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RESEARCH IN MATHEMATICS EDUCATION

STEM Academy for Science Teachers and Leaders: 2018 Teacher Academy I Evaluation

Technical Report 18-02

STEM Academy for Science Teachers and Leaders: 2018 Teacher Academy I Evaluation

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Executive Summary

Students who pursue a STEM major tend to be more competitive in the job market and are more likely to earn higher salaries (National Center for Education Statistics [NCES], 2014). The STEM Academy for Science Teachers and Leaders is an intensive professional development program designed to encourage students' interest in STEM career pathways. This report focuses on teachers' perceptions of the first of three summer academy courses. This summer academy course is entitled STEM Academy for Science Teachers and Leaders 1: Teacher Development in STEM Education (hereafter Academy I). Academy I was designed to emphasize four foundational pillars of STEM learning including (a) active learning or inquiry-based instruction, (b) the scientific process standards, (c) deep content knowledge, and (d) differentiated support for all learners.

Following the implementation of Academy I in summer 2017, minor modifications were made to the activities within the academy based on teacher feedback. This report summarizes the modifications that were made to the academy including: (a) additional structure and support for utilizing maker-based instruction (MBI) in the classroom; (b) an additional project-based learning (PBL) unit focused on cardiovascular health to address a wider range of grade levels; and (c) two different field trips for teachers to emphasize the role of informal learning spaces in science. These modifications were made based on teacher feedback on Academy I from summer 2017 and feedback from the SMU coach, who worked with teachers during the 2017-18 school year.

This report summarizes teachers' perceptions of Academy I across two cohorts of teachers including teachers who participated in summer 2017 (n=13) and teachers who participated in summer 2018 (n=24). Results are summarized based on the four foundational pillars referenced above. Teacher perceptions across both years suggest that Academy I deepened teachers' knowledge of active learning, the scientific process standards, teacher science content knowledge, and differentiated support for all learners through attending to social-emotional learning. Additionally, the results indicate that 100 percent of Cohort 2 teachers who participated in summer 2018 either agreed or strongly agreed that the academy was valuable, helped them improve their science instruction, was interactive, should be shared with colleagues, and met their expectations. On open-ended survey items, teachers identified that the academy's emphasis on active learning strategies was especially useful to them. One teacher wrote, "This experience has changed my teaching forever. I am enlightened. … The traditional style of teaching doesn't reach [students] the same way."

Three recommendations were made based on teachers' perceptions as measured by the survey. First, the positive perceptions suggest that the content, structure, and speakers should remain relatively consistent across future implementations. Summer 2018 teachers perceived the field trips more favorably than summer 2017 teachers perceived that year's field trips, suggesting that the changes to the field trip component may have been improved over last year. Teachers felt least favorably about the walkSTEM field trip experience, suggesting that this trip should be modified for future implementations.

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STEM Academy for Science Teachers and Leaders: 2018 Teacher Academy I Evaluation

Background

In 2012, individuals who held a bachelor's degree in a STEM major were more likely to be employed following graduation and had higher salaries compared to other students (The National Center for Education Statistics, 2014). In the same year, the full-time employment rate for STEM majors was seven percentage points higher than the rate for graduates overall (77% compared to 70%). Furthermore, the median salary for STEM majors was $14,000 higher than the median for students overall ($60,000 compared to $46,000). This evidence shows that the pursuit of a STEM career is both promising in terms of job attainment and salary opportunities. Despite this evidence, individuals who belong to historically underrepresented subgroups continue to be less likely to pursue STEM careers. These underrepresented subgroups include women (Mau, 2016, Sassler, Glass, Levitte, & Michelmore, 2017), students with disabilities (Basham & Marino, 2013), students from low-income households (Chen, 2009; Dika & D'Amico, 2016), and individuals who identify as Black or Hispanic (Fealing, Lai, & Myers, 2015, Mau, 2016).

Dallas Independent School District (ISD) is a large urban school district serving a student population of over 150,000 students where the majority of students are Hispanic (70%), Black (22%), or identify as economically disadvantaged (82%) (Dallas ISD, 2018). In 2017, only 41 percent of Grade 8 students were identified as at grade level in science, which was 11 percentage points lower than the state average of 52 percent (TEA, 2018). During the same year, only one percent of students with disabilities completed an advanced high school science course (TEA, 2018). In 2015, incoming high school students in Dallas ISD were asked to endorse a future career pathway – either STEM, Business and Industry, Public Services, Arts and Humanities, or Multi-disciplinary Studies. Only 17% of students reported an interest in a STEM pathway (Perry, Reeder, Brattain, Hatfield, & Ketterlin-Geller, 2017). Thus, Dallas ISD is a critical environment in which to intervene with students' STEM interest. The four-year STEM Academy project, which is a focus of this report, was developed in response to this need in order to encourage individuals who belong to underrepresented subgroups to actively engage in STEM. A primary goal of this project is to increase the percentage of students interested in STEM careers.

Overview of Project

Funded by the Texas Instruments Foundation and the O'Donnell Foundation, the STEM Academy for Science Teachers and Leaders is a partnership between Dallas Independent School District (ISD) and Southern Methodist University (SMU). As a part of the STEM Academy for Science Teachers and Leaders, participating teachers engaged in two components of the program each year for up to three years including: (a) 70 hours of face-to-face and 20 hours of online summer academy coursework at SMU, and (b) up to seven one-on-one coaching cycles at their schools with an SMU instructional coach. Participating teachers engaged in these two

components of the program each year for up to three years. The project implementation utilizes a cohort model. At the time of this report, one cohort of teachers was in their second year of participation (Cohort 1), and a second cohort of teachers was in their first year of participation (Cohort 2). This report includes data across these two cohorts of teachers: the Cohort 1 teachers who began participation in summer 2017, and Cohort 2 teachers who began participation in summer 2018.

In this report, we focus on the first of three intensive summer academy courses. This first academy course is entitled the STEM Academy for Science Teachers and Leaders 1: Teacher Development in STEM Education (hereafter Academy I). All participating teachers experience this course during their first summer with the project. Similar to the other summer academy courses, Academy I includes 70 hours of face-to-face and 20 hours of online coursework. The content of Academy I is undergirded by four foundational pillars for STEM learning as shown in Figure 1. These pillars include (a) active learning or inquiry-based instruction, (b) scientific process standards, (c) deep content knowledge, and (d) differentiated support for all learners.

Active learning or inquiry-based instruction. For Academy I, the first pillar encompasses two primary instructional strategies including **project-based learning (PBL)** and **maker-based instruction (MBI)**. Both strategies emphasize student-led investigation through student engagement, exploration, explanation, elaboration, and evaluation (Bybee, 2015).

Scientific process standards. The utilization of PBL and MBI sets the stage for the implementation of the second pillar, the scientific process standards. These standards encourage student behaviors such as hypothesizing, manipulating variables, and recording data.

Deep content knowledge. The third pillar focuses on deepening teachers' content knowledge. During Academy I, instructors model PBL and MBI units centralized around Texas Essential Knowledge and Skills (TEKS) identified as low performing standards based on STAAR data and Dallas ISD common assessment data provided by the district. These standards are known by teachers as "hard to teach, hard to learn" standards. By incorporating the content of these standards into the academy content, teachers have an opportunity to increase their content knowledge, and in turn support student understanding.

Differentiated support for all learners. The fourth pillar emphasizes student differentiation in ways that meet the needs of all learners, specifically students from underrepresented backgrounds. Research shows that attending to students' social-emotional well-being is important for their academic success (Rutledge, Cohen-Vogel, Obsorne-Lampkin, & Roberts, 2015) and reduces achievement gaps (Durlak, 2015). Thus, Academy I encourages teachers to attend to students' social-emotional needs through evidence-based instructional strategies that encourage self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (CASEL, 2018).

Across these pillars, an overarching theme involves connections to STEM-based community resources, which illustrates career connections and real-life application of STEM learning. Through utilization of community resources, teachers have an opportunity to consider how they can embed community resources or knowledge gained from community resources to further enhance the curriculum. By highlighting career connections within Academy I, teachers

recognize that there are many STEM careers that they themselves were not aware of (e.g., electronic application development for the local busing and train system). As illustrated in Figure 1, these foundational pillars of Academy I were selected as areas of focus to increase teacher and student success in STEM. For more detail on the structure and content of Academy I, please see the previous Academy I evaluation report (Perry et al., 2017).

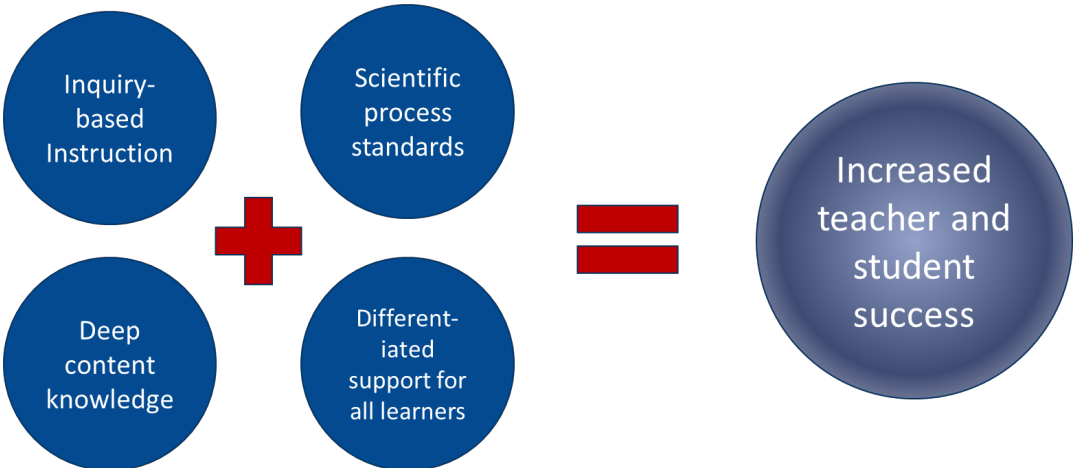

Figure 1. Main Pillars of Academy I

Purpose of this Report

This evaluation report serves four purposes. First, the report provides an overview of the components and goals of Academy I. Second, the report outlines modifications that were made to the implementation of Academy I based on feedback from Cohort 1, who engaged in the academy during summer 2017. Based on this feedback, course developers modified activities to better meet the needs of teachers, but did not change the foundational pillars of the academy. Third, this report provides a summary of teachers' perceptions of Academy I based on a teacher survey across two cohorts of teachers (2017 and 2018). Fourth, this report provides recommendations for the future implementations of Academy I.

Evaluation Questions

In this report, we focus on two main evaluation questions:

- What are teachers' perceptions of Academy I based on the academy evaluation survey?
- Were teachers' perceptions of Academy I different across cohorts in summer 2017 compared to summer 2018?

Modifications to Academy I Across Years

This section provides a summary of modications to the content and structure of Academy I overall, as well as specific to active learning, the scientific process standards, content knowledge, social-emotional learning, and community-based resources. Overall, the modifications to the

Academy I components were made to enhance the attainment of the goals specified by the foundational pillars. These enhancements were based on teachers' perceptions of Academy I in summer 2017 and feedback from the SMU coach, who engaged with the teachers during the 2017-18 academic year.

- **MBI**: Modifications to this portion of the academy support teachers' utilization of a unit design format known as a Skill Sprint Cycle where students iteratively learn to use a scientific tool as they engage in content. More specifically, a *3D Modeling & Printing Skill Sprint Cycle* was modeled for the teachers by the instructors. During the modeling, teachers became the students, learning scientific content while also learning the building blocks necessary for successful 3D printing. Then, based on the model and curriculum documents provided, teachers selected their own TEKS and adapted the *3D Modeling & Printing Skill Sprint Cycle* for their classrooms. In summer 2017, teachers engaged in a Skill Sprint Cycle, but in summer 2018, teachers received additional scaffolding and structure. The modifications made for summer 2018 provided additional pre-prepared curriculum documents, which teachers could adapt and use in their classrooms.

- **PBL**: To accommodate the multiple grades teachers taught, a new model PBL project was added to the academy. Teachers selected if they engaged in a Rocketry (original) or Cardiovascular (new in 2018) model PBL unit delivery. Teachers were asked to determine which model unit they selected as a campus. The rationale for campus-level selection was to support common knowledge across participating teachers within a school. No other modifications to the PBL content were made.

- **Community Resources**; Revisions were made to the community resources that teachers engaged in to further support an understanding that community resources extend beyond field trips for students. Given the financial constraints at many schools, students may not be able to physically attend a field trip. Thus, specific considerations were given to increasing teacher content knowledge and knowledge of STEM careers that can be incorporated into the curriculum. Additionally, SMU staff discussed with teachers how community resource representatives can visit classrooms in person or via video. This year teachers engaged with a new community resource called walkSTEM. walkSTEM is an innovative methodology and set of curated experiences designed to connect math and science to the real world in informal settings. walkSTEM is an open-source online platform of short videos. Teachers received an introduction to walkSTEM approaches as well as suggestions for ways that they can engage in existing walkSTEM experiences at SMU, Dallas Arts District, and elsewhere in Dallas. Teachers were encouraged to think about how the walkSTEM experience could be created within and around their school community. In addition, two alternative field trip locations were selected for the academy. First, teachers attended the Frontiers of Flight Museum, which connected to aeronautics, history, astronomy, and many other STEM-related fields. During the experience at the Flight Museum, teachers developed their content knowledge of the sun, earth, and moon. Second, teachers visited the Dallas Area Rapid Transit (DART). The DART field trip had an intense focus on careers in STEM by considering the technological features of the buses, trains, web-based applications, and other internet resources. Career connections for DART included mechanical, electrical, and software engineering.

Participating Teachers

Overall, 16 Cohort 1 teachers participated in Academy I in summer 2017, and 30 Cohort 2 teachers participated in Academy I in summer 2018. Of those participating teachers, 13 Cohort 1 and 24 Cohort 2 teachers completed the academy evaluation survey, resulting in response rates of 80 percent and 77 percent respectively. Table 1 shows the demographic characteristics of the teachers who participated in Academy I in summer 2017 (Cohort 1) and summer 2018 (Cohort 2).

Table 1. Teacher Demographic Information

Teacher Characteristic		Cohort 1 Summer 2017		Cohort 2 Summer 2018	
		#	%	#	%
Gender	Male	4	25%	10	33%
	Female	12	75%	20	67%
Race	Alaska Native	0	0%	0	0%
	Asian	0	0%	2	6%
	Black	9	56%	18	53%
	Native Hawaiian	0	0%	0	0%
	Other Pacific Islander	0	0%	1	3%
	White	7	44%	13	38%
Ethnicity	Hispanic or Latino	4	25%	3	10%
	Not Hispanic of Latino	12	75%	27	90%
Total		*16*	*100%*	*30*	*100%*

Note: Three teachers in Cohort 2 identified as two or more races, which resulted in a total percentage of reported races higher than 100%.

Work Experience

Table 2 shows teachers' average years of experience. The two groups of teachers were relatively similar in their years teaching science, in other careers, and at their current school. On average, Cohort 2 teachers had slightly more years in education and teaching than Cohort 1 teachers.

Table 2. Teacher Work Experience

Years	Cohort 1 Mean (SD)	Cohort 2 Mean (SD)
In Education	5.4 (4.7)	7.6 (5.7)
Teaching	5.5 (4.8)	6.8 (5.8)
Teaching science	5.2 (4.8)	6.2 (5.7)
In other careers	7.8 (6.6)	6.8 (6.3)
At current school	4.0 (3.1)	3.5 (3.2)

Note: SD indicates standard deviation. Table includes 16 Cohort 1 and 30 Cohort 2 teachers.

Teacher Certification

Table 3 shows the number of teacher certifications for Cohort 1 and Cohort 2 teachers. All teachers has at least one teacher certification. A qualitative examination of reported teacher certifications indicated that the majority of Cohort 1 and 2 teachers were certified in Science Grades 4-8, with 10 of 16 Cohort 1 teachers (63%) and 20 of 30 Cohort 2 teachers (67%) reporting they had earned this certification. The second most common teacher certification type for both cohorts was General Education, with six of 16 Cohort 1 teachers (38%) and 14 of 30 Cohort 2 teachers (47%) reporting they had earned this certification. Frequencies of these and other certifications are represented in Figure 1.

Table 3. Number of Teacher Certifications

Teacher Certifications	**Cohort 1 Summer 2017**		**Cohort 2 Summer 2018**	
	#	%	#	%
1 subject-area certification	10	63%	15	50%
2 subject-area certifications	5	31%	11	37%
3 subject-area certifications	1	6%	3	10%
4 subject-area certifications	0	0%	0	0%
5 subject-area certifications	0	0%	0	0%
6 subject-area certifications	0	0%	1	3%

Note: Table includes 16 Cohort 1 and 30 Cohort 2 teachers.

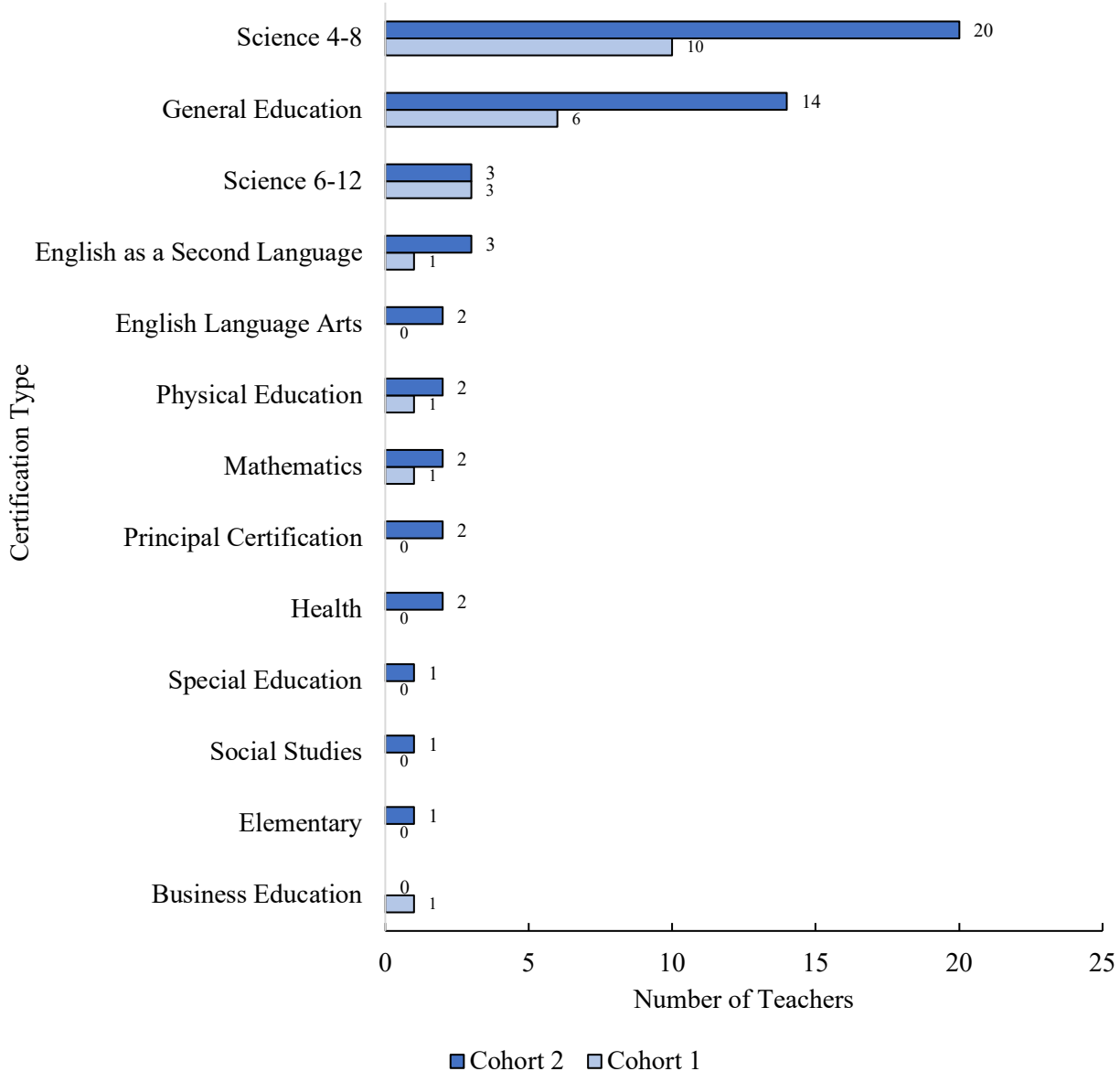

Figure 1. Frequencies of Teacher Certification Type for Cohort 1 and 2 Teachers

Note: Figure includes 16 Cohort 1 and 30 Cohort 2 teachers.

Grade Levels

Table 4 shows teachers' grade levels. The majority of teachers in Cohort 1 taught Grade 8, whereas, the majority of teachers in Cohort 2 taught Grade 6. Cohort 1 recruitment of teachers targeted Grade 8 science teachers and Grade 7 Pre-AP teachers; whereas, Cohort 2 recruitment was open to all middle school science teachers.

Table 4. Teachers' Grade Levels Taught

Grade Level	**Cohort 1 Summer 2017**	**Cohort 2 Summer 2018**
	# of Teachers	# of Teachers
6	1	16
7	9	12
8	10	7

Note: Table includes 16 Cohort 1 and 27 Cohort 2 teachers. Four teachers in Cohort 1 taught more than one grade level, and five teachers in Cohort 2 taught more than one grade level.

Professional Development

Table 5 and Figure 2 show the number of hours of professional development by topic for Cohort 1 teachers. Overall, 16 teachers in Cohort 1 received some professional development in science content. The second highest attended professional development topic was English language learners, followed by social emotional learning. The least attended professional development for Cohort 1 teachers was maker-based instruction.

Table 5. Cohort 1 Teacher Previous Professional Development by Topic

	Topic	Less than 6 hours	6-15 Hours	16-35 Hours	More than 35 Hours	# of teachers	% of teachers
Science	Science Content	1	8	2	5	16/16	100%
	Other Content	5	6	0	2	13/16	81%
	Project-based Learning	5	3	1	0	9/16	56%
	Maker-based Instruction	2	1	0	0	3/16	19%
Non-science	English Language Learners	5	0	8	1	14/16	88%
	Social-emotional Learning	8	1	1	0	10/16	63%
	Students with Disabilities	9	1	0	0	10/16	63%

Note: Table includes 16 Cohort 1 teachers.

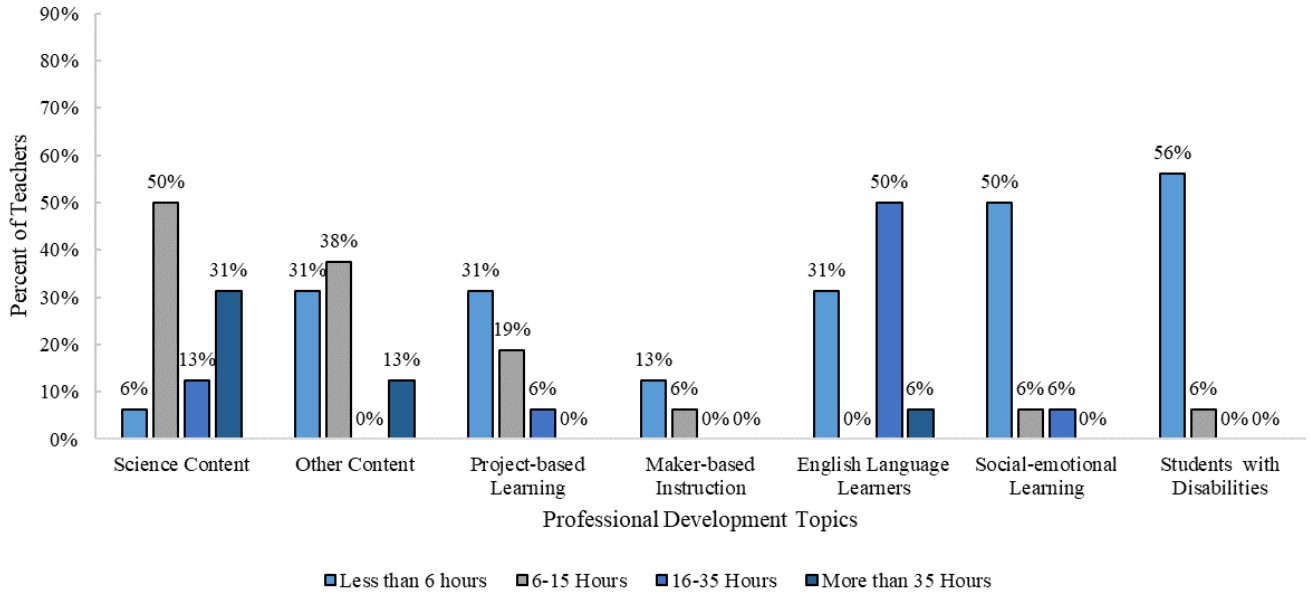

Figure 1. Percent of Cohort 1 Teachers who Completed Professional Development by Topic

Note: Figure includes 16 Cohort 1 teachers.

Table 6 and Figure 3 show the number of hours of professional development by topic for Cohort 2 teachers. Overall, the professional development topics with the highest participation were similar to Cohort 1 teachers. For example, the most teachers participated in professional development focused on science content and English language learners. Similar to Cohort 1 teachers, Cohort 2 teachers also tended to have higher participation in non-science topics. Again, the least attended professional development for Cohort 1 teachers was maker-based instruction. One notable difference is in the percentage of teachers who took professional development focused on PBL. Seventy percent of Cohort 2 teachers compared to 56 percent of Cohort 1 teachers had participated in professional development focused on PBL.

Table 6. Cohort 2 Teacher Previous Professional Development by Topic

Topic		Less than 6 hours	6-15 Hours	16-35 Hours	More than 35 Hours	# of teachers	% of teachers
Science	Science Content	6	9	5	7	27/30	90%
	Other Content	8	9	2	1	20/30	67%
	Project-based Learning	17	2	2	0	21/30	70%
	Maker-based Instruction	7	0	0	0	7/30	23%
Non-science	English Language Learners	16	9	2	1	28/30	93%
	Social-emotional Learning	16	7	2	0	25/30	83%
	Students with Disabilities	16	5	1	1	23/30	77%

Note: Table includes 27 Cohort 2 teachers.

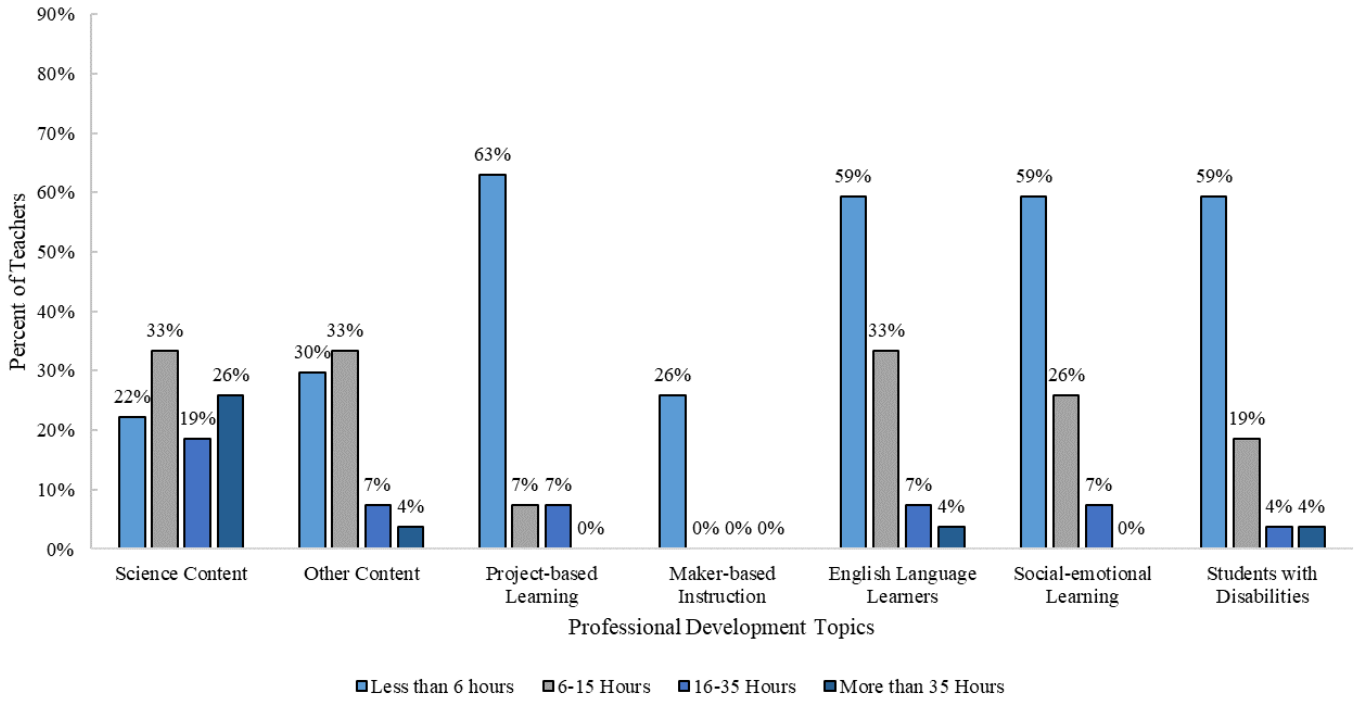

Figure 2. Percent of Cohort 1 Teachers who Completed Professional Development by Topic

Note: Figure includes 30 Cohort 2 teachers.

In summary, the descriptive statistics presented in this section for Cohort 1 and 2 teachers show that participating teachers were majority Black (56% in Cohort 1 and 53% in Cohort 2) and female (75% in Cohort 1 and 67% in Cohort 2). On average, teachers had more than five years of experience in teaching (5.5 years for Cohort 1 and 6.8 for Cohort 2).

Academy Evaluation Survey

Following Academy I, teachers completed the *STEM Academy for Teachers and Leaders: Academy Evaluation*, which included 12 items. Teachers reported their level of agreement with statements about the quality of the academy. Items focused on understanding teachers' overall perceptions of the Academy I structure, content, and speakers. The survey was administered via Qualtrics (Qualtrics, 2018) immediately following the implementation of Academy I.

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, active learning, content knowledge, social-emotional learning, and

community-based resources). For Cohort 1 teachers' qualitative perceptions, see last year's Academy I report (Perry et al., 2017).

The results in this section are grouped based on teacher perceptions of the academy overall, as well as implementation of active learning, the scientific process standards, content knowledge, social-emotional learning (an aspect of the original differentiation foundational pillar), and community-based resources. We examine teachers' perceptions quantitatively by looking at agreement rates across cohorts. It is important to note that the sample sizes across years were different sizes (13 Cohort 1 teachers and 24 Cohort 2 teachers completed the survey); thus, differences in the percentage of teachers who agree or strongly agree with items across years are sensitive to sample size. Additionally, because these two groups of teachers are different, the percentage of teachers who agree or strongly agree with items across cohorts are descriptive and may or may not be attributable to the modifications that were made to the academy.

Overall Results

Figure 2 shows the percent of Cohort 1 and 2 teachers who *agreed* or *strongly agreed* with statements about Academy I overall. These statements inquired about the extent to which teachers agreed that the academy was valuable, would help them improve their instruction, was interactive, should be shared with their colleagues, and met their expectations. Teachers responded with high agreement to these statements across both years. One hundred percent of Cohort 2 teachers (24/24 teachers) either agreed or strongly agreed with the six statements about the overall academy. In addition, the percent of teachers who strongly agreed with statements about Academy I was higher in summer 2018 for each of the six items in Figure 1. The smallest difference in the percentage of teachers who strongly agreed was for the item "The STEM Academy was a valuable professional development opportunity," and the largest difference was for the item "I will share the knowledge I gained with my colleagues."

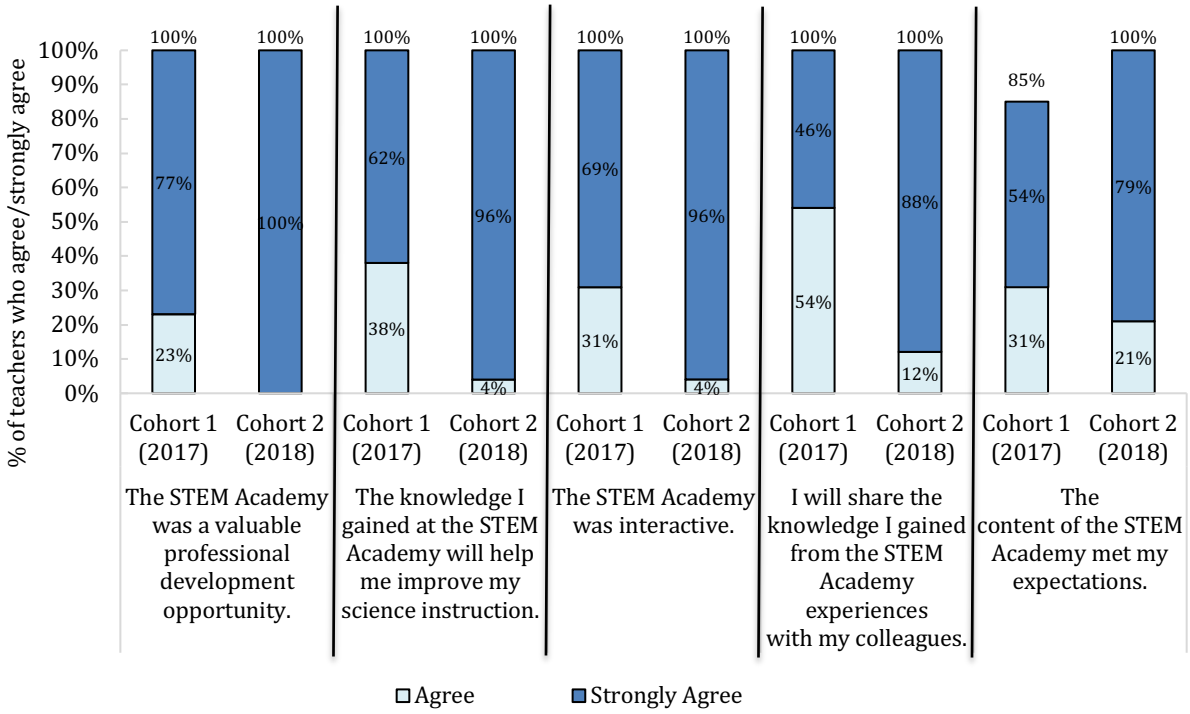

Figure 2. Percent of Teachers who *Agreed* or *Strongly Agreed* Across Years with Statements about Academy I
Note: Sample includes 13 Cohort 1 teachers and 24 Cohort 2 teachers.

On the open-ended survey items, 22 of 24 teachers (92%) identified an aspect of the academy that was useful to them or reported that the academy overall was useful. The other two teachers wrote "N/A" in response to this item. One teacher wrote, "This experience has changed my teaching forever. I am enlightened. … The traditional style of teaching doesn't reach them the same way." Another teacher wrote, "The STEM Academy in all my years of attending [professional development] has so far been the most enjoyable and fruitful PD for me."

Fourteen of 24 teachers (58%) identified an aspect of the academy that could be improved. Two teachers requested adjustments to the online coursework. Specifically, one requested more time to work on the modules and the other requested access to future work once they complete the week's modules "so [they] can do the work while the material is fresh in [their] minds." Individual teachers expressed concerns related to: (a) parking, (b) tardy classmates, which resulted in sessions starting late, (c) recruitment efforts, and (d) a need to increase the representation of students of color in videos that were utilized as exemplars during the academy.

Active Learning

Figure 3 shows the percent of Cohort 1 and 2 teachers who *agreed* or *strongly agreed* with statements specific to active learning strategies, with PBL identified in green and MBI identified in blue. These statements inquired about the extent to which teachers agreed that Academy I deepened their understanding of these strategies, provided them with the tools and ongoing support to apply these strategies, and provided high-quality content about these strategies. Similar to Figure 2, 100 percent of Cohort 2 teachers (24/24 teachers) either agreed or strongly

agreed that the academy was effective in supporting their knowledge and implementation for the eight items focused on active learning. Similar to Figure 1, the percent of teachers who strongly agreed with items was higher in Summer 2018 compared to Summer 2017 across all items, with the smallest difference for "Speakers at the STEM Academy workshops delivered high-quality information about maker-based instruction" and the largest difference for "The STEM Academy provided me with the tools I need to apply in my classroom the principles of maker-based instruction."

On the open-ended survey items, 20 of 24 teachers (83%) reported that active learning strategies was the most or one of the most useful areas of the academy with 14 teachers explicitly referencing MBI and 12 teachers explicitly referencing PBL (7 teachers referenced both). Specifically, three teachers reported they liked MBI because they were not familiar with this strategy prior to the academy. One teacher said that MBI showed the importance of allowing "[her or his] students the freedom to choose." Another teacher reported that PBL was beneficial for teachers because "[they] could see the difference between planning a 'project' and an actual PBL unit."

Six of 24 teachers (25%) suggested improvements be made to the MBI and PBL components. Specifically, two teachers suggested laying out clear expectations for MBI; one teacher suggested the same for PBL. The other teachers did not provide specific suggestions for improvements, but generally suggested that those areas could be improved.

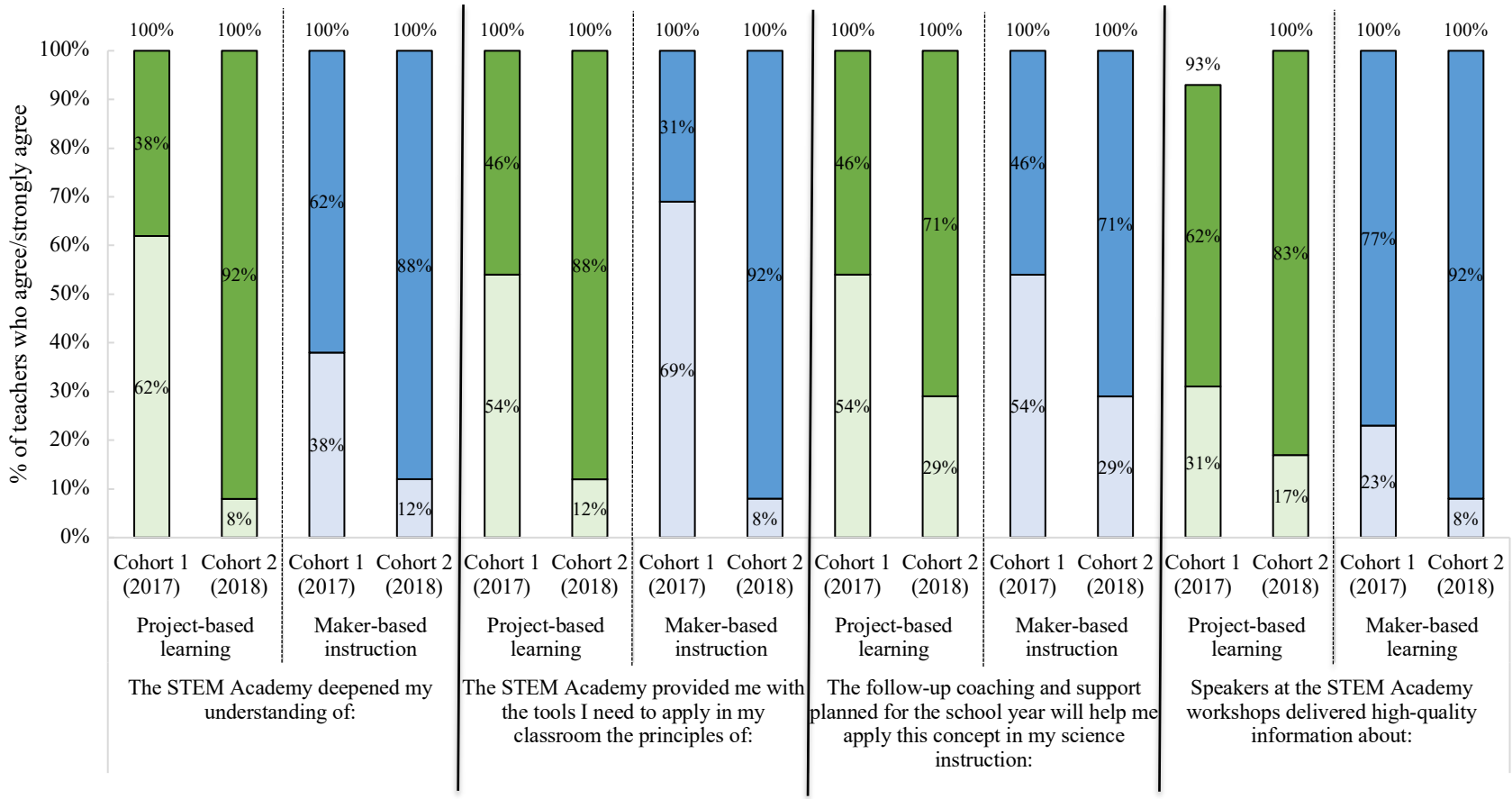

Figure 3. Percent of Teachers who *Agreed* or *Strongly Agreed* Across Years with Statements about Active Learning

Note: PBL items are identified with green columns. MBI items are identified with blue columns. Darker green or blue indicates 'strongly agree' and lighter green or blue indicates 'agree'. Sample includes 13 Cohort 1 teachers and 24 Cohort 2 teachers.

Content Knowledge

Figure 4 shows that 100 percent of Cohort 2 teachers (24/24 teachers) *agreed* or *strongly agreed* that the structure of Academy I enhanced their understanding of the science content they teach. Last year, only 77 percent of teachers (10/13 teachers) agreed or strongly agreed with this statement. Two remaining teachers disagreed with this statement, and one teacher strongly disagreed with this statement (Perry et al., 2017).This year 24 of 24 teachers agreed or strongly agreed with 15 of 24 teachers (63%) strongly agreeing. This was the largest difference across the two years of implementation in the overall percent of teachers agreeing or strongly agreeing observed in this report.

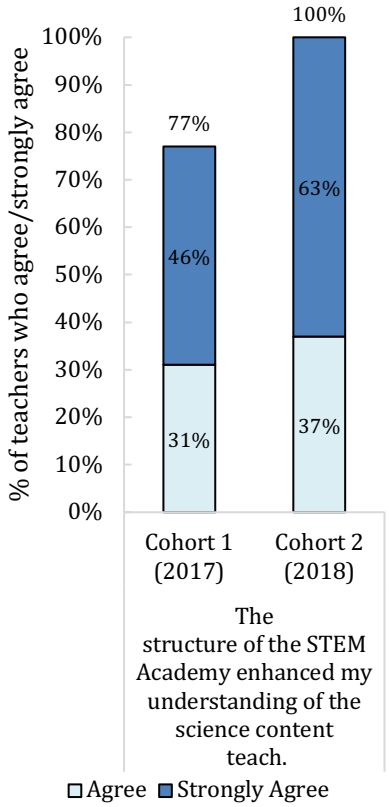

Figure 4. Percent of Teachers who *Agreed* or *Strongly Agreed* Across Years with a Statement about Content Knowledge
Note: Sample includes 13 Cohort 1 teachers and 24 Cohort 2 teachers.

On the open-ended items, teachers did not explicitly mention content knowledge as a useful aspect within the academy. However, one teacher referenced content knowledge when describing opportunities for improvement. Specifically, this teacher stated that aspects of the rocketry content were above a middle school level. She suggested revising this content such that it was at a middle school level.

Social-Emotional Learning

Figure 5 depicts the percentage of teachers who *agreed* or *strongly agreed* with statements specific to social-emotional learning. These items examined the extent to which teachers agreed that the academy deepened their understanding about social-emotional learning, provided them with the tools and support necessary to implement social-emotional learning, and that the speakers delivered high-quality information specific to social-emotional learning. For items specific to social-emotional learning, the difference across years in the percentage of teachers who strongly agreed with items decreased for one item, increased for one item, and was relatively consistent for two items. The percentage of teachers who strongly agreed that 'The follow-up coaching and support planned for the school year will help me apply social and emotional learning in my science classroom' increased across years. On the other hand, the percentage of teachers who strongly agreed that 'Speakers at the STEM Academy workshops delivered high-quality information about social and emotional learning' decreased across years. These increases should be interpreted with caution as they are sensitive to sample size.

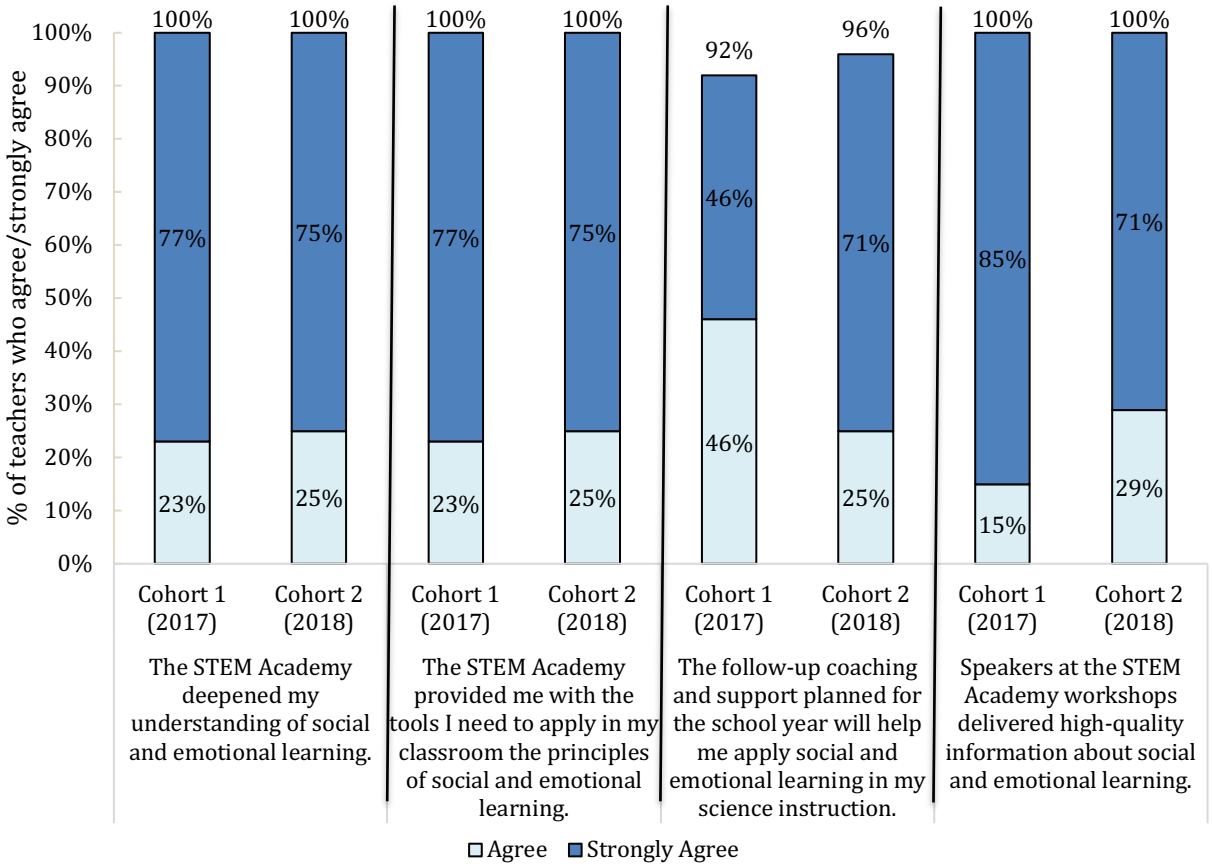

Figure 5. Percent of Teachers who *Agreed* or *Strongly Agreed* Across Years with Statements about Social-Emotional Learning
Note: Sample includes 13 Cohort 1 teachers and 24 Cohort 2 teachers.

On the open-ended items, three of 24 teachers (13%) reported that the social-emotional learning was the most or one of the most useful aspects of the academy. One teacher reported that this

component "helped [her or him] understand the need for student choice in the classroom." On the open-ended question focused on opportunities for improvement, two of 24 Cohort 2 teachers (8%) expressed that they would like more time during the academy to be spent on social-emotional learning.

Community Resources

In Summer 2018, 100% of Cohort 2 teachers (24/24 teachers) either *agreed* or *strongly agreed* that Academy I deepened their understand of community-based STEM educational resources (Figure 6), which is an increase in percentage point difference from the previous year. The percentage of teachers who strongly agreed with this statement also increased compared to the previous year. However, these increases should be interpreted with caution as they are sensitive to sample size.

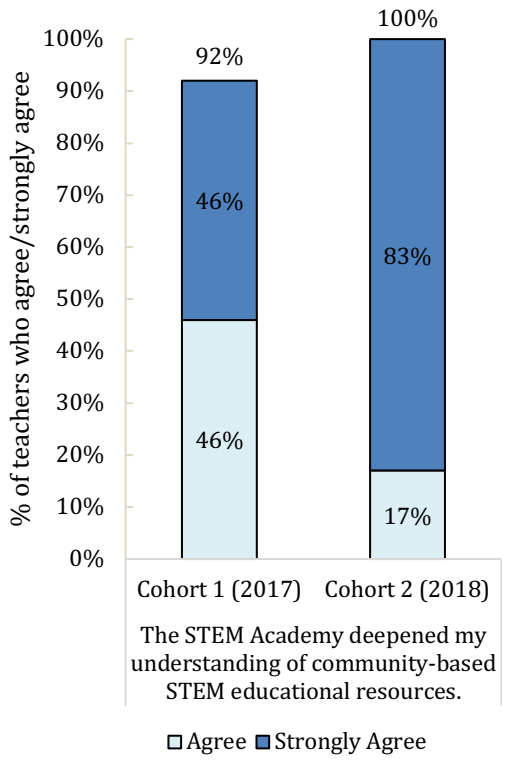

Figure 6. Percent of Teachers who *Agreed* or *Strongly Agreed* Across Years with a Statement about Community Resources
Note: Sample includes 13 Cohort 1 teachers and 24 Cohort 2 teachers.

The structure of Academy I included two field trips (the Flight Museum and DART) and an on-campus visit from a representative from walkSTEM. These activities focused on (a) deepening teachers' understanding of community-based resources and (b) making connections between curriculum and innovative, newly emerging careers. Based on feedback from summer 2017 teachers, the field trip locations changed in summer 2018, which limits side-by-side comparison of teacher perceptions of the field trips. Because these field trips were not the same across years,

differences across years are less meaningful to compare. Thus, this report focuses on teachers' perceptions of the field trips taken during summer 2018.

Figure 7 shows the percentage of teachers responding favorably to the Flight Museum indicated in blue, DART indicated in green, and walkSTEM indicated in orange. Overall, Cohort 2 teachers responded most favorably toward the Flight Museum. Specifically, 96 percent of teachers (23/24 teachers) agreed or strongly agreed that the Flight Museum was relevant to the science content they taught. Similarly, 100 percent of teachers (24/24 teachers) agreed or strongly agreed that the Flight Museum provided ideas to supplement in-class learning. Teachers also responded favorably to the DART trip. Almost all teachers (96% or 23/24 teachers) either agreed or strongly agreed that the DART trip was relevant and provided ideas that could be used in class. Teachers responded least favorably toward walkSTEM. Only 71 percent of teachers (17/24 teachers) reported that the walkSTEM content was relevant, and 88 percent (21/24 teachers) reported that walkSTEM provided them with ideas that they could use in their classes. Of the teachers who disagreed that the walkSTEM content was relevant, 25 percent of teachers (6/24 teachers) disagreed and only 4 percent of teachers strongly disagreed (1/24 teachers). Of the teachers who disagreed that the walkSTEM provided them with ideas that they could use in their classes, 8 percent of teachers (2/24 teachers) disagreed and 4 percent (1/24 teachers) strongly disagreed. Teacher perceptions of last year's field trips are described in last year's report (Perry et al., 2017).

On the open-ended items, five of 24 teachers (20%) reported that the field trips were the most or one of the most useful aspects of the academy. One teacher reported that the DART field trip was especially useful, saying, "I am excited about using DART as both a career and content connection for my students."

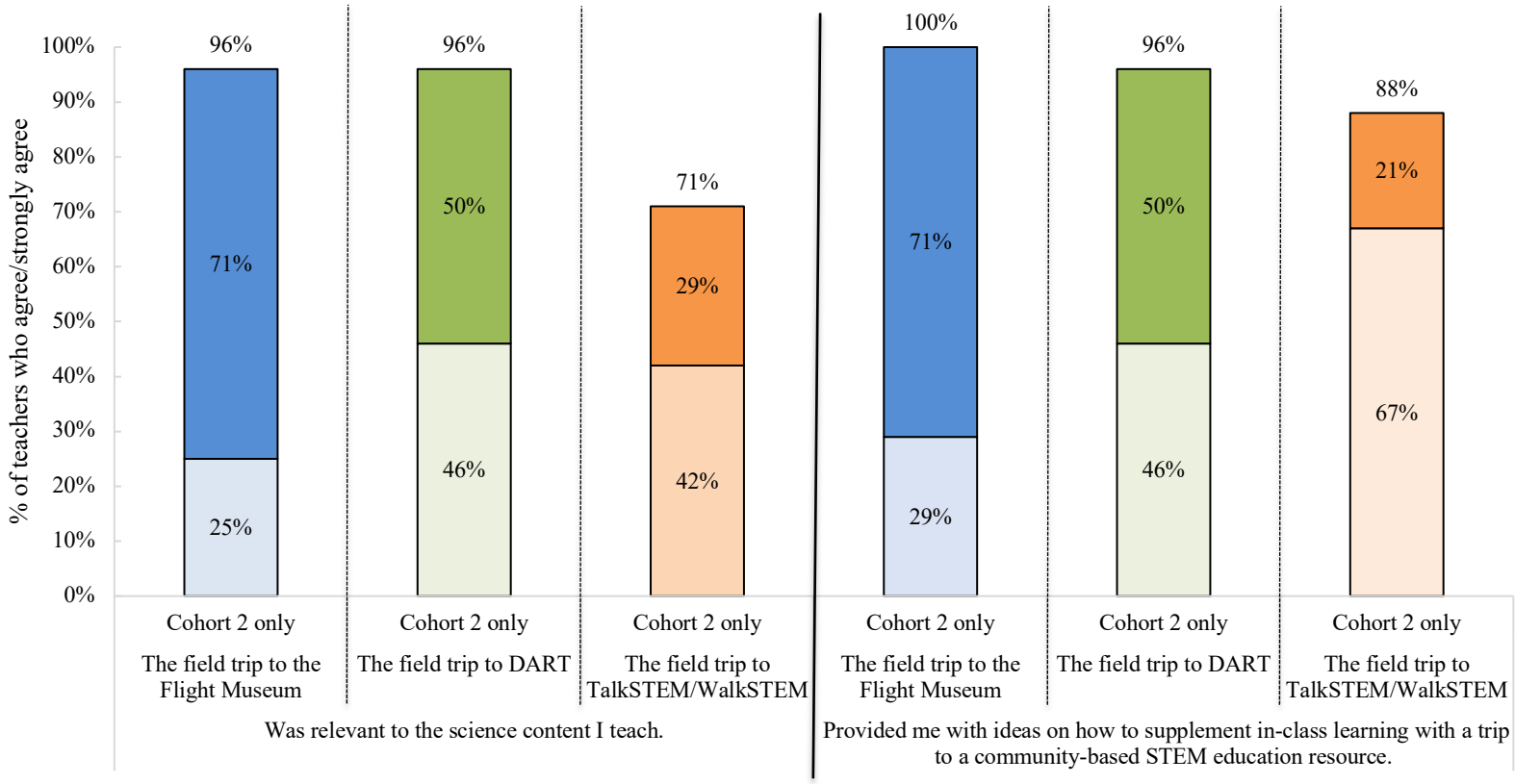

Figure 7. Percent of Teachers who *Agreed* or *Strongly Agreed* with Statements about Field Trips

Note: Flight Museum items are identified with blue columns. DART items are identified with green columns. walkSTEM items are identified with orange columns. Darker colors indicate 'strongly agree' and lighter colors indicate 'agree'. Sample includes 24 Cohort 2 teachers.

Summary

Overall. Across both years, every teacher (13/13 Cohort 1 teachers; 24/24 Cohort 2 teachers) *agreed* or *strongly agreed* that Academy I was a valuable professional development opportunity, was interactive, and should be shared with their colleagues.

Academy content. Across both years, every teacher (13/13 Cohort 1 teachers; 24/24 Cohort 2 teachers) agreed or strongly agreed that the knowledge gained at Academy I would help them improve their science instruction. The percentage of teachers who agreed that the content of Academy I met their expectations increased from 85 percent (11/13 teachers) to 100 percent (24/24 teachers), suggesting that the modifications that were made to the content of Academy I may have been effective in improving teachers' favorable perceptions of Academy I.

Active learning. Teachers responded most favorably about their PBL and MBI learning experiences within Academy I. Across both years, every teacher (13/13 Cohort 1 teachers; 24/24 Cohort 2 teachers) reported that Academy I deepened their understanding of PBL and MBI, provided them with the tools necessary to implement PBL and MBI, would help them implement PBL and MBI through follow-up coaching and support, and delivered high-quality speakers for MBI. The percentage of teachers who agreed that the speakers delivered high-quality information about PBL increased from 93 percent (12/13 teachers) to 100 percent (24/24 teachers), suggesting that the modifications that speakers made may be associated with improved teacher perceptions.

Science content. The largest increase in the percentage of teachers responding favorably across years was specific to science content within the academy. The percentage of teachers responding favorably that the academy enhanced the science content they teach increased from 77 percent (10/13 teachers) to 100 percent (24/24 teachers). This evidence suggests that the modifications to the science content emphasized within the academy may have contributed to improved teacher perceptions.

Social-emotional learning. Across both years, every teacher (13/13 Cohort 1 teachers; 24/24 Cohort 2 teachers) *agreed* or *strongly agreed* that Academy I deepened their understanding of social-emotional learning, provided them with the tools needed to apply social-emotional learning in their classrooms, and delivered high quality speakers about social-emotional learning. The percentage of teachers who agreed or strongly agreed that the coaching and ongoing support would support their implementation of social-emotional learning in the classroom remained relatively consistent across years (12/13 Cohort 1 teachers and 23/24 Cohort 2 teachers).

Community-based resources. The percentage of teachers who *agreed* or *strongly agreed* that Academy I deepened their understanding of community-based STEM education resources increased from 92 percent (12/13 teachers) to 100 percent (24/24 teachers). Teachers responded most favorably toward the Flight Museum and DART trips. Every teacher (24/24 teachers) agreed or strongly agreed that the Flight Museum provided ideas on how to support in-class learning with a trip to a community-based STEM education resource. Almost every teacher (96% or 23/24 teachers) agreed or strongly agreed that: (a) the Flight Museum and DART were relevant to the content they teach and (b) DART provided ideas on how to supplement in-class learning with a trip to a community-based STEM education resource. Fewer teachers agreed or

strongly agreed that walkSTEM was relevant to the content they teach (71% or 17/24 teachers) or provided ideas on how to supplement in-class learning with a trip to a community-based resource (88% or 21/24 teachers).

In summary, these results suggest that across both years of implementation, teachers' experiences deepened their knowledge of the four foundational pillars of the STEM Academy including: (a) active learning, (b) scientific process standards, (c) teacher science content knowledge, and (d) differentiated support for all learners through attending to social-emotional learning. In general, a similar or higher percentage of teachers had favorable perceptions of Academy I during the second year of implementation as compared to the first year of implementation.

Recommendations

Three recommendations are based on the results presented within this report.

1. On all items on the teacher evaluation survey, the majority of Cohort 2 teachers (over 60%) strongly agreed that the academy (a) deepened their understanding, (b) provided tools needed to implement their learning, (c) provided appropriate follow-up support, and (d) delivered high-quality information. This evidence suggests that the Academy met the goals outlined in the foundational pillars. Programmatically, these data suggest that minimal changes are warranted. As such, the content, structure, and speakers at the academy should remain relatively consistent across future implementations.

2. Three new community-based STEM education resources were integrated as a part of Academy I. Teachers felt most favorable toward the Flight Museum, suggesting that this resource should be continued in future academy implementations. Teachers also felt favorable toward the DART trip, but not as strongly as teachers did toward the Flight Museum. Summer 2018 teachers perceived the Flight Museum and DART more favorably than summer 2017 teachers responded about the Dallas Zoo and Trinity River Audubon Center (see Perry et al., 2017), suggesting this year's trips may have been improvemed over last year's trips.

3. Teachers felt least favorable toward the talkSTEM/walkSTEM community-based resource. Teachers' perceptions suggest that this activity should either be changed or removed from the academy.

Overall, these results illustrate that Academy I is a promising program that is perceived as beneficial by middle school teachers. Future reports will investigate the influence of the full treatment on teachers' science beliefs, efficacy for teaching science, and instructional practices.

References

Basham, J.D. & Marino, M.T. (2013). Understanding STEM education and supporting students through universal design for learning. *TEACHING Exceptional Children, 45*(4), 8-15.

Bybee, R. W. (2015). *The BSCS 5E instructional model: Creating teachable moments.* Thousand Oaks, CA: Corwin.

Chen X., & Weko, T. (2009). Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education. *National Center for Education Statistics, 161,* 1-24.

Dika, S.L., & D'Amico, M.M. (2016). Early experiences and integration in the persistence of first-generation college students in STEM and non-STEM majors. *Journal of Research in Science Teaching, 53*(3), 368-383.

Durak, J.A., Domitrovich, C.E., Weissberg, R.P., & Gullotta, T.P. (2015?). *Handbook of social and emotional learning: Research and practice.* New York, NY: The Guilford Press.

Fealing, K.H., Lai, Y., & Myers, S.L. (2015). Pathways vs. pipelines to broadening participation in the stem workforce. *Journal of Women and Minorities in Science and Engineering, 21*(4), 271-293. doi: 10.1615/JWomenMinorScienEng.2015004760

Mau, W.J. (2016). Characteristics of US students that pursued a STEM major and factors that predicted their persistence in degree completion. *Universal Journal of Educational Research, 4*(6), 1495-1500. doi: 10.13189/ujer.2016.040630

Perry, L., Reeder, M.J., Brattain, K., Hatfield, C., & Ketterlin-Geller, L. (2017). STEM Academy for Teachers and Leaders: 2017 Academy Evaluation. Dallas, TX: Research in Mathematics Education, Southern Methodist University.

Qualtrics. (2018). Provo, UT. https://www.qualtrics.com

Rutledge, S.A., Cohen-Vogel, L., Osborne-Lampkin, L., & Roberts, R.L. (2015). Understanding effective high schools: Evidence for personalization for academic and social emotional learning. *American Educational Research Journal, 52* (6), 1060-1092.

Sassler, S., Glass, J., Levitte, Y., & Michelmore, K. (2017). The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. *Social Science Research, 63,* 192-208.

Texas Education Agency. (2018). *2016-17 Texas academic performance report (District name: Dallas ISD).* https://rptsvr1.tea.texas.gov/perfreport/tapr/2017/srch.html?srch=D

Xue, Y. & Larson, R.C. (2015). STEM crisis or STEM surplus? Yes and yes. *Monthly Labor Review,* 1-14.

Appendix A – Presenter Biographies

Scott Douglas: Scott Douglas is a professor in the Department of Electrical Engineering at SMU. Dr. Douglas received his B.S. and M.S. in Electrical Engineering from Stanford University, as well as his Ph.D. His research focuses on adaptive signal processing, acoustics and speech processing, engineering education, and technology in the music and entertainment industries. Scott was an Assistant Professor in the Department of Electrical Engineering at the University of Utah from 1992 to 1998. He has been with the Department of Electrical Engineering in the School of Engineering and Applied Science at SMU since August 1998. Dr. Douglas received the Hughes Masters Fellowship Award in 1988 and the NSF Graduate Fellowship Award in 1989. He was a recipient of the NSF CAREER Award in 1995. He is the author or co-author of eight book chapters and more than 180 articles in journals and conference proceedings.

Robyn Hartzell: With over 19 years of experience as an educator, Robyn Hartzell serves 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 11 years of teaching and coaching, Ms. Hartzell transitioned to the role of Consultant, then Program Coordinator for the second largest Educational Service Center in the state of Texas. While there, she developed and provided training for K-12 teachers and instructional coaches in public, private, and charter schools.

Paul Krueger: Paul Krueger received his B.S. in Mechanical Engineering in 1997 from the University of California at Berkeley. He received his M.S. in Aeronautics in 1998 and his Ph.D. in Aeronautics in 2001, both from the California Institute of Technology. In 2002 he joined the Mechanical Engineering Department in the Lyle School of Engineering where he is currently a Professor. He is a recipient of the Rolf D. Buhler Memorial Award in Aeronautics, the Richard Bruce Chapman Memorial Award for distinguished research in Hydrodynamics, the 2004 Faculty Early Career Development (CAREER) Award from the National Science Foundation, and the 2012 Ford Senior Research Fellowship. His research interests include unsteady hydrodynamics and aerodynamics, vortex dynamics, bio-fluid mechanics, bio-morphic propulsion, fluid-boundary and fluid particle interactions, and fluid processes in additive manufacturing (3D printing).

Katie Krummeck: Katie is the former director of the Deason Innovation Gym at the Lyle School of Engineering at SMU. Before directing the Deason Innovation Gym, Ms. Krummeck was working to implement design thinking in K-12 education at the Hasso Plattner Institute for Design (d.school) at Stanford University. At the d.school, Ms. Krummeck led the implementation of the SparkTruck project, a mobile makerspace for children. Mrs. Krummeck is now the Director of Programs for the Construct Foundation in Portland, Oregon.

Alain Mota: Alain is the STEM Development and Implementation Coordinator at RME. 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 in the form of classroom observations. This role is part of SMU's STEM Academy for Science Teachers & Leaders initiative, intended to increase student achievement in science, student interest in STEM and students' persistence in STEM coursework by supporting teachers' professional knowledge and skills, and campus administrators' instructional leadership skills.

Dara Rossi: Dara Rossi joined the faculty of Simmons School of Education & Human Development at SMU in 2010. She earned her Ph.D. from the University of North Texas with a major in Curriculum and Instruction and a minor in Educational Administration. Additionally, she holds a Master's degree in Science Education from the University of Texas at Dallas. Dr. Rossi is an experienced educator with a strong science background, including K-12 curriculum development and administration. Prior to coming to SMU, she taught undergraduate and graduate courses at the University of North Texas in secondary education. Her primary research interests concern the interconnectivity of STEM and teacher development.

Rob Rouse: 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, Dr. Rouse 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, Dr. Rouse taught high school chemistry for four years at a performing arts high school in New York City, as a member of the New York City Teaching Fellows. Dr. Rouse'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. Dr. Rouse's teaching focuses on two strands: (a) helping educators conceptualize the design of innovative STEM learning environments that integrate STEM disciplines and (b) supporting K–12 teachers implementing high-quality maker-based instruction.

Juan Torralba: Juan Torralba is currently a doctoral student at University of Miami. Juan began his Ph.D. in Teaching and Learning in STEM Education in August 2016. Juan received his Bachelor of Business Administration from University of North Texas in 2013 and received his M.Ed. from SMU in 2016. After completing his M.Ed, Mr. Torralba was a research assistant for Lyle School of Engineering's Deason Innovation Gym. At University of Miami, Juan is a graduate research assistant in the School of Education's STEM Department. His research focuses on building students' critical thinking and social-emotional skills through applied challenges that extend beyond the classroom.

Appendix B – Cohort 2 Academy I Evaluation Survey

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 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				
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				
8. The field trip to the Dallas Zoo:				

○ 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.				
9. The field trip to the Flight Museum: ○ 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.				
10. The field trip to the DART: ○ 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. The field trip to Talk STEM/Walk STEM: ○ 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				
12. I will share the knowledge I gained from the STEM Academy experiences with my colleagues.				

13. Speakers at the STEM Academy workshops delivered high-quality information about: o Project-based learning o Maker-based instruction o Social and emotional learning				
14. The STEM Academy was interactive.				

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

16. Which areas of the STEM Academy need improvement?

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