 1 teachers who participated in the previous year. The majority of cohort 2 teachers were certified in 1 subject area, three of the teachers obtained a second certification. Figure 2 shows the number of teachers who earned each type of certification.

Table 3. *Number of Certifications for Participating Teachers*

	2018-19		2019-20	
Certifications	# of Teachers	% of Teachers	# of Teachers	% of Teachers
1 subject-area certification	8	67%	7	46%
2 subject-area certifications	4	33%	3	20%
3 subject-area certifications	0	0%	3	20%
4 subject-area certifications	0	0%	1	7%
5 subject-area certifications	0	0%	0	0%
6 subject-area certifications	0	0%	1	7%
Total	12	100%	15	100%

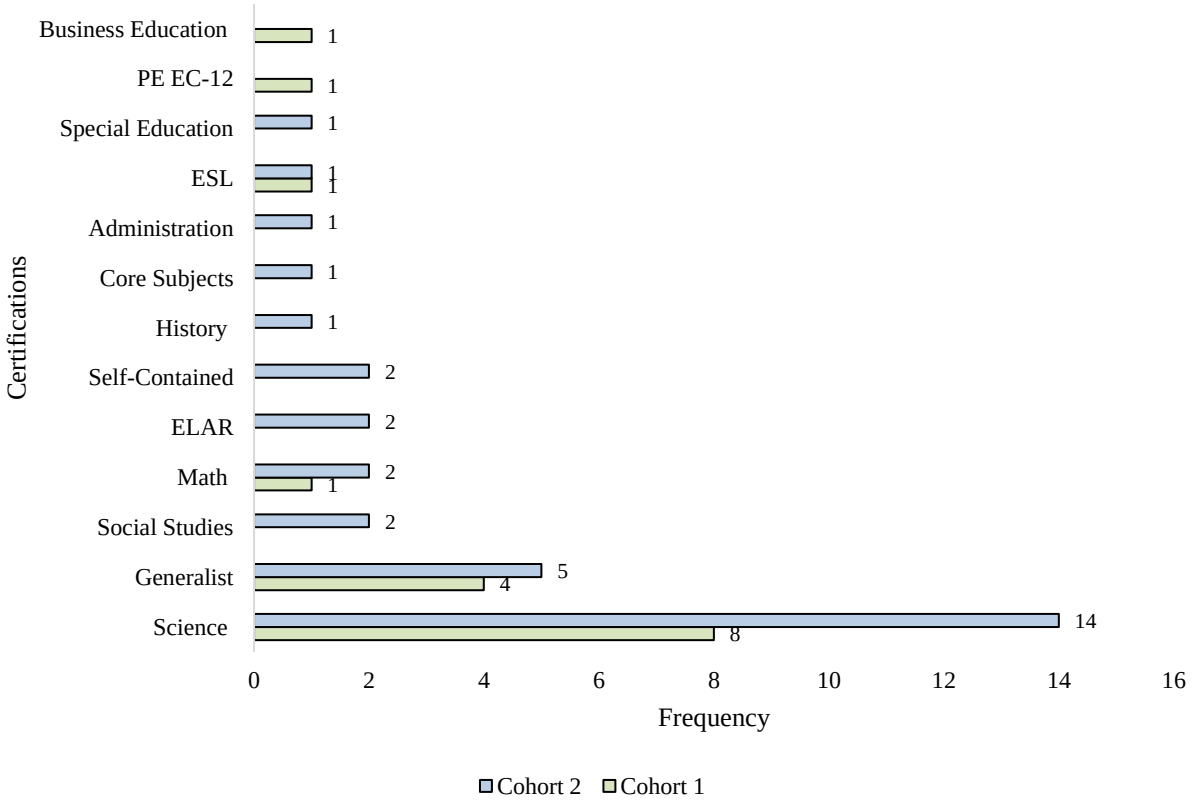

Figure 2. Cohort 2 Teacher Certifications
Note: Figure includes 15 teachers for cohort 2 and 12 teachers for cohort 1, some teachers have multiple certifications

Table 4 shows the grade levels that teachers anticipated teaching during the 2019-20 school year. The majority of teachers (80%) anticipated that they would be teaching Grade 6 classes during 2019-20.

Table 4. *Grade-level Taught*

	2018-19	**2019-20**
Current Grade Level	Number of Teachers	Number of Teachers
6th	0	12
7th	6	6
8th	9	6

Note. Table includes 12 teachers for 2018-19 and 15 teachers for 2019-20. Some teachers teach more than one grade level.

Table 5 and Figure 3 show the number of hours of professional development by topic that cohort 2 teachers engaged in the 2018-19 school year outside of the STEM Academy. Overall, 14 teachers in cohort 2 received professional development in science content (93%). Similarly, 14 teachers also received professional development in English language learner instruction and social and emotional learning. Outside of the STEM Academy, only nine (60%) teachers reported receiving professional development in project-based learning and only eight teachers (53%) reported receiving professional development in maker-based instruction.

Table 5. *Cohort 2 Teacher Professional Development by Topic*

Topic	Less than 6 hours	6-15 Hours	16-35 Hours	More than 35 Hours	# of teachers completed PD in each area	% of teachers completed PD in each area
Science Content	3	6	3	2	14/15	93%
Other Content	6	2	2	0	10/15	67%
Project Based Learning	6	2	1	0	9/15	60%
Maker Based Instruction	4	3	1	0	8/15	53%
English Language Learners	9	4	0	0	14/15	93%
Social Emotional Learning	8	5	1	0	14/15	93%
Students with Disabilities	6	4	0	1	11/15	73%

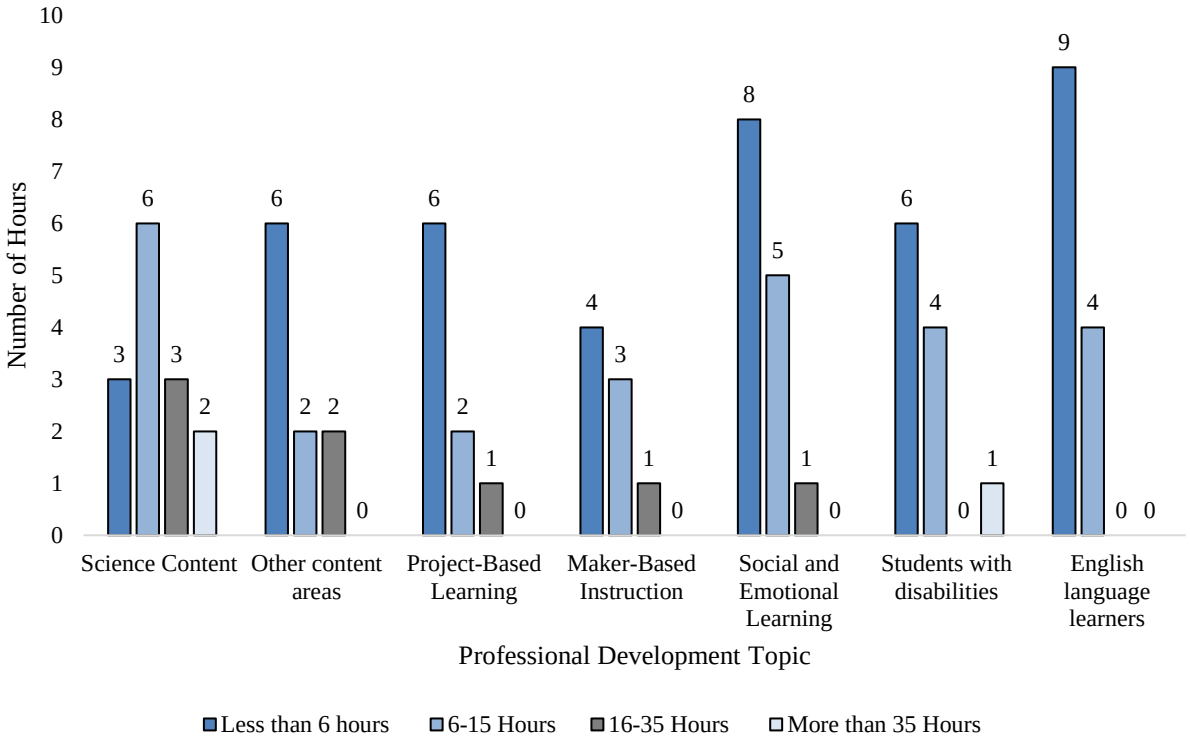

Figure 3. Cohort 2 Professional Development by Topic

Overall, the descriptive statistics for cohort 2 teachers show that participating teachers were majority Black (60%) and female (67%). On average, teachers in cohort 2 had nine years in teaching. On average, teachers in cohort 2 were most likely to have one subject area certification. The most common subject-area certification was science; only three teachers were not specifically certified to teach science.

Academy 2 Evaluation Survey

Following Academy 2, teachers completed the *STEM Academy for Teachers and Leaders: Academy 2 Evaluation Survey*, which included 15 questions, six of which had multiple components, and allowed teachers to report their level of agreement with statements about the quality of Academy 2 (Appendix B). Items focused on understanding teachers' overall impressions of the Academy 2 structure, content, and speakers. The survey was administered via Qualtrics (Qualtrics, 2018) immediately following the conclusion of Academy 2.

The results in the following section summarize the academy evaluation data collected following Academy 2 with cohort 2 teachers who continued in the program (n=15). Of the participating teachers, all 15 cohort 2 teachers completed the survey, resulting in a response rate of 100%. We implemented Academy 2 for the first time in the summer 2018 to cohort 1 (n = 12); change across time is examined below. It is important to remember that each cohort includes different teachers, which limits comparisons across years.

Results

The results in this section are guided by the foundational pillars and are grouped based on teacher perceptions (a) overall, (b) specific to *inquiry* in the classroom, (c) specific to application of activities that teach and incorporate the *scientific process standards,* (d) specific to *content knowledge,* and (e) specific to *differentiation* and on-going support for teachers. We examine teachers' perceptions quantitatively by analyzing agreement rates. It is important to note that the sample sizes were small, but representative of Academy 2 participants. The sample size for cohort 1 during the second year (2018-19) was 12 teachers with 100% completing the survey. The sample size for cohort 2 during the third year (2019-20) was 15 teachers with 100% completing the survey.

In addition, the survey included three open-ended items, which inquired: (a) about the areas of the academy that were most useful, (b) about the areas of the academy that need improvement, and (c) if teachers had anything else they would like to share. We examined cohort 2 teachers' responses to these open-ended items qualitatively using a priori codes focused on the groupings specified above (i.e., overall, inquiry, the process standards, content knowledge, and differentiation and support).

Overall

Figure 4 shows the percent of cohort 1 and cohort 2 teachers who agreed or strongly agreed with statements about Academy 2 overall. These statements inquired about the extent to which teachers agreed that the academy was valuable, would improve their science instruction, met their expectations, gave them knowledge that they would share with their colleagues, and was interactive. Teachers responded with high agreement to all five statements with 87% (13/15) to 93% (14/15) of cohort 2 teachers either agreed or strongly agreed with the statements overall. These results are slightly less than cohort 1 teachers' perceptions of Academy 2 overall, with their agreement between 92% (11/12) and 100% (12/12). A slight increase was observed in the percent of teachers reporting that the structure of Academy 2 enhanced their understanding of the science content they teach, with the percentage of teachers increasing from 92% to 93%.

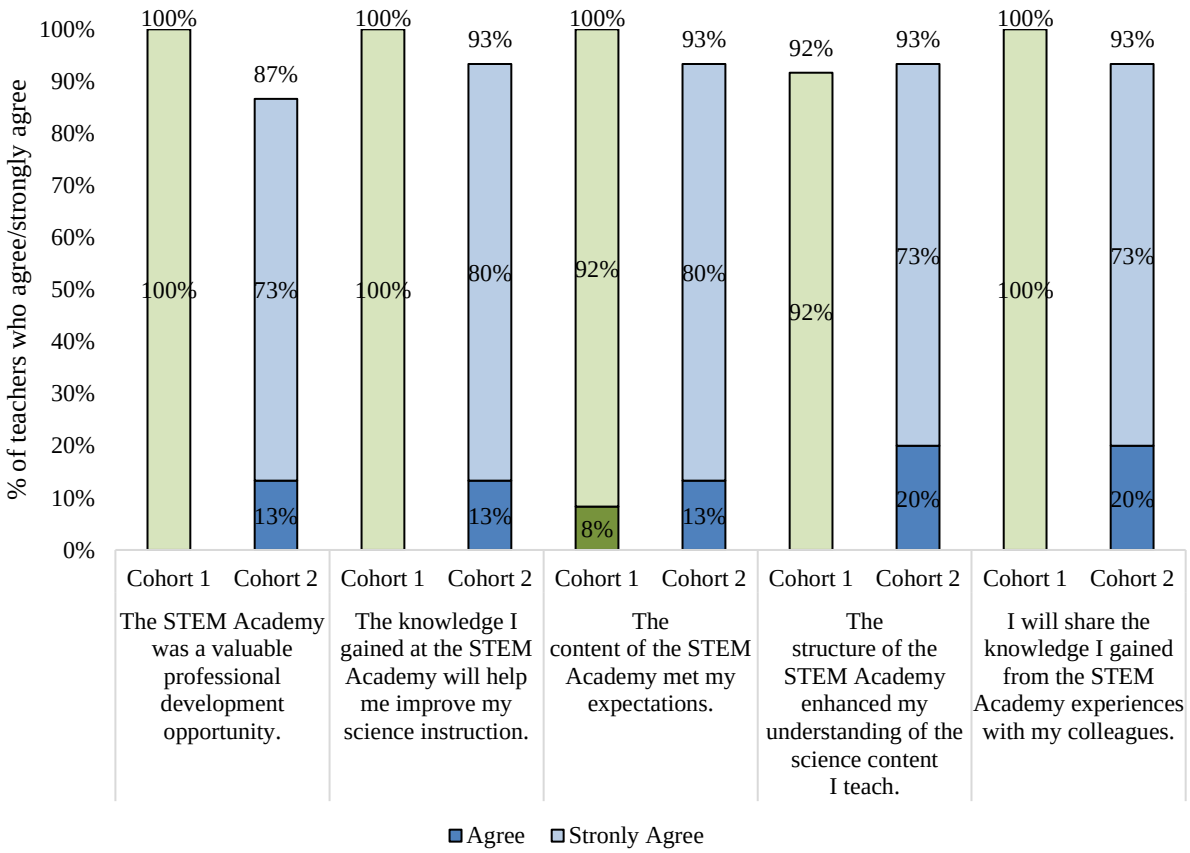

Figure 4. Percent of Teachers who Agreed or Strongly Agreed with Overall Statements about Academy 2 across Cohorts

In addition to the questions above, 100% (15/15) cohort 2 teachers wrote positive comments about the academy either overall or specifically related to one of the four core pillars in the open-ended response sections. One teacher specifically stated, "I enjoyed being able to practice strategies so that we could better implement them for our own students".

Seven out of the fifteen (47%) teachers identified aspects of the academy that could be improved. Two teachers specifically mentioned the online content. One teacher stated, "Some clarity of the online content would be helpful." Three teachers highlighted the amount of time required or pacing of the content. One teacher stated, "The pacing of the content could be spread more evenly…I feel we didn't utilize our time effectively at the beginning of the first week."

Inquiry

Figure 5 shows the percent of cohort 1 and cohort 2 teachers who agreed or strongly agreed with statements about the impact of Academy 2 on their understanding of inquiry. A main goal of Academy 2 was to provide teachers with high-quality information and deepen their understanding of these aspects as critical for effective inquiry instruction.

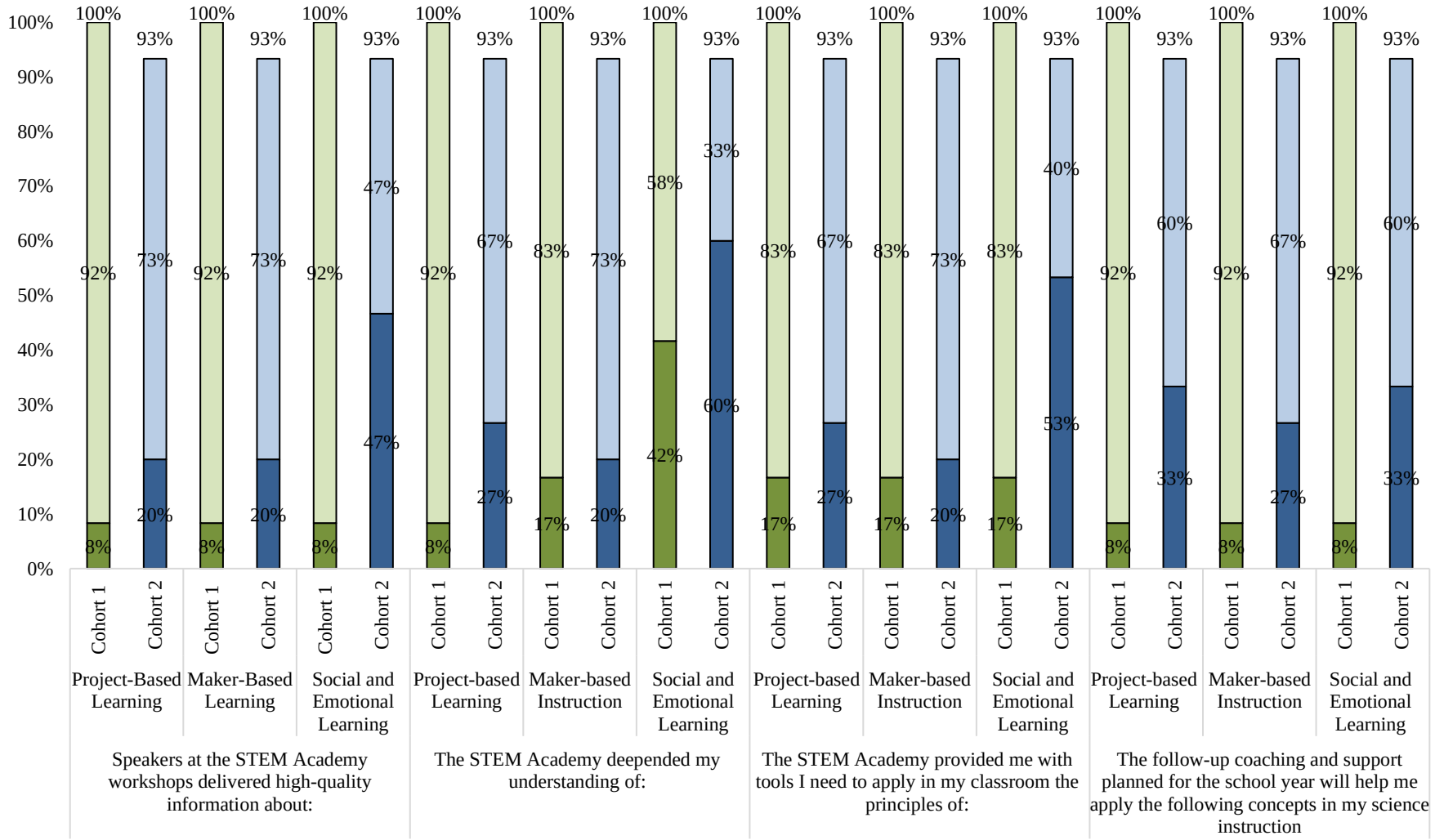

Figure 5. Percentage of Teachers who Agreed or Strongly Agreed to Benefits of Academy 2 on Inquiry.
Note: Light colors of green and blue indicate "strongly agreed" while darker colors indicate "agreed".

For cohort 2, 93% (14/15) of cohort 2 teachers either agreed or strongly agreed that Academy 2 effectively delivered high-quality information about and deepened their understanding of inquiry (i.e., PBL, MBI, SEL). This percentage is slightly lower than the percent agreement for cohort 1 (100% or 12/12 teachers).

On the open-ended survey items, 33% (5/15) teachers reported that active learning strategies were the most or one of the most useful areas of the academy. One teacher stated, "The opportunity for hands-on inquiry and having someone model the inquiry-based lessons and sprint cycles for us, and also the field trips and visitors [were useful]."

Also, when prompted about confidence in implementing STEM instruction in their classroom, 40% (6/15) teachers reported they were most confident in implementing active learning strategies. One teacher stated, "I will continue with Maker-Based Instruction and adding in the questioning aspects that we learned this summer."

Instructional Planning and Implementation

Based on feedback from the first year of implementation, we increased the emphasis on PBL and MBI instructional design and implementation during the second year of implementation. Furthermore, we included an emphasis on 5E Lesson Design Model, promoting student problem solving, facilitating student engagement, and a focus on the scientific process standards.

Figure 6 provides an overview of cohort 2 teachers' perceptions of these aspects of instructional planning and implementation. Because we did not ask these questions to the first cohort of teachers, we are not able to make comparisons to the previous year. These items were added during summer 2019 to better understand teachers' perceptions specific to Academy 2; as such, these items were only asked of cohort 2 teachers.

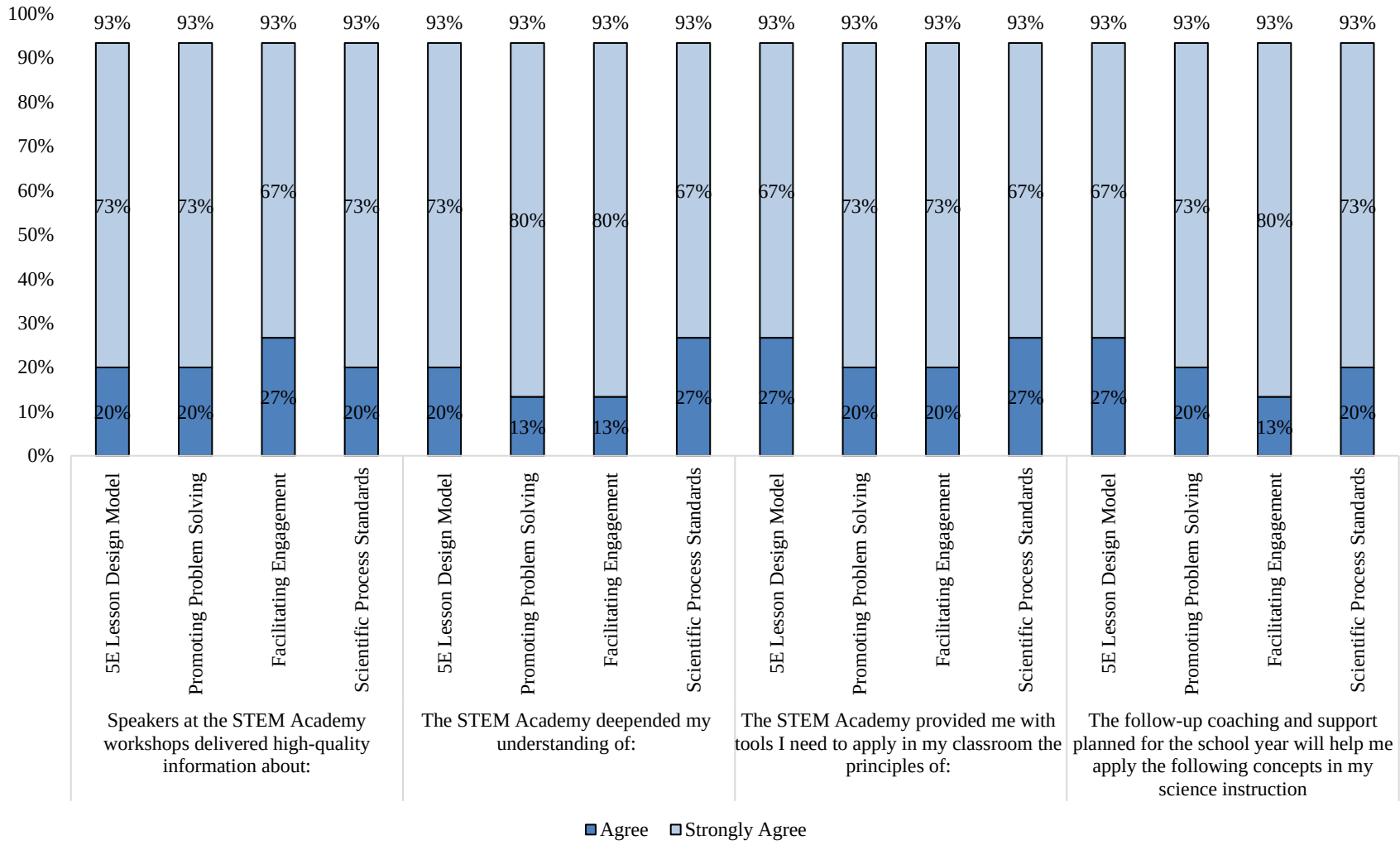

Figure 6. Percentage of Cohort 2 Teachers who Agreed or Strongly Agreed to Statements about Instructional Planning and Implementation.

Note: Light colors of green and blue indicate “strongly agreed” while darker colors indicate “agreed”.

Across all aspects, 93% (14/15) cohort 2 teachers agreed of strongly agreed that the content and activities of Academy 2 improved their understanding and implementation of the 5E Lesson Design Model, promoted student problem solving, facilitated student engagement, and incorporated the scientific process standards. When prompted to explain what aspects of the academy were most useful, one teacher stated “student engagement and STEM careers”.

Content Knowledge

Another shift in focus from the first year of implementation of Academy 2 was an increased focus on teachers’ content knowledge in science. We define content knowledge as general knowledge in science, STEM careers, and community-based resources. Figure 7 shows cohort 2 teachers’ perceptions of the influence Academy 2 had in these areas of their content knowledge. These items were added to the survey in 2019, as such comparisons across years are not possible.

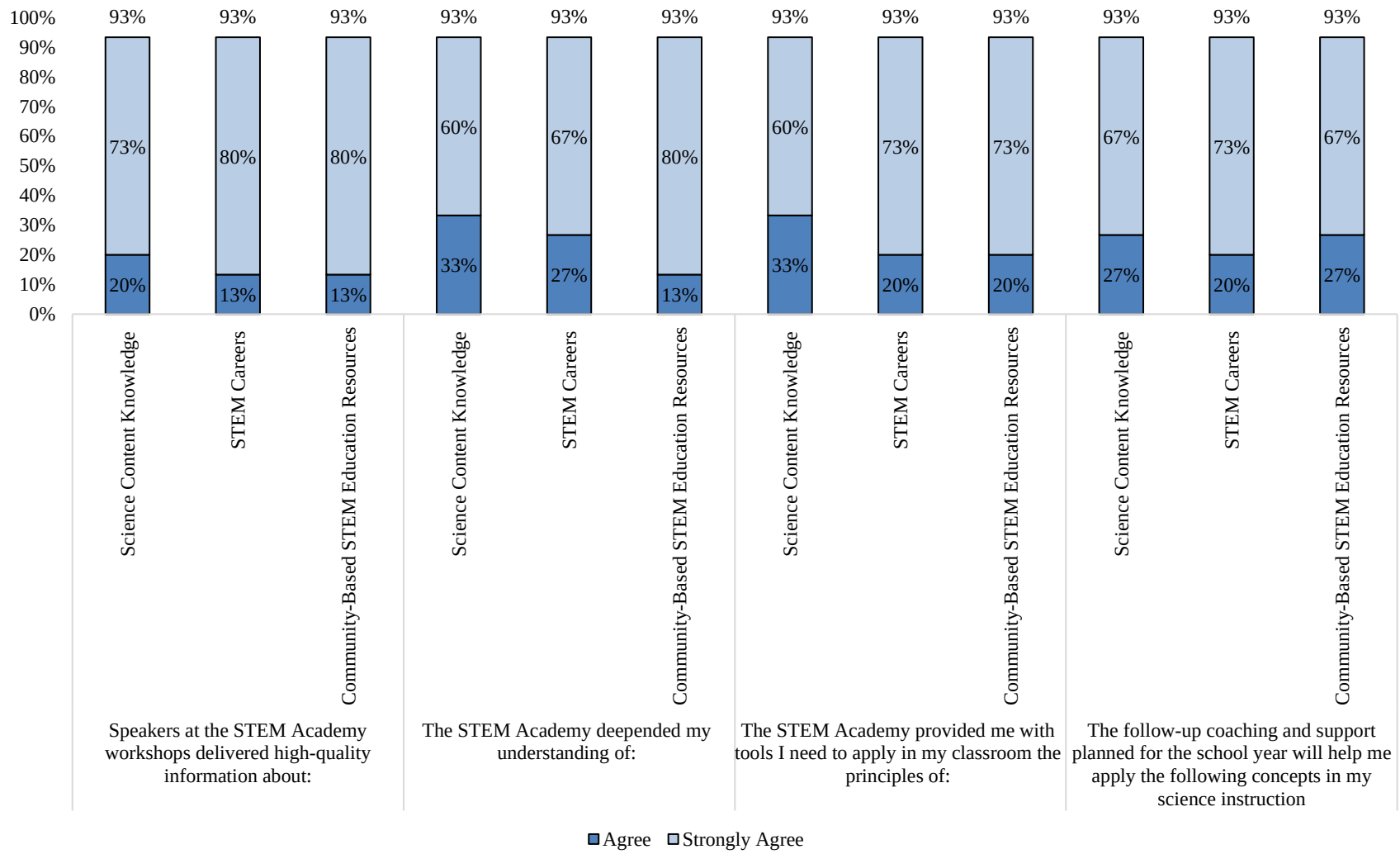

Figure 7. Percentage of Cohort 2 Teachers who Agree or Strongly Agree about the Impact of Academy 2 on their Content Knowledge

Similar to the previous section of responses, 93% (14/15) of teachers agreed or strongly agreed across items focused on the influence of Academy 2 on their content knowledge. When promoted, one teacher stated that "the field trips provided application to what we were learning."

In the Academy 2 evaluation survey, we specifically asked teachers about field trips they participated in as part of the academy: HILTI and TRAC. We asked about their perceived relevance of these trips to the content they teach and the extent to which the trip provided them with ideas of how to supplement in-class learning. Figure 17 shows cohort 2 teachers' responses to these questions. Overall, 93% (14/15) teachers either agreed or strongly agreed that the field trips were relevant to the science content they taught and provided them with ideas of how to supplement in-class learning with a trip to a community-based STEM education resource. In the open responses, 33% (5/15) teachers mentioned the trips as the most useful aspect of Academy 2.

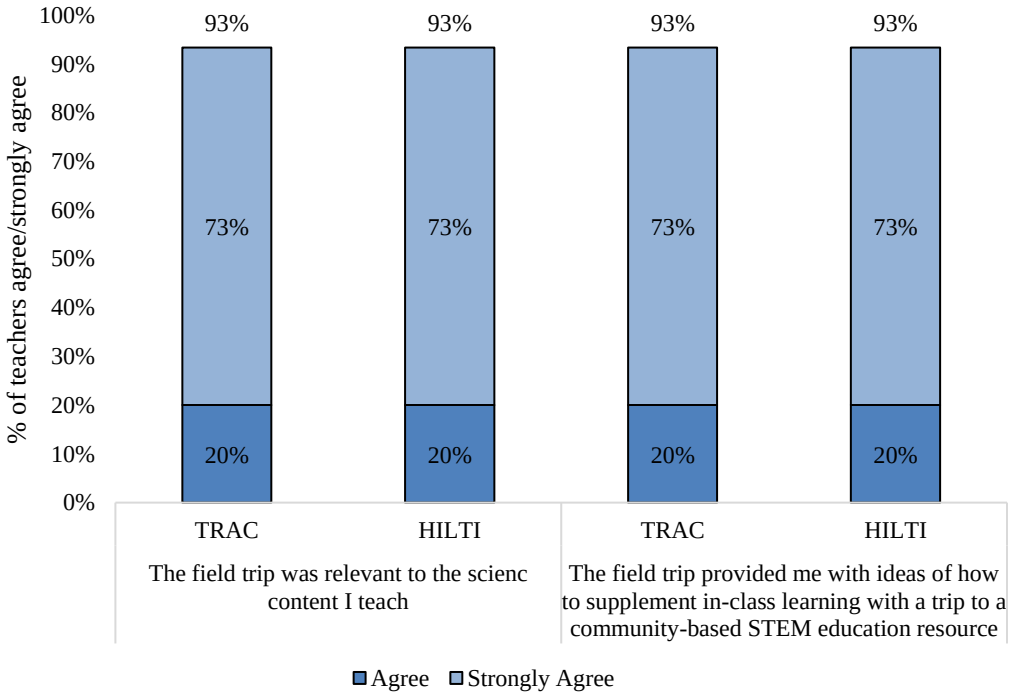

Figure 17. Cohort 2 teachers' perception of community-based STEM field trips

The results in this section highlight teachers' perceptions of Academy 2 across cohorts. In general, teacher perceptions were favorable of the Academy components.

Summary

Overall. Between 87% (13/15) and 93% (14/15) of cohort 2 teachers participating in Academy 2 indicated that they strongly agreed or agreed that the academy was valuable, interactive, and that they would share their knowledge gained through this experience with their colleagues. Compared to the previous implementation of Academy 2 with cohort 1 teachers, the percentages for cohort 2 were slightly lower. However, the sample sizes in both cohorts were small (i.e., 12 and 15 teachers).

Academy Content. The content of Academy 2 included 90 hours of professional development. Seventy of these hours were face-to-face on or near the campus. The content emphasized active learning strategies and connections to community-based STEM education resources. These instructional strategies were connected to the four foundational pillars. Ninety-three percent (14/15) of teachers strongly agreed or agreed that the content of Academy 2 met their expectations and improve their science instruction. Compared to cohort 1, these responses are slightly lower but caution should be noted as sample sizes for both cohorts were small.

Inquiry. Teachers in cohort 2 responded positively to questions about inquiry, with 93% (14/15) of teachers agreeing of strongly agreeing that the STEM Academy deepened their understanding of inquiry strategies including PBL, MBI, and SEL. Furthermore, 93% (14/15) of teachers agreed or strongly agreed that the speakers at the academy delivered high-quality information about the different inquiry-oriented strategies. In comparison to cohort 1 teachers, cohort 2 teachers' perceptions were slightly lower.

Instructional Planning and Implementation. The content of Academy 2 for cohort 2 also emphasized aspects of instructional planning and implementation. These aspects include 5E Lesson Design Model, promoting student problem solving, facilitating student engagement, and the scientific process standards. For instructional planning and implementation, 93% (14/15) of teachers agreed of strongly agreed that Academy 2 provided a deepened understanding of these aspects and provided them with the tools to implement in the classroom. These questions were not asked during the first year of implementation.

Content Knowledge. Teachers responded favorably to questions about the influence of Academy 2 on their content knowledge (i.e., science content knowledge, STEM careers, community-based STEM resources). Ninety-three percent (14/15) of teachers agreed or strongly agreed that the Academy 2 influenced their content knowledge. Furthermore, teachers participated in field trips to better understand the community-based STEM resources available to them. Ninety-three percent of teachers agreed of strongly agreed that the trips were relevant to the content they teach and provided them with ideas to supplement their in-class instruction.

Conclusions and Recommendations

Two recommendations for improving the Academy 2 for future iterations are suggested, based on the results and analyses within this report.

1. The structure and activities within Academy 2 should continue with minor if any adjustment for future implementations. Despite the fact that cohort 2 teachers' perceptions were slightly lower than cohort 1 teachers' perceptions, perceptions were largely positive and perceptions of cohorts may not be comparable across years given that cohorts are comprised of different teachers. All cohort 2 teachers made positive comments about the academy as a whole or made comments related to one of the foundational pillars.
2. The participating teachers noted time issues with the online content. Three (20%) teachers noted that the time allotted for the online material was not sufficient for the amount of material covered. The development team for Academy 2 might consider re-evaluating how much time is needed for teachers to complete the online materials and make adjustments as necessary.

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Appendix A – Presenter Biographies

John H. Easton: Dr. John Easton is a lecturer working with the Department of Civil and Environmental Engineering at Southern Methodist University. John graduated from the School of Electronic, Electrical, and Computer Engineering at University of Birmingham in 2004 with a MEng in Computer Systems Engineering with Management. He then went on to spend five years in the same School working on his PhD, which was co-supervised by the School of Biosciences and Birmingham Children's Hospital. He graduated in 2009.

Robyn Hartzell: Robyn Hartzell has over 19 years of experience as an educator and has served in a variety of roles including teacher, instructional coach, interventionist, trainer, and consultant. She was a classroom teacher for eight years before moving into an interventionist/coaching position. After eleven years of teaching and coaching, Robyn transitioned into the role of a consultant, then Program Coordinator for the second largest Educational Service Center in the state of Texas. While there, she developed and provided trainings for K-12 teachers and instructional coaches in public, private, and charter schools.

DiMitri Higginbotham: DiMitri Higginbotham is a graduate student at Southern Methodist University where he is working on his M.A. in Design and Innovation, focusing on maker education and human-centered design strategies. He is a graduate assistant for the SMU Maker Education Project, where he drives and teaches from the SMU Maker Truck.

Alain Mota: Alain Mota is the STEM Development and Implementation Coordinator at Research in Mathematics Education (RME) at Southern Methodist University. In this role, he supports campus leaders and science teachers in the delivery of classroom lessons that focus on the integration of STEM and active learning techniques through individualized coaching, co-planning, and facilitating Professional Learning Communities, and feedback following classroom observations.

Rob Rouse: Dr. Rob Rouse joined SMU's School of Education after completing his Ph.D. in Mathematics and Science Education at Vanderbilt University's Peabody College. At Vanderbilt, Rob worked with pre-service and in-service teachers in various contexts, including as a graduate teaching assistant, university field mentor, and course co-instructor. Prior to pursuing his doctorate, Rob taught high school chemistry for four years at the performing arts high school in New York City as a member of the New York City Teaching Fellows. Rob's research focuses on the intersection of science and engineering by investigating how design-based learning environments engage students in approximations of the epistemic practices of scientists and engineers. He is currently a Clinical Assistant Professor at SMU.

Erica Simon: Erica Simon is the Assistant Director for Strategic Development and Partnerships for Research in Mathematics Education (RME) at Southern Methodist University. Her emphasis is on developing research, practitioner, and community partnerships to support RME's mission while being highly focused on access and equity for all children in mathematics. Erica joined SMU in August of 2009 as an observer on the Early Learning in Mathematics (ELM) study and returned to SMU in 2012. Erica participates in grant writing teams, disseminates RME research

and development findings at state and national conferences, and promotes RME outreach through leading the coordination team for the annual Research-to-Practice Conference.

Appendix B – Academy 2 Evaluation Survey

STEM Academy for Teachers and Leaders: Academy Evaluation

To what extent do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. The STEM Academy was a valuable professional development opportunity.				
2. The STEM Academy deepened my understanding of: o Project-based learning o Maker-based instruction o Social and emotional learning o 5E Lesson Design Model o Promoting student problem solving o Facilitating student engagement o The scientific process standards o Science content knowledge o STEM careers o Community-based STEM education resources				
3. The STEM Academy provided me with the tools I need to apply in my classroom the principles of: o Project-based learning o Maker-based instruction o Social and emotional learning o 5E Lesson Design Model o Student problem solving o Student engagement o The scientific process standards o STEM education (e.g., STEM careers, community-based resources)				

4. The knowledge I gained at the STEM Academy will help me improve my science instruction.				
5. The content of the STEM Academy met my expectations.				
6. The structure of the STEM Academy enhanced my understanding of the science content I teach.				
7. The follow-up coaching and support planned for the school year will help me apply the following concepts in my science instruction: o Project-based learning o Maker-based instruction o Social and emotional learning o 5E Lesson Design Model o Student problem solving o Student engagement o The scientific process standards o STEM education (e.g., STEM careers, community-based resources)				
8. The **[insert field trip]**was: o was relevant to the science content I teach. o provided me with ideas on how to supplement in-class learning with a trip to a community-based STEM education resource.				
9. The field trip to **[insert field trip]**: o was relevant to the science content I teach. o provided me with ideas on how to supplement in-class learning with a trip to a community-based STEM education resource.				
10. The field trip to **[insert field trip]**:				

○ was relevant to the science content I teach. ○ provided me with ideas on how to supplement in-class learning with a trip to a community-based STEM education resource.				
11. I will share the knowledge I gained from the STEM Academy experiences with my colleagues.				
12. Speakers at the STEM Academy workshops delivered high-quality information about: ○ Project-based learning ○ Maker-based instruction ○ Social and emotional learning ○ 5E Lesson Design Model ○ Student problem solving ○ Student engagement ○ The scientific process standards ○ STEM education (e.g., STEM careers, community-based resources)				
13. The STEM Academy was interactive.				

14. What areas of the STEM Academy were most useful to you?

15. Which areas of the STEM Academy need improvement?

16. Which aspects of STEM Academy do you feel the most confident in implementing in the next school year? Please explain your response.

17. Is there anything else you would like to share about the STEM Academy?