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Advancing STEM Teaching and Learning in Utah: An Evaluation of the STEM Action Center's Professional Learning Grant Program in the 2022-2023 School Year

THE UNIVERSITY OF UTAH
UTAH EDUCATION POLICY CENTER

Prepared by the Utah Education Policy Center
on behalf of the STEM Action Center

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THE UNIVERSITY OF UTAH

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Bridging Research, Policy, and Practice

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Executive Summary

The following key finding summarize the results of the 2022-23 evaluation and represent highlights related to the implementation of grant activities across participating schools and districts, the extent to which participants perceived that STEM professional learning activities offered through the grant led to the intended outcomes for participating educators and their students, as well as the role of STEM AC in supporting capacity building and the scaling of grant activities within participating schools and districts.

- **Key Finding #1:** The design of grant program activities in relation to their focus areas and grade-level targets are generally aligned with those of the educators who reported participating in grant activities during the 2022-23 academic year.
- **Key Finding #2:** Participants perceived the STEM professional learning communities (PLCs) that were supported by the grant to be well aligned to professional learning program expectations and practices for effective collaboration, particularly in relation to the ways in which PLCs promoted collective learning and collaboration that was improvement-focused and responsive to contextual factors as well as individual preferences, needs, and expertise.
- **Key Finding #3:** Participating educators felt as though participating in STEM professional learning experiences through the grant had the most positive impacts on their STEM identity and instructional skills, with many educators expressing excitement to be engaging in this work and reporting success in implementation and shifts in practice.
- **Key Finding #4:** Although more educators reported engaging in video-based reflection as a part of grant activities than using TeachFX, preliminary data suggests that not only did educators find this tool accessible and useful, but also that positive impacts were observed in relation to target educator outcomes for those who utilized this tool at least once per month, particularly in relation to STEM integration & planning and instructional skills.
- **Key Finding #5:** Participation in STEM professional learning activities was perceived to positively impact students' interest, confidence, and academic achievement in STEM areas; however, there are opportunities for grant programs to focus on how they might be able to leverage their knowledge and skills from these experiences to promote the STEM identities of their students.
- **Key Finding #6:** Findings suggest that the STEM Action Center effectively engages with grant administrators at the project sites to build capacity in STEM professional learning and to support the expansion of these activities at schools and districts; however, participating educators are often unaware of the involvement of STEM AC in these efforts.

Based on these findings, the UEPC evaluation team identified program considerations to inform the 2023-2024 STEM Action Center Professional Learning Grant Program. The considerations expand on the evaluation findings by offering clear, actionable steps that STEM AC might consider for the design and implementation of the next round of grant programs to promote quality implementation and program efficacy. The considerations are summarized below, with a more detailed explanation provided in the final section of this report.

- **Consideration #1:** Continue to offer optional STEM professional learning experiences that are aligned with the existing continuous improvement efforts, educational priorities, and values of educators, schools, and districts participating in the grant program.
- **Consideration #2:** Bring renewed focus to development of shared understandings of what effective STEM professional learning, planning, and integration looks like within participating

schools and districts as well as how to set aside more time for collaboration and further development of educators' abilities to plan and implement lessons that are responsive to diverse student learning needs and interests and promote student STEM identity.

- **Consideration #3:** Additional reflection should be given to the ways in which the STEM Action Center can continue to leverage their position as an intermediary in ways that strengthen networking opportunities across sites, provide more direct supports and resources to educators who are benefiting from the funding and resources provided through the grant, and facilitate the collection and reporting of more detailed and nuanced information about the implementation and effectiveness of particular features of STEM professional learning activities across partner schools and districts.

Introduction

Professional Learning Grant Program Overview

The STEM Professional Learning Grant program with the STEM Action Center (STEM AC) was established in July 2014, and awards funds to local education agencies (LEAs) to support STEM-focused professional learning activities that address local priorities and needs related to STEM education. Historically, LEAs have received between one- to three-year awards to support STEM-focused professional learning activities (e.g., off-contract work time; professional learning workshops on STEM content knowledge and instructional practices; mentoring and coaching experiences; and engagement in professional learning communities (PLCs)).

The Utah Education Policy Center (UEPC) team has partnered with STEM AC to support their ongoing evaluation efforts and promote continuous improvement as they collaborate with local schools and organizations to meet their goals since 2016. This year's evaluation focuses on the implementation and outcomes of this grant during the final year of a three-year grant cycle, which kicked off during the 2020-21 academic year (AY). During this time, STEM AC continued to support 31 projects across 16 districts.

STEM AC PL grant activities for this funding cycle were organized around three core grant focus areas:

- Professional learning opportunities (e.g., workshops and professional learning series designed to improve educators' STEM content knowledge, pedagogical content knowledge, and instructional practices),
- STEM Professional Learning Communities (PLCs), and
- Activities supporting STEM planning and integration.

The STEM AC Professional Learning program promotes building educators' STEM content and pedagogical knowledge to support STEM planning and integration as well as to increase educator outcomes (e.g., STEM knowledge, STEM teaching self-efficacy, and confidence; STEM identity) and student outcomes (e.g., STEM achievement, interest, confidence, engagement, understanding/knowledge, and identity development).

A notable development this year was STEM AC's allocation of funds to purchase licenses for a new professional learning tool, TeachFX. TeachFX is an app-based professional development tool that records and analyzes lesson audio to identify patterns in discourse and engagement to provide educators with data and specific, automated instructional feedback to guide reflective practice and instructional changes to promote student discourse (Gerwertz, 2019; TeachFX, n.d.).

This year's evaluation utilized UEPC surveys from prior years' evaluations (i.e., UEPC STEM Educator Professional Learning Survey and Educator Collaboration Self-Assessment Survey) as well as focus groups in participating schools and districts to better understand both how grantees leveraged grant funds to support STEM professional learning and the impacts of grant activities. The evaluation questions guiding this study remained largely consistent with those of the prior two evaluations conducted during this three-year grant cycle, with some additions based on the introduction of TeachFX as another professional learning tool. As such, the evaluation questions for the 2022-23 evaluation of STEM Action Center's Professional Learning Grant were as follows:

- How is STEM Professional Learning implemented across LEAs?

    - In particular, how do STEM professional learning communities adhere to professional learning program expectations and promote effective collaboration?
- What are the outcomes of teachers who participate in STEM Professional Learning?
    - In particular, are there any notable differences in outcomes between those who utilize different professional learning tools (e.g., video-based self-reflection, video-based peer reflection, TeachFX)?
- How do participating educators believe their STEM professional learning experiences impact their students?
- How and in what ways do grant administrators and educators at participating grant projects perceive STEM Action Center as an intermediary in facilitating and/or supporting STEM professional learning?
    - In particular, to what extent do grant administrators report STEM AC has built the capacity and practice of participants across sites and supported the scaling of STEM professional learning efforts?

Relevant Literature

Over the last few decades, the promise of global competitiveness, economic development, and enhanced societal living standards have placed international attention on the quality of science, technology, math, and engineering (STEM) education (Carnevale et al., 2011; Xie et al., 2015). Notably, student performance in STEM, particularly mathematics, in the United States continues to be lower than their international peers (National Science Board, National Science Foundation, 2019).

As attention to STEM education has grown alongside research on best practices in science learning and teaching, educators and policymakers in the United States have taken strides to advance STEM standards and develop consensus about what constitutes quality STEM education. More specifically, the National Research Council developed a Framework for K-12 Science Education in 2012 and recommended that K-12 science education be centered around three core dimensions (i.e., scientific and engineering practices, crosscutting concepts, and core disciplinary ideas), setting the groundwork for the creation of the Next Generation Science Standards (NGSS) (NGSS Lead States, 2013). By incorporating both scientific principles and engineering practices, the NGSS standards aim to foster inquiry-based learning and cultivate critical thinking abilities among students and require educators to assume new ways of learning and teaching STEM. Many states, including Utah, used these national standards as a foundation for the development of their own, state-specific standards. In Utah, the Utah State Board of Education (USBE) created the Utah K-12 Science with Engineering Education (SEEd) Standards in 2015 to establish a unified and comprehensive structure for science education in the state. Schools throughout Utah were required to adopt the SEEd standards for Grades 6-8 in December 2015 and for Grades K-2, 3-5, and high school (i.e., biology, chemistry, earth and space science, and physics) in June 2019 (USBE, 2015).

STEM education continues to be a key priority for educators and policymakers. Despite its prominence and centrality in discussions of workforce and economic competitiveness, STEM education quality remains somewhat illusive. One of the main challenges in improving STEM education has been the preparation and training of STEM teachers, particularly the concerns about their content-specific expertise and STEM pedagogical content knowledge. Prior studies have shown that K-12 STEM educators often lack STEM subject area degrees (Hossain & Robinson, 2012; Leyzberg & Moretti, 2017; Swars et al., 2016) and sufficient content knowledge to effectively engage their students in these subject areas (Berry III et al., 2014; Jensen et al., 2016a), let alone cross-disciplinary or integrative STEM learning opportunities. However, there is evidence that educators who participate in effective STEM professional learning are better able to improve and sustain their students' learning, achievement, and

interest in STEM subjects (Capraro et al., 2016; Estapa & Tank, 2017; Fulton & Britton, 2011; Jensen et al., 2016a).
In relation to what constitutes effective professional learning, several studies highlight the importance of STEM professional development focusing on supporting educators to create authentic STEM learning experiences for their students (Fulton & Britton, 2011; Rogers et al., 2016), increasing their knowledge of STEM careers (Burrows, 2015; Chiyaka et al., 2017; Fulton & Britton, 2011; Nadelson et al., 2013; Nathan et al., 2011; Webb, 2015). Furthermore, an additional review of the literature suggests the importance of addressing other factors (e.g., teacher attitudes and beliefs, professional learning in specific content and curriculum, promoting coherence with their everyday work practices and overarching learning goals, as well as engaging educators in active learning experiences, collaboration, and coaching) to improve STEM teaching and learning (Darling-Hammond et al., 2017; Desimone, 2009; Gardner, Glassmeyer, & Worthy, 2019; Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010; Thiele & Bogdon, 2022). Recent studies have examined specific features and components of effective professional learning, including the importance of coupling STEM professional development with curriculum and embedding content-focused pedagogical training (Hasim, Rosli, Halim, Capraro, & Capraro, 2022; Lynch, Hill, Gonzalez & Pollard, 2019; Zhou, Shu, Xu, & Padron, 2023).

Although content and pedagogical knowledge are important, research has also demonstrated that STEM educators' teaching self-efficacy was an important factor in promoting changes in instructional practices and promoting student outcomes and, as such, it emerged as one of the primary outcome measures in this area of research (Gardner et al., 2019; Hasim et al., 2022; Havice, Havice, Waugaman, & Walker, 2018; Kasakak & Dagyar, 2020; Kelley et al., 2017; Wenner, 1995; Zhou et al., 2023). One recent meta-analysis byZhou et al. (2023), drew upon Bandura's Social Cognitive Theory (1977, 1997) and suggested four various avenues through which STEM PD can impact STEM educators' self-efficacy: facilitating mastery experiences (e.g., personal achievements, successful experiences, task mastery), providing vicarious experiences (e.g., observational learning, modeling), leveraging social persuasion (e.g., encouragement, positive feedback, affirmation), and being attentive to educators emotions and how their perception and appraisal of their emotional states and ability to regulate their emotions to reduce anxiety and fear can influence their self-efficacy beliefs. Results of this study suggest that there are no significant differences in STEM educators' teaching self-efficacy based on which source of self-efficacy was targeted during STEM professional development. As a result, the authors cautiously suggest employing "multi-faceted PD [professional development] designs" (p.14) that target various sources of self-efficacy simultaneously.

As noted in last year's report, the COVID-19 pandemic has transformed the role of technology in education, including the context how STEM professional development is being rolled out (Brown, Correll, & Stormer, 2021). Thus far, research suggests mixed results concerning the effectiveness of online STEM professional learning opportunities. Given the impact of the pandemic on teacher turnover and challenges related to finding and retaining qualified educators (Zamarro, Camp, Fuchsman, & McGee, 2021), some research has suggested that the teaching self-efficacy of STEM teachers is an important factor in these educators' job satisfaction and desire to continue teaching (Kasakak & Dagyar, 2020). Although research in this area is still developing, it is important to consider how and in what ways STEM professional learning can be leveraged and contribute to educators' overall job satisfaction and the retention of highly-qualified STEM educators who are capable of meeting the tall task of transforming STEM education throughout the nation.

Methods

Evaluation Questions

This UEPC evaluation used both quantitative and qualitative data from surveys and focus groups with participants from across partner sites to address the evaluation questions guiding this study. Table 1 contains a summary of our evaluation questions as well as data sources. Additional information about data sources and data collection methods will be discussed in subsequent sections.

Table 1. Evaluation questions and data sources

Evaluation Questions	Data Sources			
	UEPC STEM Professional Learning Survey			Focus Groups
	Collaborative Self-Assessment	Administrator Items	Educator Items	
Program Implementation				
How is STEM Professional Learning implemented across LEAs? • In particular, how do STEM professional learning communities adhere to professional learning program expectations and promote effective collaboration?	✓	✓	✓	✓
STEM Educator and Student Outcomes				
How do educators feel their participation in STEM professional learning has impacted their STEM teaching self-efficacy, knowledge, identity, instructional skills, and ability to plan and integrate STEM content in practice? • In particular, are there any notable differences in outcomes between those who utilize different professional learning tools (e.g., video-based self-reflection, video-based peer reflection, TeachFX)?			✓	✓
How do participating educators believe their STEM professional learning experiences impact their students			✓	✓
STEM Action Center as an Intermediary				
How and in what ways do grant administrators and educators at participating grant projects perceive STEM Action Center as an intermediary in facilitating and/or supporting STEM professional learning? • In particular, to what extent do site grant administrators report STEM AC has built the capacity and practice of participants across sites and supported the scaling of STEM professional learning efforts?		✓	✓	✓

Data Sources & Analysis

Data were collected to address the evaluation questions using instruments designed by the Utah Education Policy Center (UEPC). These instruments included the annual professional learning survey and site-specific focus groups with grant partners. Both survey data and focus group data were used to address all evaluation questions. In the following subsections, we describe each data source in more detail as well as how data sources were analyzed to answer the evaluation questions.

UEPC STEM Professional Learning Survey

Overview. There were three main sections of the UEPC Professional Learning survey for this evaluation: (1) Collaborative Self-Assessment (CSA), which was administered to all respondents, (2) items administered only to grant program administrators (i.e., grant program leadership), (3) and items administered to educators (i.e., teachers and coaches) at participating schools and districts. Table 2 provides an overview of the topics covered in each of these survey sections.

Table 2. Focus of items on the UEPC Professional Learning Survey, by survey section

Collaborative Self-Assessment	Grant Administrator Items

• Capacity Building
• Empowerment
• Intentional
• Improvement Focused
• Inquiry Based
• Collective Responsibility
	• STEM Professional Learning Participation
	• STEM Action Center as an Intermediary Organization
	    ○ Building Capacity & Practice
	    ○ Supporting Scaling Up Professional Learning

Educator Items	

• Professional Background & PL Engagement
• Demographics
• Specific PL Activities & Tools
    ○ Video-based self-reflection
    ○ Video-based peer-reflection
    ○ TeachFX
• STEM Instructional & Planning Time
• Adherence of STEM Professional Learning Communities to Professional Learning Program Expectations
    ○ Shared Values & Vision
    ○ Collective Learning
    ○ Coaching & Shared Practice
    ○ Relational Conditions
    ○ Supportive & Involved Leadership
    ○ Consistency & Duration
    ○ Adherence to Adult Learning Principles
    ○ Theories of Action
	• Impact on Educator Outcomes
	    ○ STEM Teaching Self-efficacy & Confidence
	    ○ STEM Knowledge
	    ○ STEM Identity
	    ○ STEM Instructional Skills
	    ○ Planning & Integration of STEM Content
	    ○ Teaching Satisfaction
	• Perceived Impact on Student Outcomes
	    ○ STEM Cognitive & Emotional Interest
	    ○ STEM Engagement
	    ○ STEM Confidence
	    ○ STEM Identity
	    ○ STEM Achievement
	• Educator Feedback:
	    ○ Perceived Successes & Challenges
	    ○ Needs & Suggestions

The UEPC Collaboration Self-Assessment. The CSA, which is a validated instrument, was designed to measure changes in collaboration practices over the course of the school year in six domains of effective collaboration: capacity building, empowerment, intentional, improvement-focused, inquiry-based, and collective responsibility. Each domain included seven to ten survey items. Educators and grant administrators were asked to rate the extent to which the collaboration practice was present in their STEM professional learning community, using a five-point scale ranging from "not at all" to "extremely." In open-ended items, respondents were also asked to share what they perceived to be the greatest collaboration strengths in their PLCs as well as ways in which collaboration could be strengthened to improve student outcomes.

Grant Administrator Items. The first set of items for grant project administrators asked them to report on STEM professional learning participation at their site (i.e., STEM focus area(s), participating grade levels, estimated educator engagement in specific PL activities, and use of tools). Then, grant administrators were asked to rate items related to their perceptions of the role of STEM AC as an intermediary. More specifically, they were asked to rate five items related to how STEM AC built the capacity and practices of participants at their grant program and four items related to how the center supported the scaling of professional learning activities at their site. Responses to these items were on the following five-point rating scale: (1) Not at All, (2) To a Small Extent, (3) To a Moderate Extent, (4) To A Large Extent, and (5) To a Very Large Extent. The final set of items for grant administrators asked them to provide comments about the successes and challenges they have experienced this year in relation to the professional learning grant program as well as any additional resources they need or suggestion they have related to the grant.

Educator Items. These items for educators asked respondents to provide information about their professional backgrounds and professional learning engagement, STEM planning and instructional practices, the attributes of the STEM professional learning communities they participated in, as well as their perceptions of the impact of STEM professional learning on their outcomes and those of their students. Furthermore, educators were asked to provide comments about the successes and challenges they have experienced this year in relation to the professional learning grant program, any additional resources they need or suggestion they have related to the grant, and actionable feedback they would like to provide for consideration.

Survey Distribution. The survey was administered between April 26th and May 25th. In an effort to be responsive to the requests of partner schools and districts, this year's survey was administered with the assistance of grant administrators. Specifically, grant administrators were provided with an anonymous link that they could use to participate in the survey and that they were then asked to distribute to educators at their grant program (i.e., school or district) who had participated in the Professional Learning grant during the 2022-23 academic year. To better understand response rates, grant administrators at participating schools and districts were also asked to provide STEM AC with lists of participating educators so that the number of educators in each sampling frame could be used to estimate the response rate. In total, 986 of 4,224 or 23.1% of the educators and administrators identified by partner schools and districts responded to the survey. A notable limitation of this distribution method is the inability to determine how many surveys were delivered to or opened by individuals across grant programs or account for potential duplications in the target lists across grant programs within a single district. In relation to the latter, the potential for duplications in the target list would suggest that the response rate is higher than the estimated 23.1%, which itself was a 4.6% increase from the 18.5% response rate last year. However, going forward, we recommend returning to the centralized distribution method used for prior reports, which would allow more accurate estimates of response rates and will open up discussions with grant administrators about concerns that might have led to their desire to distribute these surveys themselves.

Data Analysis. Analysis of the items on the survey included the generation and interpretation of descriptive summary statistics to identify common trends in responses across topics. When appropriate, statistical analyses (i.e., repeated measures Analysis of Variance (ANOVA) and pairwise comparisons, independent t-tests) were conducted to test for differences across item groups (e.g., comparing responses across factors within surveys) and respondent groups (e.g., groups of respondents who reported using TeachFX versus those who did not). Furthermore, qualitative data from open-ended survey responses are presented by theme and subthemes. We also include quotes provided by educators and grant administrators to provide examples of how participants described their experiences related to grant implementation and outcomes as well as their perceptions of the program successes, challenges, and suggestions for improvement.

Participant Demographics. Of the 977 valid survey respondents from individuals across participating schools and districts, 20 individuals or 2% self-identified as grant administrators, 923 or 94% self-identified as educators, and 34 or 3% self-identified as "other." However, further review of the role descriptions provided by those who selected "other" showed that all of the individuals who provided additional descriptions of their roles indicated that they were an instructional coach, teacher lead, mentor teacher, or facilitator. Due to their instructional support role, these individuals were re-categorized as educators for the purposes of this report. Furthermore, of the 17 school districts with Professional Learning projects funded by STEM AC during the 2022-23 AY, 10 or 58.8% of the schools or districts had administrators participate in the survey, and 16 or 94% of the grant programs had educators participate in the survey. However, as shown in Table 3, there were considerable differences in the proportion of respondents from each participating district. As such, it is important to acknowledge the limitations of survey results in relation to the generalizability of the findings to the experiences of those across all participating programs, particularly when the majority of survey respondents were from the two largest districts participating in the grant program (i.e., Alpine and Davis School Districts). However, to provide a more balanced and nuanced understanding of the experiences of participants across all grant projects, the evaluation team was attentive to representation of participants across as many schools or districts as possible when providing representative quotes from open-ended responses on the survey. To maintain confidentiality in responses, school districts are not identified with quotes.

Table 3. UEPC STEM Educator Survey participants by school or district

	Administrators		Educators		All Respondents	
School District or Site	#	%	#	%	#	%
Alpine School District	3	15%	365	38%	368	38%
Beehive Academy	3	15%	16	2%	19	2%
Cache County School District	1	5%	28	3%	29	3%
Canyons School District	0	0%	10	1%	10	1%
Davis School District	4	20%	141	15%	145	15%
Iron County School District	1	5%	64	7%	65	7%
Jordan School District	2	10%	57	6%	59	6%
Juab School District	0	0%	3	0%	3	0%
Mountainville Academy	1	5%	15	2%	16	2%
Murray City School District	2	10%	90	9%	92	9%
Nebo School District	0	0%	12	1%	12	1%
Provo City School District	1	5%	52	5%	53	5%
Salt Lake City School District	0	0%	44	5%	44	5%
South Sanpete School District	0	0%	3	0%	3	0%
San Juan School District	0	0%	0	0%	0	0%
Washington County School District	0	0%	51	5%	51	5%
Weilenmann School of Discovery	2	10%	6	1%	8	1%
Total	**20**	**100%**	**957**	**100%**	**977**	**100%**

The following tables and figures show the demographics of the educators who completed the survey. As this data shows, a large proportion of the respondents were female (85.1%), and the majority were White (92.0%). In relation to years of experience, none of the respondents had been teaching for less than a year, and about half had been teaching for at least 10 years (Figure 1).

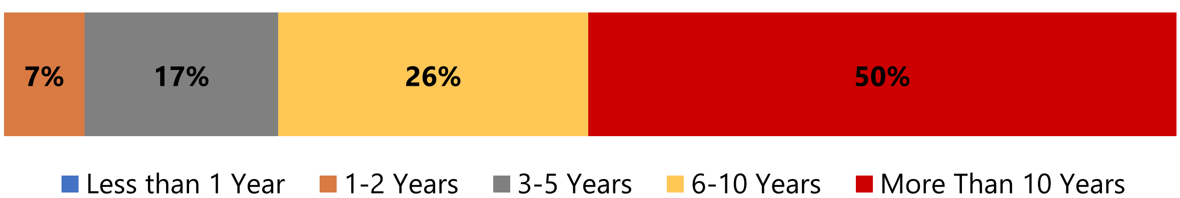
Table 4. Educator survey participants by gender

Gender	Percent
Female	85.1%
Male	11.3%
Prefer Not to Say	3.4%
Non-binary	0.1%

Table 5. Educator survey participants by race/ethnicity

Race/ Ethnicity	Percent
White	92.0%
Hispanic/Latino	3.2%
Asian	1.8%
Multi Race	1.0%
Pacific Islander	0.1%

Figure 1. Educator survey participants' years of teaching experience



Focus Groups

Purpose. The 2022-2023 evaluation included focus groups with district- and school-level staff from across a sample of grant programs. The purposes of these focus groups were to better understand how STEM Action Center's Professional Learning Grant program was implemented and impacted participants across grant programs that had previously shown above-average outcomes on UEPC STEM Professional Learning at the end of the prior academic year (i.e., during the Spring 2022 administration of the educator survey). Initially, these focus groups were designed to be one of the primary data collection methods for planned case studies that were intended to provide detailed accounts of promising practices related to three core areas as sites implement and scale up their grant activities. More specifically, the goal was to construct cases on each of the following grant activity areas: (1) the STEM professional learning opportunities offered through the program, (2) the functioning of STEM professional learning communities (PLCs), and (3) how grant activities support STEM integration and planning. However, analysis of focus groups data indicated that these three areas were integrated and interrelated in ways that made it necessary to understand them in relation to one another and made it impossible to disentangle the three grant emphasis areas. As such, the decision was made to pivot from cases focused on each of these three areas to seeking a more general understanding of how these three focus areas play out within particular grant programs, which we will refer to throughout this report as instrumental case sites.

Sample Selection. Since the initial goal of the focus groups was to inform the case studies about promising practices across grant programs and within the three PL areas, a purposeful sample of the PL sites was invited for study participation. Specifically, sites were sampled according to the estimated intensity (Miles & Huberman, 1994) or extent to which core program features had been implemented across sites, as determined by responses to the Spring 2022 UEPC STEM Professional Learning survey, which had the same contents as this year's survey. The study plan included identifying what Patton (2001) refers to as critical cases or sites that were most likely to "…yield the most information and have the greatest impact on the development of knowledge" (p. 236). In accordance with this sampling strategy, outcomes related to the three program foci (i.e., PL opportunities, PLCs functioning, and STEM planning and integration) from the Spring 2022 evaluation were reviewed to identify cases where key program features are enacted more strongly in relation to other sites but were not extreme or particularly unusual.

To select sites for participation, composite ratings were created from items on the Spring 2022 educator survey to create indices for each of these areas and overall educator outcomes. These indices were then compared across sites to identify cases where their index related to educator outcomes and at least one of these features was above average. Additional details about the selection procedure are included in Appendix A. In total, 13 grant programs across 11 school districts and sites (approximately 65% of the districts or sites) were identified for study recruitment. Within this sample, nine grant programs were identified. Since buy-in and access are essential in case studies, an additional layer of chain sampling was utilized such that the initial recruitment list was then shared with the PL grant program director at STEM Action Center to determine if the programs selected would be information-rich, insightful, and would likely have sufficient buy-in from educators and administrators at the sites. After this review, four sites were excluded from the sampling frame for one of the following reasons: they no longer participated in the grant, their project had been combined with another at their site, or because they were not expected to yield sufficient information. As a result, the final sample for focus groups included eight grant programs, which represented seven or 41% of the 17 grant sites (i.e., school districts or charters) with at least one PL grant program during the 2022-23 academic year.

Recruitment. The primary contacts for each grant program identified to participate were emailed by UEPC staff in late February to request their assistance in identifying participants for the focus groups. More specifically, they were asked to provide the UEPC with names and contact information for five to ten educators and/or administrators at their site who had been highly involved in the grant activity areas that their program was identified as having above average outcomes for professional learning opportunities (e.g., workshops and professional learning series designed to improve educators STEM content knowledge, pedagogical content knowledge, and instructional practices), the functioning of STEM Professional Learning Communities (PLCs), and/or activities supporting STEM planning and integration. In total, 74 educator contacts were provided across six of the nine grant programs that were targeted for inclusion. Most of these individual participants who were recruited for the focus groups were asked to participate in one session (N=54 or 73%), though some were identified for multiple focus groups (N=20 or 27%) based on the nature of their involvement in STEM professional learning grant opportunities, PLCs, and STEM integration and planning at their school or district. The evaluation team then used this information to send individual focus group invitations and scheduling information to potential participants via email.

Data Collection Procedures. Nine focus groups were successfully conducted in late March and April, representing four unique districts. (See Participant Information section for additional details.) Each focus group or interview included between one to six participants and ranged from approximately 40 minutes to an hour and a half. While focus groups were intended to include at least three participants and between three and 17 individuals were invited to each, the actual number of participants ranged from one to six individuals, and the majority or two-thirds of the sessions had fewer than three educators who were able to attend. All focus groups were conducted virtually via Zoom, and each was recorded and transcribed for analysis. One site combined their focus groups so that both protocols were covered during a single session with the same group of individuals. Although it was expected that these three core features could be discussed in isolation, upon completing the first few sessions, it became apparent that, in practice, these features of the PL program were intertwined such that conversations about one topic naturally included other focus areas. For this reason, the decision was made to pivot from constructing cases related to these three focus areas.

Instrumentation. Three semi-structured focus group protocols were developed for these interviews, one aligning with the three grant focus areas. Which protocol was used depended on which core grant activity area the site was identified for. Details about each of these protocols are outlined in Table 6 below.

Table 6. Details of focus group protocols by grant focus area

Focus Group	Topic list
STEM Professional Learning Communities (PLC)	• Differences between PLC's and other collaborations • PLC organization and the role of others (e.g., administrators, support staff) • Changes, challenges and successes of PLC's over time • Promotion of collaboration and distributed leadership in PLC's STEM needs and Professional Learning during PLC's • Discussions of STEM related topics and integration of STEM topics because of participating in a PLC • Best practices and impact of PLCs in the school • Support of STEM Action Center in the STEM PLC's
STEM Professional Learning (PL) Opportunities	• Changes in relation to PL opportunities • Impact of PL opportunities on students and educators • Support of STEM Action Center in identification and implementation of PL opportunities
STEM Planning and Integration	• Integration of STEM in different content areas and disciplines • What works for STEM Integration and Planning • Process description, from ideas to practice • Changes and successes in integrating and planning for STEM • Collaborations with others to integrate and plan for STEM • Impact of STEM Planning and Integration on students and educators • Engagement of educators in STEM Planning and Integration

Data Analysis. Analysis involved the use of open coding to generate themes derived from the topics and issues mentioned by participants during these sessions (Saldaña, 2016). Throughout the report, discussions of key qualitative findings are integrated with the survey findings to provide more context and meaning for interpretation. Furthermore, quotes included provide examples of how participants described their experiences participating in professional learning activities through the grant and the impacts they perceived on targeted outcomes.

Participant Information. In total, 32 individuals from four school districts participated in the focus groups and interviews. As shown in Table 7, the majority of the participants (78%) were teachers, with 56% of participants reporting that they were classroom teachers and 22% reporting that they were classroom teachers who also served in a leadership capacity (e.g., content or grade-level lead for the district, STEM lead). The remaining participants were district-level specialists (i.e., Elementary Math &

Science Specialists) and school-level leadership (i.e., instructional coaches and principals). Although the intention was to gather the perspectives of individuals in various roles from across the nine districts identified for inclusion, challenges with outreach as well as the logistics of scheduling these sessions, led to notable limitations in relation to representation across all identified sites. More specifically, only about 38% of the 74 individuals identified by site leadership for inclusion in these sessions ended up participating in at least one focus group. Furthermore, as is shown in Table 8, there was a considerably higher proportion of focus group participants from Davis School District (59%) in comparison to the other sites. Davis was one of the larger school districts participating in the PL grant program and two of their grant programs were identified for inclusion in the target sample based on the criteria outlined above.

Table 7. Focus group participants by professional title or position

	Focus Group Participants	
School District or Site	#	%
District-level Specialist	5	16%
Principal	1	3%
Instructional Coach	1	3%
Teacher Leader	7	22%
Teacher	18	56%

Table 8. Focus group participants by district or site

	Focus Group Participants	
School District or Site	#	%
Alpine School District	6	19%
Davis School District	19	59%
Mountainville Academy	5	16%
Washington County SD	2	6%

When interpreting the results from the focus groups, it is important to do so with the recognition that the participating sites and educators are small subsets of individuals from a specific subset of sites that were selected based on prior data about the extent to which core program features had been implemented and the recommendation of the PL grant program lead due to how the site was expected to be information-rich on core grant activities. As such, these data are not generalizable to all experiences across participating sites. Instead, the information from these sites is intended to provide additional context and examples about how key features and outcomes are perceived through the vantage points of sites that have previously shown evidence of progress in relation to the three grant activity areas: PL opportunities, PLCs, and STEM planning and integration activities. To maintain confidentiality in responses, school districts are not identified with quotes.

Findings: Program Implementation

Data from the UEPC STEM Professional Learning Survey with all PL grantees, focus group sessions with participants from instrumental case sites, and open-ended responses on surveys from both the instrumental case sites and other grant programs were analyzed to provide information about program implementation. Specifically, educator and administrator responses to the survey were analyzed to construct descriptive statistics about the focus of professional learning activities (i.e., STEM content focus areas and grade level spans), the content areas and grade levels taught by participating educators, as well as engagement in professional learning using TeachFX and through video-based self- and peer-reflection across grant programs. Furthermore, educator responses to the subset of survey items related to the professional learning program expectations were analyzed to investigate the extent to which program activities within the professional learning communities established across sites aligned with these standards. Finally, survey responses to UEPC's Collaborative-Self Assessment (CSA) were also analyzed and included in the report of findings. Comments from focus groups and open-ended survey responses related to these standards were included as a part of these findings to provide examples and additional insight into how STEM professional learning communities across sites promoted effective collaboration and aligned or diverged from the professional learning program expectations.

The Focus of Professional Learning Activities Across Grant Programs

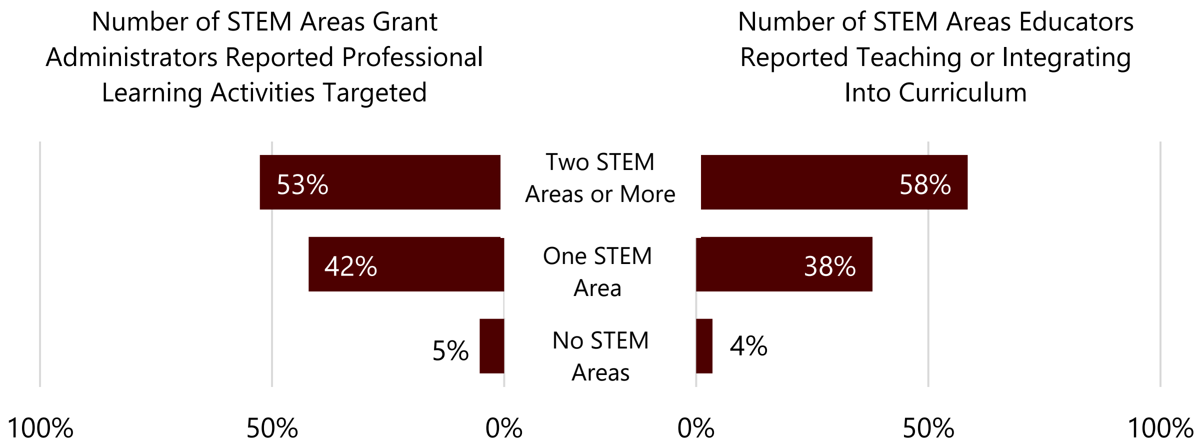
In order to better understand the focus of professional learning activities across sites, we analyzed grant administrator reports about the focus of their professional learning grant (i.e., STEM content focus areas and grade level spans) at their grant program, the content areas and grade levels taught by participating educators, and usage rates for specific professional learning tools or platforms (i.e., Self- and Peer-Based Video Reflection, TeachFX). Additional details are provided in the following sections.

STEM Content Focus Areas

In relation to the content area or disciplinary focus of the professional learning grant activities, administrators were asked to indicate whether grant activities at their site focused on science, technology, engineering, mathematics, or none of these areas. Because some sites had multiple focus areas, respondents were able to select as many as were applicable. Similar questions were asked of educators about which STEM-content areas they taught or integrated into their curriculum. Figure 2 shows the number of STEM areas targeted by professional learning grant activities according to the sample of administrators alongside the STEM areas educators reported teaching or integrating into their curriculum.

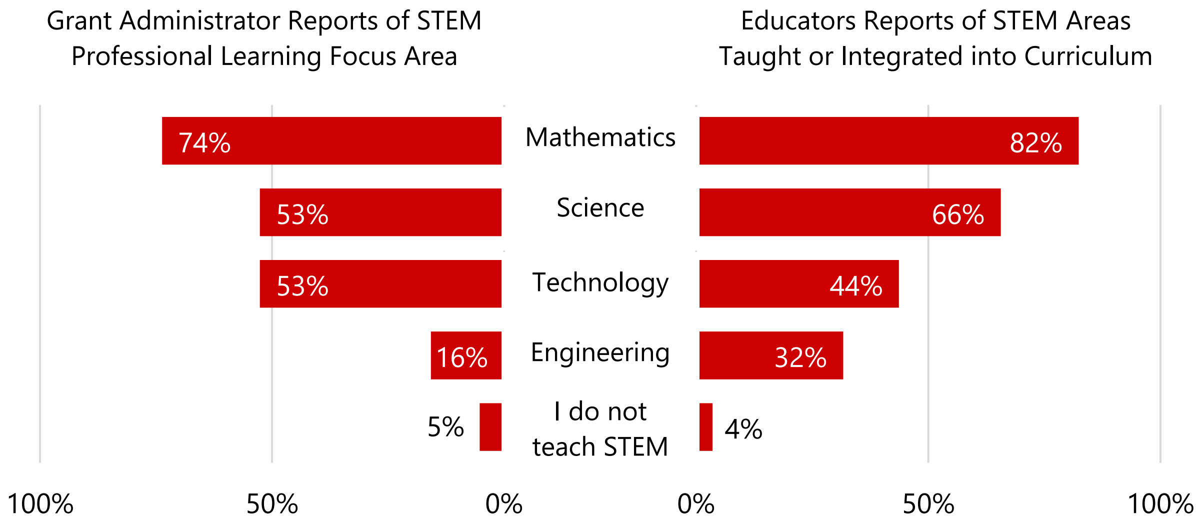
As Figure 2 shows, administrators reported that more grant-related STEM professional learning activities within their grant programs focused on two or more STEM focus areas (53%) than one specific area or subject. A similar percentage of educators reported teaching or integrating multiple STEM subject areas (58%). Similar proportions were also found in relation to how many educators reported teaching or focusing on one STEM subject area (38%), and administrators reporting that their grant program focused their professional learning activities on only one STEM-related content area. Another interesting finding was that a small percentage (4%) of educators who indicated that they participated in STEM professional learning (PL) this academic school year also indicated that they did not teach STEM. Additional data about why educators might be responding in this way would need to be collected to adequately explain this finding. However, it is promising that more teachers are engaging in STEM professional learning.

Figure 2. Number of STEM focus areas grant administrators report are targeted by grant programs compared to educator reports of the number of STEM areas they teach and integrate into curriculum



In addition to investigating how many STEM areas site administrators and educators reported focusing on, we also investigated *which* subject areas were the focus of the grant professional learning activities and educators' professional practice. Figure 3 shows grant administrator reports of the STEM areas where sites offered professional learning related to STEM teaching or integration as a part of the STEM Action Center professional learning grant alongside all STEM areas that educators reported currently teaching or integrating into their curriculum. A comparison of these percentages suggests that the focus areas of professional learning activities were similar to the STEM areas that educators teach and integrate into their curriculum, particularly in relation to mathematics, science, and technology. However, there were some notable differences. Specifically, a higher percentage of educators reported teaching or integrating engineering practices into their curriculum (32%), despite only 16% of grant administrators reporting that this content area was a focus of grant-related STEM professional learning activities at their site.

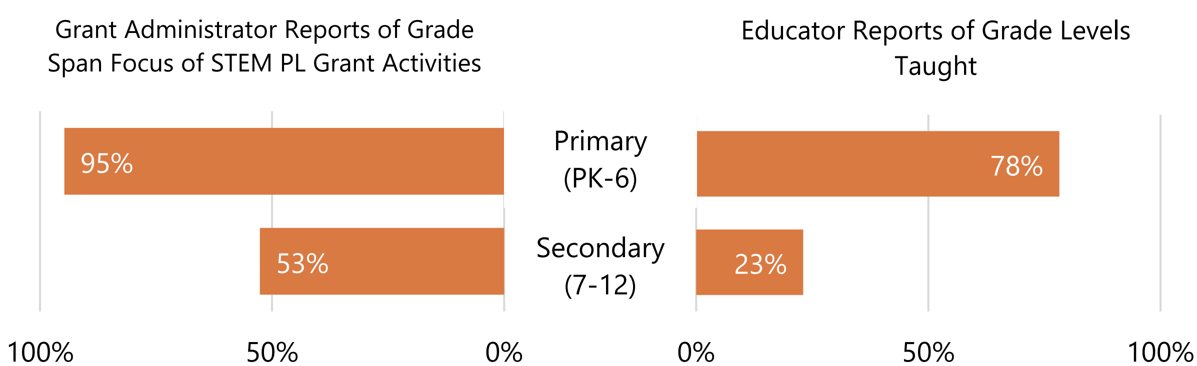
Figure 3. STEM focus areas grant administrators report are targeted by grant activities compared to educator reports of the STEM areas they teach or integrate into curriculum



Grade Level Focus of Professional Learning Activities

Further analysis of grant administrator and educator reports of the grade level focus of STEM professional learning activities shows some interesting patterns in relation to the grade spans focused on by grant programs and the grade levels taught by participating educators. As Figure 4 shows, grant administrator reports indicate that the vast majority of professional learning activities have focused on supporting quality STEM education in primary grades (i.e., Pre-K through sixth grade). Still, survey responses show that a sizable percentage (53%) of grant programs are focusing on secondary STEM education (i.e., grades 7-12). The focus across sites on leveraging grant funds to build the capacity of elementary educators resulted in a higher percentage of educators who reported teaching at least one primary grade level (i.e., PK-6) participating in grant-related activities (78%) than those who reported teaching at least one secondary grade level (i.e., grades 7-12).

Figure 4. Grade span focus of STEM professional learning activities according to grant administrators compared to educator reports of grade levels taught

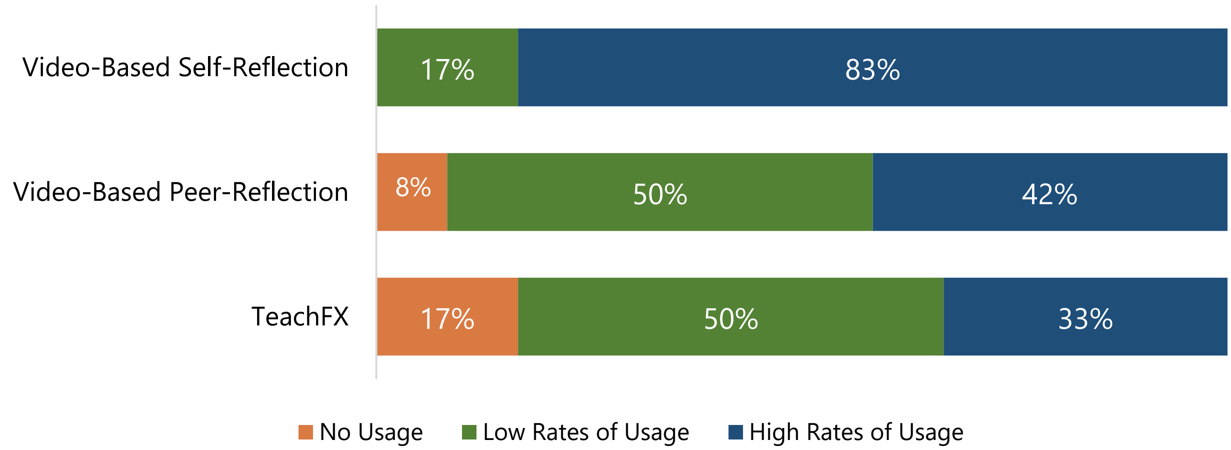


Engagement in Video-based Self- and Peer-reflection, and TeachFX

In addition to analyzing grant administrator and educator reports of the focus of STEM professional learning activities in content areas and grade levels, we also analyzed engagement of educators in specific professional learning activities to gain a better understanding of how grant activities have been implemented across sites. As previously mentioned, some grantees used TeachFX, which is an app-based professional development tool that educators can use to record and analyze the audio of their lessons to reflect on patterns in their classroom discourse and engagement to inform instructional changes aimed at promoting student discourse (Gerwertz, 2019; TeachFX, n.d.). This year STEM AC purchased licenses to TeachFX. These licenses were provided to grant participants for use as a part of their STEM professional learning activities. In addition to TeachFX, some schools and district grantees intentionally integrated video-based self- and peer-reflection into their STEM professional learning initiatives. As noted in prior years' evaluations of this program, those who engaged in video-based reflection as a part of the grant were expected to record themselves or their peers teaching STEM lessons and then review these recordings to reflect on the effectiveness of their instruction. For instance, those engaging in video-based self-reflection were asked to reflect individually after reviewing their video recording, whereas those engaging in video-based peer-reflection shared their videos with other educators for feedback. Previous reports found that the format of these reflections often varied depending on how these activities were integrated into professional learning activities within schools and districts, with some occurring via written feedback and others verbally via either one-on-one conversations or group discussions.
Data collection related to these three specific professional learning activities focused on investigating expected and actual engagement rates. More specifically, in the UEPC survey, grant administrators from across sites were asked to estimate whether 0%, 1-10%, 11-20%, 21-40%, 41-60%, 61-80%, or 81-100% of educators at their site had engaged in video-based reflections (i.e., peer- or self-reflection) and leveraged the platform TeachFX to support their STEM professional development at least once over the course of the last academic year. For the purposes of these analyses, these groups were categorized into three usage groups: Expect No Usage (0%), Expect Low Usage (1-40%), Expect High Usage (41-100%). On the other hand, the survey asked educators to directly indicate whether they participated in video-based peer-reflection, video-based, or self-reflection, and whether they used TeachFX at least once over the past year to support their STEM professional learning. Percentages of educators who reported using each of these tools were computed by district or school (i.e., for charter schools) and then categorized into groups comparable with those for grant administrator estimates – i.e., No Usage (0%), Low Usage (1-40%), High Usage (41-100%).

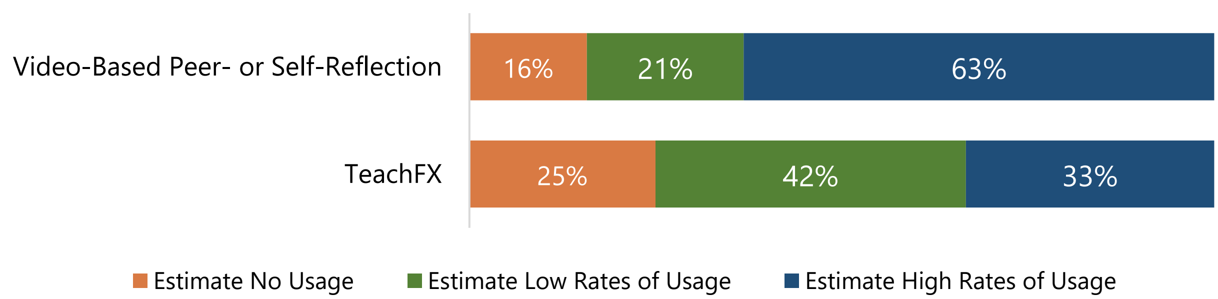
Although the grant administrator reports are estimates, comparing these responses to actual usage percentages provides insight into how successfully the STEM professional learning grant programs are strategically integrating and leveraging these tools a part of their formal grant activities. Discrepancies between these statistics might also provide important information about what tools are most accessible and useful to educators based on their usage rates, as well as which tools have been more formally integrated into the implementation of grant activities. However, one notable limitation to these comparisons is that the grant administrator items asked about video-based peer- and self-reflection as a single item. In future administrations of the survey, it will be important to ask these questions separately, especially in light of the differences observed in educator-reported usage of peer- and self-reflection across sites. As shown in Figure 5, the responses from educators at approximately 83% of the schools or districts with survey respondents suggested high rates of usage for video-based self-reflection (i.e., more than 40% of educators in these districts reported participating in this type of professional development activity), whereas a much smaller percentage (42%) of grant administrators expected high rates of video-based peer reflection among their educators.

Figure 5. Percentage of districts or sites with educators reporting various use rates of specific professional learning tools/platforms



The percentage of grant administrators who reported that they expect high usage rates in relation to video-based peer-and self-reflection *combined* was essentially the average of the percentages of sites with high rates of educator usage across these two activities (see Figure 6 below). On the contrary, grant administrator estimates appeared to either overestimate the percentage of educators not participating in either video-based peer- and self-reflection, or the sample of educators responding to the survey might be biased such that those who responded were more likely to participate in these activities. More data would need to be collected to determine which interpretation of these findings is more likely.

Figure 6. Percentage of grant administrators across sites and districts estimating various rates of educator usage of specific tools/platforms to support STEM professional learning



Another key finding that is apparent through the comparison of educator reports (Figure 5) and grant administrator reports of estimates (Figure 6) is that the rate of TeachFX usage is not as high across all sites as video-based peer- and self-reflection. This may be due to the fact that this tool is relatively new and may not have been formally embedded in the professional learning activities across sites in the same way video-based reflections were when these projects identified their focus areas and developed the core features of their implementation plans three years ago.

Adherence of Professional Learning Communities to Professional Learning Program Expectations

As previously noted, the three core grant focus areas were: (1) the professional learning opportunities offered through the program, (2) professional learning communities (PLCs), and (3) how grant activities support STEM integration and planning. The prior section focused on investigating the nature of the professional learning opportunities offered via the grant through the vantage point of educator and grant administrator reports about the focus of their professional learning grant, the content areas and grade levels taught by participating educators, and usage rates for specific professional learning tools or platforms. This section will explore implementation through the lens of the second core grant activity: Professional Learning Communities (PLCs). More specifically, the findings in the subsequent sections are based on educator responses to items on the UEPC STEM Professional Learning Survey, which focused on the extent to which PLCs functioned in alignment with professional learning program expectations, and the Collaborative Self-Assessment (CSA), which measures specific dimensions related to effective communication with STEM PLCs. When appropriate, comments from focus groups and open-ended survey responses were included to provide examples and additional insight into how implementation across sites occurred through PLC activities that aligned or diverged from professional learning program expectations and the effectiveness of communication within these communities.

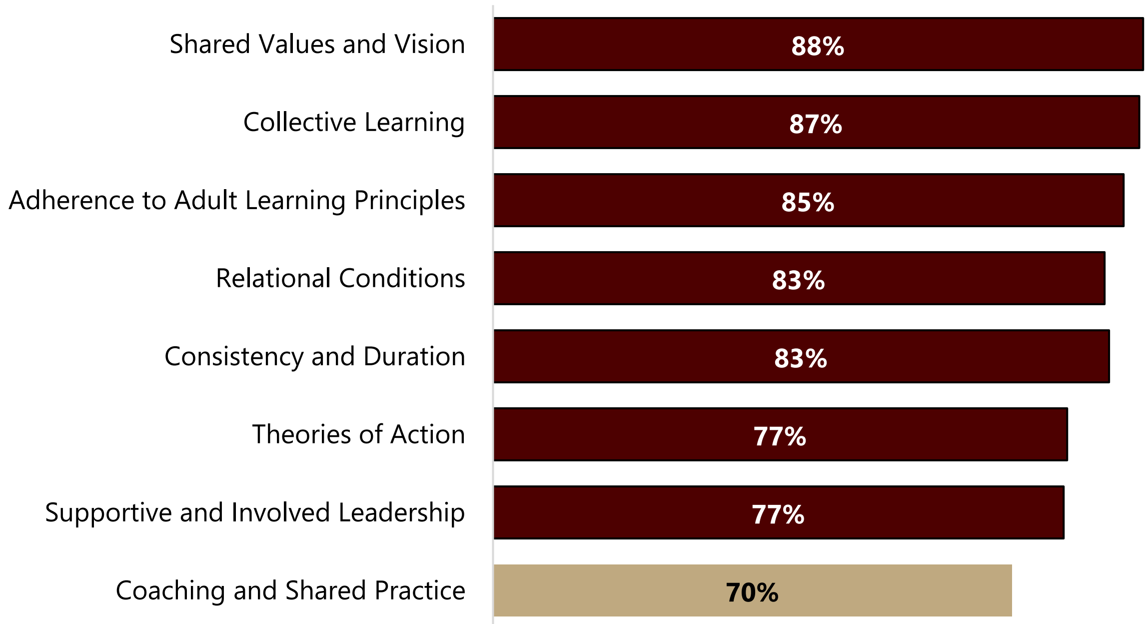
The Alignment of STEM Professional Learning Communities with Professional Learning Program Expectations

As mentioned in the methods section, the extent to which PLCs were perceived to function in alignment with professional learning program expectations was measured across eight dimensions or attributes (i.e., shared values and vision; collective learning; adherence to adult learning principles; relational conditions; consistency and duration; theories of action; supportive and involved leadership; and coaching and shared practice). For each of these dimensions, educators were asked to rate the extent to which they agreed with three to ten statements (48 items total) on a five-point Likert scale ranging from "Strongly Disagree (1)" to "Strongly Agree (5)." Before looking more specifically at the items and findings within each attribute, results will be compared across the eight attributes to identify strengths and potential challenges in relation to the alignment of STEM PLC activities with professional learning program expectations. Successive sections will delve more into specific items and associated findings within each dimension to provide more nuanced information about PLC functioning across sites.

Comparing Educator Perceptions of STEM PLC Alignment with Professional Learning Program Expectations Across Eight Key Attributes.

Figure 7 shows overall agreement across all eight attributes or dimensions of professional learning communities that align with professional learning program expectations. Overall agreement was computed for each attribute by aggregating the number of educators who agreed or strongly agreed with each of the statements related to that dimension on the survey and then dividing the sum by the total number of valid responses times the number of scale points (i.e., five). As the results show, most educators agreed that the STEM professional learning communities they participated in at their sites adhered to the eight dimensions of professional learning program expectations measured by the survey (i.e., the overall percent agreement across the eight attributes ranged from 70% to 88%).

Figure 7. Educators' agreement that PLC activities reflected the eight attributes of professional learning program expectations

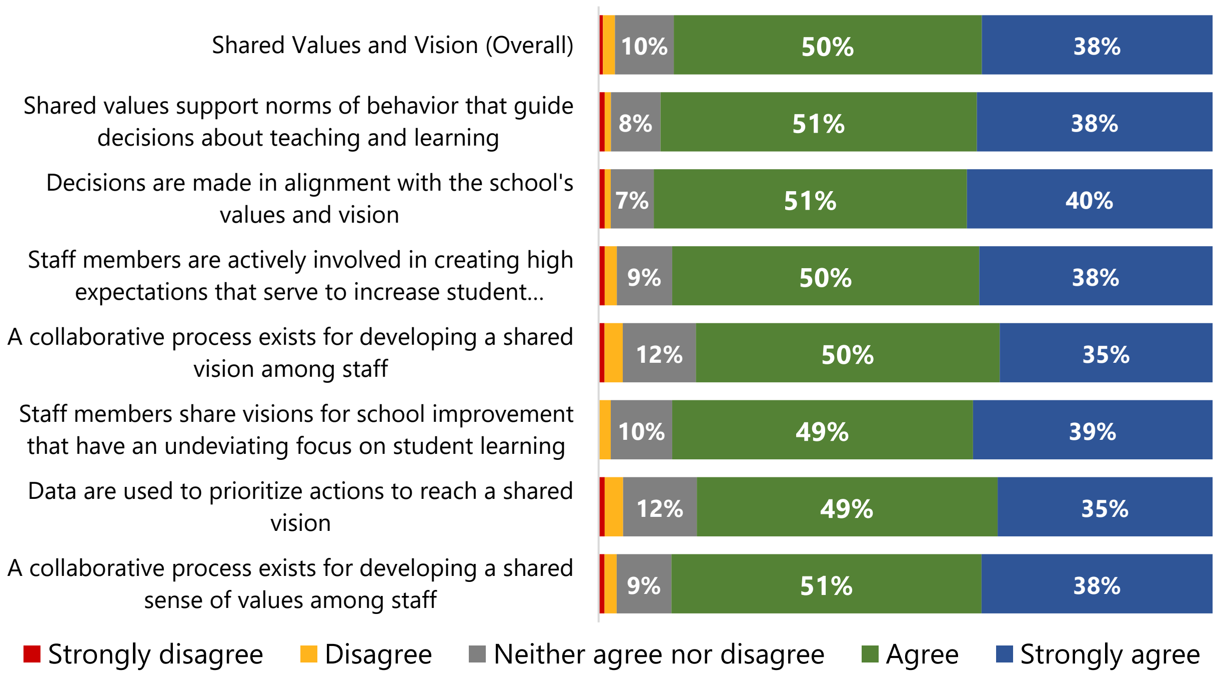


Based on a repeated measures analysis of variance (ANOVA) that was conducted on the average scale scores for each dimension, there was a statistically significant difference in teachers' extent of agreement across the eight attributes ($F=63.9$, $p<0.01$). This suggests that certain professional learning program expectations were adhered to more strongly than others within the STEM professional learning communities across participating schools and districts. Furthermore, pairwise comparisons showed that the area of coaching and shared practice was significantly lower than the other attributes; no other dimension was significantly different from the other dimensions. The finding that educators' agreement was relatively low in relation to the extent to which the PLCs at their sites adhered to professional learning program expectations on the dimension of coaching and shared practice was consistent with the prior years' reports for this grant cycle, where it was also rated lowest overall.

Shared Values and Vision of Professional Learning.

In relation to the other dimensions, educators indicated the highest level of agreement (88%) on items related to the extent to which STEM professional learning communities at their site were guided by a common vision and shared values. Furthermore, qualitative data from focus groups and open-ended survey items suggested that some teachers believed there was a shared purpose in their PLCs, although these data did not provide specifics about how these purposes were achieved. A few teachers listed norms as a collaboration strength of their PLC, though they did not describe specific agreements. Teachers who described shared purpose in their PLCs noted that teachers were committed to improving teaching practices and promoting student learning. A closer examination of agreement percentages for individual items related to this attribute on the educator survey (see Figure 8) suggests that although the decisions made at STEM PLCs are perceived to be in alignment with the overall values and visions of the schools where these professional learning activities are being implemented (88% agreement), there is an opportunity to increase the usage of data to inform STEM professional learning activities and monitor progress toward goals (84% agreement).

Figure 8. Educators' agreement that their professional learning community cultivated shared values and vision ("In my STEM professional learning community...")



Note. Excluded labels are less than or equal to 3%.

The following quotes from participants are examples of how participants in STEM professional learning communities have discussed the ways in which shared values and visions guide team goals and interactions in these spaces:

- *Team norms have been set and are discussed each meeting. Teachers are very encouraged to share their thinking and how they would solve problems or what their understanding of the content is. There is a lot of collaborative talk and there is an expectation to contribute. (Educator, Survey)*

- *We spend a lot of time really figuring out specific things to work on in each PLC for the district that would be helpful for those teachers. I'm department head at my school as well, and so running the PLC at my school with just my [grade level] teachers, we talk more about specific tests or specific test questions, things like that. Whereas in this district one, we're focusing more on the SEPs [science and engineering practices] and how to use them and resources the teachers need, at least on my end that's kind of how it's running. (Teacher Leader, Focus Group)*

- *Everyone is there for the same purpose to improve our teaching practice. We all want to be better and try new things to help our students. (Educator, Survey)*

- *I think that we are all focused on doing what is going to best help student learning, which then makes collaboration more purposeful and focused. (Educator, Survey)*

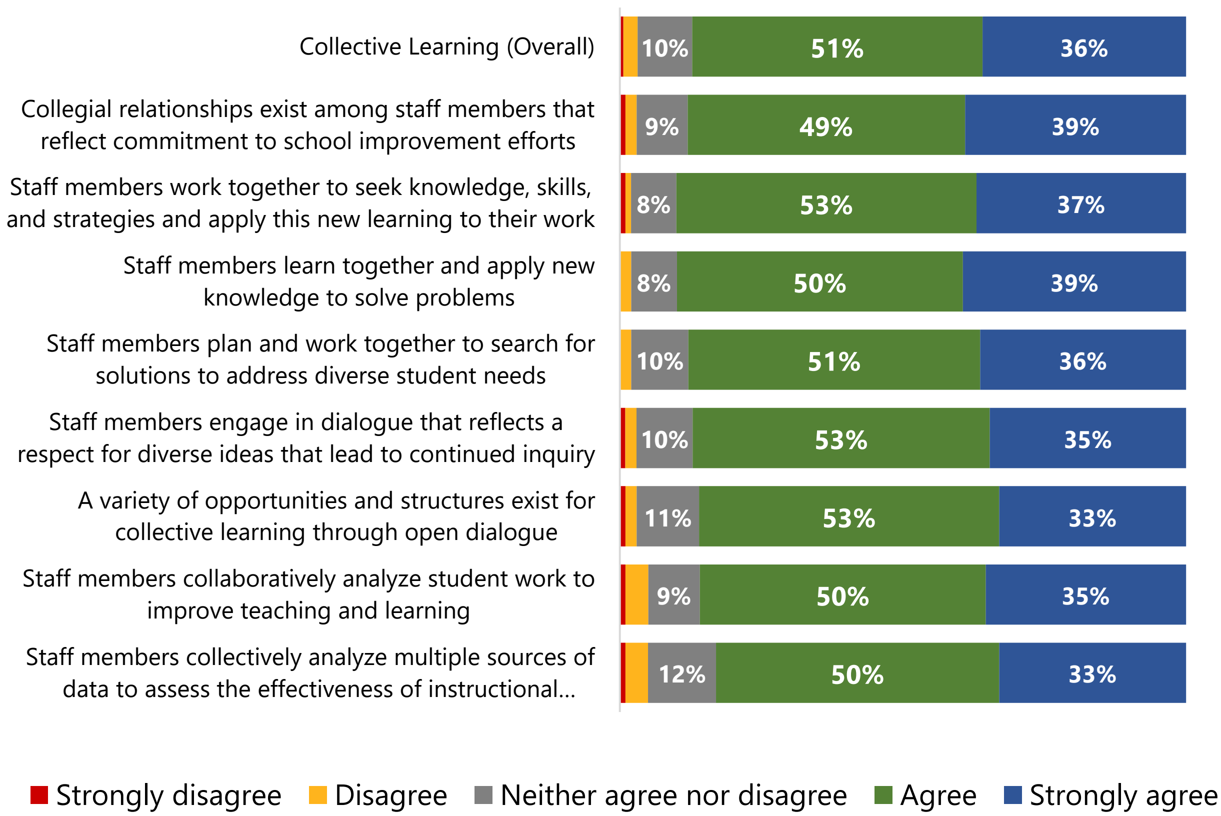
- *I love to use norms when collaborating with others and making sure we are on the same page. (Educator, survey)*

- *We look at data to know what we need to work on and we called [a member of the district-level support staff] to come to our school for extra help with our holes. (Educator, Survey)*

Collective Learning.

Educator ratings on the survey indicated that the dimension of collective learning had the second highest level of agreement (87%) among items measuring the extent to which the functioning of STEM professional learning communities across sites adhered to professional learning program expectations. As shown in Figure 9, item-level analyses show that the rates of agreement across all items were generally high, ranging from 83% to 90% agreement. The item with the highest level of agreement was that "staff members work together to seek knowledge, skills, and strategies and apply this new learning to their work." Data from focus groups and open-ended survey items suggests that, overall, teachers appreciated opportunities to engage in collective learning in their PLCs. In particular, teachers described valuing the ability to learn from one another, bounce ideas off each other, and build upon each other's strengths. One lead teacher reported believing that "powerful educational conversations" were the most impactful practice to shift teachers' instruction. It is important to note that one teacher who identified as a special educator reported feeling like special education teachers were not as included in collaborative spaces. One of the areas of opportunity related to collective learning was creating opportunities to collectively analyze multiple data sources to assess the effectiveness of instructional practices (83% agreement).

Figure 9. Educators' agreement that their professional learning community involved collective learning ("In my STEM professional learning community...")



Note. Excluded labels less than or equal to 4%.

The following quotes are examples of how collaborative learning occurred in the STEM professional learning communities:

- *We want to make sure that our teacher leadership that they're attending and co-instructing those professional learning opportunities so that we can longevity have that be something that is carried past just the short termness [sic] of what we might be. (District Specialist, Focus Group)*

- *The greatest collaboration strength is to give teachers opportunities to improve their practice using each other's strengths. (Instructional Coach, Survey)*

- *My PLC team is greatly benefitted (sic.) by each member we include as we share ideas, build off of each other, develop creative ways to ensure student learning and share the workload. (Educator, Survey)*

- *My collaboration group is really good at building on each other's ideas. I feel like we have good discussions that start with one idea and then just build off of that idea for the whole meeting. (Educator, Survey)*

- *I will always say that I think powerful educational conversations is what changes practice the most. And so allowing people to engage in progressive best practice focused conversations is where we're really going to move the needle, either getting people to shift to teach more three dimensionally, and some of the shifts just do your activity before content, right? We're going to engage in a phenomenon before we start sensemaking. And making those simple shifts and having discussions and collaborations I think is where teachers are going to shift, not reading a book or reading an article on their own or individually. (Teacher Leader, Focus Group)*

- *I feel that the special education staff is not included as much as we should be in the collaboration process. (Educator, Survey)*

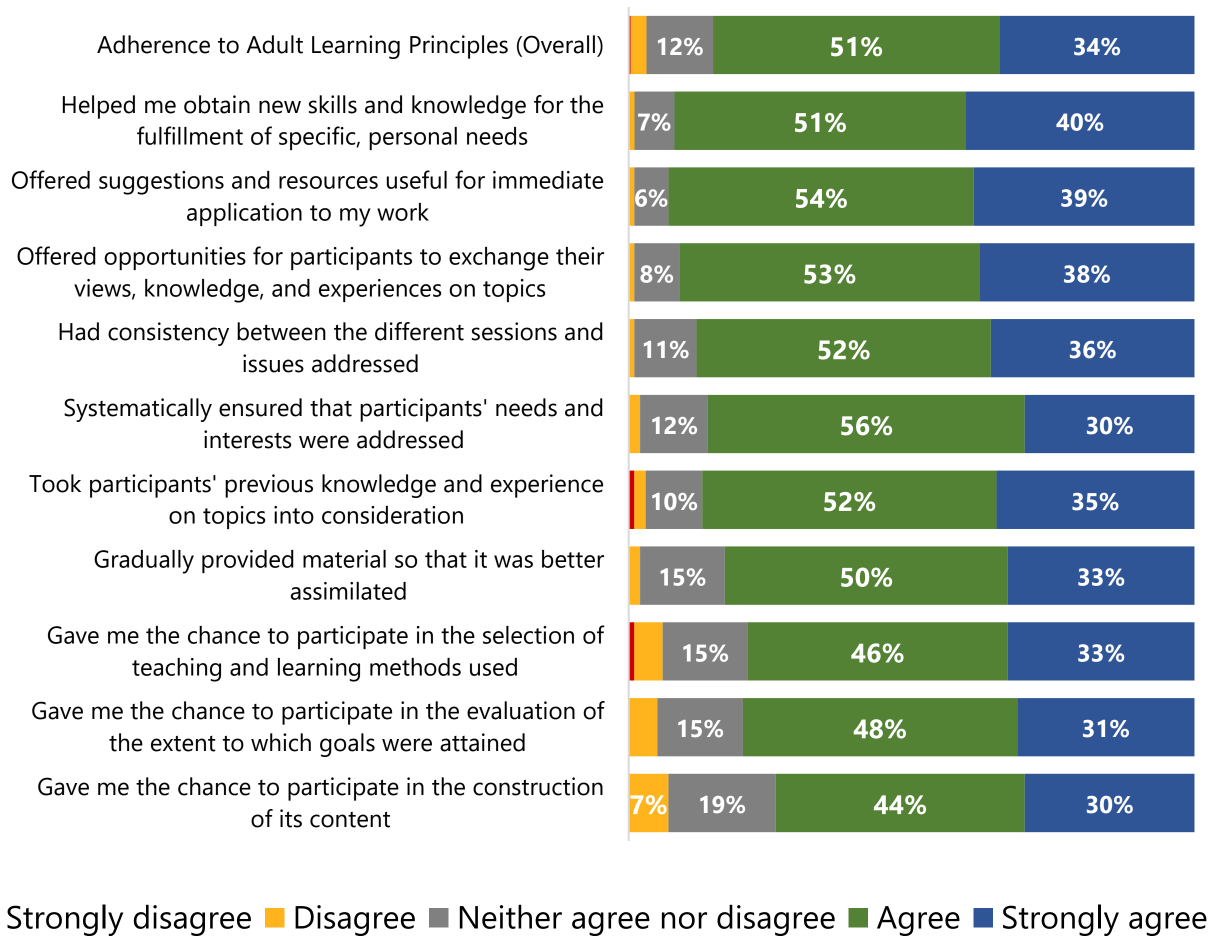
Adherence to Adult Learning Principles in Professional Learning.

Findings from the educator survey suggest overall very high levels of agreement (85%) about perceptions that the functioning of STEM professional learning communities is in alignment with adult learning principles. The items on this dimension of the survey represent the extent to which professional learning experiences are responsive to educators' unique learning styles, needs, and previous knowledge, as well as the ability to make these experiences directly applicable to educators' work practices.

As shown in Figure 10, notable strengths in this regard were how STEM professional learning experiences: (1) provided educators with suggestions and resources that were perceived to be immediately applicable to their work; (2) gave them opportunities to exchange their views, knowledge, and experiences with each other; and (3) helped educators gain new knowledge and skills related to their own, personal, professional needs. Approximately, 85% of educators who participated in the survey indicated that the professional learning experiences at their site aligned with these adult learning principles. However, item-level analyses for this dimension also suggested that there remain to be opportunities for participating sites to more intentionally offer educators the chance to select teaching and learning methods (79% agreement), evaluate the professional learning goals (79% agreement), and participate in creating content for professional learning sessions (74% agreement).

Our qualitative data collection methods did not ask specifically about adherence to adult learning principles. However, results from focus groups and open-ended responses to the educator survey suggested that educators valued opportunities to determine the focus of and design of professional learning experiences, which is aligned with adult learning principles. Some teachers also reported appreciating professional learning experiences designed or led by current classroom teachers from their district and that included materials and resources that would allow them to implement their learning. Findings from these sources also provide some evidence that this autonomy was provided at some grant sites but also draw attention to how district- and school-level priorities and initiatives are shaping the focus of professional learning experiences.

Figure 10. Educators' agreement that their professional learning experiences adhered to adult learning principles ("My STEM professional learning experience ...")



Note. Excluded labels less than or equal to 5%.

The following quotes are examples of how professional learning experience across sites aligned with adult learning principles:

- When discussing how the topics for PLCs are determined, one educator stated: *[District leadership] has had a form for us, like a Google form where [they]'ll have multiple things listed, but you can select more than one... what's most important to you ahead of time, and then that's what we focus on. I'm assuming most people vote on whatever, and that's what [they focus] on, not just whatever [they want].* *(Teacher Leader, Focus Group)*

- *So at our school, it's usually kind of left up to the teams to decide what they want to focus on. There are times where they will say, we want to focus on science, or we want to focus on math, or we want to focus on this, bring your data with you. But usually it is left up to the teams to decide what they want to focus on. And that's usually something that [we] will sit* *down and look at our data, see if there's something that we want to run through the PLC cycle, and maybe it's something we're looking to remediate or something we're looking to extend or something that we have coming up that we want some additional feedback on or things like that. So for us, that is more of an autonomous decision. It doesn't usually come from admin, but we do occasionally have meetings where we're going to focus on one specific topic and they will ask us to bring our data with us to go over. (Teacher, Focus Group)*

- *It's like, to begin everything, we've set up like, "Okay, this is what us as a school, us teachers really want to focus on," instead of having some arbitrary thing that the admins who are in the classroom every day think we need, we tell them what we need, and they've set up resources to help us with that. (Teacher, Focus Group)*

- *Our whole school PLC is very similar to what you just said too, where it's driven by our needs, rather than the administration's wants. (Teacher, Focus Group)*

- *So there's three different ways topics come up. Sometimes our curriculum people want us to talk about something, or we're going to do some sort of training with the 3D science or something. The leader can pick the topic we're talking about. Or we address problems that are brought up by the community, and that's what I like the best. I think sometimes I scramble for stuff to, here, let's talk about this thing, and I decide it, and so everybody just has to deal with the problem I have. But I like it when I have a problem as a community we can talk about and solve. Those are the best PLC meetings. But yeah, they kind of come from those three different sources, I think. (Teacher Leader, Focus Group)*

- *I think another place that we've seen a lot of impact, at least [my colleague] and I have noticed is having the classroom teachers help teach the flex courses. Because as a teacher, I know it's meaningful to me to hear from someone who's actually doing it in the classroom and see how they are doing it. So I think that has been something that has been really powerful is to have those teachers that are part of the science leadership PLC helping teach the flex courses alongside the district people because then teachers can see themselves actually doing it. It's not just, well, this is coming from the district, it's, well this is coming from another teacher. (Teacher, Focus Group)*

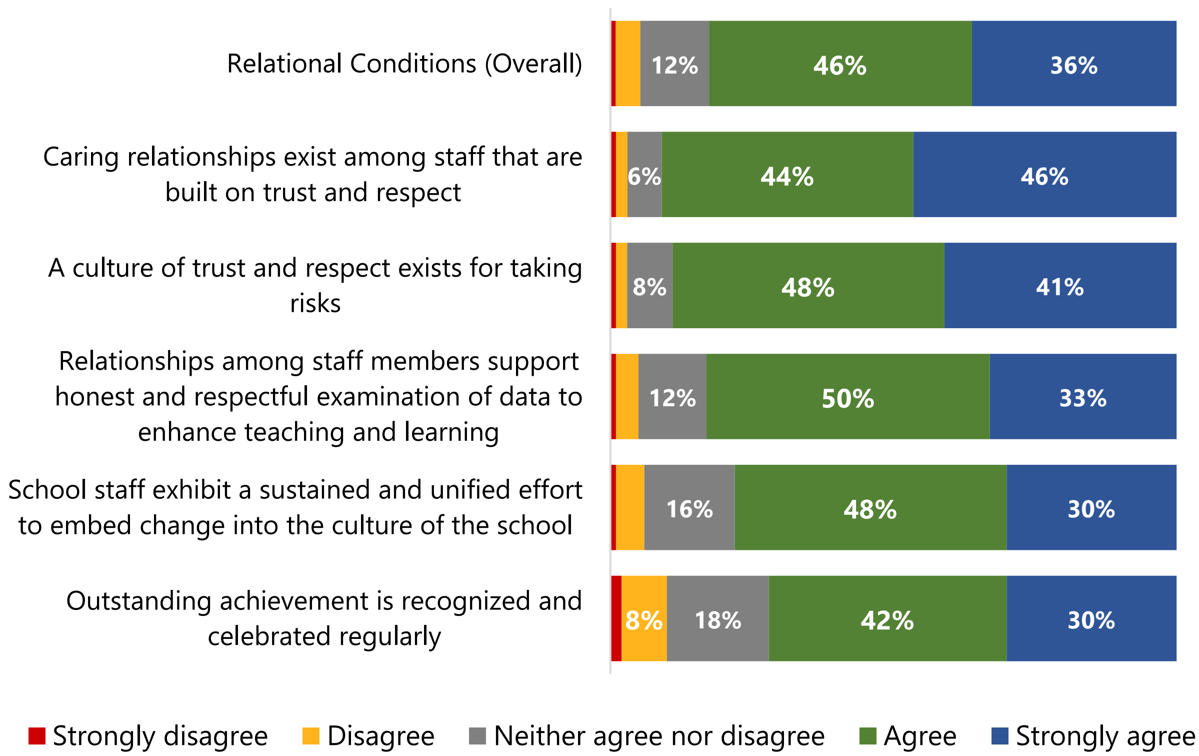
- *I learned great information not just relating to STEM content but also on integration, classroom strategies and I was given supplies and materials that made it possible to implement the learning. My students love the lessons and the resources that I was able to share with them. I highly recommend the classes and I am grateful that I could participate in them. (Educator, Survey)*

Relational Conditions.

The relational conditions – i.e., the culture, nature of professional relationships, and modes of interaction that are cultivated within STEM professional learning communities – are another core attribute of quality professional learning experiences. Item-level analyses on this dimension of adherence to STEM professional learning program expectations suggest that PLC across grant sites have been most successful in establishing cultures of trust and respect and promoting caring relationships among colleagues that allow participants to take risks, with approximately 82% agreement on these two items (see Figure 11).

Qualitative data echoed this finding, as many participants reported positive and respectful interactions with peers and a sense of safety to make mistakes. These data also suggested that some teachers felt like they "got along" with each other, welcomed differing points of view, and cultivated a sense of trust and safety. However, educator survey responses also indicate opportunities to celebrate teachers' outstanding achievements regularly as they practice and implement instructional strategies and practices more regularly (72% agreement) and more deeply embed change into the school culture (78% agreement).

Figure 11. Educators' agreement that their professional learning community supported relational conditions ("In my STEM professional learning community…")



Note. Excluded labels less than or equal to 5%.

The following quotes are examples of how STEM professional learning communities across grant sites attended to cultivating relational conditions that are conducive to effective professional learning:

- *Sharing ideas and sharing responsibility for problems. If something isn't working, everyone is willing to pitch in and try to solve the problem, as needed. (Educator, Survey)*

- *It is a safe environment where everyone knows we are all there to be better. No one is there to judge each other, but to give true feedback that is non evaluative. At the same time we see best practices to give us goals to work toward. (Educator, Survey)*

- *I think that our PLC is a place with great communication and trust. This allows us to work effectively together. (Educator, Survey)*

- *Participants are respectful and kind. We are encouraged to ask questions, make mistakes, and keep learning. (Educator, Survey)*

- *People in our PLC really put an emphasis on fairness, letting everyone have a say and allowing people to make mistakes and grow from those mistakes. Everyone is respectful and gets along very well, everyone is professional. Different points of view are typically appreciated. (Educator, Survey)*

- *We have a healthy relationship with each other and respect each other's abilities and content understanding. (Educator, Survey)*

- *[Our collaboration has] taken away that fear of failure that we always had, that we wanted to try something, but we were afraid to fail. And when we saw other people just around us, trying and failing, and they were okay, and they survived, then we realized it's okay for us to try new things and fail with new things, and we can bring that experience, and we're not going to have a judgment placed on us. It's going to be more of, "Here's how we can work together to make this a better experience for both the teachers and the students." (Teacher, Focus Group)*

- *I feel that I am allowed to try new things. If it works, great! I not, we learned and we will improve. (Educator, Survey)*

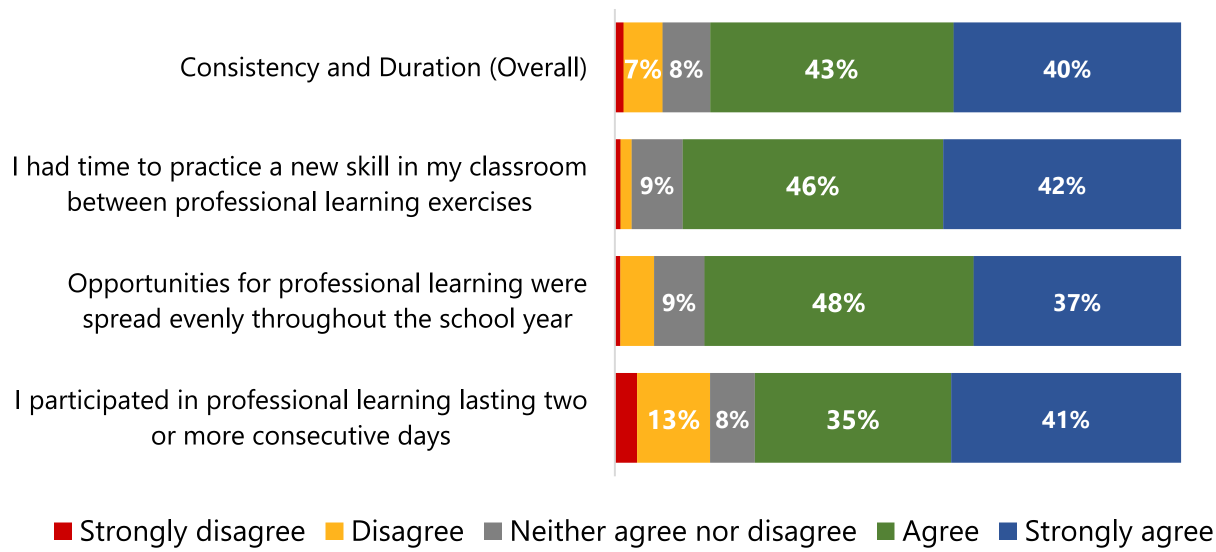
Consistency and Duration.

Consistency and sustained duration are another key attribute of quality STEM professional learning experiences that align with professional learning program expectations. The educator survey items that were related to this dimension focused on the pacing and duration of professional learning activities over the course of the academic year. As shown in 12, just over 80% of educators agreed that their professional learning experiences aligned with this program expectation, and the item-level agreement for the three items on this dimension ranged from 76% to 88%.

Considering qualitative and quantitative data in relation to this dimension suggests some notable similarities and differences in the findings from these data sources. Participants in focus groups and open-ended survey responses described time as a critical feature of their professional learning experiences. Time was one of the most commonly reported challenges to implementing professional learning across sites, with some teachers expressing that they felt like they did not have enough time to implement what they had learned in these experiences in practice. Somewhat contrary to this finding, educator survey responses suggested that providing educators with opportunities to practice new skills gained during their experiences between professional learning exercises was a strength (88% agreement). This suggests that educators need more sustained support in order to implement their new skills and knowledge in practice. As shown in 12, only 76% of educators reported participating in professional learning lasting two or more consecutive days. This might suggest that increasing the duration of these experiences across sites could assist educators in implementing their learning and new skills in practice.

One finding related to the timing of professional learning that emerged in the focus group and open response data but was not measured on the survey was related to when professional learning experiences were scheduled. Specifically, some participants in the focus groups and respondents to the open-ended items on the survey expressed appreciation for professional learning opportunities that were hosted outside of school hours, which prevented them from needing to find substitute teachers and create sub plans. However, some teachers expressed challenges related to attending after-school professional learning activities related to commuting and extending a full workday. Other participants preferred to attend professional learning during contract time, however, if professional learning was held during class time, some teachers who attended professional learning experiences during the school day lamented the loss of instructional time with their students. Multiple educators expressed appreciation for stipends for participation. Taken together, these findings suggest that educator preferences and needs in relation to scheduling might vary across sites and individuals and attention should be paid to meeting educators scheduling needs to promote engagement and buy-in for STEM professional learning experiences.

Figure 12. Educators' agreement that their professional learning experiences reflected appropriate consistency and duration



Note. Excluded labels less than or equal to 6%.

The quotations below provide a sample of comments related to the timing of professional learning experiences and the time needed to implement their learning:

- *The classes were held after school so we didn't have to worry about getting a sub to attend the classes. (Educator, Survey)*
- *I did not have enough time to teach, video my teaching, and discuss my teaching with a peer in order to receive the stipend offered. (Educator, Survey)*
- *Finding time to implement the new activities has been difficult. (Educator, Survey)*

- *It is hard to miss class time with my students. Sub plans take more planning and are often less effective than what I would do if I were present in my classroom. (Educator, Survey)*

- *It is difficult to find the time to incorporate all that we have learned about into teaching. There are a lot of great resources we have received, however it takes time to see how they can be used in our classrooms. (Educator, Survey)*

- *It is difficult at times to add two more hours onto an already long day. If a teacher is unable to attend, there are relatively no opportunities for make-up. (Educator, Survey)*

- *Taking the class after school is hard. Sometimes I have a hard time focusing because I have already had a hard day. (Educator, Survey)*

- *Timing of the professional developments was the greatest challenge that I faced this year. Some of the courses were offered during the day, so I had to get a substitute. Yes, the substitute was paid for, but it is hard to be gone and get a sub. (Educator, Survey)*

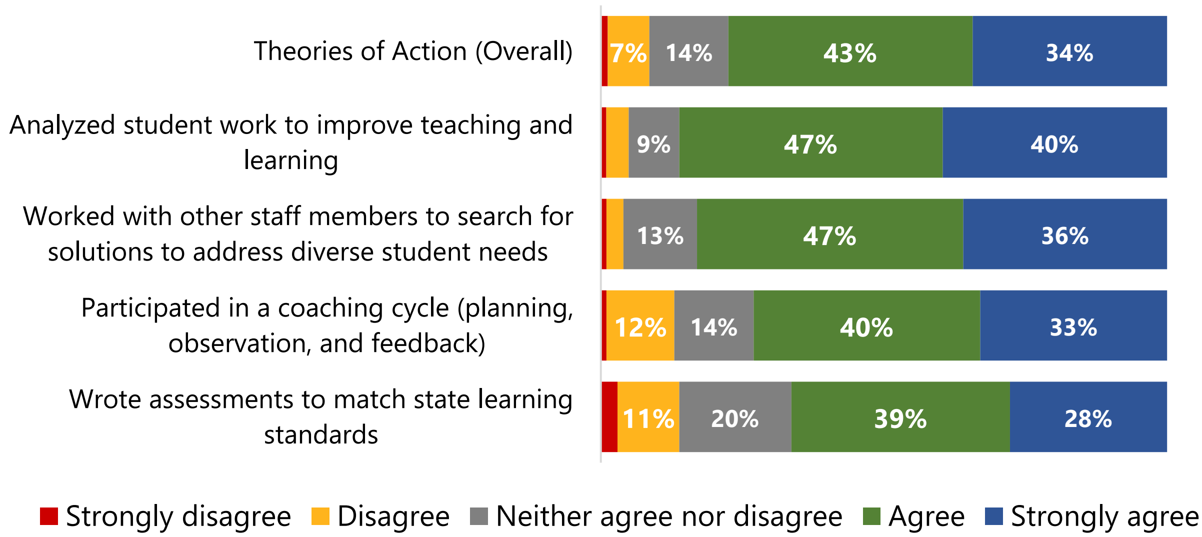
- *I have so many needs at school with students, more meetings can be a challenge. But getting a stipend does help. (Educator, Survey)*

Theories of Action.

Running STEM professional learning communities according to a theory of action, or how the implementation of specific strategies or initiatives are expected to lead to targeted outcomes, is another key attribute of quality STEM professional learning experiences that align with professional learning program expectations. Item-level analyses for this dimension indicated that educators' agreement with specific statements about whether their PLC experiences aligned with this program expectation ranged from 67% to 87% (see Figure 13).

Notable strengths in this area, as indicated by educator responses, were how PLCs relied on the analysis of student work to inform strategies for improving teaching and learning as well as the ways in which staff members worked together on these teams to find ways to address diverse student needs, with these items having 87% and 83% agreement respectively. In relation to opportunities for growth, educator responses suggest that STEM professional learning communities could be more involved in the creation of local assessments to match state learning standards, with only 67% of educators agreeing that this occurs within the STEM professional learning communities at their site. While qualitative data largely echoed these findings, some teachers in open-ended survey responses reported feeling unconfident that their assessments were aligned with SEEd standards. Some teachers expressed a desire to clarify and/or for the state to adopt more specific STEM standards.

Figure 13. Educators' agreement that their professional learning community followed theories of action ("In my STEM professional learning community, I…")



Note. Excluded labels less than or equal to 4%.

The quotations below provide a sample of comments related to how the work of STEM professional learning communities were perceived to be guided by theories of action:

- *I have been able to analyze my class data and brainstorm with other teachers to improve on areas of deficits. I was really struggling with students using technology to cheat and fighting apathy. After a reviewing data and having a conversation with colleagues, we were able to come up with a strategy to motivate students to work right away and be engaged in their lessons. (Educator, Survey)*

- *I'm still working on how to best assess my students' understanding. I feel like I do a good job with creating lessons and the students are engaged, but I'm unsure about how well my assessments align with the SEEd standards and what I've been working on this year. (Educator, Survey)*

- *[A way to improve collaboration in my STEM PLC is to] clarify further with the essential standards for STEM including formative assessments for each standard. (Educator, Survey)*

- *[A way to improve collaboration in my STEM PLC is to] have some state STEM standards to use (Educator, Survey)*

- *The state needs to develop state STEM standards for elementary school so [our] district will continue to have stem specialty teachers instead of getting rid of them all and "forcing me out of the district" in a manner of speaking. (Educator, Survey)*

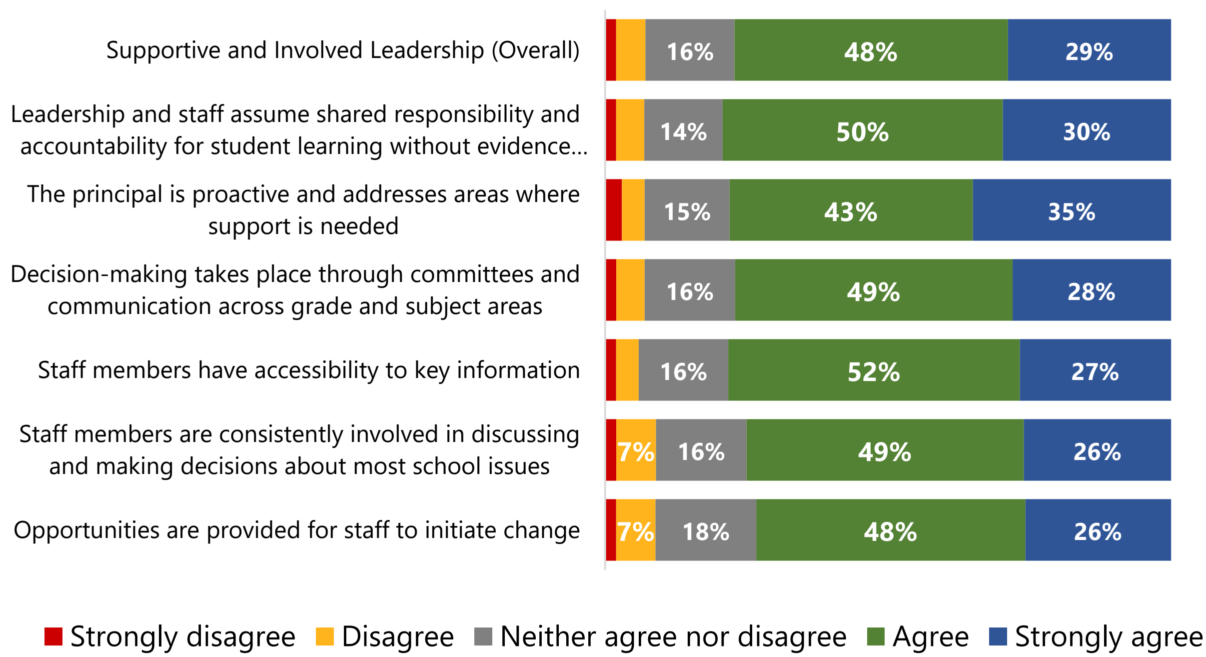
Supportive and Involved Leadership.

Leadership is another important attribute of quality professional learning. Survey items related to this attribute focused on the extent to which educators agreed that school leaders at their sites provided access to information, shared responsibility for student outcomes, and supported school staff while also empowering them to make decisions and create change. Respondents' ratings of these items showed that this dimension was rated slightly lower than others, with 77% agreement across all items. Furthermore, as shown in Figure 14, the extent to which educators agreed with items on this dimension of adherence to professional learning program expectations was relatively consistent across items (ranging from 74% to 80%). However, there were some notable differences in relation to the percentage of educators who strongly agreed with the items, such that approximately 35% of educators strongly agreed that their principles were proactive in addressing their STEM professional learning support needs.

Qualitative data from focus groups and open-ended survey items indicated that many participants felt their school-level administrators supported their STEM professional learning experiences, naming most frequently principals' encouragement to attend professional learning opportunities, their willingness to pay for substitute teachers while teachers attend PL, and their willingness to provide autonomy to teachers to manage their STEM PLCs. In addition, some survey respondents reported that their district-level STEM specialists were integral to the success of their PL experiences.

In relation to opportunities for growth, relatively fewer educators agreed that staff are given opportunities to initiate change and are consistently involved in discussing and making decisions about most school issues, with agreement ratings of 74% and 75% respectively. This is consistent with previously discussed findings related to adult learning principles, which also had relatively low ratings on items related to educator involvement in the design of professional learning.

Figure 14. Educators' agreement that their professional learning experiences included supportive and involved leadership



Note. Excluded labels less than or equal to 5%.

The quotations below provide examples of the role leadership has played in supporting STEM professional learning across sites:

- *My admin has been very supportive if I've had to take a day, they've always made sure that even if a sub doesn't show up, I'm able to go do what I need to support that PLC. So they have been very supportive in making sure that I am able to get where I need to help other teachers. (Teacher Leader, Focus Group)*

- *Our administration is actually really good about like if there's ever professional development that we want to go to or that we've found on our own and said, I think this would be awesome for us to go to, or anything like that. They're always really supportive in those ways of sending us out wherever we decide and finding opportunities. They will often be like, "Hey, I got this email about this conference that's coming up that I think would be great for you." And so they're really good and supportive that way. (Teacher, Focus Group)*

- *My [admin's] really, really great on supporting us. Like if I tell them like I want to go do a specific meeting with a teacher, or even asked to be like, "Hey, I'm having trouble with this, would I be able to go watch another teacher at another school?" They would 100% set that up. That way I can be a better teacher for the kids up here. But yeah, they're super supportive, and they encourage it a lot. There was one time where they actually said, "Find a teacher, we will pay for one or two sub days for you to go have a better PLC." Because they know we can't get as good of a PLC up here as we could at a bigger school. (Teacher, Focus Group)*

- *I cannot say enough good about the science PD opportunities that have been offered/curated/provided by [our district specialist]. (Educator, Survey)*

- *[District specialist] has been a life saver in helping me get started. (Educator, Survey)*

- *I'm quite happy with where I am in my math teaching journey right now, and I know there is a good support system in the district to help me when I feel I need it. (Educator, Survey)*

- *The people leading the team of trainers in [name of school district] are top teachers and understand how teaching impacts learners. (Educator, Survey)*

- *Teacher autonomy is respected and defended. Everyone gets a chance to share their ideas. Leaders listen and implement others' ideas. (Educator, Survey)*

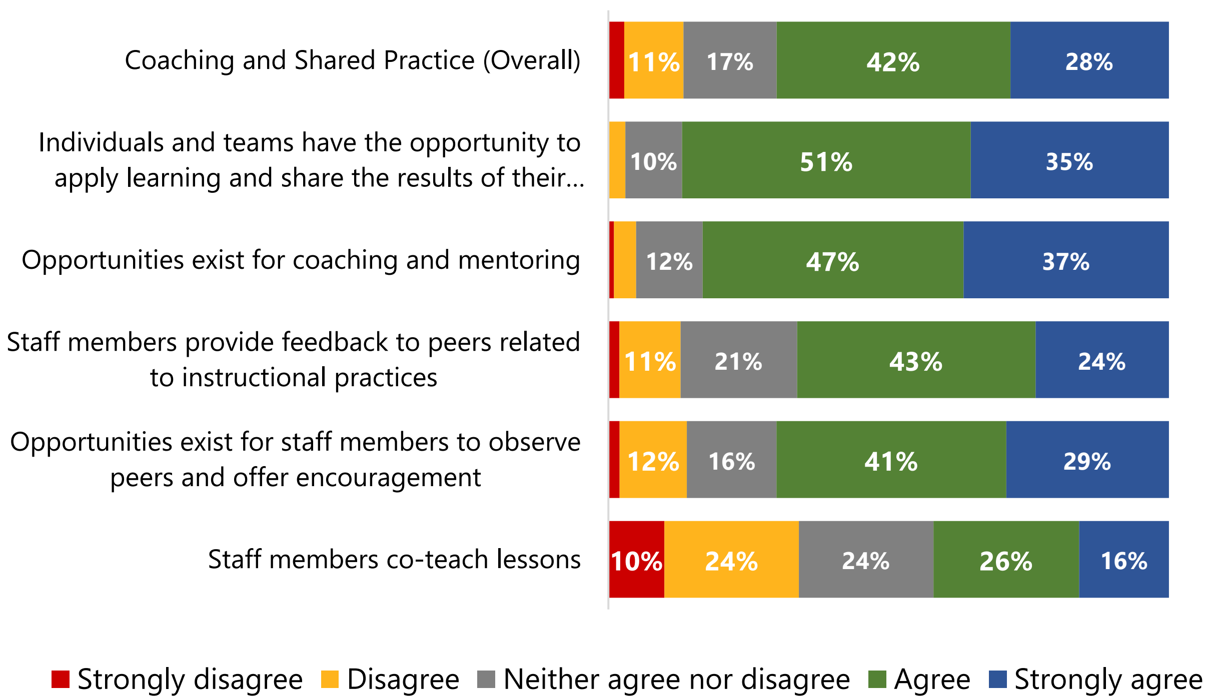
- *Our district math leadership support us in our collaborative teams across grade levels efforts to create and strengthen deep, equitable, rich learning of math for our students. (Educator, Survey)*

Coaching and Shared Practice.

As previously noted, educators' agreement that their sites' professional learning communities adhered to professional learning program expectations with respect to coaching and shared practice was the lowest across all of the attributes measured. These items asked educators about their opportunities to engage in coaching/mentoring, co-teaching with other educators, and engage with their peers during their professional learning experiences. As shown in Figure 15, agreement across the items on this dimension ranged from 42% to 86% (70% agreement overall), representing a difference of 44% agreement across the highest and lowest rated items in this dimension or the largest across any of the dimensions measuring adherence to attributes of professional learning. Based on these item ratings, some of the strengths in relation to coaching and shared practices were the opportunities for coaching and mentoring offered across sites (84% agreement) as well as professional learning experiences that allowed educators to apply their learning and share results (86% agreement).

Most teachers who mentioned coaching in their open-ended survey responses shared relatively positive sentiments, describing their coaches as helpful resources in implementing their STEM professional learning. A few teachers noted that completing coaching cycles was a notable success of their experience with the grant program. Teachers who expressed negative sentiments related to coaching tended to express concerns related to a lack of coaches' availability or engagement or a lack of teacher bandwidth to engage in the coaching process. On the other hand, across all items measuring adherence to professional learning program expectations, two of the items with the lowest levels of agreement were in this dimension. Specifically, these ratings suggest that there is considerable room for improvement in relation to creating opportunities for educators to co-teach lessons (42% agreement) and provide feedback to their peers about instructional practices (67% agreement).

Figure 15. Educators' agreement that their professional learning community involved coaching and shared practice ("In my STEM professional learning community…")



Note. Excluded labels less than or equal to 4%.

The quotations below provide examples of how educators engaged in coaching and shared practice as a part of STEM professional learning activities across sites:

- *As a team, we meet probably about twice a week. And then, if we need any extra help on how to do things, I go down the hall to my learning coach, and actually talk to him a lot more than anybody else, just on how to do different things when I have trouble. (Teacher, Focus Group)*

- *I love that WE get to pick and make personal goals and that our coach helps guide us to people who can help us achieve those goals. (Educator, Survey)*

- *One success I have experienced is the coaching cycle my learning community did together for math. We are learning and growing as a group and individually as teachers. We saw student outcomes improve because of the coaching cycle. (Educator, Survey)*

- *I think that I lacked the bandwidth to more consistently be coached or be accountable to the principles we talked about during the professional development. (Educator, Survey)*

- *We need an instructional coach that actually comes to our PLC's and helps us develop best practices and effective teaching strategies - not teachers pay teachers materials. (Educator, Survey)*

- *I would like it if I got matched with someone close to my school and maybe we could see each other do it one day. Or have my math coach more involved and the coach would come observe one that I do so I know I am on the right track. (Educator, Survey)*

- *Our professional learning coach was a bit busy at the beginning of the year, so our coaching cycle was later in the year. I feel that it would have been better to do it sooner, so that we could make changes, try again, evaluate, reflect and continue the cycle many times in one year. (Educator, Survey)*

- *I believe more awareness from the coach would benefit and more interest in how we are doing. (Educator, Survey)*

- *I have enjoyed the coaching cycles. (Educator, Survey)*

- *Had a great coach who helped me implement ideas in the book. [Name] is a great coach! (Educator, Survey)*

- *We have been using coaching differently and more teachers are being coached in their classrooms to meet their individual and specific goals tied to the district goals. (Grant Administrator, Survey)*

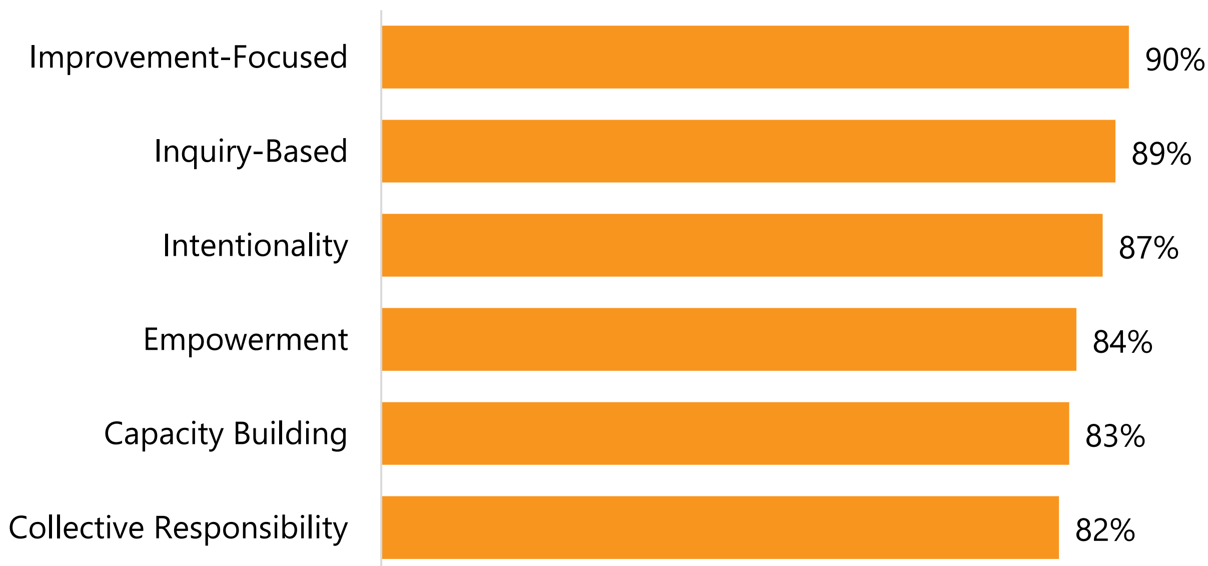
Collaboration Within Professional Learning Communities

As previously mentioned, UEPC's Collaborative Self-Assessment (CSA) was administered to both educators and grant administrators across participating grant sites to better understand the functioning of STEM professional learning communities. The six domains of effective collaboration were measured, namely the extent to which these communities promoted intentional, inquiry-based, and improvement-focused engagement as well as collective responsibility, empowerment, and capacity building among participants.

The extent to which collaboration in STEM professional learning communities reflected effective practices in each domain was measured via educator ratings on seven to ten items associated with each area. All items were rated on the following five-point scale: (1) not at all, (2) slightly, (3) somewhat, (4) moderately, or (5) extremely. Figure 16 shows the average percentage of educators who reported moderate or extreme collaboration across the items in each domain of effective collaboration (i.e., the highest two ratings on the scale).

These results suggest that there is overwhelmingly high agreement across sites that the STEM PLCs educators and grant administrators are participating in through the grant are promoting effective collaboration in various ways, particularly in relation to promoting improvement-focused and inquiry-based engagement. In relation to opportunities for improvement with collaboration, the CSA domains related to capacity building and collective responsibility were rated relatively lower than the other areas.

Figure 16. Educator reports of moderate or extreme collaboration, by area, in their professional learning communities in Spring 2023



Item-level statistics across all items were reviewed to better understand the variation of moderate and extreme agreement across items within each of these domains and identify some of the more specific strengths and areas for improvement in relation to collaboration. As shown in Table 9, the domains with widest range of moderate and extreme agreement across items and variability were empowerment and collective responsibility. Furthermore, the items with the smallest percentages of moderate or extreme agreement in these domains and contributed to this high variability were related to the extent to which respondents felt collaboration within their STEM professional learning communities were responsive to educators' emotional needs and provide participants with social and emotional support, suggesting this might be an area for improvement. Other items with relatively lower percentages of moderate or extreme agreement suggest that there can be improvement in relation to logistics and the clarification of participant roles across sites; for example, clarifying the roles of participants and others during the decision-making processes (75% for both items); ensuring individuals have additional opportunities to choose when, where and with whom to collaborate with (77%); and creating more flexible structures that allow for spontaneous collaborations (78% agreement). For more details, see Appendix B. Item-Level Statistics for the Collaborative Self-Assessment (CSA).

Table 9. Descriptive statistics for percentages of moderate or extreme agreement across all items within each CSA domain

CSA Domain	Max	Min	Range	Variance
Improvement-Focused	95.4%	85.5%	9.9%	0.11%
Inquiry-Based	90.8%	86.1%	4.7%	0.03%
Intentionality	90.6%	83.4%	7.2%	0.04%
Empowerment	91.5%	73.1%	18.4%	0.31%
Capacity Building	90.3%	74.7%	15.6%	0.20%
Collective Responsibility	87.0%	75.1%	11.9%	0.17%

In relation to some of the highest-rated items across the CSA, three of the top five items were in the domain related to the extent to which these STEM PLCs promoted improvement-focused engagement, with the highest-rated items focusing on how PLCs focused on improving student learning and instruction (both items with 95% agreement) and evaluating new ideas based on goals and intended outcomes (91% agreement). Another notable finding from the highest-rated items on the CSA was that the other two top-five items on this survey were loosely related to what was referred to as relational conditions on the items that focused on adherence to professional learning program expectations discussed in previous sections. Specifically, the results of this survey suggest that additional strengths of STEM PLCs across participating sites were how they provided equal opportunities for participation and promoted idea sharing among participants, with 92% and 91% expressing moderate or extreme agreement with these statements. Complete item-level statistics for all items on the CSA can be found in Appendix B.

Findings: STEM Educator and Student Outcomes

Data from the UEPC STEM Professional Learning survey as well as data from focus groups, was analyzed to evaluate the extent to which the STEM Action Center's Professional Learning Grant Program was associated with positive educator and perceived student outcomes.

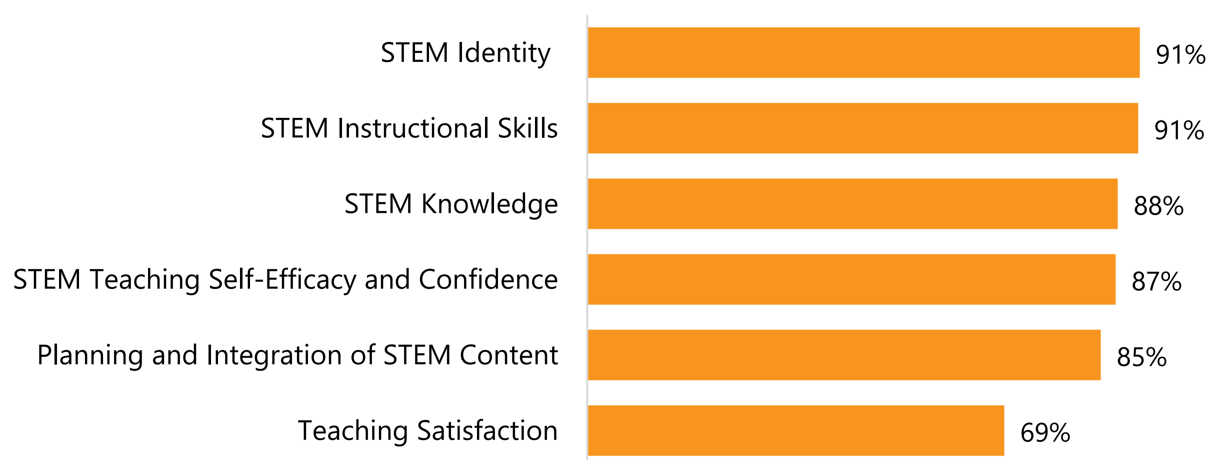
Educator Outcomes

Educators were asked to self-report the extent to which their participation in STEM professional learning activities impacted their STEM identity, instructional skills, teaching self-efficacy, knowledge, as well as their ability to plan and integrate STEM lessons in practice. Each outcome was measured using six to nine items that were rated on a five-point scale ranging from "strongly disagree (1)" to "strongly agree (5)." Educators' overall agreement for each target outcome was computed by aggregating the number of educators who agreed or strongly agreed with each of the statements related to that outcome on the survey and then dividing the sum by the total number of valid responses times the number of scale points (i.e., five). During the focus group sessions, participants were also asked to share how their participation in grant activities impacted them. Quotes from the analysis of focus group data are included to provide examples of how educators believed participating in grant activities impacted their professional knowledge and practices. In interpreting these results, it is important to acknowledge how interrelated these concepts are. For example, educators' sense of self-efficacy and confidence regarding STEM teaching is related to their STEM instructional skills and knowledge.

Comparing Educator Agreement Across Six Target Outcomes

Educators' survey responses suggest that most educators believed their participation in STEM professional learning positively impacted on the educator outcomes targeted by the Professional Learning Grant program. All but one of the six outcomes measured had at least 85% overall agreement that participation in grant activities led to the intended outcomes (see Figure 17 below). The two outcomes that were tied for the highest level of agreement at 91% agreement overall, suggest that participation was perceived to have the greatest impact on educators' STEM identity and their STEM instructional skills.

Figure 17. Educators' agreement that their participation in STEM PL led to growth in five key outcome areas



Since the overall rates of agreement were high across all items, item-level statistics were also reviewed to identify patterns of higher or lower agreement across items within the outcome areas. Item-level agreement ratings ranged from 58% to 95% and were negatively skewed such that there were more items with ratings at the higher end of the scale than the lower end. Additional statistics by outcome measure are shown in Table 10. These results suggest that the items related to STEM identity, instructional skills, and knowledge are consistently rated highly, whereas there is more variation in the extent of agreement for the other measures. Further inspection of item-level agreement within these outcomes shows that five of the seven or 71% of the items related to STEM instructional skills had agreement ratings higher than 90% (see item-level statistics in Figure 21 below in the section related to STEM instructional skills). The variation and range of agreement across items related to STEM teaching self-efficacy and confidence, as well as STEM planning and integration, were large in relation to the other educator outcome measures. Variation was also large for teaching satisfaction, but that was primarily due to the fact that one of these five items was rated much higher than any of the others (12% more agreement than the next highest item in this group); the other four items measuring this outcome had relatively low (i.e., less than <70%) agreement.

Table 10. Descriptive statistics for percent agreement across items within measures of educator outcomes

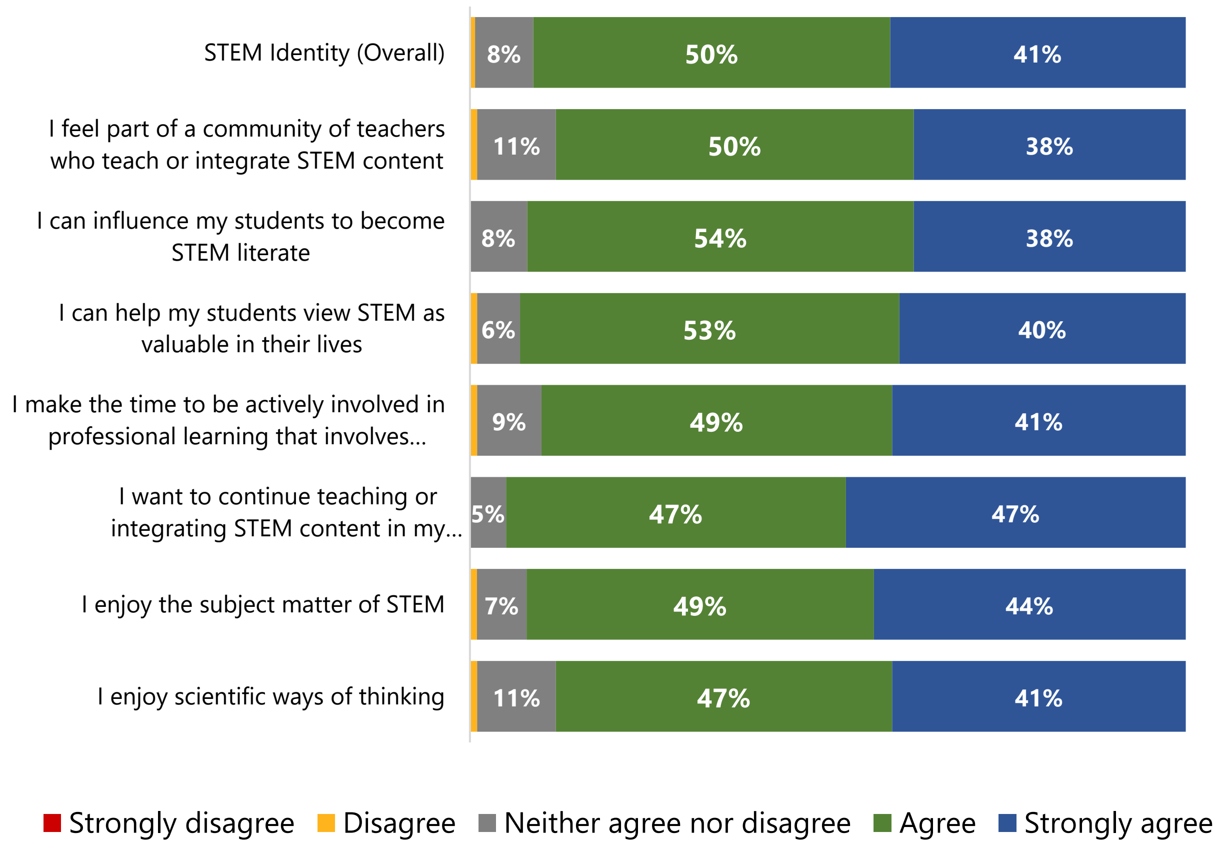
Educator Outcome Measures	Max	Min	Range	Variance
STEM Identity	94%	88%	6%	0.05%
STEM Instructional Skills	95%	86%	9%	0.05%
STEM Knowledge	90%	84%	6%	0.03%
STEM Teaching Self-Efficacy and Confidence	93%	79%	14%	0.27%
Planning and Integration of STEM Content	91%	79%	12%	0.13%
Teaching Satisfaction	84%	58%	26%	0.79%

Educator STEM Identity

As previously noted, STEM identity was one of the most highly rated educator outcomes, according to survey respondents who expressed 91% agreement overall (see Figure 18). In addition to the overall positive perceived outcomes in this area, item-level rates of agreement show that nearly half of the responding educators strongly agreed that they are interested in continuing to teach or integrate STEM content into their instruction. This finding aligns with focus group data that suggested that many educators who participated in STEM professional learning across sites had an intrinsic interest in doing so and voluntarily participated in these activities. Though most qualitative data gathered in this study did not explicitly mention STEM identity, many educators described impacts related to their professional learning experiences that were aligned to various aspects of STEM identity, including feeling part of a community of teachers who are teaching STEM and enjoying learning about and implementing new STEM instruction.

In relation to challenges, survey responses showed that relatively fewer educators agreed with statements about enjoying scientific ways of thinking and that they feel part of a community of teachers who teach or integrate STEM content. However, qualitative data from focus groups and surveys suggested that many educators had been able to collaborate more around STEM instruction and that these interactions have been valued. Furthermore, comments from district administrators in one of the focus groups indicated that they believed that, compared to their secondary counterparts, elementary teachers "did not identify as science teachers." Therefore, they described being intentional in cultivating and assessing elementary teachers' STEM identity in their professional learning experiences. Another educator from that same district reported noticing positive shifts in elementary educators' STEM identity throughout their professional learning experiences. Together, these results suggest that there are opportunities to focus on how to better cultivate educators' excitement about scientific thinking as well as chances to connect and engage teachers across sites in a community of other teachers working to integrate STEM content into the school day.

Figure 18. Educators' agreement that their participation in STEM PL impacted their STEM identity



Note. Excluded labels less than or equal to 1%.

The quotations below provide examples of educators' beliefs about stem identity, including enjoying feeling part of a community dedicated to STEM learning, implementing new STEM instruction, and challenges related to cultivating STEM identity for teachers of lower grades:

- *I've enjoyed exploring new concepts with my students, applying new ways to teach them. (Educator, Survey)*

- *I have learned that I enjoy math more than what I had thought. I now understand math concepts better and I feel more comfortable teaching my students. (Educator, Survey)*

- *I feel a little intimidated, I guess. But I'm not sure why. (Educator, Survey)*

- *I also felt intimidated at times as a kindergarten teacher, because our learning is so foundational, I haven't had the practice and training that other educators have had, so I felt somewhat inadequate at times. (Educator, Survey)*

- *And that is the number one biggest problem that we have with our elementary teachers is they don't identify as science teachers. And so when you don't have that identity, you're not able to pass that on as quickly to your students either. And it's not created as an essential because they can't see themselves as it and feel successful, but it is daunting, and this is new for a lot of them because wasn't what they had extra learning in or had... They get one course in a content course only in their pre-service teaching stuff and that's it. And they're expect to know all of this stuff. So we're dealing where people are coming at quite a deficit in how they identify themselves as a teacher. Most would strongly say they identify as a literacy teacher if they're an elementary teacher, and then secondary you'd have some, but with secondary teachers in this kind of aspect, they're already coming at it with that in place. I am a science teacher, we have to battle that in elementary to help them identify themselves as a science teacher. So identities and cultures and shifts that way take time and take reinforcement and a lot of successes to be able to make that change in identity. (District Specialist, Focus Group)*

- *So [a kindergarten team] wrote [as a collaborative. So it's just really great. It's awesome to see, like as [my colleague] was saying, it's awesome for us to be able to talk and discuss with these teachers who have attended, to see that shift in that mindset and identity and see how science is being taught in their everyday classrooms now. It's awesome. (District Specialist, Focus Group)*

- *I really enjoyed this opportunity to work with Number Talks. This helped me to add meaning math critical thinking to my daily schedule. Allowed me to collaborate with my colleagues about different strategies to try. (Educator, Survey)*

- *Collaborating with other motivated teachers throughout and during the school year was inspiring for me. I like to learn by discussing and getting deep into topics. It is even better when I can do math with my peers, people who care. I liked being challenged with tasks that would increase my abilities to teach math, then being accountable at the next meeting. (Educator, Survey)*

- *I have found more success and enjoyment in teaching math. (Educator, Survey)*

- *I enjoyed being a part of the math leadership team. Everything we did was relevant to what I am doing in my class right now. The way to teach the students and the ideas we were given to use to get the students into their math mindset was awesome. (Educator, Survey)*

- *I have really enjoyed the concentrated time to get out of my classroom and work with my peers on developing STEM curriculum and exploring best practices. With over 200 students, I find it hard otherwise to get enough time to interact with my fellow teachers in a meaningful way. (Educator, Survey)*

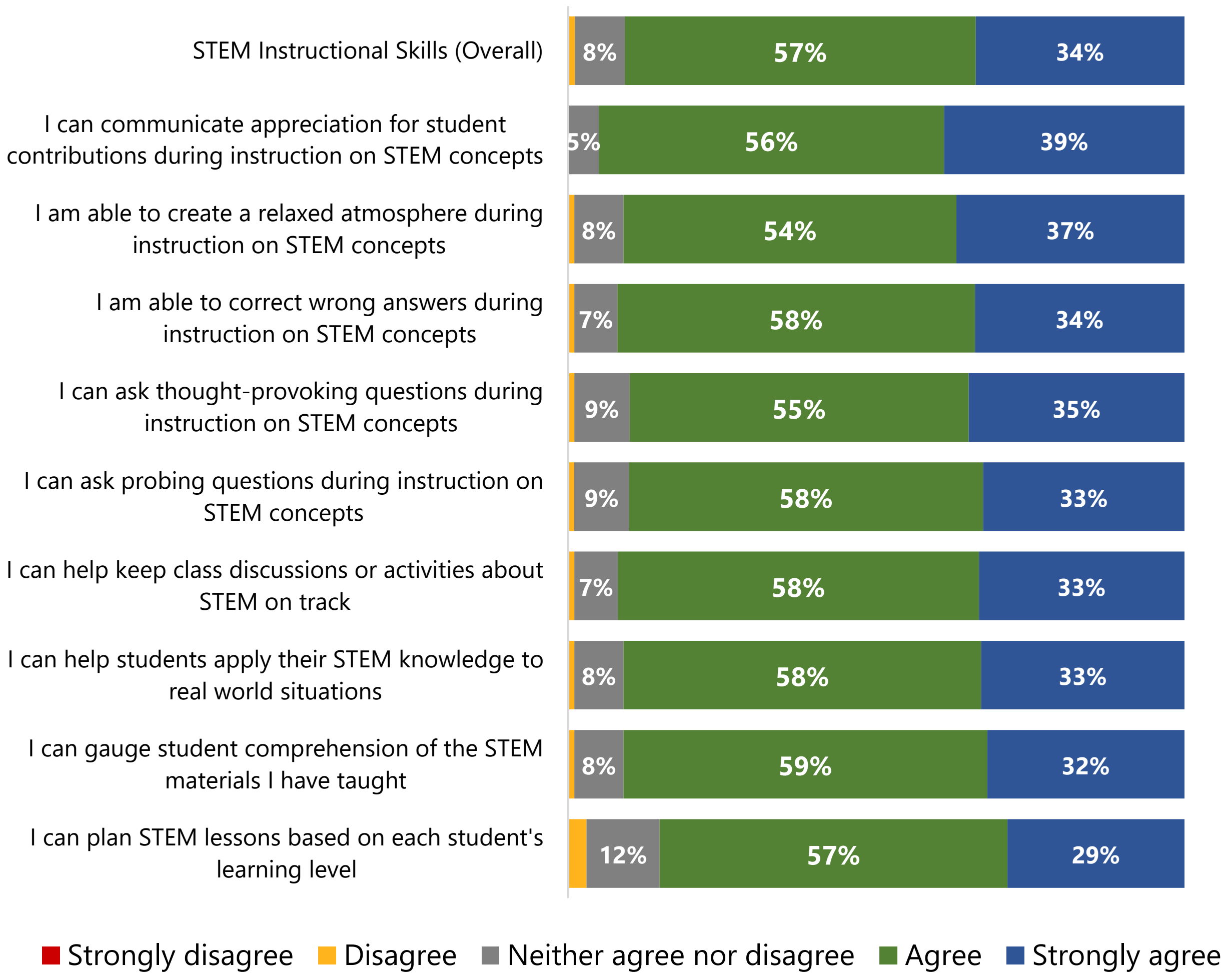
Educator STEM Instructional Skills.

The next highest-rated educator outcome on the survey was STEM instructional skills, with 91% agreement overall (see Figure 19). A review of item-level agreement showed that for all but one of the items measuring this outcome, at least 91% of educators agreed that their professional learning experiences promoted the development of their instructional skills in specific ways (see Figure 19). In addition to the high level of agreement on the educator survey for this measure, qualitative data also suggested that many teachers made shifts to their instruction and implemented new instructional strategies as a result of their professional learning experiences. In some instances, educators reported adopting new approaches or ways of thinking about their instruction that they did not consider "traditional. These new approaches included shifting their instructional practices so that the students, instead of the teacher, are functioning as the "experts" in the room; providing students more time to engage in discussions about their STEM content and learning; utilizing phenomenon-based instruction; and leveraging new materials and resources to provide more interactive, hands-on learning activities.

Additional consideration of item-level statistics shows that educators agreed most that they can communicate appreciation for student contributions to STEM concepts during instruction (95%). In relation to opportunities for improvement, educators agreed least that they can plan lessons tailored to each student's learning level (86%), with less than a third of educators strongly agreeing with this statement. Qualitative data analysis suggested that educators' beliefs that that their professional learning experiences supported their ability to differentiate instruction for their students were mixed. A few participants who identified themselves as special educators articulated that their professional learning experiences were geared more toward general education teachers and students, with one teacher wanting professional learning experiences that were more directly related to the needs of students in special education. Another teacher expressed appreciation for a professional learning experience that helped them differentiate to reach their students.

Furthermore, although most teachers described their administrators as supportive, one educator who participated in the focus groups described feeling like their administrator was not supportive of implementing new instructional approaches that strayed from "traditional" approaches like direct instruction. As such, future professional learning initiatives might consider providing educators with additional training and support related to how more intentionally consider individual students' learning levels while planning STEM lessons and explore ways to promote more buy-in related to the intended instructional shifts across various stakeholder groups.

Figure 19. Educators' agreement that their participation in STEM PL impacted their STEM instructional skills



Note. Excluded labels are less than or equal to 3%.

The following quotations provide examples of the comments that teachers made related instructional shifts and new practices as a result of their professional learning experiences:

- *Anyone who sees [my instruction] and experiences it is like, "oh!" and has an open mind about it is really cool because you walk by a traditional classroom and all the kids are sitting there. It's just crazy the difference across the hall through the windows. It breaks my heart to really see that and I know that's what my kids are getting. It makes me feel really sad. (Teacher, Focus Group)*

- *I've seen major changes between the teacher being the expert and allowing the kids to make mistakes and celebrating the mistakes. It's not about, in math, it's not about getting the right answer. It's about understanding conceptually what the thinking is, and if they can explain their wrong answer, then they usually understand, wait a minute, this isn't where I wanted to* *go. It's not that it's wrong. You just did something different, and for teachers to let the kids fail and not fix them immediately is tricky, and we've got one teacher though that's making great growth because she used to do a lot of, "Good, that's right, good job, that's right," and instead, she's been able to shift, "Do you think that's right," or "Why do you feel that's right? Why did you do that," instead of good job, yeah, you got that right. So just that little minor shift is cool to watch. (Principal, Focus Group)*

- *[Teachers are] like, "Oh, this is eye-opening. And because I created these assessments and looked at progressions in practices, in core content ideas, and also in crosscutting concepts across disciplines and subjects…" they were just saying how it's changed their instruction and they can see why end of year rise testing as we're doing a lot more with phenomenon-based instruction and we have a lot more science and different articles now in literacy, they're starting to see, "oh, I'm changing my instruction and now I'm seeing that bigger picture of these kids need to be using all of these skills and ideas." So that was pretty cool 'cause I was like, yes, it's changing in your classroom based on that professional development experience and guiding into creating district assessments. (District Specialist, Focus Group)*

- *It's been really great to have Ambitious Science Teaching [i.e., a framework with four core sets of teaching practices to support rigorous and equitable science instruction] where it helped me to integrate everything and give me more ideas on how to better reach everybody and differentiate, which is a struggle. That's been really helpful. (Teacher, Focus Group)*

- *…The interesting thing is I think when my seventh graders came in at the beginning of the year, it took a little bit for them to be okay with this because I never let them know if the answer is right or wrong, never. All the kids end up at the end realizing what the answer is, but we don't ever even discuss it. It never even gets talked about because the kids know that we're trying to focus on the process, not the answer. (Teacher, Focus Group)*

- *I do have something to say about, you were talking about a barrier. My admin has been like, I would say they lean a lot more towards traditional math teaching. They think direct instruction is the "tippity top", and I'm like, that is not a good way for kids to learn, and parents, they just want math to be how it was when they grew up. So those are two things that have been really hard for me this year is to not feel supported in the best teaching practice. I know they're the best teaching practices that I can do, that are available to me. So that's been hard. (District Specialist, Focus Group)*

- *The only challenge I ever experience is that I feel that the approach of the classes and learning opportunities are geared toward general education students. I wish there were more opportunities for learning about helping students with learning differences or other disabilities. (Educator, Survey)*

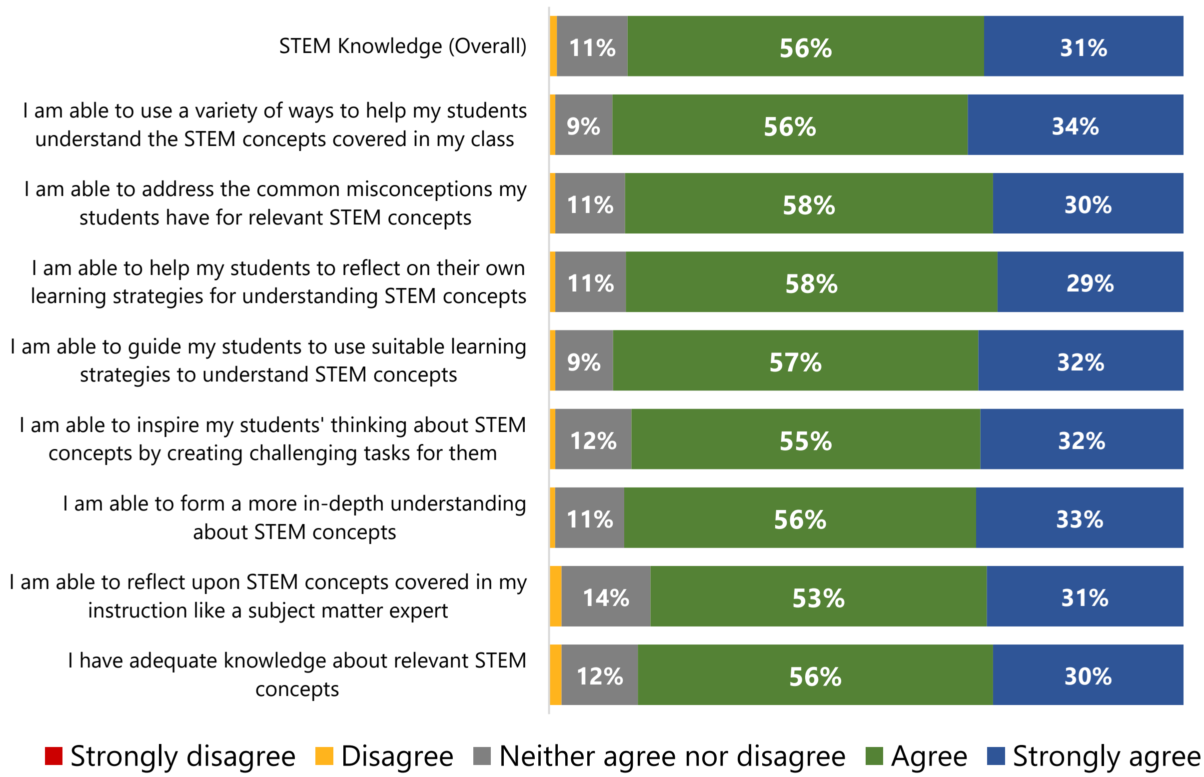
Educator STEM Knowledge.

The next educator outcome of interest was educators' self-reported STEM knowledge. In the context of this evaluation, this is conceptualized as educators' own STEM content knowledge and how they can draw upon this knowledge to facilitate student understanding and learning. Overall, 87% of teachers agreed or strongly agreed that their STEM knowledge increased as a result of participating in professional learning experiences, and percentages of agreement were relatively consistent across items (see Figure 20) Furthermore, nine out of ten educators agreed that they are able to use a variety of strategies to help their students understand STEM concepts.

Qualitative data from focus groups and open-ended survey items triangulated these findings, as many educators reported that they had learned new concepts related to STEM content area instruction. Some teachers named specific learning, including knowledge related to new technologies, content area, and standards. Relative to other survey items, fewer educators agreed that they are able to reflect upon STEM concepts covered in their instruction, like a subject matter expert (84%). Furthermore, as mentioned above in the findings section related to educator stem identity, qualitative data suggested that some participants perceived differences between the STEM knowledge of elementary and secondary educators.

An independent t-test on the differences of average scale scores on this measure between educators who only taught primary grade levels (i.e., PK-6, mean=4.16) and those who only taught secondary grades (i.e., 7-12, mean=4.22), suggest no statistical difference between these groups in relation to their self-reported STEM knowledge (t=1.40, *df*>0.05). Qualitative data also suggested that while teachers largely reported increased knowledge related to STEM instruction, some teachers did not feel confident that they had the time to integrate their learning into their practice. These results suggest there is an opportunity to explore strategies to increase educators' STEM knowledge so that they feel as though they are able to think about STEM concepts like subject matter experts. Still, there should be further investigation into whether or not these efforts need to be more strategically targeted at building the STEM content knowledge of primary grades teachers at specific sites. There is also an opportunity to ensure educators have the time needed to integrate their learning into their practice.

Figure 20. Educators' agreement that their participation in STEM PL impacted their knowledge of STEM



Note. Excluded labels less than or equal to 2%.

The following quotations provide examples of the comments that educators made related to their STEM knowledge as a result of their professional learning experiences:

- *We've had several schools in the district that do CMI [Comprehensive Math Instruction], and it really does promote this shift in thinking about what teaching is and what learning is and student focused through giving instructional practices and shifting in that, and then also deepening teachers' content knowledge. So we've seen growth across multiple subjects, math especially, but across multiple subjects as well. (Teacher, Focus Group)*

- *I think one thing that I've just noticed is there's a real strength in pedagogy in the elementary level and a real strength in content knowledge in the secondary level, and one thing that CMI [Comprehensive Math Instruction] has done is it's increased the content knowledge in the elementary school teachers and along with just tweaking their pedagogy. (Principal, Focus Group)*

- *I have learned many new strategies on how to teach science through my professional learning. It has helped me to have more dynamic, fun and motivating classes. (Educator, Survey)*
- *Improved my own math content knowledge which helps me be a better educator. (Educator, Survey)*
- *I feel that I have grown in knowledge and confidence. (Educator, Survey)*
- *I have improved my instruction and knowledge related to STEM. (Educator, Survey)*
- *I have loved both the math and science PD training that I followed. I felt more knowledgeable on what to do, and I could implement it directly into my classroom. (Educator, Survey)*
- *I have learned a lot about the importance of inquiry based problems, growth mindset, and communication in math. I am excited to implement what I learned in my classroom next year. (Educator, Survey)*
- *[I] learned more about how to teach science and other stem content. (Educator, Survey)*
- *I have learned a lot about how to access and adapt the standards to my student's needs. (Educator, Survey)*
- *There are always so many great ideas, and finding the time to integrate what we learn is hard. We have time to think about the curriculum, but putting it to use on a daily basis takes more time than we have. (Educator, Survey)*
- *I love learning about new technologies that can help my instructional practices (sic.). (Educator, Survey)*
- *[A success I have experienced is] Altering an entire unit of mass to coincide with the concepts learned during professional development. (Educator, Survey)*
- *These programs give the teachers a chance to deepen their knowledge on the content area and reflect upon their own teaching, finding ways to improve teaching and students' engagement. (Educator, Survey)*

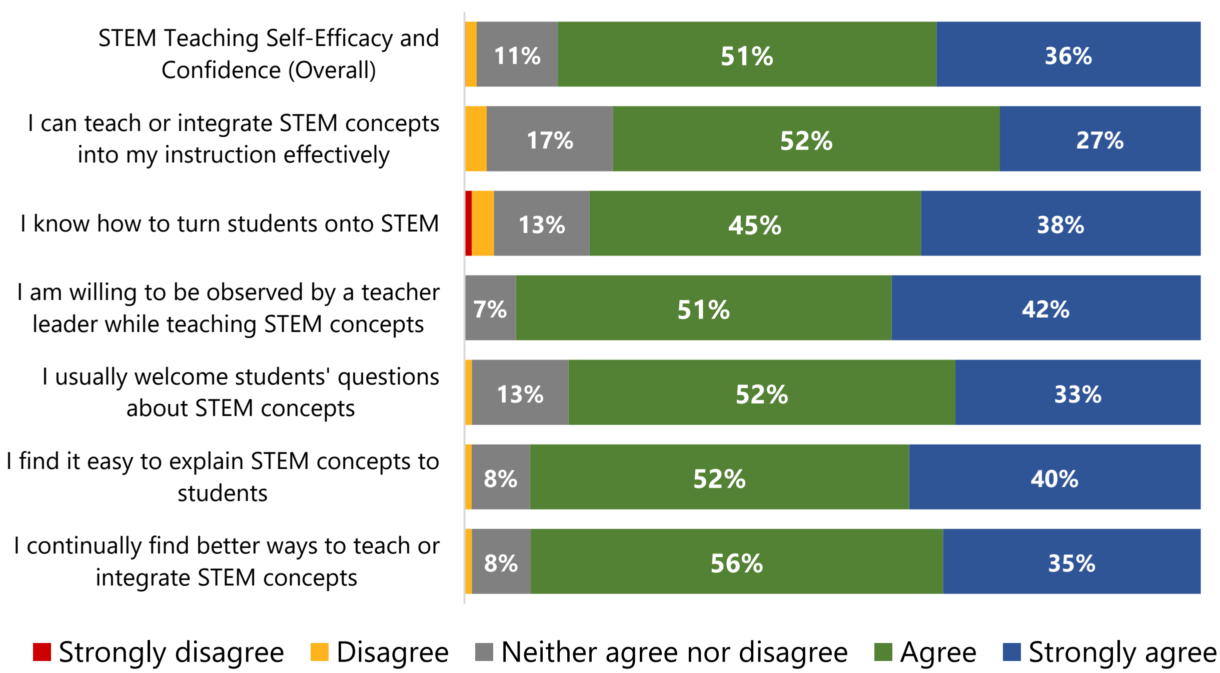
Educator STEM Teaching Self-Efficacy and Confidence.

Another target outcome of STEM professional learning activities offered through the grant was increasing educators' STEM teaching self-efficacy and confidence. As previously mentioned, survey responses indicated that, overall, most educators (87%) agreed or strongly agreed that their STEM teaching self-efficacy and confidence improved as a result of participating in the PL Grant Program (see Figure 21).

Qualitative data also suggested that many teachers reported increased self-efficacy as a result of their STEM professional learning experiences. Many of these statements came from open-ended survey responses and communicated a general sense of an improved ability to provide effective or integrated STEM instruction. However, approximately 21% of educators who responded to the survey did not agree that they could effectively integrate STEM concepts into their instruction. Furthermore, two survey respondents who were both early elementary teachers reported feeling "intimidated" throughout their STEM professional learning experiences. However, overall, educators' survey ratings for this outcome as well as the findings from qualitative data, suggested an increase in educator confidence. More specifically, the highest percentage of agreement for items related to this outcome was for the item related to educators' willingness to be observed by a teacher leader while teaching STEM concepts, which may suggest that educators have sufficient confidence as well as openness to instructional feedback and suggestions. Additional discussion of findings related to peer reflection is provided in later sections of the report.

In the open-ended survey responses, some educators explicitly mentioned that their confidence had increased. For instance, several educators noted how they felt their participation in STEM professional learning activities had improved their ability to teach STEM concepts, understand the standards, and provide more engaging lessons and activities for students, particularly when they were provided materials and resources. Overall, the results indicate that almost all participating teachers are constantly exploring opportunities to teach or integrate STEM concepts and feel comfortable explaining STEM concepts to their students. However, some findings simultaneously suggest that supporting educator's self-efficacy in STEM teaching might continue to be an area of need. It warrants further exploration to consider strategies teachers could implement to teach or integrate STEM concepts more effectively.

Figure 21. Educators' agreement that their participation in STEM PL impacted their self-efficacy and confidence



Note. Excluded labels less than or equal to 3%.

The following quotations provide examples of statements grant participants made about how participation in grant activities has impacted their STEM teaching self-efficacy and confidence:

- *So we look exactly at their grade level of what their standards are, and we show them their content ideas, their DCIs or their core ideas I should say, and they grade themselves and they always grade themselves ones or twos, which is the low grades. But then when we dive into the content and say, you know what, this is really what you're teaching, this is really what it means. And then we have them regrade themselves and they're all threes or fours by then. So just shifting their view of, oh, I can do this... So I feel like those are the top three challenges and we're addressing them in our courses. (District Specialist, Focus Group)*

- *But the most impactful has been the ambitious science teaching, which has given me more confidence in building my curriculum and just implementing it and having more student engagement. (Teacher, Focus group)*

- *I have become more confident in teaching STEM concepts and have been able to understand better what the standards and strands mean and require to be taught well. I loved receiving the materials! It is so hard to gather all that stuff sometimes. (Educator, Survey)*

- *I am much more confident in teaching STEM lessons. (Educator, Survey)*

- *I have found a lot more confidence in my abilities to teach and convey information. (Educator, Survey)*

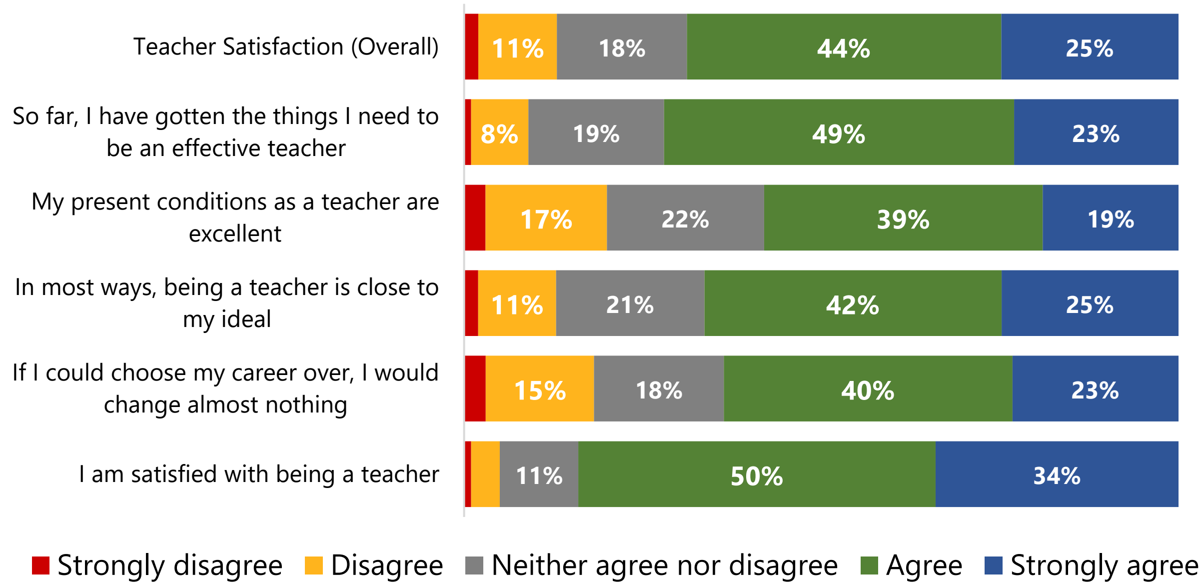
- *I am so much more confident in teaching STEM! The supplies we received made all of the difference for me. (Educator, Survey)*

Teacher Satisfaction.

Another intended outcome of the STEM professional learning activities was promoting teacher satisfaction. In the context of this evaluation, this was measured by items that focused on educator satisfaction with their present teaching conditions, feelings they have what they need to be an effective teacher, satisfaction with their career as a teacher overall, feelings that it lives up to their ideal, and whether they would choose teaching as a career if they could do things over again. Across the educator outcomes measured, this outcome had the lowest level of agreement overall, with 69% of educators agreeing or strongly agreeing that participation in the PL Grant Program increased their overall satisfaction as a teacher (see Figure 22). The range of agreement across items for this measure was the highest among all educator outcomes, with 26% more educators agreeing with the highest-rated item than the lowest-rated item. While they agreed the most on their overall satisfaction with their occupation, teachers agreed least that their current teaching conditions are excellent.

Despite these mixed results on the survey, some teachers in both focus group interviews and open-ended survey responses expressed that they felt their professional learning experiences led to an increased sense of joy and job satisfaction. In some instances, this joy came from their collaboration with other teachers, who they could "bounce ideas off of." As one teacher explained, professional learning "helped us bring the joy back to the curriculum," partly by trying new things.

Figure 22. Educators' agreement that their participation in STEM PL impacted their teaching satisfaction



Note. Excluded labels less than or equal to 3%.

The following comments provide some additional examples of statements participating educators made about how participating in STEM professional learning how increased their teaching satisfaction in specific ways:

- *[Collaborating with another teacher in my district about STEM has] made it so much more enjoyable. And like I said, when I started here, I had seven different courses I taught, and every single one was different, and honestly, I knew two of them. And it was a nightmare coming to school every day, because I was literally planning, I think the period right before, for that next one, to do it all, and without the collaboration with [this teacher], or anybody else, I probably would've quit my job, because I now have somebody else to bounce ideas off of, or even come up... It's not all on me to come up with the curriculum, even if I'm taking somebody else's, I have somebody else to bounce ideas off of, and it's been amazing. (Teacher, Focus Group)*

- *So it's not only brought the joy back to teaching, but it helped us to bring the joy back to the curriculum. (Teacher, Focus Group)*

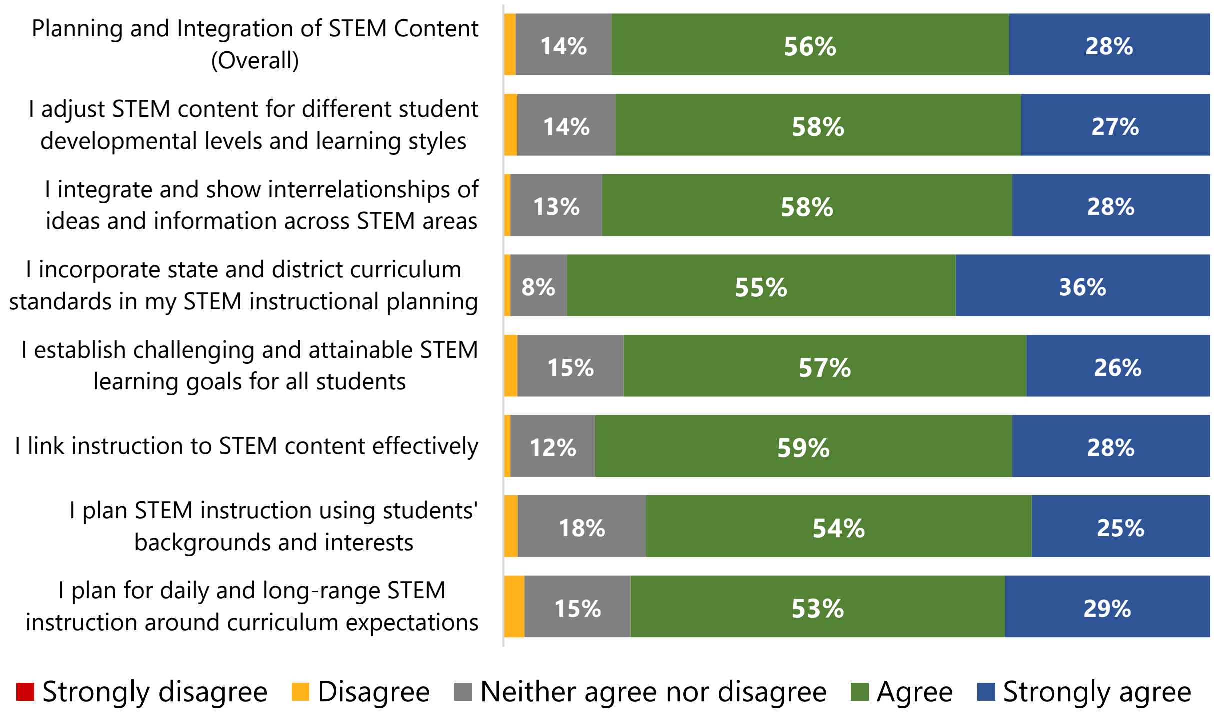
- *I have grown as a teacher and a leader. Our job as a teacher is more enjoyable as I get students thinking and sharing instead of just mimicking the teacher's thinking. I am grateful for the opportunity to have participated in this learning experience ... (Teacher, Survey)*

Educator STEM Planning and Integration of STEM Content.

In addition to being one of the educator outcomes of STEM professional learning activities, the planning and integration of STEM content is one of the core grant focus areas alongside the professional learning opportunities offered through the program and professional learning communities (PLCs). As such, outcomes related to STEM planning and integration were assessed based on educator agreement with statements related to this outcome as well as additional survey items that asked specifically about changes in educators' instructional and planning activities related to STEM content or the integration of STEM. As illustrated in Figure 23, overall, 84% of teachers reported an increase in planning and integration of STEM content due to their participation in STEM professional learning, and item-level agreement ranged from 79% to 91%. According to these survey responses, one of the strengths in relation to this outcome was the ability of educators to incorporate state and district curriculum standards into their STEM instruction. On the other hand, one area of opportunity suggested by educator rates of agreement on the survey was in relation to planning STEM instruction using students' backgrounds and interests, with only about one in four educators strongly agreeing that they do this.

Qualitative data specific to STEM integration was mixed. In some instances, teachers and district specialists described STEM integration as a focus of their PLCs or other professional learning experiences. In one instance, a district specialist reported providing teachers with a course specific to STEM integration, and coaches would support teachers in their STEM integration efforts. In a few instances, teachers described feeling like it was their responsibility to figure out how to integrate STEM content into their instruction. In a similar vein, a different interviewee described relying on informal collaboration opportunities to determine how to integrate their content with other teachers. Another educator described feeling like it was up to teachers to determine how best to integrate their STEM learning with other district instructional initiatives (e.g., LETRS training). In response to interview questions about how teachers in their district integrate STEM, a few educators reported that STEM activities were present in their school. Still, they were described as separate activities that students could engage in outside of traditional classroom time, including clubs (e.g., robotics club). Another interviewee at the secondary level reported feeling like although their school offered a number of math and science courses, the learning from these courses was not necessarily integrated in meaningful ways. On the other hand, one interviewee reported feeling confident that STEM was integrated into classes at her school because they had adopted SEEd standards, suggesting that implementing these standards would result in integrated STEM learning experiences for students. Lastly, a few educators reported wanting more training specific to integration. Together, these qualitative findings suggest that educators were mixed in their perceptions about their ability to effectively integrate STEM, which they often attributed in part to the effectiveness of their professional learning, district support, and time.

Figure 23. Educators' agreement that their participation in STEM PL impacted their integration of STEM content



Note. Excluded labels less than or equal to 3%.

The following quotations provide some additional examples of comments related to how participating in STEM professional learning how increased educators' STEM instruction:

- *I think there's an unspoken expectation that it's fully up to the teacher to integrate learning that you just took from a science training into another area of your school day. For example, I just today went to a science training, and they're talking a lot about using discussion in the classroom and helping the students learn specific vocabulary and beyond for our ELLs. My team, who went with me, we were discussing how that relates to the letters training, the language arts and reading training that we've been doing more recently, and students need a strong understanding of vocabulary in order to progress in their studies. But that was fully just us as teachers. The professor in the class didn't make that connection or discuss that with the class. (Teacher, Focus Group)*

- *And so having access to that sometimes really looks like we are part of their PLC and that comes through professional learning and then the coaching is embedded in that. And so that's where we'll talk about integration. We specifically have a course that talks about integration and they go in and they apply it, do some video reflections, respond back about how they're integrating what that looks like, different kind of stuff or any kind of instruction. (District Specialist, Focus Group)*

- *I think where we're trying to address that is through integration. So trying to show how we can fit STEM and science into literacy, because literacy is obviously hit really hard, especially in our lower grades. And so we're trying to focus on trying to show teachers how to integrate and how to bring those pieces in to make learning more engaging and also to make the PLC cycle more rigorous and student learning where they can really, really define that a student has shown proficiency not only in one core subject at one time, but across content areas. (District Specialist, Focus Group*[1])*

- *In our professional learning courses that we offer teachers after school that our wonderful teachers help co-teach, we ask our teachers. "So what are the challenges you face? Why aren't we teaching science much? What challenges?" And there's three main challenges and they've all been said today. So time, not having the time to teach. And so we combat that with our integration. We understand that time is a struggle and not only within your day, but within your year, you have to get it all in before testing type of thing. So we attack that as professional in our courses and say, hey, let's integrate. Let's use our time more applicable. Let's make sure that we're following the standards so that we're not just doing the fluff because we always have done it for 13 years, that we're actually implementing inquiry-based learning and we're using our time appropriately as much as we can. (District Specialist, Focus Group)*

- *In our school, of course, we have it integrated into every grade, we're teaching the SEEd standards. But additionally, we have a weekly prep. So 45 minutes for our first through sixth, that is what we call our technology prep. Twice a month it's in the computer lab, and twice a month it's in our robotics lab. So coding, robotics, things like that. Green screen, those types of things. We also do the coding week, like code.org week, type things. We have an afterschool robotics camp that goes on. She's done two sessions of it. So the first one was the VEX robotics, and they went and competed. And our team, in fact, my students, so I do have to brag, they took first. So that was quite exciting. And now she's got a second round that are preparing for the Lagoon Physics Day. So we have that going on. Then of course, integrated into all of our classes is, of course we read anything that has to do with science. And we have that integrated into our language arts also. (Teacher Leader, Focus Group)*

- *We are a PLC model school, so we do the professional learning communities often. The way it looks for STEM and science is that we meet together as a science team for seventh grade science, and then we discuss the wants and needs for our kids. And then we also meet together with our sixth grade science team, and then there are certain times where if we have something in our curriculum that we know our STEM teacher can kind of match up with, like Newton's laws, and we do rockets, they make rockets, we go down and have conversations with them about how they can incorporate what we're teaching into what they're teaching. The same as when we're doing our mathematics portion for Newton's laws. We go down and talk to the math teachers and ask them what do they know, what should they know? Here's what we're doing, how can we incorporate that in there? So, there's a little bit of that cross-*

[1]We note that the two starred comments above were made by the same interviewee.

curricular action that we try to put into our classrooms, and we do the best we can. It's not always a perfect balance, but we do meet with the other departments within our school to make sure that the kids are getting everything that they can from all of us. (Teacher, Focus Group)

- *I know our district, I'm sorry, I can only talk to the math, but our district does do a science math Olympiad in the spring. It's usually at the end of the year towards May, but they do some teams, each school can send teams fourth, fifth, and sixth graders. They do math games like crypto and sets, and it changes every year, tangrams and different things like that, but this year, it's Sphero for the STEM or the science side, there's STEM ping pong circuits, and they can send teams, two to three people per grade level, and then it's like you win certain rounds and then top ones get these little medals and stuff. So they do promote some things like that that. Some do it through clubs, some do it through grade levels, different way, each school is in charge of how they run it, but that's a really fun thing that we do. (District Specialist, Focus Group)*

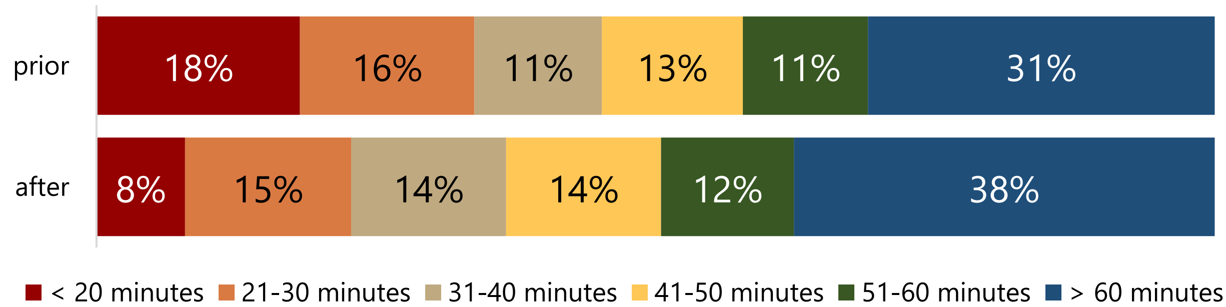
- *Elementary was just what I said earlier, the one-year plan on and on and on. But we had Google Forms, or not forms, just slideshows basically, but they were different for each group. So each group was filling them out for what we thought would be necessary to integrate, as far as math and science as we moved forward. So that's about as far as we got though. We didn't get to go back and look at everything everybody else put yet. I assume that's next, and then we'll move from there to see how to help our schools integrate it starting next year. (Teacher Leader, Focus Group)*

- *Right at the beginning of the meeting, before you even started recording, you were talking about how part of this interview is for support. Like I said, I think I just wish that we had more training. I think that's the biggest thing, is just more opportunities to know how to integrate STEM because I think we have the electives. We have the math courses. We have the science courses and everything, but knowing how to actually integrate it into our lessons, I think is a place where I feel like I'm lacking. (Teacher, Focus Group)*

Educator Reports of Changes to STEM Instructional Time

As previously noted, in addition to survey items asking educators to rate the extent to which they agreed that participation in STEM professional learning led to specific changes in their STEM instructional time, survey respondents were also asked to share how many minutes of daily instructional time they spend on STEM instruction before and after participation in STEM professional learning activities. Specifically, respondents were asked to estimate the amount of time per day they spent engaging their students in instruction that integrates science, technology, engineering, and/or mathematics on the following scale: (1) < 20 minutes, (2) 21-30 minutes, (3) 31-40 minutes, (4) 41-50 minutes, (5) 51-60 minutes, and (6) > 60 minutes. As is shown in Figure 24, there were noticeable changes in the percentage of educators at the high and low ends of the scale after participation. More specifically, the results show that after participating, 7% more of the educators reported spending more than an hour per day on STEM instruction, and 11% fewer reported spending less than 20 minutes per day.

Figure 24. Time spent on daily STEM instruction by teachers prior to and after participating in STEM professional learning



In addition to changes in the percentages across these instructional groups for this sample overall, changes in the duration of daily STEM instruction before and participation in STEM professional learning activities were also explored at the level of individual educators. More specifically, educator responses were reviewed to determine the percentage of educators who reported increasing, decreasing, or not changing the number of minutes spent on STEM instruction per day based on the scale mentioned above. As shown in Figure 25., these results indicate that more than a third, or 37%, of the educators reported increasing the amount of time they dedicated to STEM instruction. However, when we consider those educators who did not report spending more than an hour on STEM instruction daily prior to participating in professional learning (i.e., those who could report an increase in the amount of time), the percentage of educators who could have reported increasing the duration of their daily STEM instruction and did so increases to 53% (see Figure 26.).

Figure 25. Reported changes in teachers' daily STEM instructional time as a result of their participation STEM professional learning

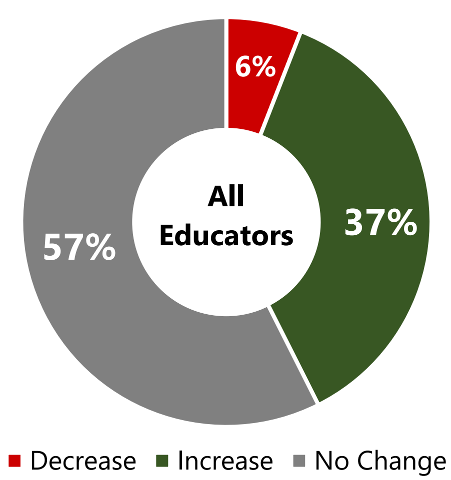
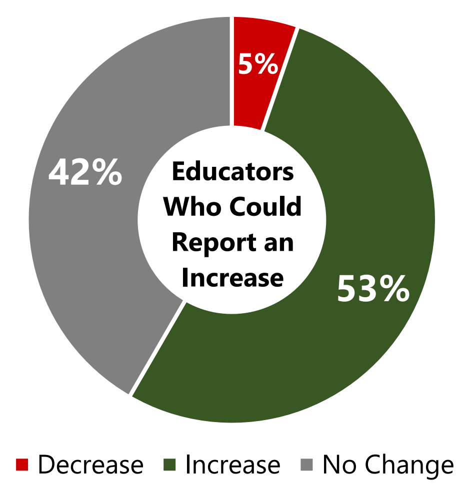


Figure 26. Reported changes for those who did not report spending more than an hour per day on STEM instruction prior to participating in professional learning activities



Comparing Educator Outcomes based on Video-Based Peer- and Self-Reflection and TeachFX Engagement

The use of TeachFX and engagement in video-based peer- and self-reflection were specific professional learning activities that educators from across sites might have participated in as a part of grant activities. These activities generally provided educators with opportunities to collect data and engage in reflective practice related to their STEM instruction. As noted in earlier discussion, survey data from grant administrators suggested that more educators were expected to engage in video-based self- and peer-reflection as a part of grant activities than were expected to engage in TeachFX.

Table 11. Percentage of educators reporting engaging in video-based peer- and self-reflection and Using TeachFX

Professional Learning Activity	Percent of Educators
Video-based self-reflection	62%
Video-based peer-reflection	42%
TeachFX	26%

As is shown above in Table 11, the actual rates of educator engagement in video-based peer- and self-reflection are notably higher than that of TeachFX. More specifically, 62% and 42% of educators reported engaging in video-based self-reflection and peer-reflection, respectively. In open-ended survey items, relatively few participants shared their perceptions about video-based self- and peer-reflection, but those who did mostly described these activities positively, naming increased awareness about the quality of their instruction as the primary positive outcome.

Despite the lower rates of educator engagement in TeachFX found based on educators' survey responses, in many instances, comments in the open-ended survey items related to recording and reflecting on instruction were linked to teachers' usage of TeachFX, which we present additional findings about below. Educators who reported that they did not engage in video-based self-reflection frequently reported that they did not know or feel that this activity was necessary. In one instance, an educator explained that they did not want a recording of their instruction to be "used against" them. Also, educators who reported that they did not engage in video-based peer reflection also frequently said they were unaware that they were "supposed to." Some respondents also explained that they did not participate because they were already observed by a peer or coach in person, and/or would prefer a live to a recorded observation. A few respondents reported not having a peer to reflect with.

The following quotes are examples of teachers' perceptions of the impact of participating in video-based observation activities along with examples of teachers' explanations about why they did not participate:

- *After videoing myself and reflection on it, I feel like I have a better grasp on the concepts and can effectively teach it to my class! 80% of my class was proficient on the RISE test at the end of the year! (Educator, Survey)*

- *I have loved using TeachFX. I feel like it gives me immediate feedback that I can self reflect. It also helped me become more conscious while I was recording a lesson to try using better strategies. These strategies have now become more second nature. (Educator, Survey)*

- *Being able to record myself while I am teaching has helped me be more aware of strategies that I need to work on and recognize what my strengths are. (Educator, Survey)*

- *I learned that self reflection is important as it lets me be more aware in the classroom of how clear, and positive I am being as a teacher. (Educator, Survey)*

- *The collaboration strength is to be willing to share the outcomes of a STEM lesson even when it didn't go so well. I became a risk-taker after I videoed and shared feedback with my colleagues on ways I wanted to improve after watching myself. (Educator, Survey)*

- *We were encouraged to watch each other do a number talk. I never made it to another school. (I'm the only math teacher at my school). However, I believe that watching each other and then discussing how it went would have been good. Since it was hard for me to leave school, maybe we could have recorded a number talk and then watched it together. (Educator, Survey)*

- *I have to do video reflections and I don't love those. (Educator, Survey)*

- *I was able to participate with peers in real time (live) reflection focusing on student understanding. (Educator, Survey)*

- *I participated in self-reflection and talked with a coach about it instead. (Educator, Survey)*

When educators who indicated that they did not participate in video-based <u>self-reflection/peer-reflection</u> were asked why, some individuals stated the following:

- *I was not asked to. (Educator, Survey)*

- *I didn't know about this. (Educator, Survey)*

- *We watched each other live - we weren't asked to. (Educator, Survey)*

- *The idea did not come to my mind, nor was it suggested by my PLC (Educator, Survey)*

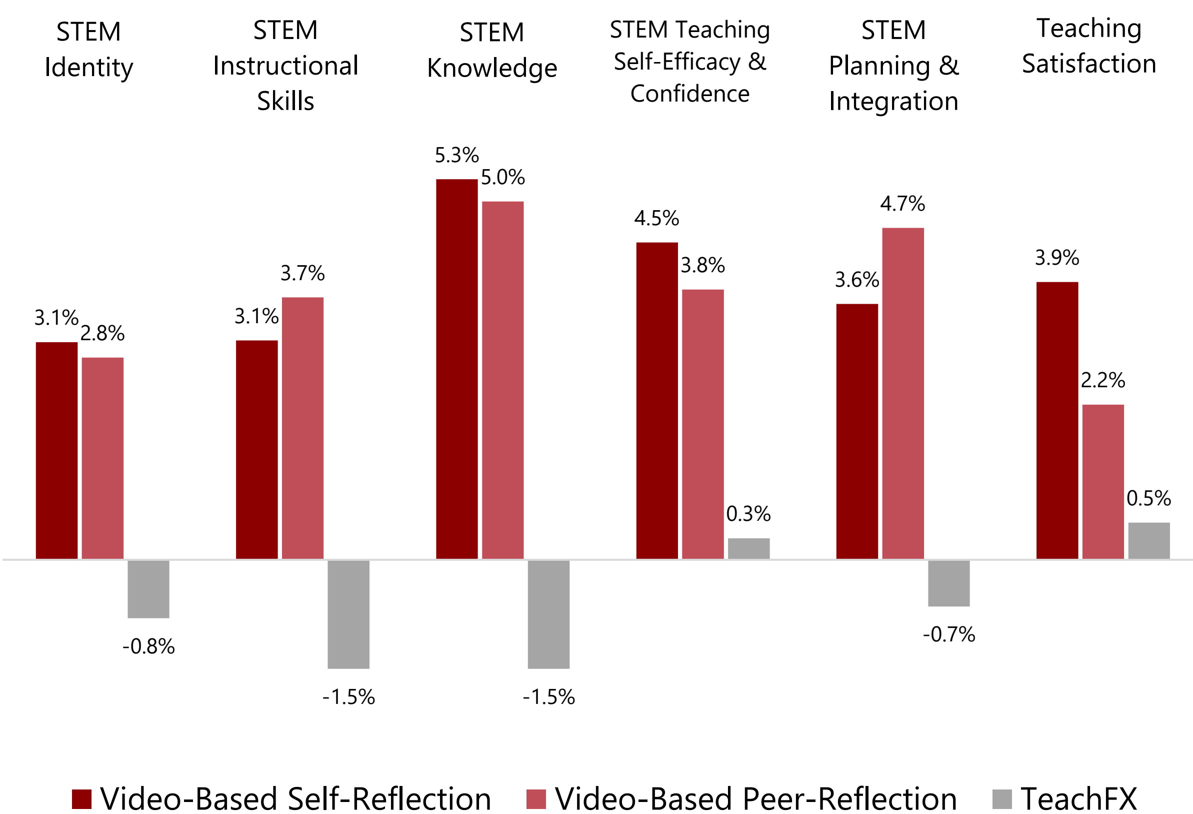
- *Time was taken with other trainings (Educator, Survey)*

- *I had no one to peer-reflect with (Educator, Survey)*

Differences in Educator Outcomes Between Those Who Did and Did Not Engage in Video-Based Self- & Peer-Reflection and TeachFX Professional Learning Activities.

In addition to the perceived impacts of participating in these professional learning activities expressed by educators and outlined above, specific differences in the overall agreement between those who did and did not participate in these activities were also explored. Figure 27. shows differences in overall agreement for target educator outcomes based on whether respondents indicated that they did or did not engage in video-based self- and peer-reflection and TeachFX professional learning activities. Positive differences mean that the educators who reported participating in the specific professional learning activity (e.g., engaging in video-based peer reflection) had a higher overall agreement that their participation in STEM professional learning promoted the target outcome. As is indicated in the figure, differences between groups of educators who did and did not engage in these specific activities ranged from a difference of -1.5% to a difference of 5.3%. Furthermore, an analysis of data show that the magnitude of differences is generally greater and more positive for video-based peer- and self-reflection compared to TeachFX. These results suggest that whether educators did or did not engage in professional learning activities using TeachFX has less impact on the target outcomes compared to engaging or not engaging in video-based self- or peer-reflection. Furthermore, the results do not indicate any specific patterns related to whether self-reflection or peer-reflection led to more positive self-reported outcomes among educators.

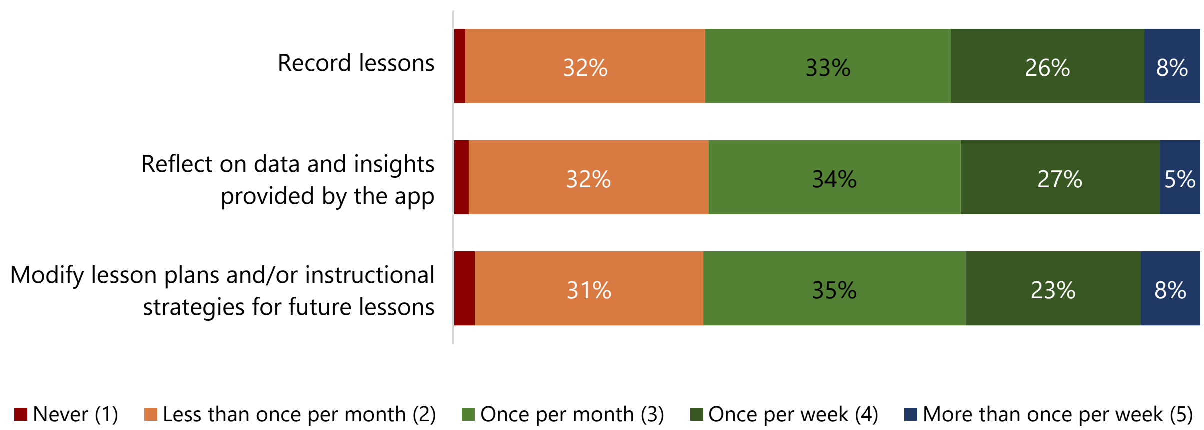
Figure 27. Differences in overall educator agreement for target outcomes based on whether they did or did not engage in video-based self- and peer-reflection and TeachFX professional learning activities



Since TeachFX was new this year and little is known about the frequency of usage across sites, additional items were asked to better understand the frequency and nature of educators' engagement in STEM professional learning using this tool. Specifically, educators were asked to indicate the frequency with which they used TeachFX to record their lessons, reflect on data and insights provided by the app, and modify lesson plans and/or instructional strategies for future lessons on the following scale: (1) never, (2) less than once per month, (3) once per month, (4) once per week, and (5) more than once per week. Figure

28. shows the percentages of educators who reported using TeachFX with these frequencies for each of the three uses. These findings suggest that there are no notable differences in the frequencies with which educators are using TeachFX to record their lessons, reflect on data and insights provided by the app, and modify lesson plans and/or instructional strategies for future lessons. Instead, this implies that educators who reported using this app are engaging such that they complete the full data collection, reflection, and modification cycle when they are using this tool. This and comments from a couple of educators who noted how useful the app was for gathering data and providing meaningful information with "incredible ease" tentatively suggest that one of the advantages of this tool is the ease with which it allows educators to engage in targeted reflection to inform changes to their instructional practices.

Figure 28. Educator reports of the frequency with which they have used TeachFX to record their lessons, reflect on their instruction, and modify their instructional practices during the 2022-23 academic year

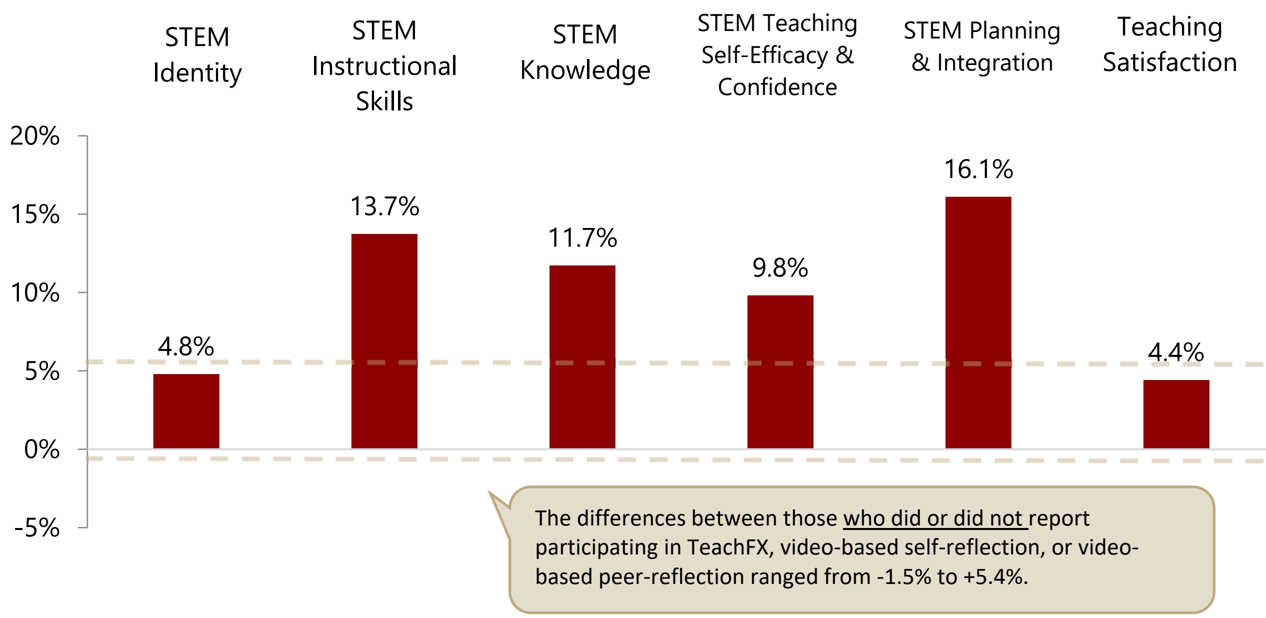


Note. Excluded labels are less than or equal to 3%.

Collecting additional data about the frequency of TeachFX usage allowed for further investigation into how the frequency of engagement impacted educators' self-reported outcomes. More specifically, data was disaggregated to investigate the differences in agreement between those educators who reported high usage of TeachFX and those who reported using the app but less frequently. Since TeachFX is a relatively new professional learning tool and has yet to establish specific guidelines related to the frequency with which educators should utilize the platform as a part of their professional learning, our team consulted with STEM Action Center to identify an operational definition of "high" usage of the app in this first year of adoption. Staff at STEM AC asked their contacts at TeachFX about the recommended frequency of usage. Although TeachFX staff expressed that it would be ideal for educators to use TeachFX weekly since the app has only recently started being used by educators throughout the state, and many are still figuring out how to use this tool and integrate it into their regular professional learning and work practices, high usage in the current context is more likely to mean that educators are using this platform at least once per month. As such, the decision was made to operationalize high usage of TeachFX for the 2022-23 academic year by using TeachFX *at least once per month* to record lessons, engage in reflection using the data and insights provided by the app, and modify lesson plans and instructional strategies. Only when educators indicated that they did all three of these things at least once per month or more were they considered to engage in high usage of the app.

Of those educators who reported using TeachFX at least one time for STEM professional learning over the course of the year and provided data about their frequency of usage (N=240), 61% or 147 educators reported high usage according to our operational definition and 39% or 93 educators did not. Figure 29. shows the differences in overall educator agreement for target outcomes based on whether they used TeachFX with high or low frequency. Similar to the differences in Figure 27. (see prior section), positive differences in this context mean that the group of educators who reported high usage of TeachFX had a higher overall agreement that their participation in STEM professional learning promoted the target outcome in comparison to those who used TeachFX but with less consistency.

Figure 29. Differences in overall educator agreement for target outcomes based on whether they used TeachFX with high or low frequency.



As is shown, differences between groups of educators who used TeachFX with high frequency and those who did not range from a difference of +4.4% to a difference of +16.1%. The magnitude of these differences is considerably higher than the differences observed when simply looking at differences between those who used TeachFX and those who did not (range of differences: -1.5% to +0.5%). Furthermore, the magnitude of the differences between those who did and did not use video-based self- and peer reflection (ranges of differences: +3.1% to +5.3% and +2.2% to +5.0%, respectively) were also considerable smaller than the differences when looking at these differences. The full range for the differences for usage or no usage, previously displayed in Figure 27. (see section above), are indicated with the tan dotted lines in the figure above for reference. These results suggest that the frequency and consistency of usage is an important factor in leveraging TeachFX to support STEM professional learning. Whether similar patterns occur in relation to educator usage of video-based self- and peer-reflection warrants further investigation. Furthermore, as more educators start integrating TeachFX as a part of their STEM professional learning in the coming years, it will be important to investigate what specific frequencies of usage might serve as a meaningful threshold for promoting specific educator outcomes and how might these practices be built into educator professional learning experiences through the grant.

In open-ended survey responses, some educators commented on the value of using TeachFX, particularly in terms of helping them reflect on their practice, implement new strategies, and increase student discourse:

- *I have a better talk ratio with my classes due to using TeachFX. (Educator, Survey)*
- *TeachFX has especially been helpful. Being able to see different things like how much I talk vs. my students, what kinds of questions I ask and what kinds of answer they give, all with incredible ease and no need to fast forward and "find places" has finally helped me really be aware of some of my practices and work on them. (Educator, Survey)*
- *I have been trying to use TeachFX to help me visualize my teaching style. I have been specifically trying to improve my questioning technique and allowing more discussion in class. TeachFX was very useful in gathering data. (Educator, Survey)*
- *I have been able to create lots of goals to reflect on myself that teachfx helped with. (Educator, Survey)*
- *I think more about questioning that I use with the students. I've made this a part of my lesson planning because of using Teachfx. (Educator, Survey)*
- *TeachFX was a great resource for improving math discourse. (Educator, Survey)*
- *TeachFX is a great tool that I am glad to know about. (Educator, Survey)*

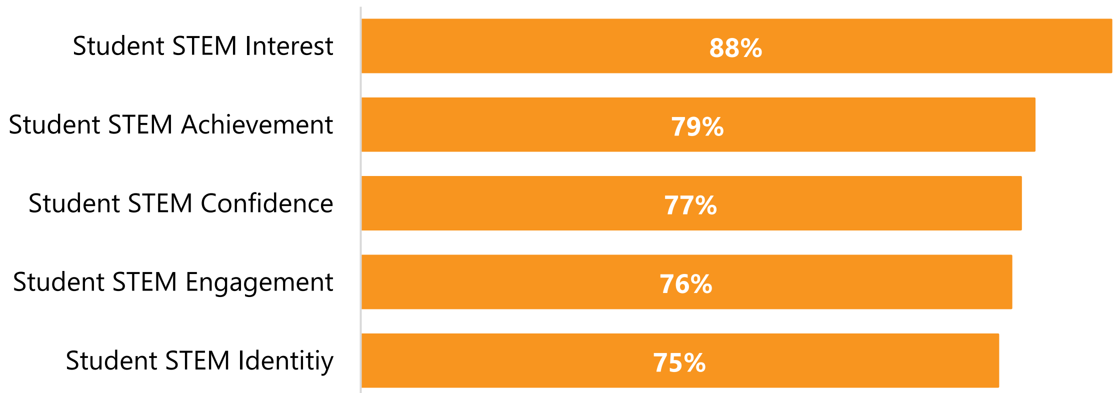
Educator Perceptions of Student Outcomes

In addition to providing ratings related to their outcomes, educators were also asked to provide their perceptions of how their participation in STEM professional learning activities through the grant, and by extension, the instructional changes they have implemented, have impacted their students. These perceived impacts were reported in relation to five categories: STEM interest, achievement, confidence, engagement, and identity. Each student outcome was measured using four to twelve items that were rated on a five-point scale ranging from "strongly disagree (1)" to "strongly agree (5)." Educators' overall agreement that their STEM professional learning experience impacted their students in relation to these five target outcomes was computed in the same way comparable statistics were computed for their outcomes. Representative quotes from qualitative data analysis and themes are included to provide specific examples of how educators believed participating in grant activities impacted their students. As was the case with the educator outcomes of interest, it is important to ask how interrelated these constructs are as well as their limitations in that they are only educator perceptions and not direct measures of student outcomes. Additional details and findings related to these target outcomes for the students of educators who have participated in STEM professional learning are included in the sections that follow.

Comparing Educator Agreement Across Six Student Outcome Areas

As shown in Figure 30., educator perceptions that their STEM professional learning impact their students' STEM interest, achievement, confidence, engagement, and identity were moderate overall. Overall agreement ranged from 75% to 88% across the target outcomes. Furthermore, the results suggest that educators perceived that their participation in grant activities had a relatively higher impact on their ability to increase their students' interest in STEM (88% agreement), which was 9% higher than the next highest target outcome (i.e., student STEM achievement at 79% agreement). Educators rated the impact of their engagement on students' STEM identity as low in relation to the other outcomes (75% agreement). In the sections that follow, the results for specific items within these measures will be discussed to provide more detailed information about particular ways educators feel better able to promote specific STEM-related outcomes in their students and which might require additional support.

Figure 30. Educator agreement that student outcomes were impacted by their STEM professional learning

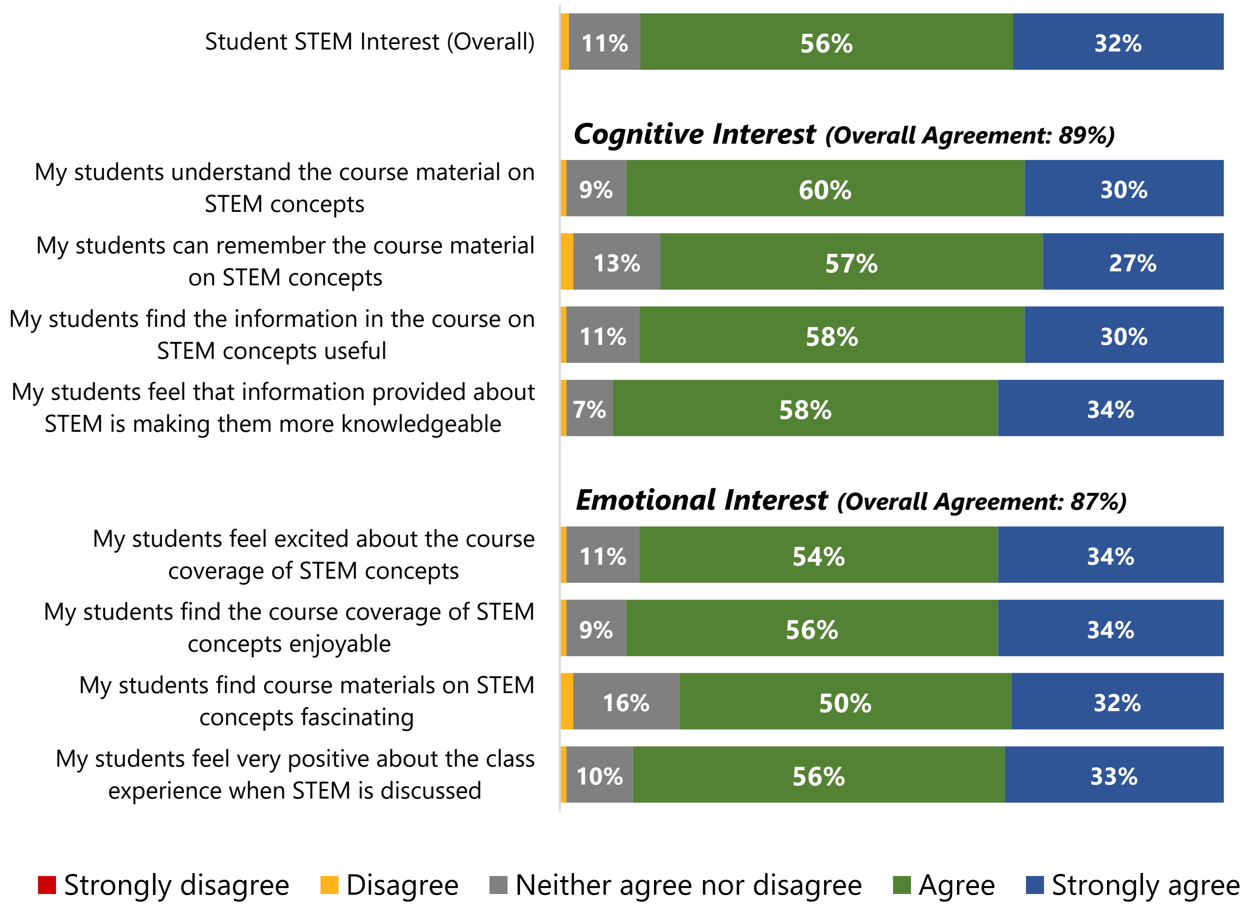


Educator Perceptions of Student STEM Interest.

To estimate educator perceptions of student STEM interest resulting from their participation in grant activities, survey respondents were asked items that targeted cognitive and emotional interest perceptions. Each of these sub-components of STEM interest was measured by four items – i.e., cognitive interest by the first four and emotional interest by the last. As the item prompts show, cognitive interest was related to educator perceptions of the extent to which students found STEM concepts useful, made them feel more knowledgeable overall, and can understand and remember course materials related to STEM content. On the other hand, emotional interest was related to educators' perceptions that their students were excited to cover STEM content, had positive experiences during STEM lessons, and found course coverage of STEM content fascinating and enjoyable. As shown in Figure 31., educator agreement across all items on this measure was approximately 88%, with item-level agreement ranging from 82% to 92%. Furthermore, educators agreed most that their participation in STEM professional learning increased their students' STEM interest by making them more knowledgeable (92% agreement); however, there was relatively low agreement among educators about whether their participation in STEM professional learning resulted in their students finding course materials on STEM concepts fascinating (82%).

Educator responses to the survey showed no notable differences in relation to educators' overall agreement across these two sub-components, with 89% agreement overall for cognitive interest and 87% agreement for emotional interest. However, qualitative data from focus groups and open-ended survey responses suggested that many teachers believed their students demonstrated an increased interest in STEM as a result of teachers' professional learning experiences and primarily conceptualized this interest in terms of emotional interest. More specifically, teachers commented that their students demonstrated interest in STEM topics outside of the classroom and reported that STEM subject areas had become some students' "favorite" classes, even if students had previously disliked the content area.

Figure 31. Educator perceptions of student STEM interest, overall and by item



Note. Excluded labels less than or equal to 2%.

The following quotes provide specific examples of statements participating educators made about how they felt participating in STEM professional learning increased STEM interest among their students:

- *But [an impact is] also just that the kids were very engaged in a classroom where the engagement of what they thought was engaging of, hey, you watched us do this. It was so fun. We watched a movie too, them owning their knowledge and coming back and being like, hey, they were so excited they went and tried to figure out this on their own at their own time. They went home and tried to search the phenomenon or that's the kind of stuff we'll hear about. (District Specialist, Focus Group)*

- *I've had a remarkably large amount of students who have said, "I used to hate science, but I like it now." And whenever we have our parent teacher conferences, we only have them two days once a year. We always have just tons of parents lined up at the door because they want to come in, because science is their favorite class. So I've asked several students, "Why is* *science your favorite?" "Because you don't just teach us from a textbook, we get to experience science, we get to do projects, we get to put hands on things, we get to build things." So we make sure that we are really intentional to put those science and engineering practices into the lessons, and when we collaborate, we talk about those practices, and the kids respond to it. They enjoy coming to science. They oftentimes say that it's one of their favorite subjects, and if they ever have to miss, they don't missing science class. They'll rather be pulled from their math, or their language arts, or any other class, but they don't ever want to be pulled out of their science class to go and do testing, or other things. (Teacher, Focus Group)*

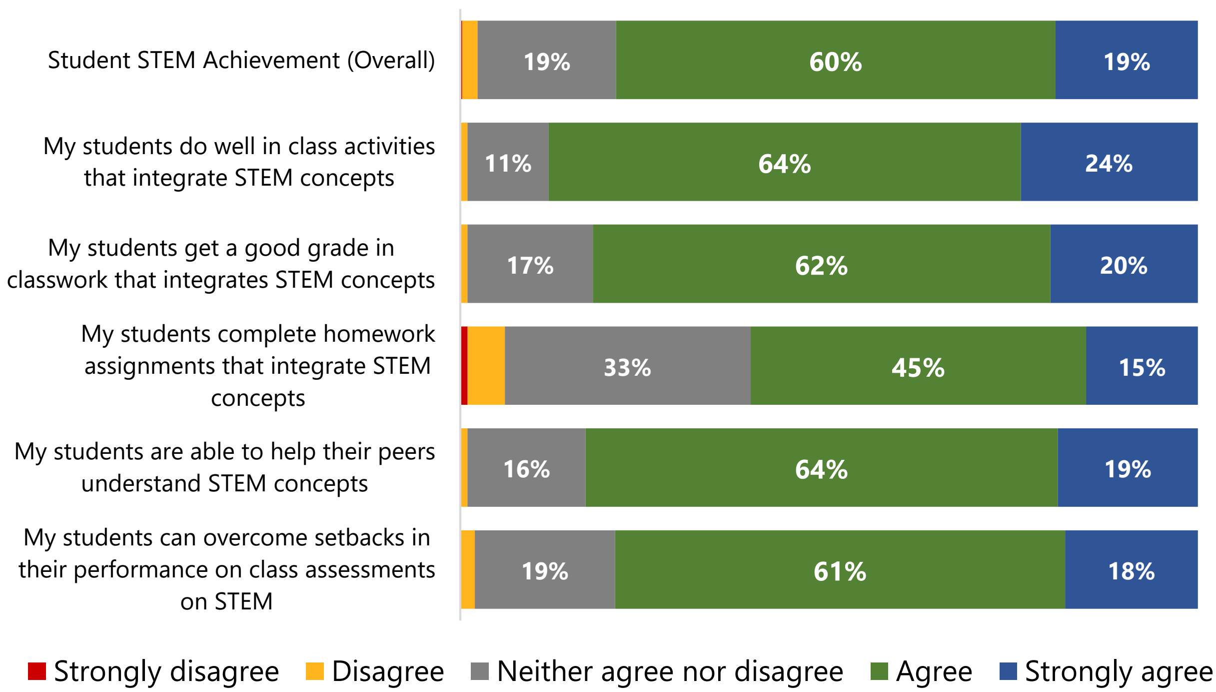
- *I feel like I have seen a shift. I have had so many students and parents this year send me, I have a whole file of lists or emails from parents who have said my kids have never loved math and now, that's their favorite class. They come home and they tell me the tasks that you've done. They ask if I can figure them out, and so that, to me, has been one huge thing that I've seen. (Teacher, Focus Group)*
- *Students are enjoying the activities related to math fluency. (Educator, Survey)*
- *Dot talks and number talks have become part of our everyday classroom routines. Students enjoy looking at numbers in different ways. (Educator, Survey)*
- *I have seen students more excited about learning and excited to engage in the topics. (Instructional Coach, Survey)*
- *Having students become engaged in 3D printing and designing. Students were resistant in the beginning but are now excited to create things. (Educator, Survey)*
- *One success that I have experienced is that my students interests in STEM have grown and they say Math and Science are their favorite subjects. (Educator, Survey)*

Educator Perceptions of Student STEM Achievement.

The next target outcome for students that educators were asked about was the extent to which they believed their participation in grant activities led to increased STEM achievement among their students. This outcome was measured using five items that focused on how well students perform on classwork and during in-class activities that integrate STEM concepts, can assist their peers in understanding STEM concepts, complete their homework that integrates STEM concepts, and overcome setbacks in their performance on class-based assessments related to STEM. Although most educators (79%) indicated that they agreed that student STEM achievement had improved as a result of their participation, particularly in relation to the abilities of their students to successfully engage in in-class activities that integrate STEM (85% item-level agreement, see
Figure 32.).

These survey findings were supported by qualitative data from focus groups and open-ended survey items related to student achievement, which suggested that many teachers believed that students' achievement had increased as a result of teachers' professional learning experiences. Specifically, educators described their students as having a deeper understanding of STEM topics, a greater ability to engage in discussions and discourse related to STEM, and increased scores on standardized assessments. A secondary teacher leader reported that she could tell the difference between students who had engaged in the specific learning approaches endorsed in grant activities in elementary school because they came to her class with higher achievement and increased strength of academic discourse. In relation to challenges or opportunities for additional support, only 60% of educators agreed that their students complete homework assignments that integrate STEM topics. Furthermore, additional research should be done to determine whether educator perceptions of student outcomes align with directly measurable differences in the academic performances of students whose teachers did participate in STEM professional learning through the grant and those who did not.

Figure 32. Educator perceptions of student STEM achievement, overall and by item



Note. Excluded labels less than or equal to 5%.

The following are examples of comments made by participating educators about how they believed participating in STEM professional learning increased the STEM achievement of their students:

- *My overall math scores are much higher than in previous years, and I feel my students grasp the concepts I've taught and have much better math sense since I've taken the Number Sense class. (Educator, Survey)*
- *I have learned ways to make my math instruction stronger and my student's understanding deeper. (Instructional Coach, Survey)*
- *My students' math scores increased significantly. (Educator, Survey)*

- *Students' ability to converse about math has increased. (Educator, Survey)*

- *My students were positively impacted in their ability to solve application problems by the math Impact professional learning my team participated in. They are excellent at word problems now... My students have grown in their ability to estimate throughout the year as I've applied what learned. Furthermore, they have grown comfortable analyzing their own mathwork and the work of others and explaining and defending their thinking to their peers in both partnerships and large group settings. (Educator, Survey)*

- *This program is amazing at getting students to share their ideas and understanding and to grow and learn from each other. Any student at any level of understanding can participate and increase their understanding in how multiplication works and what it represents. (Educator, Survey)*

- *My students were really struggling to apply multiplication to word problems. This program has helped build an understanding of how multiplication works and what it represents helping them to be more successful. (Educator, Survey)*

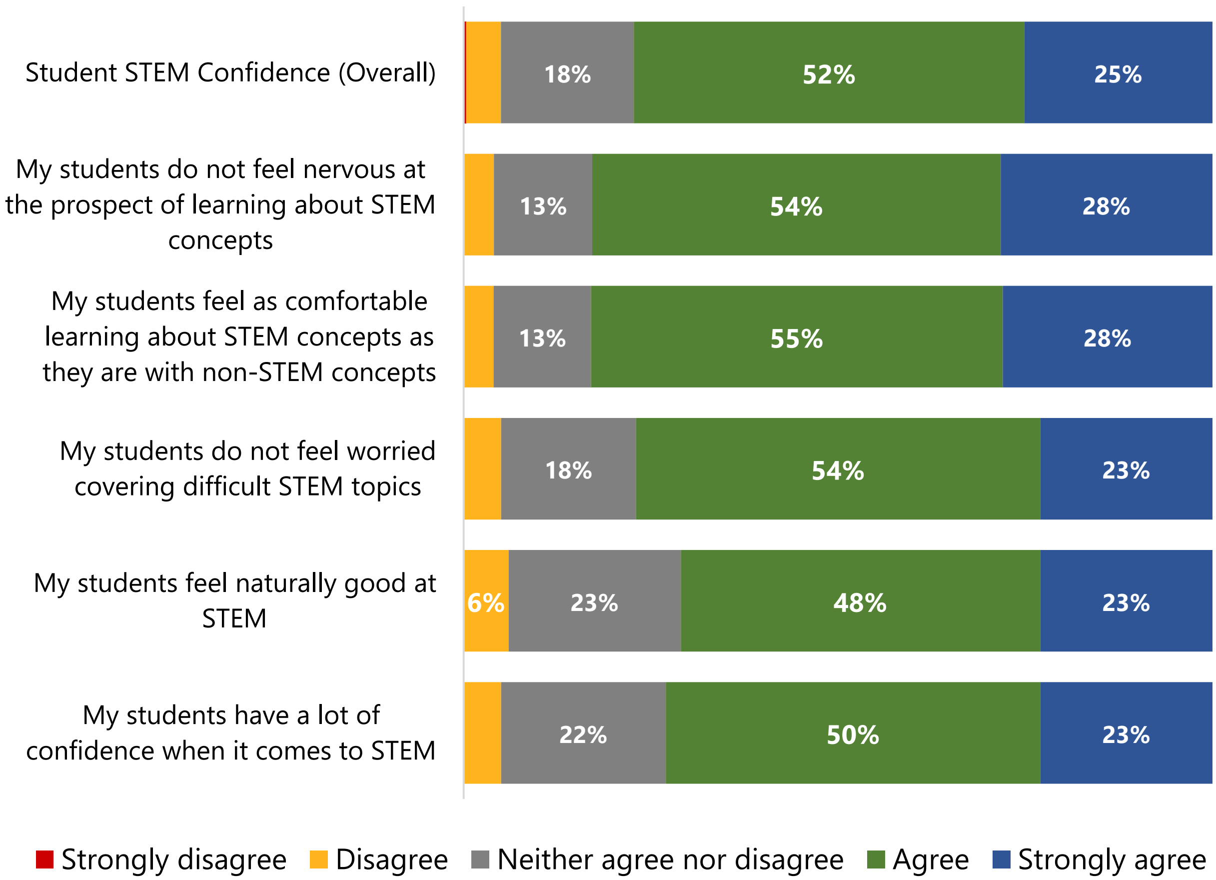
- *My students are able to communicate their mathematical thinking in a more clear and concise way. They have better mental math skills, as well. (Educator, Survey)*

- *I've noticed the students that come to me from elementaries who have engaged in these practices before are ahead of the ones who haven't. And you can tell the difference because in their language, in the science classroom, the way they speak. (Teacher Leader, Focus Group)*

Educator Perceptions of Student STEM Confidence.
The next target outcome for students was related to their STEM confidence, or how comfortable educators felt students were when learning STEM-related content. Educators' survey responses show that approximately 77% of educators agreed (52%) or strongly agreed (25%) with items related to their students' STEM confidence (see Figure 33).

Focus groups and open-ended survey responses also suggested that teachers believed their students' confidence had increased as a result of teachers' participation in STEM professional learning experiences. In many instances, teachers made general statements about confidence increases (e.g., "I've seen my kids' confidence really improve"). In other cases, teachers named specific skills that students seemed more confident in executing STEM-related tasks, including their ability to think critically, analyze their work, engage in discourse related to the STEM content area, complete tasks independently, and defend their thinking. One teacher reported that students' increased confidence in STEM carried over into other content areas. This finding aligns with educator survey responses, which indicate that they agreed most that their participation in STEM professional learning led to improvements in student confidence such that their students seemed to feel as comfortable learning about STEM concepts as they did with non-STEM concepts (83%) and do not seem to be nervous about learning STEM topics (82%). Related to confidence, in their open-ended survey responses and during focus group discussions, teachers also reported seeing shifts in their students' comfort in engaging in a variety of activities, including sharing in class discussions and taking on new challenges.

Figure 33. Educator perceptions of student STEM confidence, overall and by item



Note. Excluded labels less than or equal to 5%.

The following quotes highlight some examples of statements participating educators made about perceived increases to their students' STEM confidence:

- *I've seen kids' confidence really improve. (Teacher Leader, Focus Group)*
- *And so we're seeing that confidence that they've gained in STEM and science carrying over into other areas, and we've seen just the confidence in their own abilities go up. And I think it's translating into better quality in work and better scores on tests and things like that because they can see themselves in that role and are able to say, okay, I can do this. It's not hard. (District Specialist, Focus Group)*
- *My students' confidence in their ability to talk about math and their critical thinking has skyrocketed since beginning with the group. (Educator, Survey)*

- *Students feel more confident in completing non-curricular tasks independently. (Educator, Survey)*

- *I have another student who came in feeling "dumb" and now has great confidence in math (which has bled over to her ELA work). She has so much more joy in school. (Educator, Survey)*

- *I have seen my students not only grow, but enjoy learning and persevering. I see a vast improvement in my state testing scores that lead me to believe my instruction was more effective and that they are not as intimidated by the subject matter. (Educator, Survey)*

- *I have learned new STEM related strategies that I have been able to use in my classroom, particularly the strategies I learned during my Number Talks PD. This allowed students to find multiple ways to solve problems and stretch their math thinking. It also got all students, regardless of level of math confidence, talking about math. (Educator, Survey)*

- *Number talks have given my lower students confidence to speak up and share in class. (Educator, Survey)*

- *I loved integrating the math number sense class into my program. I feel it helped my students have more number sense and feel confident in their math abilities. (Educator, Survey)*

- *Students are able to write their own math word problems and also explain the appropriate strategies of solving the problems in Chinese confidently. (Educator, Survey)*

- *Had students be more comfortable with different ways of approaching math and communicating their thoughts. (Educator, Survey)*

- *Due to the use of technology, more students feel comfortable at taking up STEM challenges (Educator, Survey)*

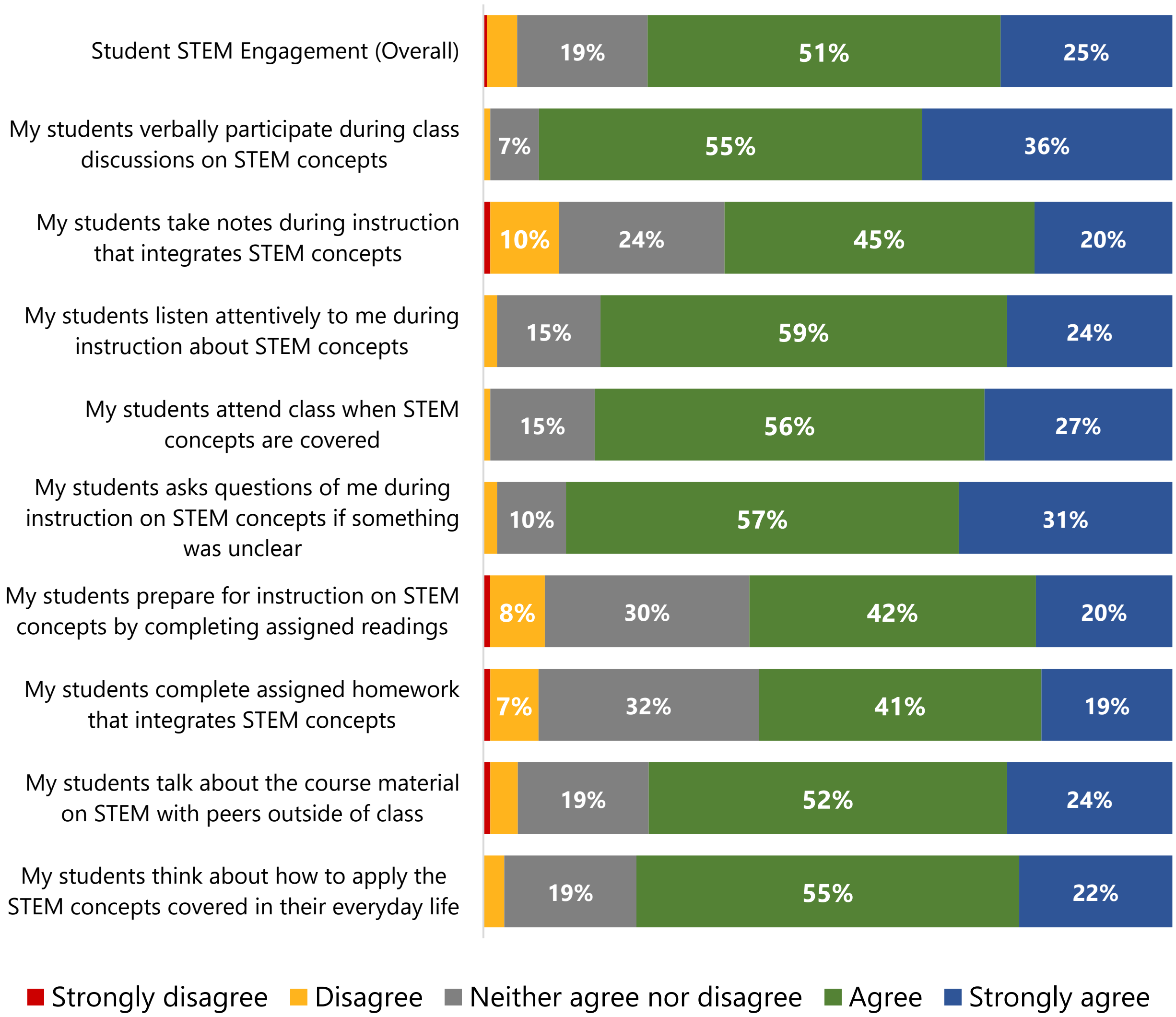
- *Students have begun to feel more comfortable contributing to classroom discussions. (Educator, Survey)*

Educator Perceptions of Student STEM Engagement.

The next student outcome of interest, STEM engagement, was measured using nine items that broadly described how students engaged during lessons that covered or integrated STEM content; for example, attending class, verbally participating, taking notes, and asking the teacher for clarification. However, some were also related to engagement with STEM concepts outside of class: completion of pre-readings and homework in advance of lessons with STEM content, talking to others outside of class about STEM, and thinking about how to apply STEM concepts to their daily life. As shown in Figure 34, approximately three out of four educators perceived their participation in STEM professional learning led to increased STEM engagement among their students. Item-level agreement showed that 91% of educators reported that their students are more engaged with classroom discussions of STEM topics.

Furthermore, qualitative data suggests that educators' reports of increased student engagement were often linked to teachers' use of new instructional strategies as a result of their professional learning experiences. For example, an interviewee noted increases in engagement and student interest after she made shifts to empower students as the experts, which included letting students, as opposed to the teacher, "talk it out." Another educator described seeing increases in engagement after providing students opportunities to engage in projects that provided real-life application and opportunities to "think outside the box" and to "unleash the kids and see what they come up with." Another interviewee also noted a link between students' engagement in hands-on activities and their improved self-esteem and confidence to succeed at something difficult. In open-ended survey responses, educators reported that some students' participation in class discussions had increased and that students were taking greater ownership of their STEM learning. However, in relation to areas for potential improvement, item-level statistics show that more than 38% of educators did not think that their participation in grant activities led to increased student engagement in relation to pre-reading assignments and homework related to STEM content or via note-taking during instruction.

Figure 34. Educator perceptions of student STEM engagement, overall and by item



Note. Excluded labels less than or equal to 4%.

The following quotes provide specific examples of statements participating educators made about how they felt participating in STEM professional learning increased STEM engagement among their students:

- *If we're letting kids be the experts and we're letting kids talk it out, I don't have to sit and plan all these things to keep everyone busy for an hour and 20 minutes and I also don't have to sit and grade all that stuff that I gave them to keep them busy. So again, I feel like it's twofold, but it's made my life easier and I'm seeing a bigger output from my students about what they're enjoying and how they're loving to learn math. (Teacher, Focus Group)*

- *I've noticed an increase on the student thinking, student sense-making, reasoning, the discussions, they're driving them... I've gone online and found a couple websites that really focus on unique data charts, graphs, those types of things... we do data analysis, just straight teaching them strategies of how to analyze data. And I've really seen an increase on students making sense of data... But it's really interesting to start to see students really start to make sense of unique graphs and data and charts. And what is it saying, but also what is it not saying? What's actually there, and then what's it saying because it's not saying something. So that's been really interesting to see them make these patterns, and start using data language and statistics language. (Teacher Leader, Focus Group)*

- *I think that it's had a positive impact overall on students. There are some students who I would say still struggle staying on task just because they're on a computer or on a device or doing some big engineering project, and so they're automatically distracted, sometimes just having a device in front of them for some of those. But I think overall, the STEM focus and the PLCs that we've had have really improved how the students are, like it's improved how they're learning the strands and standards so that they can actually learn how they're applied in real life and not just on paper or it's really helped in their problem solving situations. And just those abilities to problem solve and think outside the box has been really fun in a lot of projects to just unleash the kids and see what they come up with and to see how creative they are when they're taking these things that they've learned and how they can apply them now. Whereas before, a lot of it was very structured and answer these questions on this paper and then we're going to do this activity, but it was nothing compared to some of the projects that we're doing now. (Teacher, Focus Group)*

- *I've seen conversations developing among students over the course of the year. They take ownership and pride in their learning and progress! (Educator, Survey)*

- *The students are more engaged in lessons involving STEM related materials. (Educator, Survey)*

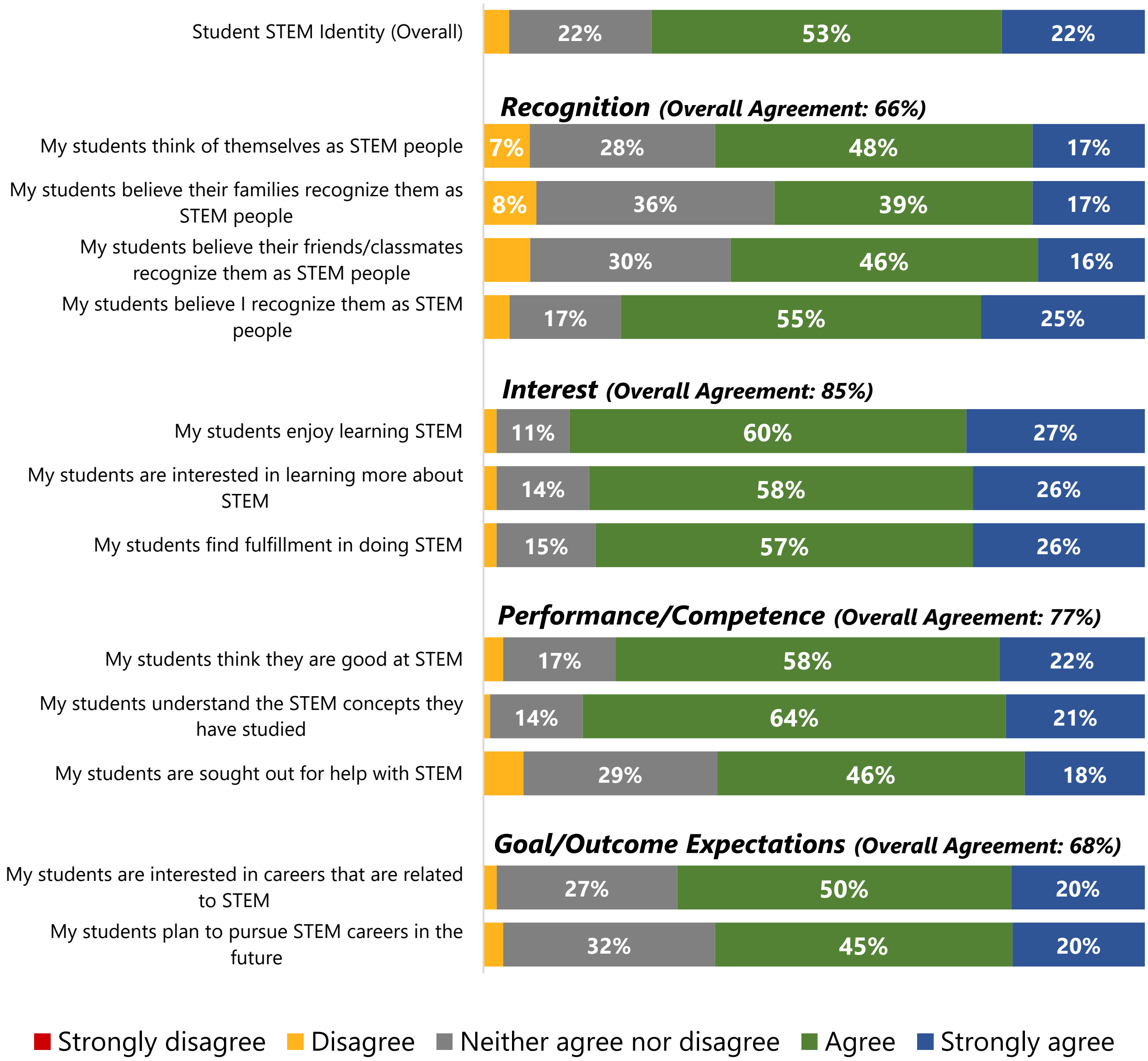
- *The more ideas and insights I get into incorporating STEM the better I am at implementing it successfully with my students. The more STEM I do with by students the more excited they become about the activities and they more they engage. (Educator, Survey)*

- *My students are willing and participate in good discussions surrounding our learning subjects. They are not afraid to contribute to conversations. They are not afraid of making a mistake they just try again. (Educator, Survey)*

Educator Perceptions of Student STEM Identity.

To estimate educator perceptions of student STEM identity resulting from their participation in grant activities, survey respondents were asked items that targeted perceptions of student STEM identity via four sub-components: recognition, interest, performance or competence, and goal or outcome expectations. On the educator survey, each of these sub-domains of STEM interest was measured by two to four items. The item groupings are shown in Figure 35, along with the overall agreement across the subset of items in these sub-domains.

Figure 35. Educator perceptions of student STEM identity, overall and by item



Note. Excluded labels less than or equal to 4%.

This figure shows, agreement across all items related to STEM identity was approximately 75%, with item-level agreement ranging from 56% to 87%. Furthermore, educators agreed most that their participation in STEM professional learning increased their student STEM identity by increasing their general enjoyment of STEM (87% agreement). Furthermore, in relation to agreement across the sub-domains measured, educators perceived their participation in grant activities to have the greatest impact on student STEM identity as it related to student interest and their performance or competence (overall sub-domain agreement: 85% and 77%, respectively). However, educator agreement was not as strong in relation to impacts related to student recognition as a STEM person (56% agreement) and perceptions of student goal attainment as it related to future plans to pursue studies or work in STEM-related fields (65% agreement). In relation to item-level statistics that suggest potential areas for improvement, the item with the lowest percent agreement was related to educator perceptions that students' families recognize the student as a STEM person. As such, professional learning that more directly helps educators engage families in their students' STEM learning might be beneficial.

Many sub-components relate to previously reported student outcomes – i.e., STEM interest, achievement, confidence, and engagement. Perhaps because of the relationship between these concepts, individuals in qualitative data rarely mentioned students' STEM identity explicitly. Instead, the majority of these comments were focused on the sub-components of this construct, which have been reported above. For this construct, the qualitative data we provide below highlights the interrelation between these concepts in comprising student STEM identity. The following quotes highlight some examples of statements participating educators made about perceived increases in their students' STEM identity:

- *I've had more and more girls this year be so excited, like you're saying, that they're able to identify as, oh, I am good at science. I can do this. This is amazing. I didn't picture myself as doing anything in the science field, but you're right, I am good at this. I can do things that these boys are answering these questions a lot of the times, and the girls have looked at them like, oh, they know everything because they talk so confidently, but their answers are all actually misguided. And by the end they know that. But the girls' answers, a lot of them were right on right off the bat, but they're a little more nervous to share. So the fact that they're able to identify with a subject area that they in the past had not considered themselves good at has been such a success. (Teacher Leader, Focus Group)*

- *I think it was articulated to me once that every student needs a content identity, and I think as we engage in better three-dimensional science and sense-making practices, that we're creating that identity where they feel like a scientist and that they can engage in those analyzing and interpreting data and explanations and writing arguments from evidence, those higher thinking skills that they're doing science, not just memorizing content. (Teacher Leader, Focus Group)*

STEM Action Center as an Intermediary

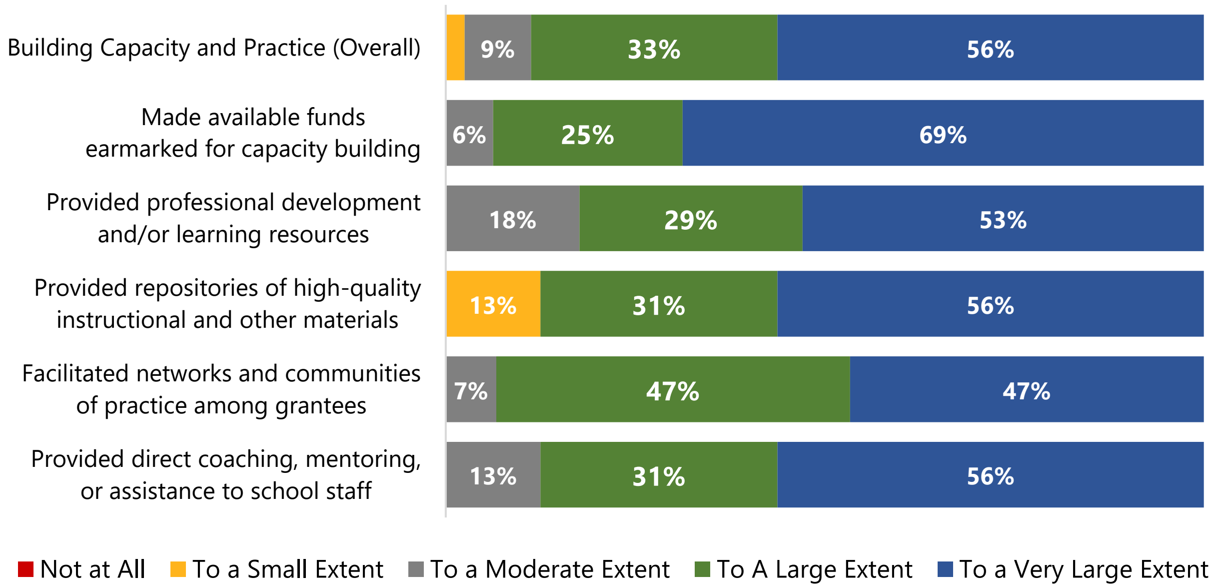
The last focus area of this year's evaluation was on the role of the STEM Action Center as an intermediary in building the capacity and practice of school administrators and teachers across partner sites as well as the role they have played in supporting the scaling up of professional learning activities at the schools and districts they have partnered with. Survey responses from twenty grant administrators from across ten partner schools and districts were analyzed to assess the extent to which these grant administrators across participating grant projects believed the STEM Action Center fulfilled these roles. For these measures, high levels of agreement were operationalized as instances when grant administrators agreed with survey items to a large or very large extent. Overall, the survey results suggest that the primary ways that the STEM Action Center has acted as an intermediary occur in promoting STEM professional learning are through funding implementation, providing the networking opportunities they have created across sites, and prioritizing both internal and external assessment to support implementation and scaling. More specific findings related to these two roles played by STEM AC are in more detail below.

Enhancing the Capacity and Practice of Educators

These items focused on the extent to which they felt the center actively engaged in enhancing capacity across sites by a variety of means, including the following: funding capacity building activities; providing professional development resources; providing direct coaching, mentoring, or assistance to school staff; providing repositories of high-quality instructional materials or resources; and facilitating networking and a community of practice among participating sites. Overall, just under 90% of grant administrators agreed to a large or very large extent that STEM AC has engaged with them in ways that build the capacity of school administrators and teachers in relation to STEM professional learning across participating sites (Figure 36). Item-level data indicates that one of the main ways this has been achieved has been through STEM AC's ability to provide funding for capacity-building activities at grant sites, with approximately 94% of grant administrators indicating that the center did this to a large or very large extent.

Qualitative data from focus groups and open-ended survey items echoed this finding, as numerous educators expressed appreciation for the STEM AC as a funder of various STEM-related activities, including competition fees, purchasing new learning programs, and compensating teachers for participation in professional learning experiences. A few teachers described a general appreciation for the STEM AC and the professional learning grant program, attributing their effectiveness and growth to their participation in the program. Responses suggest that the STEM Action Center has also played an important role in promoting networking or communities of practice across participating sites, with 94% of grant administrators agreeing to a large or very large extent with the related statement on the survey. In relation to opportunities for growth, relatively fewer grant administrators (82%) expressed high levels of agreement in relation to the item asking about the extent to which STEM AC has provided professional development and/or learning resources throughout the year.

Figure 36. Grant administrators' perceptions of STEM AC's efforts to build capacity and practice of educators



Note. Excluded labels less than or equal to 3%.

The quotations below provide examples of how participants across program sites discussed their nature of engagement with the STEM Action Center that are related to their role as an intermediary organization supporting grant activities across sites:

- *My understanding is our roles and the extra time that we put in has been compensated through the STEM Action Center, and also some of the professional development that comes out of the needs or projects of writing things like proficiency scales or rubrics or new assessment tasks, when we get teachers together on smaller projects, that funding normally has come through the STEM Action Center. (Teacher Leader, Focus Group)*

- *We used the STEM AC grant last year to pay for the competition fees for our new robotics competition team. (Teacher, Focus Group)*

- *That's one way that I have found that I've been much more effective with my grant money for my adaptive math program that we use from the STEM Action Center there. (Teacher Leader, Focus Group)*

- *But I will a hundred percent say this, there's no way we could do any of this without them. We actually run these in conjunction with another grant with Title IV and that's how we write both, is that they actually support and provide those kinds of necessary needs in different ways. So the connection of the two and how they meet the same goals are probably one of our largest strengths is knowing that this is where the STEM Action Center can provide and* *how we will implement and this is how the Title IV provides an implement and how they work together. So I'm not sure if that exactly answers it, but the STEM AC grant administrating and how that's done has been very, very supportive. (District Specialist, Focus Group)*

- *And I know about the STEM Action Center kits, and some of the things that you can check out and things. Quite a few of them don't quite meet my standards. I know they meet a lot of the younger grade standards. And I have had an opportunity to plug those a couple times at faculty meetings. (Teacher Leader, Focus Group)*

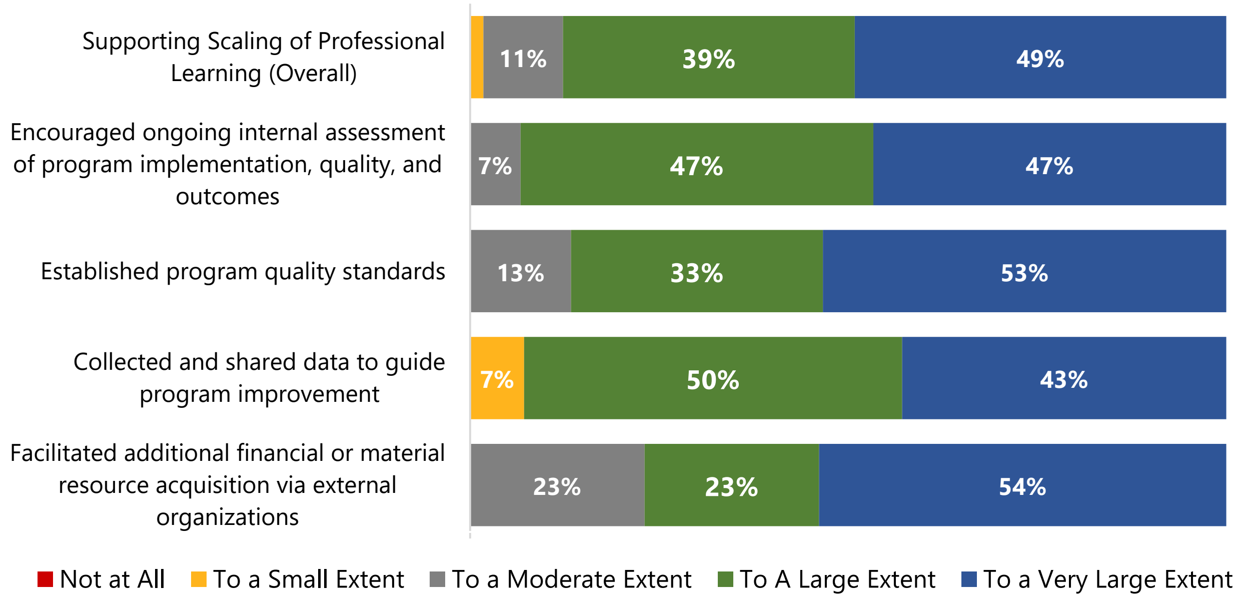
- *I am really grateful they exist and give me the opportunity to learn and grow and become a better teacher especially in an area that will be so important to these kids' futures. (Educator, Survey)*

- *I am appreciative of the grants and the training they provide to help me be a more effective teacher. I have only been teaching 3 years, but I feel like I have confidence and success beyond that because of the extra support and training through the PLGP [i.e., Professional Learning Grant Program]. (Educator, Survey)*

Supporting the Scaling-Up of Professional Learning

Grant administrators who completed the survey were also asked to provide their perspectives on the extent to which they felt the STEM Action Center had supported them in scaling their professional learning activities. These items focused on the extent to which they felt the center established program quality standards, encouraged ongoing internal assessment, collected and shared data to support program improvement, and assisted sites in securing additional funding or resources from external organizations to sustain their professional learning initiatives. As with capacity building, survey responses indicated that the vast majority of grant administrators (88%) agreed to a large or very large extent that STEM AC has supported the scaling of professional learning initiatives at their site (Figure 37). Additionally, item-level data indicates that the STEM Action Center has focused on supporting the scaling of these initiatives by collecting and sharing data to promote program improvement as well as encouraging ongoing internal assessment of program implementation, quality, and outcomes, with 93% and 94% of respondents agreeing to a large very large extent that the center did these things, respectively. In relation to opportunities for growth, relatively fewer grant administrators (77%) expressed high levels of agreement in relation to the statement about STEM Action Center facilitating the acquisition of additional financial or material resources from external organizations to support the scaling of their professional learning activities.

Figure 37. Grant administrators' perceptions of STEM AC's efforts to support the scaling up of professional learning



Note. Excluded labels less than or equal to 2%.

Despite grant administrators' positive perceptions of STEM AC as an intermediary, qualitative data from open-ended surveys and interviews suggested that some educators who did not work at the district level were less aware of the STEM AC and the Professional Learning grants program. In some instances, participants described having no previous interaction with the STEM AC. An interviewee reported that they had never heard of the STEM AC until a district coordinator explained that the STEM AC was funding a robotics activity. Furthermore, a few respondents articulated that they were not familiar with the grant program, although they were participants in grant activities. A teacher leader, however, expressed interest in facilitating interactions for district leaders across the state to collaborate to strengthen science learning, which may align with STEM AC's role as an intermediary. Taken together, these data suggest there is an opportunity for the STEM AC to engage more directly with educators in addition to grant administrators.

- *I really haven't had any interaction, I'll be completely honest with them. I don't know if that's just because A, I never really learned how to write grants and look for and find them, and B, I don't have the time to be doing that on top of teaching all of the subjects that I do in elementary school, or if it's just because [name] is our go-between between us teachers and the STEM Action center. I don't know why, but I don't have much interaction with them. (Teacher, Focus Group)*

- *I was going to say, I'd never heard of STEM AC. The only reason I knew about it was our district robotics coordinator, when she was recruiting me to start a robotics team, told me how to pay for it. Which was to go ask for a grant from STEM AC... I haven't ever heard of it. So either I'm not in the loop with all those things that Alicia mentioned. Or somehow if we could* *get that in front of teachers like me that are new to teaching, that those things are available. (Teacher, Focus Group)*

- *I don't know a lot about how specifically involved the STEM Action Center is. I think I just kind of reap the benefits of the involvement is what happens. (Teacher, Focus Group)*
- *I also think it would be interesting to facilitate even outside of our district to be able for leaders across districts to get together, whoever is supporting those things so we could beg, borrow and steal from each other and just keep improving science across the state. (Teacher Leader, Focus Group)*
- *If I'm being honest, I don't know what the professional learning grants program is. So I'm not 100% sure what part of my professional learning was attributed to this. (Educator, Survey)*
- *I don't know which successes are tied to Professional Learning Grants. (Educator, Survey)*
- *I have not used the Professional Learning Grants Program. (Educator, Survey)*

Discussion

As previously discussed, this year's evaluation of STEM AC's Professional Learning Grant program was designed to evaluate both the implementation of program activities as well as key educator outcomes and, by extension, the perceived outcomes their engagement has had on their students. Data from educator and grant administrator surveys as well as focus groups with participants across select sites, were analyzed to answer the four evaluation questions guiding this study. The following sections provide a summary of key findings that are a synthesis of the high-level results from this evaluation as well as considerations for program improvement as this grant program transitions into a new two-year grant cycle for the 2023-24 and 2024-25 academic years. These considerations are informed by the key findings of this evaluation and are intended to prompt further reflection about how specific changes to program activities could be made to promote quality implementation as new projects related to STEM professional learning begin their implementation in the fall and endeavor to create significant and lasting impacts on the practices of participating educators and improvements to the quality of STEM education offered to students across Utah.

Key Finding #1: The design of grant program activities in relation to their focus areas and grade-level targets are generally aligned with those of the educators who reported participating in grant activities during the 2022-23 academic year.

In addition to the general alignment observed between grant administrator reports of program activities and educator focus areas, the findings provided important information about the focus areas and grade levels targeted by grant activities this year. Just over half of the grant programs focused on providing STEM professional learning experiences related to more than one content area (i.e., science, technology, engineering, and mathematics), and a similar percentage of participating educators indicated that they taught or integrated more than one STEM content area in practice. Some programs are explicit about their focus areas and subsequent actions they are taking to advance STEM professional learning. Other programs suggest a more implicit focus on providing professional learning related to integrating multiple STEM content areas instead of focusing on building educator content knowledge and pedagogical knowledge in one particular STEM discipline. That being said, mathematics was the most common content area included as one of the focuses of professional learning grant activities at participating schools and districts during the 2022-23 academic year, followed by science, technology, and engineering. Furthermore, survey responses indicated that the majority of participating educators reported teaching in grades PK-6 when compared to those who reported teaching in 7-12.

Key Finding #2. Participants perceived the STEM professional learning communities (PLCs) that were supported by the grant to be well aligned to professional learning program expectations and practices for effective collaboration, particularly in relation to the ways in which PLCs promoted collective learning and collaboration that was improvement-focused and responsive to contextual factors as well as individual preferences, needs, and expertise.

The findings in this report suggest that the STEM professional learning communities (PLC) that educators engaged in as a part of grant activities were guided by shared values and visions of improving STEM teaching practices and promoting student learning that aligned with schools' values and visions. Furthermore, findings showed that, overall, STEM PLCs across grant programs facilitated intentional, inquiry-based, and improvement-focused collaborations to support STEM professional learning. More specifically, several educators at participating sites highlighted the value of engaging in collective learning within these spaces through interactions that allowed them to learn from and bounce ideas off of each other as well as build upon each other's strengths. Moreover, findings suggest the STM PLCs adhered to adult learning principles in several notable ways – i.e., in relation to how they provided participants with immediately applicable suggestions and resources; offered opportunities for participants to exchange their views, knowledge, and experiences; and allowed educators to obtain new skills and knowledge related to their individual needs. Furthermore, several educators drew attention to the trusting and respectful professional relationships that they had developed with their colleagues while participating in grant activities, though some still felt PLCs could be more responsive to participants' social and emotional needs.

Participating educators also expressed that collaborative experiences were even more positive when they felt they were designed to provide choice and allowed them to exercise autonomy. However, findings from the Collaborative Self-Assessment (CSA) suggest that there is room for improvement in relation to establishing more flexible structures that allow for more spontaneous collaborations within participating schools and districts as well as ensuring individuals have additional opportunities to choose when, where, and with whom to collaborate with. Although supportive leadership was one of the lowest-rated dimensions of alignment to professional learning program expectations, multiple participating educators mentioned the value they saw in ensuring classroom teachers were actively involved in designing and leading STEM professional learning grant activities alongside district staff and other partners. Findings on the CSA suggest that STEM PLCs have been largely successful in providing equal opportunities for participation in these professional learning activities.

Finally, one of the main areas of opportunity identified in relation to adherence to professional learning program expectations was the dimension related to coaching and shared practice. Specifically, these results suggest that co-teaching lessons were not a common practice within STEM PLCs and that there are opportunities to increase the frequency of peer observations and feedback related to instructional practices. A review of items that had relatively lower percentages of agreement across all dimensions of alignment with professional learning program expectations suggests that there is room to improve how STEM PLCs engage leverage data to inform decision-making and collaboratively engage in the design of assessments that align with state learning standards and collectively analyze student data as a part of their grant activities.

Key Finding #3. Participating educators felt as though participating in STEM professional learning experiences through the grant had the most positive impacts on their STEM identity and instructional skills, with many educators expressing excitement to be engaging in this work and reporting success in implementation and shifts in practice.

The findings related to educator outcomes highlight the positive perceived impact of STEM professional learning on educators' STEM identity and instructional skills, with 91% of educators agreeing that their participation in STEM professional learning activities through the grant increased these target outcomes. Qualitative data also suggested that participating educators reported experiencing various impacts aligned with various aspects of STEM identity, including feeling a sense of belonging among a community of educators teaching and integrating STEM, as well as enjoying the process of learning and implementing new STEM instructional skills. Furthermore, the findings suggest that more than a third of educators reported increasing the amount of time they dedicated to daily STEM instruction, and some participating educators felt a boost in relation to their confidence and feelings of self-efficacy regarding their STEM teaching abilities.

Educator comments also highlighted the value of providing ready-to-use materials and resources during professional learning experiences, which successfully facilitated the integration of new knowledge and skills into their teaching practices. There was also evidence that some educators believe their participation in grant activities has prompted them to modify their approach to teaching as they have learned about and started implementing their learnings from these experiences. Many educator participants mentioned how they have shifted from more "traditional" teaching approaches to ones where they assume more of a facilitator role, where they are developing lessons that encourage students to take a more active role in their learning.

In relation to areas for improvement in relation to educator outcomes, findings from this year's evaluation suggest that more can be done to more intentionally leverage STEM professional learning opportunities to promote teaching satisfaction more generally. Furthermore, in relation to specific aspects of the STEM professional learning activities offered across sites, some educators expressed a desire for more focus on how to differentiate STEM instruction for students at different learning levels, particularly when planning sessions for special education students or classes of students that have a wide range of abilities, backgrounds, and interests.

Key Finding #4: Although more educators reported engaging in video-based reflection as a part of grant activities than using TeachFX, preliminary data suggests that not only did educators find this tool accessible and useful, but also that positive impacts were observed in relation to target educator outcomes for those who utilized this tool at least once per month, particularly in relation to STEM integration & planning and instructional skills.

Investigation into educators' reported engagement in specific STEM professional learning activities as a part of the grant suggests that video-based self- and peer-reflection were more widely used than TeachFX, although some educators mentioned that they were not aware of or asked to engage in video-based peer- or self-reflection activities at their school or district. Some educators mentioned that their engagement in other coaching activities or training, as well as their ability to collaborate with peers for these purposes, limited their engagement in video-based reflections. Although engagement with TeachFX as a part of grant activities was not as widespread across sites, a considerable number of educators specifically mentioned their successes using this platform for reflection to inform instructional modifications. Educator responses also suggested that they appreciated how easy TeachFX made it to gather data and engage in targeted reflection to inform changes to their instructional practices.

A comparison of educator outcomes based on engagement in video-based self- and peer-reflection and using TeachFX showed only slight differences between those who did and did not participate in these particular professional learning activities. However, additional data collected this year about the frequency with which educators have been using TeachFX showed that more consistent use of this tool led to higher average agreement across all targeted educator outcomes, with considerable differences ranging from +4.4% to +16.1% agreement overall on target outcomes among those who used this tool more than once per month and those who did not. Furthermore, the largest observed differences between these two groups were found in relation to educator outcomes measuring self-reported impacts of professional learning activities on STEM integration and planning (+16.1%) as well as STEM instructional practices (+13.7%). On the other hand, the educator outcome areas with the smallest differences in agreement among these groups of TeachFX users were STEM identity (+4.8%) and teaching satisfaction (+4.1%).

Key Finding #5. Participation in STEM professional learning activities was perceived to positively impact students' interest, confidence, and academic achievement in STEM areas; however, there are opportunities for grant programs to focus on how they might be able to leverage their knowledge and skills from these experiences to continue to strengthen the STEM identities of their students.

According to educators, their participation in STEM professional learning activities had noticeable impacts on the outcomes of their students, particularly in relation to students' interest in STEM as well as greater confidence and interest in learning about STEM content. Several educators commented on student impacts that related to increases in students' emotional interests, with a few educators reporting that some of their students who once struggled with STEM subjects and lessons were now excited about these and considered these courses their favorite classes. Findings also suggested that educators' participation in STEM professional learning experiences allowed them to shift the nature of student engagement during STEM lessons, with many educators mentioning how they have successfully been able to implement their learnings and promote more robust discourse among students in their classrooms. Some educators highlighted the usefulness of TeachFX in this regard.

Educator reports also suggested that they perceived increases in their students' academic achievement that they attributed to their participation in STEM professional learning experiences through the grant. Some educators even mentioned observing positive impacts on standardized assessments (i.e., RISE scores) as a result of their participation, though more research would need to be done to substantiate this claim.

In relation to areas for continued focus, findings suggest that the impact of educator participation in STEM professional learning has not had as much impact on perceptions of students' STEM identity as other student outcome areas. This is interesting because the findings related to educator outcomes suggest that increasing educators' STEM identity was a notable strength of the STEM professional learning activities across grant programs.

Key Finding #6. Findings suggest that the STEM Action Center effectively engages with grant administrators at the project sites to enhance capacity in STEM professional learning and to support the expansion of these activities at schools and districts and could be more explicit in identifying ways that STEM AC is involved in these professional learning efforts.

Survey results suggest that just under 90% of grant administrators agreed to a large or very large extent that STEM AC has engaged with them in ways that build the capacity of school administrators and teachers in relation to STEM professional learning and support the scaling of these activities at schools and districts. Furthermore, findings suggest that capacity building primarily occurred via the funding supports and through facilitating networks and communities of practice among grantees and, more specifically, among champions of these initiatives within sites. Scaling-up support has occurred via STEM AC's collection and sharing of data to promote program improvement and encourage ongoing internal assessment of program implementation, quality, and outcomes. However, educators often did not recognize STEM AC as one of the main supports in these efforts, suggesting that much of these supports are offered at the levels of grant administration and are then indirectly provided to participating educators.

Considerations for Program Improvement

Consideration #1: Continue to offer optional STEM professional learning experiences that are aligned with the existing continuous improvement efforts, educational priorities, and values of educators, schools, and districts participating in the grant program.

To continue to enhance and sustain effective STEM professional learning activities within schools and districts funded through the grant, several key strategies should be continued. First, maintaining autonomy and optional participation in these activities allows educators to have control over their professional development and promotes meaningful engagement in these activities across sites. Incentives such as stipends, resources, and materials should continue to be provided to participating educators. Not only can these communicate to educators that their time and efforts are valued, but they are also an important way to provide educators with tangible benefits of participation in the form of ready-to-use materials aligned with their work and address their individual professional learning goals related to STEM education.

Also, providing educators with targeted and "ready-to-use" resources and materials that address specific learning standards that they are teaching allows participants directly implement their learnings in practice as well as build upon early successes and learnings from these scaffolded implementation experiences to continue to develop their STEM planning and integration skills. Additionally, grant program leadership could continue identifying current or potential champions of this work within participating schools and districts to serve as formal or informal ambassadors or recruiters for specific STEM professional learning activities. Furthermore, garnering buy-in from school leadership and staff is crucial for capacity building and sustainability. This can be achieved by promoting integration with other continuous improvement efforts, ensuring alignment with the values and visions of participating schools. Moreover, consideration may be given to aligning STEM professional learning opportunities with existing initiatives and educational priorities within schools and districts. By integrating these strategies, the effectiveness and impact of STEM professional learning can be maximized.

Consideration #2: Bring renewed focus to development of shared understandings of what effective STEM professional learning, planning, and integration looks like within participating schools and districts as well as how to set aside more time for collaboration and further development of educators' abilities to plan and implement lessons that are responsive to diverse student learning needs and interests and promote student STEM identity.

It is crucial for sites to cultivate a shared understanding of effective STEM professional learning, planning, and integration within their school and district while also allowing flexibility for grant programs to adapt to evolving best practices and contextual realities. As a part of this process, educators should be encouraged to collectively reflect on their understanding of STEM learning and embrace new instructional approaches that align with current standards and practices. The design and implementation of STEM professional learning experiences, tools, and resources should continue to be carried out in partnership with classroom teachers. Doing so will allow these activities to target capacity building around some of the practical and logistical challenges that educators face when planning and integrating STEM content and allow classroom teachers to have a voice in how educators will be expected to engage in these activities to ensure they are accessible to as many educators as possible.

Furthermore, a renewed emphasis could be placed on building educators' capacity to cater to differences in student abilities and interests during STEM instruction. Explicit attention to how educators can make instructional changes to more directly foster the development of their students' STEM identity would be beneficial. To support educators in implementing their new learning effectively, it is especially important to ensure educators have dedicated time to meaningfully and consistently engage in these STEM professional learning throughout the year. Therefore, the designers of grant activities across participating schools and districts could be encouraged to reflect on methods to incorporate more collaboration time into educators' existing practices, responsibilities, and professional learning engagements, with a particular focus on creating flexible structures that facilitate peer-based reflection and foster shared practices like co-teaching and coaching. Encouraging grant programs to implement some of these strategies could be important steps in supporting effective STEM professional learning at participating schools and districts, particularly in discussions with the leaders of new grant programs that will begin their implementation next year.

Consideration #3: Offer additional reflection time to the ways in which the STEM Action Center can continue to leverage their position as an intermediary in ways that strengthen networking opportunities across sites, provide more direct supports and resources to educators who are benefiting from the funding and resources provided through the grant, and facilitate the collection and reporting of more detailed and nuanced information about the implementation and effectiveness of particular features of STEM professional learning activities across partner schools and districts.

In addition to continuing to provide funding support and promoting the creation of networks and communities of practice among grant programs, the STEM Action Center should consider ways in which they can more directly support grant programs in securing additional funding and resource support from external partners and organizations to make grant-supported efforts sustainable and/or to expand the scope or focus of these initiatives beyond grant cycles. Similarly, STEM AC may consider additional ways in which it might be able to provide educators, not just grant program leaders, with more direct STEM professional learning support and/or ways in which they can provide educators at participating schools and districts with broader access to resources and materials that can be directly used or easily modified and applied in practice. Furthermore, STEM AC should continue to use their position as an intermediary to promote regular discussions about what effective STEM education looks like across participating schools and districts and to develop a more cohesive vision of what effective STEM professional learning looks like in practice. Doing so would allow STEM AC to develop a common assessment framework for the monitoring and reporting of program implementation and outcomes in ways that could expand the use of evaluation data at grant sites.

The establishment of core features that should be in place across all sites as well as meaningful differences in the design of specific professional learning activities within particular programs, would provide richer information about the effectiveness of various approaches to implementation that could then be reported back to grant programs to directly inform their decision making and continuous improvement efforts. STEM AC might also consider encouraging sites to make it clear to educators participating in activities funded by this grant that these funds were provided by the STEM Action Center. In these communications, the specific goals and/or target outcomes of their grant program can also be shared to promote a shared understanding within grant programs about the goals of these initiatives and the boundaries of grant activities in their context. Furthermore, this could also assist in the evaluation process by potentially increasing educators' familiarity with the STEM Action Center in ways that would hopefully make them more willing to participate in evaluation activities and provide clarity about the STEM-related professional learning activities they participated in that were funded through the grant.

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Appendix A. Program Selection Criteria for Focus Groups

Purpose & Vision

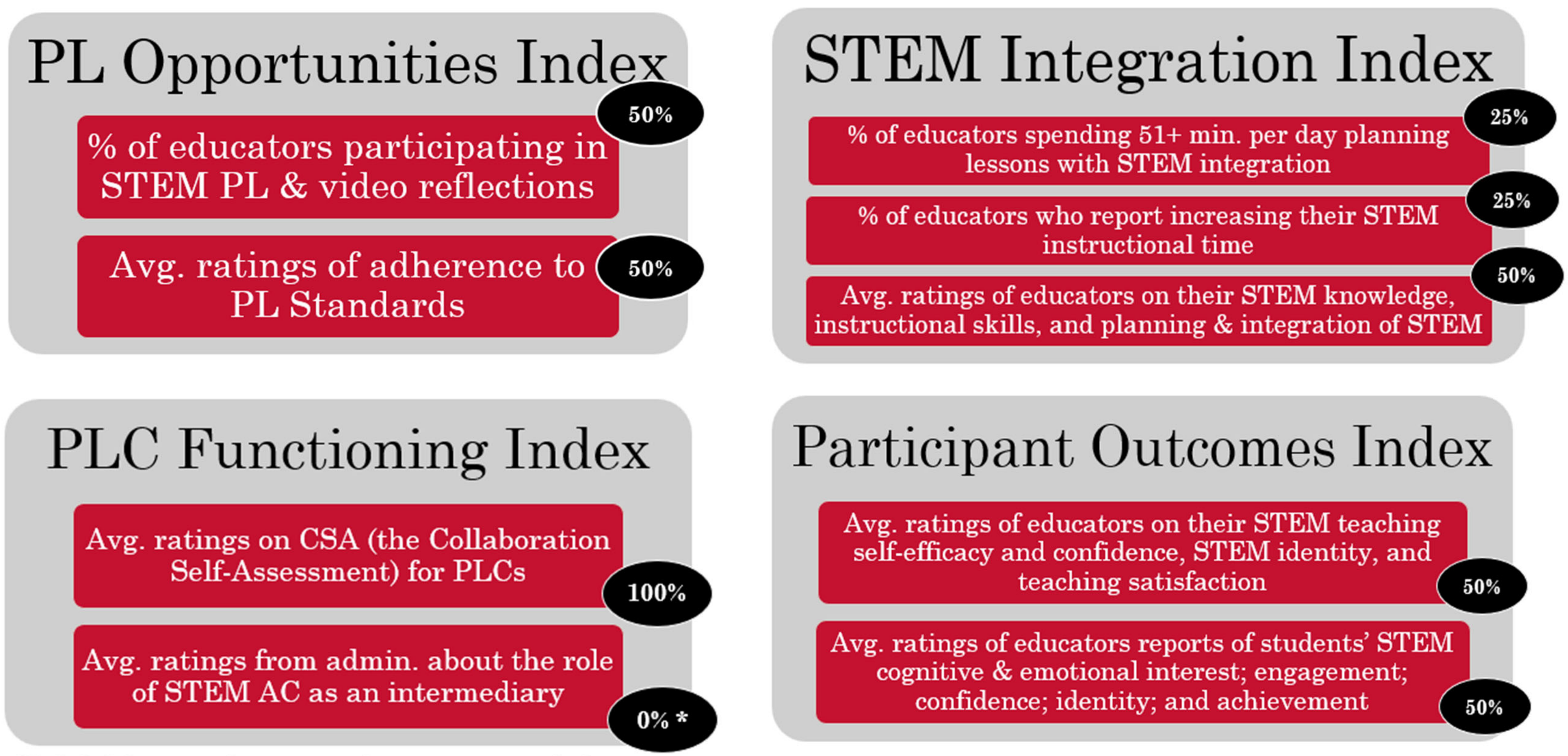
The purpose of these case studies will be to construct detailed accounts of promising or best practices across sites as they implement and scale-up their programs. They will focus on the identification and description of key practices, structures, resources, and other factors supporting successful implementation and scaling-up of programs. Cases will include site-specific "best practice highlights" organized around the following areas: (1) the professional learning opportunities offered through the program and program adherence to professional learning program expectations, (2) the functioning of your professional learning communities (PLCs), and (3) how grant activities support STEM integration and planning.

Description of the Case Study Selection Process

Type of Sampling	Purpose	Application	Index or Indices
Critical Case	Identify cases that are likely to "yield the most information and have the greatest impact on the development of knowledge" (Patton, 2001, p. 236).	Identification of cases will be based on prior evidence of promising outcomes for educators and students across project sites.	Participant Outcomes Index
Intensity	Detail information-rich cases that manifest the phenomenon intensely but are not extreme or particularly exceptional/unusual.	Prior outcomes related to the three program foci (i.e., PL, PLCs, and STEM integration) will be reviewed to identify cases where key program features are enacted more strongly in relation to other sites.	PL Opportunities Index PLC Functioning Index STEM Integration Index
Chain or snowball	Identifies cases of interest from people who know people who know what cases are information-rich.	Consider buy-in and access across potential sites	STEM AC Personnel Input

Composition of Indices

- Indices were constructed using data from the Spring 2022 administration of the educator survey
- Averages were computed for each index
- Cases were flagged as potential cases if they were above average on the participant outcomes AND if they were above average on the PL Opportunities, PLC Functioning, and STEM Integration indices
- One limitation of this method was that program sites with insufficient data on the metrics that comprised these indices were excluded



*Excluded this metric because very few grant programs had responses from administrators

Appendix B. Item-Level Statistics for the Collaborative Self-Assessment (CSA)

CSA Domain: Improvement-Focused	(1) Not at all	(2) Slightly	(3) Somewhat	(4) Moderately	(5) Extremely	(4 or 5) Moderately or Extremely
Overall	**0.4%**	**1.4%**	**8.0%**	**31.9%**	**58.3%**	**90.2%**
Focuses on improving instruction	0.4%	0.7%	4.0%	25.8%	69.1%	94.9%
Focuses on improving student learning	0.2%	0.8%	3.6%	22.9%	72.5%	95.4%
Evaluates new ideas based on goals and intended outcomes	0.4%	0.9%	7.5%	34.8%	56.4%	91.2%
Is data informed	0.4%	1.7%	9.0%	35.5%	53.4%	88.9%
Is driven by equity	0.4%	2.5%	11.6%	35.0%	50.6%	85.5%
Is driven by excellence	0.6%	1.0%	8.4%	33.1%	56.9%	90.0%
Uses pattern of productive talk	0.5%	1.9%	10.4%	34.1%	53.1%	87.1%
Challenges ideas in respectful and productive ways	0.4%	1.6%	9.4%	34.2%	54.4%	88.5%

CSA Domain: Inquiry Based	(1) Not at all	(2) Slightly	(3) Somewhat	(4) Moderately	(5) Extremely	(4 or 5) Moderately or Extremely
Overall	**0.4%**	**1.4%**	**9.6%**	**35.7%**	**52.9%**	**88.6%**
Uses questions to broaden and deepen understanding	0.2%	1.5%	8.5%	36.7%	53.1%	89.8%
Probes for specificity	0.3%	1.2%	12.3%	41.6%	44.6%	86.2%
Promotes idea sharing	0.4%	1.2%	7.6%	31.9%	58.9%	90.8%
Explores possible or alternative solutions	0.3%	1.5%	9.2%	36.2%	52.8%	89.0%
Builds upon each other's ideas	0.4%	0.9%	8.7%	33.2%	56.8%	90.0%
Promotes strengths-based conversations and communication	0.5%	1.6%	9.7%	33.9%	54.2%	88.2%
Promotes routine feedback—seeking and receiving	0.8%	2.0%	11.0%	36.2%	49.9%	86.1%

CSA Domain: Intentionality	(1) Not at all	(2) Slightly	(3) Somewhat	(4) Moderately	(5) Extremely	(4 or 5) Moderately or Extremely
Overall	**0.4%**	**2.3%**	**10.3%**	**37.0%**	**50.1%**	**87.0%**
Clarifies purpose of our collaborative work	0.3%	2.0%	9.7%	38.0%	49.9%	87.9%
Is goal oriented	0.2%	1.2%	8.0%	34.4%	56.2%	90.6%
Reflects shared understanding of our collaboration values	0.3%	1.9%	8.8%	38.9%	50.1%	88.9%
Has productive collaborations and meetings	0.4%	2.6%	11.5%	38.9%	46.7%	85.6%
Promotes coherence in efforts	0.3%	2.3%	10.4%	42.1%	45.0%	87.1%
Allocates time for collaboration	0.4%	4.1%	12.1%	36.6%	46.8%	83.4%
Uses norms for communication	0.4%	3.0%	11.6%	38.7%	46.4%	85.1%
Provides formal collaboration opportunities	0.5%	2.3%	9.8%	37.8%	49.6%	87.4%
Creates safe space for all	0.4%	1.3%	10.0%	30.8%	57.4%	88.3%
Recognizes contributions	0.6%	2.3%	11.0%	33.4%	52.6%	86.0%

CSA Domain: Empowerment	(1) Not at all	(2) Slightly	(3) Somewhat	(4) Moderately	(5) Extremely	(4 or 5) Moderately or Extremely
Overall	**0.9%**	**2.8%**	**12.5%**	**35.3%**	**48.6%**	**83.9%**
Provides social and emotional support	2.2%	6.5%	18.1%	38.5%	34.6%	73.1%
Honors professional expertise and experience	0.7%	1.8%	9.9%	35.9%	51.7%	87.6%
Provides an equal opportunity to participate	0.1%	1.1%	7.2%	32.1%	59.5%	91.5%
Encourages and supports innovation and creativity	0.2%	1.7%	8.5%	35.1%	54.5%	89.6%
Ensures individuals have additional opportunities to choose when, where, and with whom to collaborate	1.3%	4.8%	17.0%	38.5%	38.3%	76.9%
Views failure as part of professional practice	1.2%	2.6%	14.3%	35.1%	46.7%	81.9%
Views failure as part of learning	0.6%	2.4%	11.4%	33.2%	52.3%	85.6%
Encourages and celebrates risk-taking	0.7%	2.1%	13.2%	33.5%	50.5%	83.9%
Encourages informal collaboration opportunities	0.7%	2.0%	12.5%	35.6%	49.1%	84.7%

CSA Domain: Capacity Building	(1) Not at all	(2) Slightly	(3) Somewhat	(4) Moderately	(5) Extremely	(4 or 5) Moderately or Extremely
Overall	**0.6%**	**3.0%**	**13.4%**	**40.0%**	**43.0%**	**83.0%**
Is flexible in structure and allows for spontaneous collaborations	0.7%	5.1%	16.4%	42.5%	35.4%	77.8%
Adapts to educator professional learning needs and desired areas of growth	0.4%	2.4%	11.4%	41.7%	44.0%	85.8%
Engages teachers in informed decision-making	0.1%	2.7%	12.6%	41.0%	43.7%	84.7%
Attends to interpersonal dynamics among collaborators	0.5%	2.9%	13.8%	45.7%	37.2%	82.9%
Is responsive to educator emotional needs	2.2%	5.6%	17.4%	39.4%	35.3%	74.7%
Recognizes assets of each collaborator	0.5%	2.6%	14.4%	38.2%	44.3%	82.5%
Promotes deep learning for teachers and students alike	0.4%	1.5%	7.8%	37.3%	53.0%	90.3%
Builds competence for all	0.2%	1.8%	9.3%	40.4%	48.3%	88.6%
Regards followers as leaders in training	0.4%	3.0%	15.3%	37.0%	44.4%	81.4%
Has leaders who know when to follow	0.6%	2.5%	15.5%	37.2%	44.2%	81.4%

CSA Domain: Collective Responsibility	(1) Not at all	(2) Slightly	(3) Somewhat	(4) Moderately	(5) Extremely	(4 or 5) Moderately or Extremely
Overall	**0.8%**	**3.0%**	**14.5%**	**39.7%**	**42.1%**	**81.8%**
Establishes and follows norms for collaboration	0.2%	2.0%	10.8%	38.7%	48.3%	87.0%
Provides structures for accountability	0.6%	2.3%	12.1%	41.2%	43.7%	84.9%
Establishes decision-making processes	0.6%	2.1%	14.1%	39.9%	43.2%	83.1%
Clarifies “who” has “what” decision-making authority “when”	1.2%	4.6%	19.0%	40.2%	34.9%	75.2%
Clarifies roles of others in decision-making processes	1.1%	4.5%	19.3%	40.5%	34.6%	75.1%
Shares responsibility for solving problems	0.7%	2.2%	13.6%	37.1%	46.4%	83.5%
Shares accountability for decisions	0.9%	3.6%	14.0%	41.1%	40.4%	81.5%
Develops skills to successfully collaborate (reciprocal accountability)	0.9%	2.5%	12.6%	38.7%	45.2%	83.9%