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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 2021-2022 School Year

UTAH EDUCATION POLICY CENTER
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Prepared by the Utah Education Policy Center
on behalf of the STEM Action Center

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Bridging Research, Policy, and Practice

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Executive Summary

Since 2016, the Utah Education Policy Center (UEPC) has been contracted by the STEM Action Center to evaluate the effectiveness of the STEM Action Center's Professional Learning Grant Program (PL Grant Program). The purpose of this evaluation is to understand the implementation of the program and associated educator and student outcomes. The 2021-2022 evaluation expands on previous evaluations, including more extensive qualitative data collected through educator focus groups, and robust survey data collection from educators and students, including a larger administration of the Student STEM Survey after the previous year's pilot administration. The following key finding summarize the results of the 2021-2022 evaluation and represent highlights of the PL Grant Program's implementation and impact.

- **Key Finding #1:** Program implementation primarily involved teacher training and professional learning communities that were aligned with adult learning principles and several of Utah's professional learning standards, and reflected both increases and decreases in district-level collaboration throughout the year.

- **Key Finding #2:** Over 80% of educators who participated in STEM Professional Learning reported increases in STEM identity, instructional skills, confidence, knowledge, and content integration, and these outcomes were stronger for teachers who engaged in video-based peer reflection as part of their grant activities.

- **Key Finding #3:** More than half of students whose teachers participated in STEM Professional Learning reported increased achievement, interest, confidence, and engagement in STEM, and educators noticed improvement more broadly in students' classroom engagement and understanding.

- **Key Finding #4:** The STEM Action Center provided essential funding, offered responsive and flexible support, facilitated efforts to scale up professional learning, and connected some LEAs with external resources.

Based on these findings, the UEPC evaluation team identified program considerations to inform the 2022-2023 school year's PL Grant Program. The considerations expand on the evaluation findings by offering clear, actionable steps that STEM AC can consider in order to bolster and improve specific components of the PL Grant program, and to promote quality implementation and maximal impact. The considerations are summarized below, with a more detailed explanation provided in the final section of this report.

- **Consideration #1:** Encourage school and district leaders to support and advocate for educators by soliciting their input in the design, content, and continuous improvement of professional learning experiences.

- **Consideration #2:** Leverage grant administrators as ambassadors of the PL Grant Program among teachers to expand STEM AC's presence as a program leader and enhance use of evaluation data for site-level PL program improvement.

- **Consideration #3:** Promote STEM identity as a goal of the PL Grant Program, for both teachers and students, by creating a shared understanding of STEM identity and providing support for administrators and teachers to facilitate identity development through grant activities.

- **Consideration #4:** Establish and lead communities of practice for grant administrators and participating educators to increase consistency and connections across districts, and to strengthen program implementation, outcomes, and sustainability.

Introduction

Professional Learning Grant Program Overview

Since 2016, the Utah Education Policy Center (UEPC) has been contracted by the STEM Action Center to evaluate the effectiveness of the STEM Action Center's Professional Learning Grant Program (PL Grant Program). The purpose of this evaluation is to understand the implementation of the program and associated educator and student outcomes. This year's evaluation expands previous evaluations, including more extensive qualitative data collected through educator focus groups, and a robust survey data collection (e.g., UEPC Educator STEM Professional Learning Survey, Educator Collaboration Self-Assessment Survey, and Student STEM Survey).

As the administrator of the professional learning provision of the H.B. 150 (2014), the STEM Action Center has provided online, hybrid, and face-to-face professional learning opportunities for K-12 teachers, including:

- providing teachers access to tools, resources, and strategies;
- fostering opportunities for teachers to work in online learning communities;
- tracking and reporting data on usage of the application's components; and
- allowing the USBE, school district, or school to track results of the professional learning.

Among the bill's 2014 provisions was a mandate that the STEM Action Center provide high quality STEM education professional learning to K-12 educators. According to the STEM Action Center, this mandate is addressed through awarding one-year or three-year grants to schools and districts who apply and are selected based on identified priorities associated with STEM learning and the schools'/districts' unique STEM-related needs. In the past year, the STEM Action Center awarded new grants and continued supporting ongoing grants, indicating that the STEM Action Center's Professional Learning Grant Program is reaching new audiences. The 2021-2022 evaluation of the Professional Learning Grant Program used a mixed-method design (i.e., surveys and focus groups) to answer the following evaluation questions:

- How is STEM Professional Learning implemented across LEAs? In particular, how do LEAs attend to adult learning principles, professional learning standards, and collaboration?
- What are the outcomes of teachers who participate in STEM Professional Learning?
- What are the outcomes of students whose teachers participate in STEM professional learning?
- What is the role of the STEM Action Center as an intermediary in facilitating and/or supporting STEM Professional Learning?

Relevant Literature

As noted in a recent evaluation of the Professional Learning Grant Program by the Utah Education Policy Center (UEPC),[1] compared to students in other countries, students in the United States underperform on tests of scientific and, especially, mathematics literacy (National Science Board, National Science Foundation, 2019). This raises a challenge for the K-12 STEM educator workforce in the United States whose members often do not hold degrees in the STEM subject areas they teach (Hossain & Robinson, 2012; Leyzberg & Moretti, 2017; Swars et al., 2016) and, as a result, K-12 students are frequently

[1] Onuma, F. J., Rorrer, A. K., Pecsok, M., Weissinger, K., & Auletto, A. (2020). *Advancing STEM Teaching and Learning in Utah: An Evaluation of the Impact of the Professional Learning Grant Program.* Utah Education Policy Center: Salt Lake City, UT.

instructed by educators who do not have sufficient STEM content knowledge (Berry III et al., 2014; Jensen et al., 2016; Joshi & Jain, 2018).

In an effort to address K-12 STEM educators' lack of STEM expertise, conventional professional development and professional learning communities have been implemented (Burrows, 2015; Chiyaka et al., 2017; Fulton & Britton, 2011; Hudley & Mallinson, 2017). However, scholars have identified a number of shortcomings to the United States' approach to STEM professional learning (Hiebert & Stigler, 2017; Maltese et al., 2013; Rogers et al., 2016). Other nations, such as mainland China, Hong Kong, and Taiwan, might serve as models for professional learning in the United States (e.g., Jensen et al., 2016a; Jensen et al., 2016b). Activities such as mentorship and content-specific training may be beneficial (Chiyaka et al., 2017; Jensen et al., 2016a).

Effective STEM professional learning supports educators to create authentic STEM learning experiences for students (Fulton & Britton, 2011; Rogers et al., 2016). These experiences also increase educators' awareness of STEM careers, provide them with mentorship opportunities, and build their STEM knowledge (Burrows, 2015; Chiyaka et al., 2017; Fulton & Britton, 2011; Nadelson et al., 2013; Nathan et al., 2011; Webb, 2015). 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).

More recently, efforts to provide effective professional learning have been transformed by the COVID-19 pandemic. In the 2020-2021 school year, the pandemic was still evolving, and its impact was widespread across education, including challenges faced by districts participating in the Professional Learning Grant.[2] Despite substantial improvements in treatments for COVID-19 during the 2021-2022 school year, the shift into a post-pandemic world has revealed lasting effects of the pandemic that may influence approaches to professional learning for the foreseeable future.

The COVID-19 pandemic accelerated online learning options for students as districts attempted to mitigate virus outbreaks and maintain consistency in educational instruction. As technology is now taking a larger role in education, Brown, Correll, and Stormer (2021) suggest that technology should also take a larger role for teachers engaging in professional learning. Brown and colleagues present a framework for professional learning that directly incorporates the evolving landscape of post-pandemic education. They advocate for virtual options for professional development, which may include virtual professional learning communities, coaching sessions, classroom observations, and self-reflection.

Methods

Evaluation Questions

This mixed-method evaluation used surveys and focus groups to answer evaluation questions about the implementation and outcomes of the STEM Action Center Professional Learning Grant Program. In this report, we provide an analysis of program implementation, educator and student outcomes, and the STEM Action Center as an intermediary organization. Table 1 contains a summary of our evaluation questions as well as data sources.

[2] Auletto, A., Scarpulla, L. F., Doane, M., Rorrer, A. K., Barton, A., & McDowell, E. (2021). *Advancing STEM Teaching and Learning in Utah: An Evaluation of the STEM Action Center's Professional Learning Grant Program (2020-21 School Year)*. Salt Lake City, UT: Utah Education Policy Center.

Table 1. Evaluation questions and data sources

Evaluation Questions	Data Sources			
	Educator STEM PL Survey	Collaboration Self-Assessment	Student STEM Outcome Survey	Educator Focus Groups
Program Implementation				
How is STEM Professional Learning implemented across LEAs? In particular, how do LEAs attend to adult learning principles, professional learning standards, and collaboration?	✓	✓		✓
STEM Educator and Student Outcomes				
What are the outcomes of teachers who participate in STEM Professional Learning?	✓			✓
What are the outcomes of students whose teachers participate in STEM professional learning?			✓	✓
STEM Action Center as an Intermediary				
What is the role of the STEM Action Center as an intermediary in facilitating and/or supporting STEM Professional Learning?	✓			✓

Data Sources & Analysis

To address our evaluation questions, data were collected using instruments designed by the Utah Education Policy Center (UEPC). These instruments included the UEPC Educator STEM Professional Learning Survey, the UEPC Collaboration Self-Assessment, the UEPC Student STEM Outcome Survey, and an educator focus group protocol. At least two data sources were analyzed to address each evaluation question (see Table 1) to triangulate the findings. In the following sub-sections, we describe each data source and the accompanying analytic strategy.

UEPC Educator STEM Professional Learning Survey

Survey and Response Overview. Districts and schools participating in the Professional Learning Grant Program identified 2,972 teachers and administrators to participate in the UEPC Educator STEM Professional Learning Survey. In the spring of the 2021-2022 school year, these individuals were invited via direct email to complete the survey. We received 623 completed surveys, resulting in a 21% response rate. Participants were asked to self-identify as educators or administrators. Teachers represented 95% of participants (n=594) and administrators represented the remaining 5% (n=29).

The UEPC Educator STEM Professional Learning Survey contained questions that were aligned with educators' professional learning experiences, including topics such as participant use of video reflection,

instructional planning time, attributes of their STEM professional learning, and self-reported educator outcomes. The administrator version of the survey asked administrators to respond to items about their perceptions of the STEM Action Center and their educators' participation in the program (i.e., proportion who participated in professional learning and video-based reflection). The specific content of the UEPC Educator STEM Professional Learning Survey is presented in more depth in our findings. Analysis of these items included the generation and interpretation of descriptive summary statistics to identify common trends in responses across topics, Analysis of Variance (ANOVA) and post-hoc analysis of significant ANOVA results, such as Turkey's Honest Significant Difference (HSD).

Participant Demographics. The figures and tables in this section of the report provide a demographic summary of the teachers who participated in the UEPC Educator STEM Professional Learning Survey. Most participants (86.5%) were female and 11.2% were male. Less than one percent of teachers identified as non-binary and 1.8% preferred not to share their gender identity. Participating educators were primarily White (91.7%) with approximately 2% Asian, 2% Hispanic/Latino, and 2% multi-race. African American, American Indian, and Pacific Islander each had 0 or 1 responses (0%), and 1.6% of respondents selected "other" race or ethnicity. Thirty-one percent of teachers reported having more than 10 years of teaching experience, 24% had 6 to 10 years of experience, 23% had 3 to 5 years of experience, 21% had 1 to 2 years of experience, and 1% were new to teaching this year.

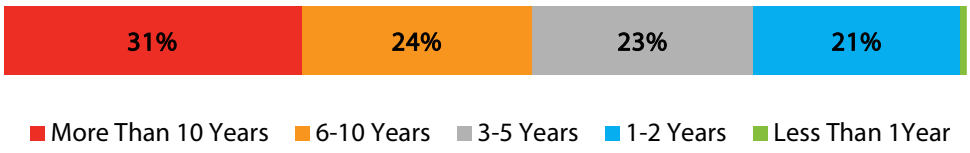
Figure 1. Educator survey participants by gender

Gender	Percent
Prefer Not to Say	1.8%
Non-binary	0.5%
Male	11.2%
Female	86.5%

Figure 2. Educator survey participants by race/ethnicity

Race/ Ethnicity	Percent
Asian	2.1%
Hispanic/Latino	2.3%
Multi Race	2.1%
White	91.7%
Other	1.6%

Figure 3. Educator survey participants' years of experience



UEPC Collaboration Self-Assessment

Educators who participated in the Professional Learning Grant Program during the 2021-2022 school year (n=2,972) were invited to complete the UEPC Collaboration Self-Assessment[3] at the beginning of the year (Fall 2021) and again at the end of the year (Spring 2022). The UEPC Collaboration Self-Assessment was developed by the UEPC as part of its ongoing work in the area of district and school

[3] Utah Education Policy Center. (2020). Collaboration Self-Assessment. Salt Lake City, UT: Utah Education Policy Center.

improvement and Leadership and Inquiry for Turnaround (LIFT). The UEPC Collaboration Self-Assessment Survey 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. Respondents 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."

While the Fall administration of the Collaboration Self-Assessment assessed collaboration program-wide, the Spring direct administration to participants at school sites aimed to provide more detailed results that could inform program improvement by site or district. However, spring results could not be linked to fall responses for comparative analyses. Thus, we are not able to compare individuals' responses in the fall to their responses in the spring.

The fall administration yielded 534 responses and the spring administration yielded 552 responses. Out of the 26 unique districts that participated in the Collaboration Self-Assessment, 14 districts had responses in both the fall and the spring while the remaining 12 districts only participated at one point in time. Only five districts had at least 10 respondents at both points in time. Due to varying response rates and small sample sizes in some districts, this report focuses on overall results rather than individual results by district. However, STEM Action Center personnel and district personnel have been provided with access to district-level results via an electronic data dashboard to support ongoing program implementation and improvement. In addition to the STEM Action Center's ability to view a summary of district-level responses, districts are also able to view their individual results and aggregated program-wide results.

Our analyses of these data include the generation and interpretation of descriptive statistics as well as Analysis of Variance (ANOVA) and post-hoc analysis of significant ANOVA results, such as Turkey's Honest Significant Difference (HSD). Specifically, we calculated composite measures of survey responses by domain, representing the average percentage of educators who reported moderate or extreme collaboration across the items in each domain for both points in time (fall and spring). Results are discussed in more depth in our presentation of results later in this report.

UEPC Student STEM Outcome Survey

The UEPC Student STEM Outcome Survey was administered to students of all participating teachers during the 2021-2022 school year. This survey measured student interest, engagement, confidence, identity, and achievement in STEM. Each construct was measured through multiple survey items—between five and eleven items per construct. Our analyses of these data include the generation and interpretation of descriptive statistics as well as Analysis of Variance (ANOVA) and post-hoc analysis of significant ANOVA results, such as Turkey's Honest Significant Difference (HSD).

All survey items were on a five-point scale ranging from "strongly disagree" to "strongly agree." Within each of the five STEM constructs included in the survey, we calculated the percentage of responses that were either "agree" or "strongly agree." Further interpretation is provided in our presentation of findings.

We received a total of 986 responses in the administration of the UEPC Student STEM Outcome Survey. As noted in Table 2, participants were in grades 6 through 12, with the most responses from seventh graders. Our presentation of findings describes student results for the entire group, and we do not disaggregate by grade level.

Table 2. Student survey participants' grade levels

Grade Level	N
6	95
7	440
8	190
9	167
10	51
11	33
12	12
Total	**986**

Educator Focus Groups

The 2021-2022 evaluation included focus groups with participants of the Professional Learning Grant Program to address key evaluation questions. Participants included district and school administrators (e.g., district office staff, school principals/executive directors), the designated grant administrator for their district, as well as teachers from elementary and secondary schools. The purpose of these focus groups was to gain a deeper and more nuanced understanding of how the PL Grant Program was implemented from the perspective of those in the field. A semi-structured protocol was developed to gather information about participants' experiences with implementation as well as suggestions for improving the grant program and future planning.

Districts receiving PL Grant Program funds were asked to provide the UEPC with names and contact information of participating educators for evaluation data collection purposes. The UEPC used this information to send focus group invitations via email to participants from 33 districts. Sixteen focus groups were successfully conducted, representing 15 unique districts (i.e., two of the groups represented the same district). Each focus group included between one and six participants and ranged in length from approximately 30 minutes to one hour. While focus groups were intended to include at least three participants, the majority of participating groups 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. Analysis involved the use of open coding to generate themes driven by the words and topics brought up during the conversations (Saldaña, 2016). Key qualitative themes are discussed in standalone sections of the report, and quotes representing secondary themes are integrated into other sections, as appropriate, to add nuance and context to quantitative findings.

Program Implementation

To understand how implementation of the Professional Learning (PL) Grant Program varied across program sites, we analyzed data from the UEPC Educator STEM Professional Learning Survey, as well as focus groups with teachers and administrators (both district-level and school-level). Focus group data provided a sense for how the PL Grant Program funds were used across districts and schools. Educator Survey data and focus group comments, together, sought to highlight how and to what extent program implementation involved guiding theories of action, shared values/vision, collective learning, leadership support, coaching, relational conditions, consistency, and professional learning that reflects adult learning principles.

EQ 1: How is STEM Professional Learning implemented across LEAs? In particular, how do LEAs attend to adult learning principles, professional learning standards, and collaboration?

PL Grant funds were most commonly used by districts and schools to support teacher trainings and professional learning communities, reflecting three of Utah's standards for effective professional learning

When asked in focus group discussions how the PL Grant funds were used this school year, teachers and administrators described two key aspects of implementation: providing training for teachers and establishing professional learning communities. Notably, the use of funds for these educator-focused activities is consistent with the standards for professional learning, outlined in Utah state law H.B. 320 (2014) section 53A-3-701[4] and referenced in the STEM AC PL Grant Program Request for Grant Applications, stating that effective PL "requires prioritizing, monitoring, and coordinating resources for educator learning."

Teacher training occurred at both the school and district levels, and the topics and structure of training sessions varied. Topics included subject area content (e.g., math), STEM integration, instructional models/frameworks, and specific learning platforms (e.g., Gizmos). Training sessions were generally held synchronously but varied in frequency and duration. In some districts, larger training sessions were followed by asynchronous work or smaller sessions at individual schools. In the quotes below, administrators and teachers provided examples of how teacher training occurred in five different districts.

- *Well, it's brought up a lot, especially with the math and science and the new SEEd [Science and Engineering Education] storylines. For [school name 1], for example, I lead out in presenting a lot of PD [professional development] on the math side that aligns with our i-Ready grant, and I do that anywhere from once to twice a month... On the [school name 2] side, the teachers, they're split. They receive training with me in small groups at least once a month. Again, all geared towards math or science... [Administrator]*

- *So we wrote a grant to do the first year – actually we started last year, but this is our first year with the grant of comprehensive mathematics instruction framework, professional learning to develop additional – or deepen our math knowledge ourselves as teachers, but also the*

[4] https://le.utah.gov/~2014/bills/static/hb0320.html

pedagogy of teaching mathematics... The teachers come out probably about every three to four weeks, but sometimes it's tighter, right? But it ends up being 12 sessions or so. [Administrator]

- *We provided two two-day trainings for our teachers K-6. We trained 68 teachers plus our – there's three facilitators and myself, that we took the training as well to continue that training throughout our schools… [Administrator]*

- *...Again with the same structure, so small personalized groups at schools hold with the presentations. District level big trainings, and then asynchronous work...but all of it pushing an instructional model that's focused on wonder sensemaking and problem solving. [Administrator]*

- *We've had...what [school name] has deemed our completion for this STEM Action money. Due to training sessions with the providers of these Gizmos, so we've met with their teachers and their and analyzers, and their programmers, and we've gone through a couple of their exercises and learn how to increase that depth of knowledge and how to modify the open-ended parts of it, and how to scaffold with the more closing parts. [Teacher]*

Another professional learning structure that was supported by PL Grant Program funds was professional learning communities (PLCs). This reflects another PL standard based on Utah state law, namely that effective professional learning "occurs within learning communities."[4] While PLCs varied across schools and districts in their scope and focus, they all involved regular meetings and collaboration between at least two teachers. One of the most common areas of focus for PLCs was reviewing student data to inform modifications to instruction. This represents a third PL standard which states that effective professional learning "uses a variety of sources and types of student, educator, and system data to plan, assess, and evaluate professional learning."[4] For example, as a middle school teacher explained, "*...with our PLCs, the other eighth grade teacher and I work really closely together, and we evaluate data, we make modifications*. An administrator from the same district explained their process in more detail:

- *...Sitting down as an instructional coach and being able to identify what instructional strategies are being used, how the students are responding using that data to support the evidence that we collect has been vital because, again, when you look at as the students came in, and then looking at the history, and in looking at our proficiency levels decreased drastically due to the circumstances we've been in for the past two years, it was nice to really be able to focus on, "Are we growing? Are we closing that gap?" because as teachers, we know we want 80 percent of our kids proficient...*

Similarly, a teacher in another district shared how his chemistry department PLC meets to talk through student data and plan modifications accordingly:

- *...We tend to have a set date every week where we actually meet and look at student data and start trying to figure out, how do we address these issues with these kids? How can we better teach this part of the subject? Where are the kids struggling? What is a more effective way of doing this? How can we modify this?*

In other districts, beyond looking at data, PLCs were used to discuss successes, challenges, and next steps, as exemplified in the quotes below. One teacher also noted that collaborating in their PLC is more efficient than if they were to troubleshoot alone.

- *It's been helpful also to the other chemistry teacher and I have met on a regular basis, looking through some of the chemistry labs and some of the units that we have coming up and seeing what labs work and what labs don't, which labs we really want to highlight, and which labs we can expand and create those questions for... And so that's really what we spent our time and our PLC time doing with this. [Teacher]*

- *And because we [meet as a] PLC, and we have respect for one another, we're able actually come up with ideas and start looking at different things. And somebody's able to research on one area while somebody else is doing something else. And so you don't have one person that's doing it all, which is awesome and amazing because considering the other classes that I teach, and I am the only person that teaches those classes here, if it doesn't work, it's all me... And so trying to figure out why is this not working the way that it's supposed can take me hours and hours and hours because there's nobody to ask, and there's not a second rank to engage with. [Teacher]*

A few PLCs had more specific formats and areas of focus, such as book clubs and lesson studies. One district's book club was divided into two groups: elementary teachers and secondary teachers. Each group met regularly to discuss a few chapters of a book, and between meetings they were asked to take what they had discussed and implement it in their classrooms. As the district administrator explained,

- *It was as simple as a book club, and then try something out... I think we'll build on that a little more going forward, at least for our secondary teachers, but I'm so pleased. I am so pleased with them just digging in and doing the work together, and really being a PLC.*

While book clubs were discussion-based, lesson studies were focused on developing new lessons or units. One district brought educators together in PLCs to build and pilot test online learning modules so that their lessons would better accommodate a hybrid classroom model, with students both at school and at home:

- *So, we really built some communities there where they were working together to create lessons that were more blended or that had a digital component that would be beneficial for kids who are either in person or at home, and they really came together through Google Meet and other types of IPLC–Instructional Professional Learning Communities – and they worked together, and then, it was really great because they build these online learning modules... They taught them to their kids and then, they came back together and did some revamping. They did a lot of lesson study, I guess is what I would call it, last year as they went through this process of how "we're going to merge these two forms of learning. It's never going away. We really need to think through the SAMR model and how to embed some of these practices." And so, they had some really great opportunities to learn from one another in their PLCs, and they were able to accomplish that through some technology, which was really cool. [Administrator]*

Interestingly, one administrator noted that there was a natural connection between teacher training and PLCs in their district. Specifically, strategies presented in training sessions were shared by participating teachers in their PLCs, spreading implementation more widely throughout schools and classrooms:

- *I think it's been amazing to watch how those trainings have kind of started to seep into the schools beyond the 68 teachers we trained. A lot of their PLC teams and other neighboring classrooms have adopted some of those strategies as well. So I've seen that go out beyond just the initial group we've trained, so that's been great. [Administrator]*

There was a lack of clarity among teachers about the allocation and usage of PL Grant funds in some districts

In some districts, teachers who participated in focus groups were unclear about where and how PL Grant Program funds were allocated. As a result, it was difficult at times for teachers to differentiate between professional learning activities that were tied to the PL Grant and activities funded by other grants in their schools/districts. One teacher specifically expressed interest in knowing more about their school's allocation and use of funds.

- *I'm not sure which part is the grant. The administration would know better. [Teacher]*
- *Yeah, I would agree with [name] in terms of like we're not ever actually told when we're using grant money or where, what money is coming from where... none of us are actually told anything about funding. [Teacher]*
- *And it's just one of those things if we don't know how much money is actually in the grant, that's something that the administration deals with. And how much is allocated to each school because I think – I'm not even sure how the grant works. I know that we've got some of it, and that's all I know... [Teacher]*
- *[I would like] maybe a clear way to see how much the STEM Action Center sends to our school. Because sometimes we'll ask for time off to prep and things like we did before, and we're told, "No." So maybe knowing how to access those funds more clearly and that kind of thing, or how much went to our school. [Teacher]*

Adherence to adult learning principles was a bright spot in educators' experiences of PL Grant Program implementation, along with shared vision, collective learning, relational conditions, consistency, and theories of action

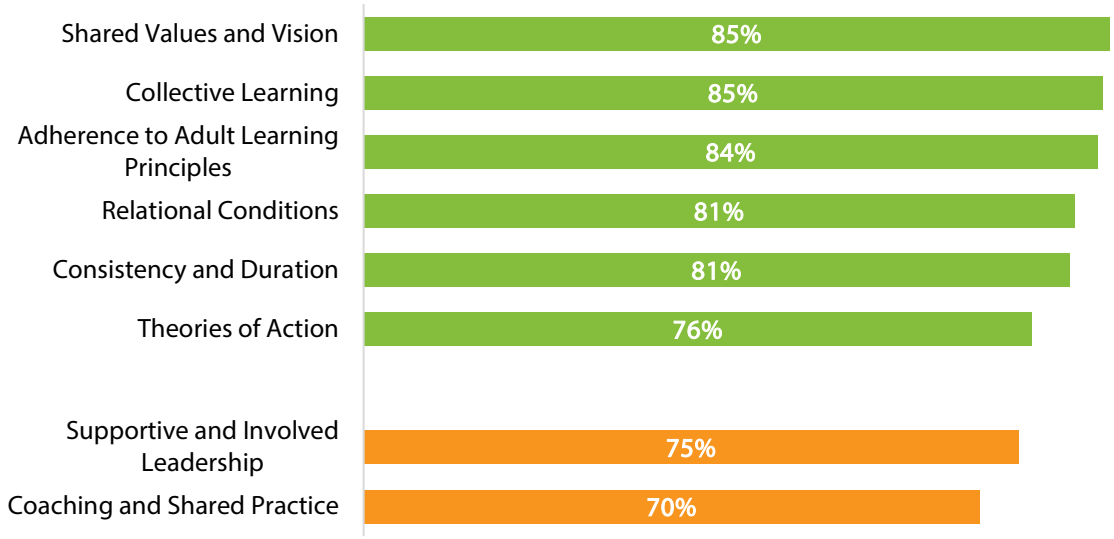
Educator Survey participants responded to various items measuring their perceptions of the implementation of eight core features of the Professional Learning Grant Program. These core features included: shared values and vision; collective learning; adherence to adult learning principles; relational conditions; consistency and duration; theories of action; supportive and involved leadership; and coaching and shared practice. Respondents were asked to report the extent to which they agreed that each feature was present during their PL Grant experiences, using a five-point scale: strongly disagree, disagree, neither agree nor disagree, agree, or strongly agree. For some features, educators were asked to think generally about their professional learning experiences, while for other features, they were asked more specifically about their professional learning communities. We begin our discussion of survey results with a high-level overview of educators' perceptions of these eight core features of implementation (see Figure 4). Next, we provide the results for the individual survey items associated with each feature. We also provide focus group data to offer further nuance and insights into program implementation.

Figure 4 allows for comparison across implementation features by showing the average percentage of respondents who "agreed" or "strongly agreed" to the items within each feature. Based on an analysis of variance (ANOVA) of the implementation features, there was a statistically significant difference in teachers' self-reported rates of agreement among all eight features ($F=8.9$, $p<.05$). This suggests that certain PL Grant Program features were implemented more strongly than others. As shown in Figure 4, 85% of educators "agreed" or "strongly agreed" that their professional learning experience reflected shared values and vision and that they engaged in collective learning. This was followed closely by adherence to adult learning principles (84%). Using the ANOVA results, a post-hoc Tukey's Honest

Significant Difference was calculated to determine which implementation features had similar rates of agreement and which had meaningful differences in agreement. These three areas—along with relational conditions (81%), consistency/duration (81%), and theories of action (76%)—had statistically similar rates of agreement. Thus, overall, these six features of the grant (green bars in Figure 4) were present to a similar degree in educators' experiences of program implementation.

The two grant implementation features that had the lowest rates of educator agreement were supportive leadership (75%) and coaching (70%). When comparing mean levels of agreement, there was a statistically significant difference between these two features of program implementation and the features discussed above. This finding indicates that supportive leadership and coaching (orange bars in Figure 4) were not as present across educators' experiences of program implementation as the other six core features of the PL Grant. This pattern is similar to what was found in the 2020-2021 school year.

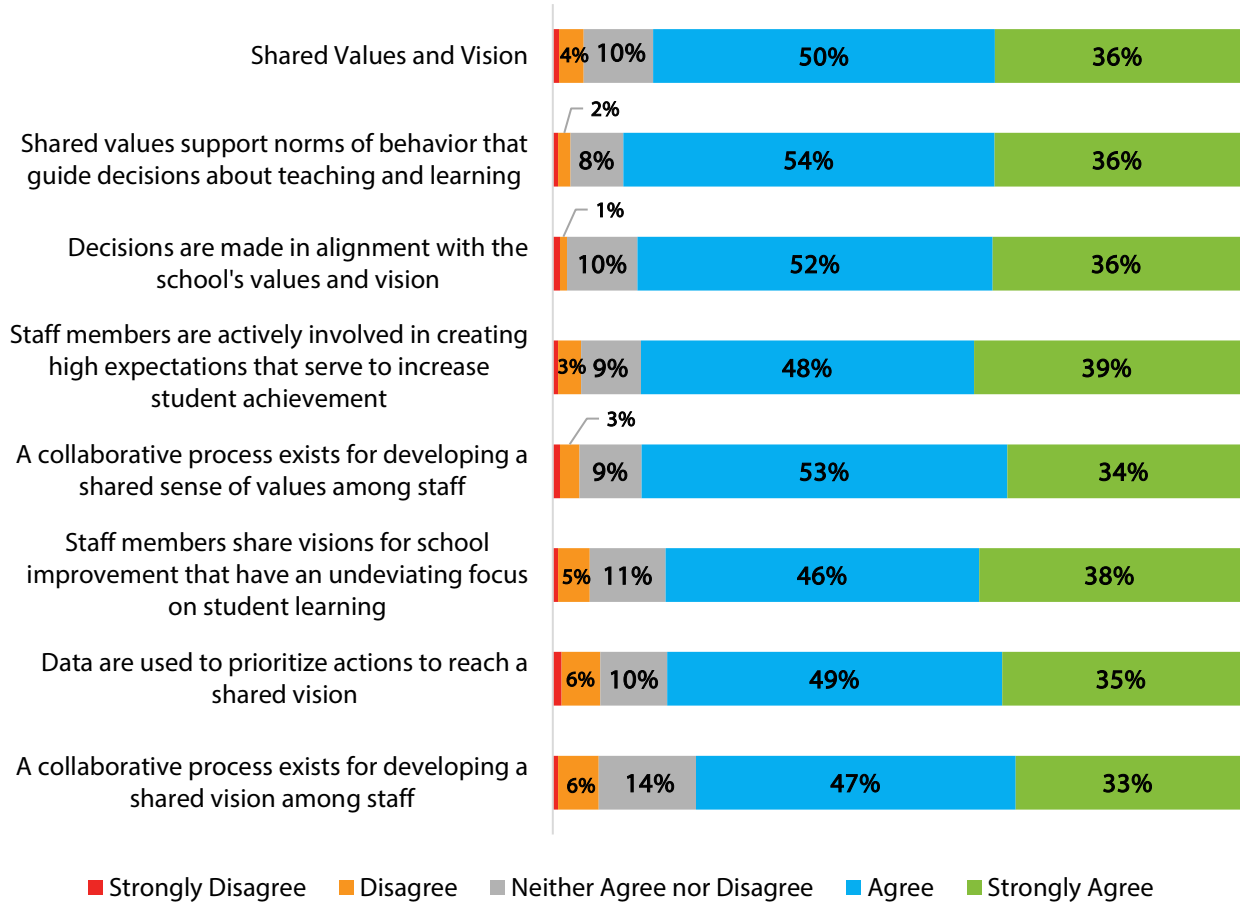
Figure 4. Educators' agreement that implementation of the PL Grant Program reflected eight core features of the grant



Note: Based on an analysis of variance (ANOVA), there was a statistically significant difference in teachers' self-reported rates of agreement among the eight implementation features ($F=8.9$, $p<.05$). A post-hoc Tukey's Honest Significant Difference test showed that the areas of supportive leadership and coaching and shared practice (orange bars) had significantly lower rates of educator agreement compared to the other six features (green bars).

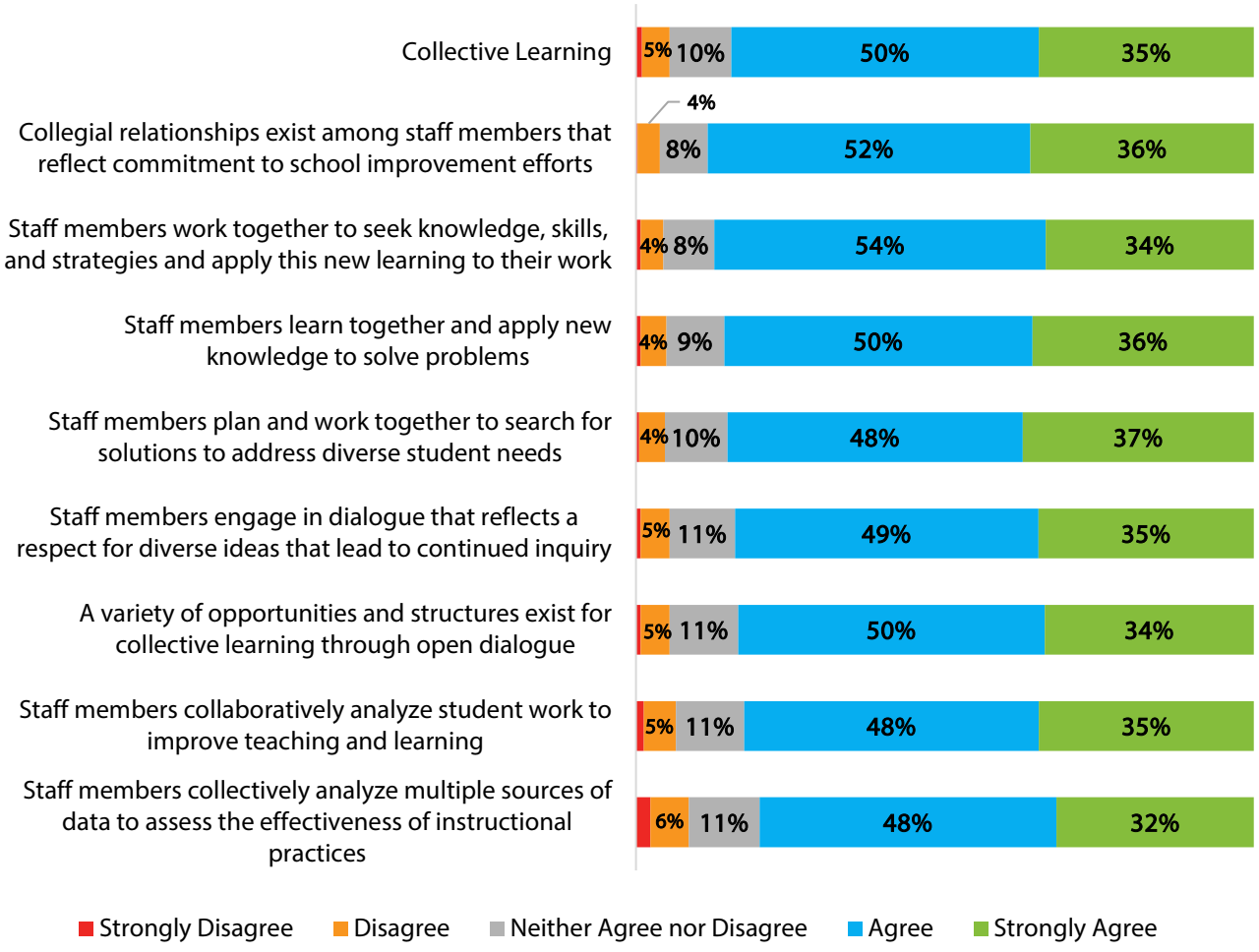
Shared Values and Vision of PL. Survey items related to shared values and vision assess the extent to which values, norms, and behaviors that foster the creation and sustainability of professional learning communities are present among participating school staff. Overall, 86% of educators either agreed (50%) or strongly agreed (36%) that their professional learning communities cultivated shared values and vision among participants (see Figure 5). Respondents' level of agreement across six items related to this construct ranged from 80% to 90%. Item-level analysis showed that the highest level of agreement was that shared values support norms of behavior that guide teaching and learning. The lowest level of agreement was that there is a collaborative process for developing a shared vision among staff, though still almost 80% of educators agreed with that statement. These results suggest that the environment and norms for shared values and vision have been established, but the substantive processes may be less clear.

Figure 5. Educators' agreement that their professional learning community cultivated shared values and vision ("In my STEM professional learning community…")



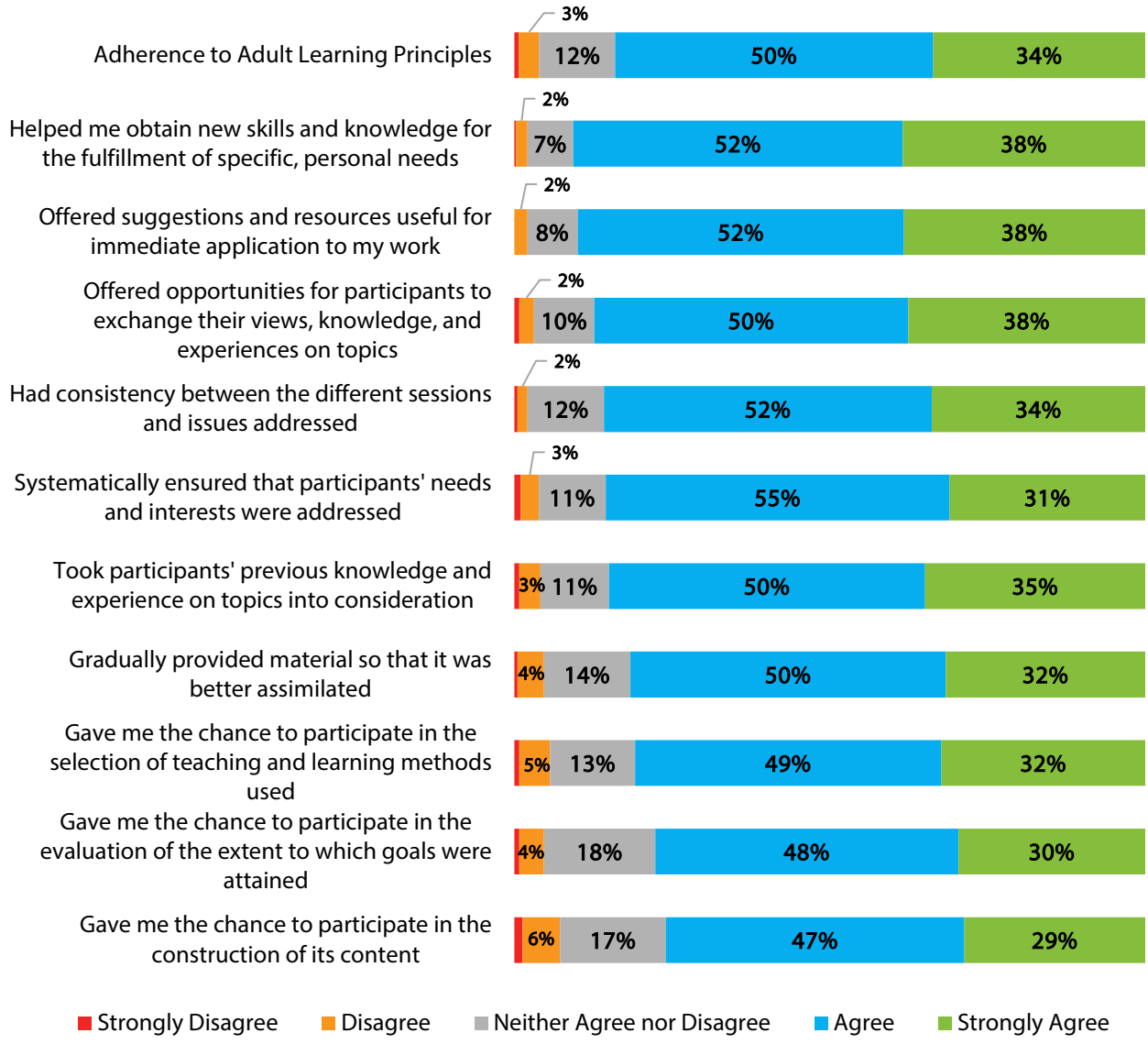
Collective Learning in PL. Collective learning focuses on the extent to which participating school staff have opportunities to build relationships, engage in dialogue and inquiry, and learn together in professional learning communities to improve their instructional practices. Approximately 85% of teachers self-reported that they agreed (50%) or strongly agreed (35%) that their professional learning community involved collective learning. As shown in Figure 6, the level of agreement by item ranged from 80% to 88%. The item with the highest level of agreement was that there are collegial relationships among staff that reflect commitment to school improvement efforts. The lowest level of agreement for educators was that their team collectively analyzed multiple sources of data to assess the effectiveness of instructional practices. However, this item still had 80% agreement among survey respondents. In focus groups with educators who described their PLCs, analyzing data was mentioned frequently, as discussed earlier in this section, but all of the examples shared were about student data. While many PLCs analyze student data, it may be less common to incorporate other/multiple sources of data (e.g., student and teacher data).

Figure 6. Educators' agreement that their professional learning community involved collective learning ("In my STEM professional learning community…")



Adherence to Adult Learning Principles in PL. Adherence to adult learning principals addresses the importance of professional learning designed to address teachers' unique learning styles, needs, and previous knowledge during professional learning experiences as well as the ability to make the PL applicable to practice. Across Educator Survey respondents, 84% agreed or strongly agreed that their experiences in the PL Grant Program reflected the principles of adult learning. When looking at individual items (see Figure 7), the highest percentage of educators agreed that they obtained new skills for personal needs (90%) and that they were provided with suggestions and resources that were immediately applicable to their work (90%). The implementation of these two adult learning principles was corroborated in focus groups with educators across districts, who shared examples of teachers developing new skills and receiving useful suggestions and resources (see comments below).

Figure 7. Educators' agreement that their professional learning experiences adhered to adult learning principles ("My STEM professional learning experience…")



- *I actually was really sick [during] the last [training]. So I wasn't able to go and the PowerPoint and the supplies that she gave me, I can easily go look at that and I can say, okay, this is what they did in that class. So I mean the – not, yeah, the supplies but also the resources that came with the supplies, the – all of it was just easy to use, easy to – well thought out that kids could do it too. That was – it wasn't just like here's this, figure it out. It was like, okay, this is a good way to think about it so kids could think about it this way. [Teacher]*

- *I think probably the professional development time that we have to just actually sit down and practice, learn something hands-on is the most effective. I know whenever I'm faced with a new piece of technology, I like to just have someone come in and guide us through, and be able to play around with it a little bit and get comfortable with it. Then, see some examples maybe of how it's been used... Teachers are busy. You know this. To have someone come in and say, this is the thing. Here's a few ideas about how you could implement this next week in your class, or here's some ways to think about how you could use this are really helpful. [Administrator]*

- *We also have a – I don't know what her role is, but at staff meetings, she brings ideas that are related to STEM that we can use in our classrooms, and so, that's been great, because she'll come in and say, "Hey, had anyone seen a merch cube? This is a merch cube. You could use this in pretty much any class. Here's how it works and here are the things that go here." And she has a lot of great ideas of how to incorporate things. [Teacher]*

- *I just think that how it has supported me as a science teacher is just the resources that the district has purchased probably with the funding that they have received so that I can implement them in my class. [Teacher]*

- *I was working with a particular teacher at the school that I service and we were talking about appropriate questioning and getting the students to start not only answering questions that the teacher poses. So there's the two-sided; there's the pedagogy point where the teacher has to do appropriate questioning with, you know, is this a leading question, is this a prodding question. And then there's also students need to generate those questions. And so that's one of the instructional skills I was working with her and we sat down and did some planning together and then she went and implemented and she came back and...one day she said, "Oh, my lesson was a disaster," and I said, "Well, let's talk about it." And so then we talked through it and then she goes, "Okay, I'm going to go back and try again." And she went back and tried again and she said, "It was outstanding. It was so great. And the kids were so engaged and they were starting to create those questions and things like that." And so sometimes for me those instructional skills is, number one, getting them to try something new and then try it again if it doesn't go well the first time. [Administrator]*

The three items with the lowest agreement (76% to 81%) in figure 7 (Adherence to Adult Learning Principles) involved various ways that educators could have participated in the design and evaluation of their professional learning experiences. In line with survey responses, these principles of adult learning were discussed in focus groups much more rarely than the principles discussed above. Administrators from only two districts indicated that teachers had input in the design or content of their professional learning experiences:

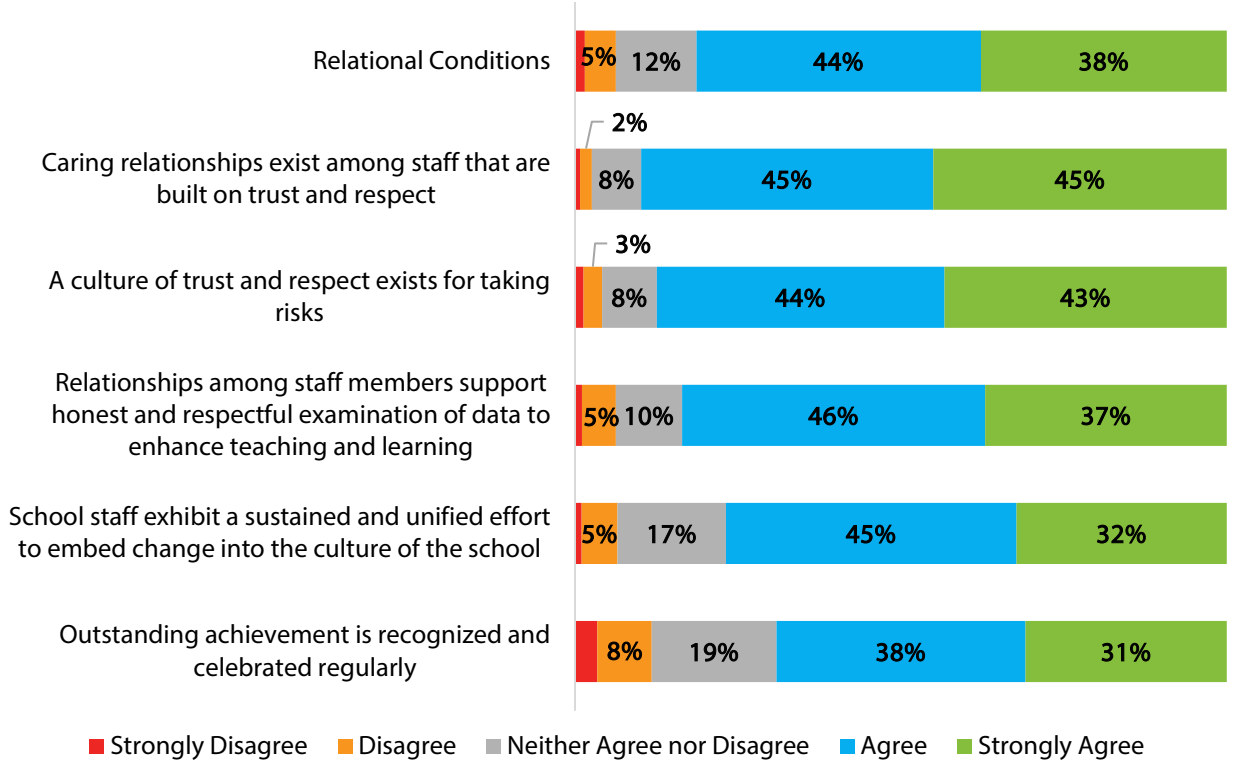
- *...I say to my [instructional] coaches, "What are the programs that you would like to enact?" So, it's provided this creative license for my coaches to use, you know, student data and teacher data,*

because we do send out surveys to teachers, and to create targeted Professional Learning in STEM leadership to respond to the needs of the teachers in the district.

- *What we did is we created a plan with a menu of choices, optional for pre-K through 12, and we tried to make them just general learning with, well, in my case, a focus on SEEd [Science and Engineering Education], understanding SEEd and implementation of science better in our classrooms. We had a variety of things that teachers could choose from. One of them was a book club...*

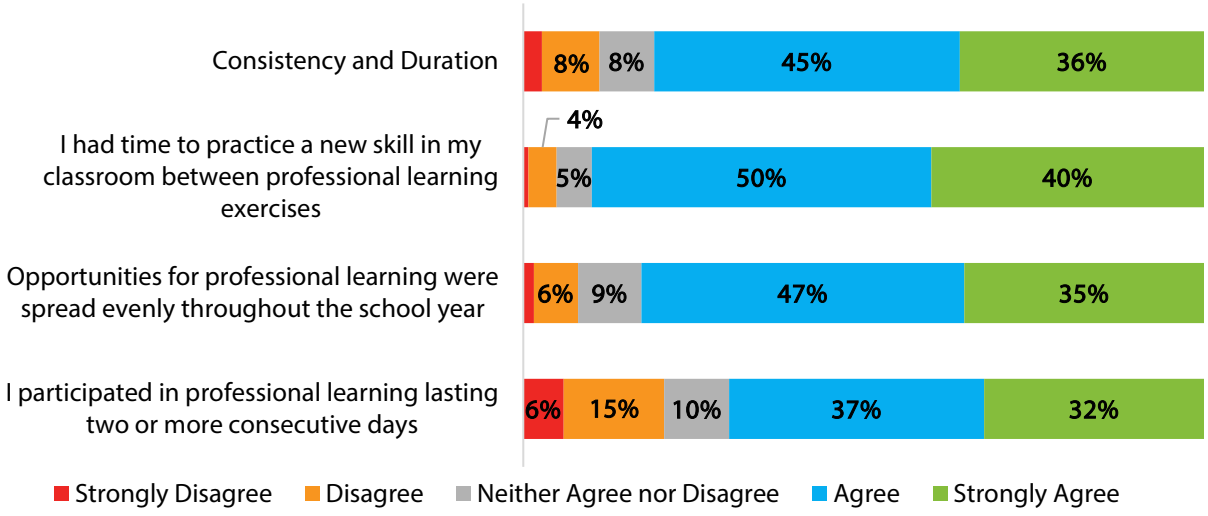
Relational Conditions in PL. Relational conditions refer to the culture, relationships, and interactions among school staff in their professional learning communities. Overall, 82% of survey respondents agreed that their professional learning community supported relational conditions, with item-level agreement ranging from 69% to 90% (see Figure 8). Educators agreed most with the statement that caring relationships exist among staff that are built on trust and respect (90%). In contrast, 69% of educators agreed that outstanding achievement is recognized and celebrated regularly, with less than one-third (31%) strongly agreeing with this item.

Figure 8. Educators' agreement that their professional learning community supported relational conditions ("In my STEM professional learning community…")



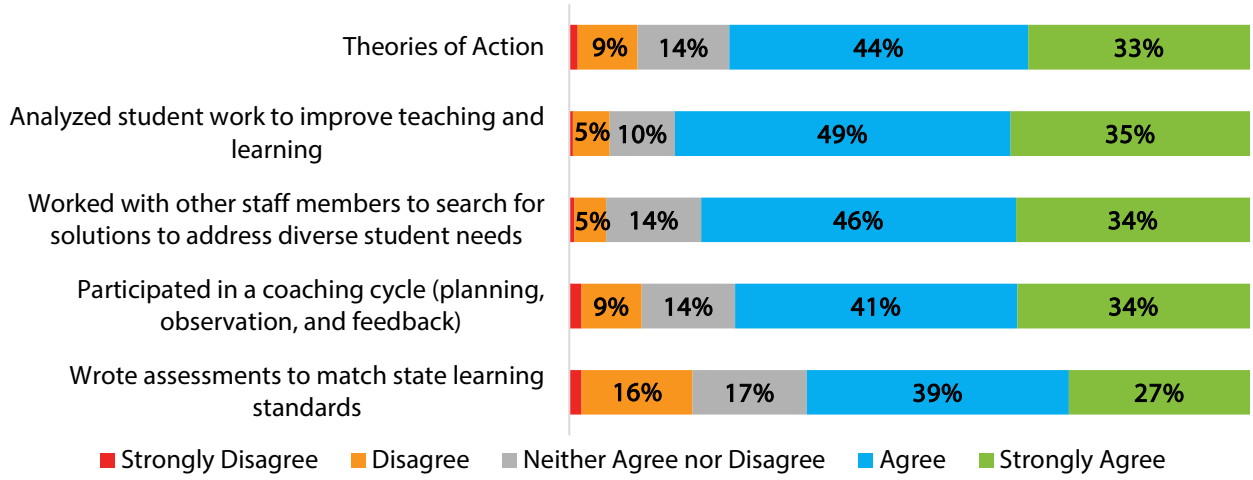
Consistency and Duration of PL. Survey items related to consistency and duration of PL refer to the pacing and duration of professional learning experiences in the PL Grant Program. Educators agreed overall (81%) that their professional learning experiences reflected appropriate consistency and duration. As shown in Figure 9, the item-level agreement ranged from 70% to 90%, with 9 of 10 educators agreeing that they had time to practice a new skill in their classroom between professional learning exercises. This was also discussed frequently by teachers in focus groups—for example, one teacher noted that the most beneficial part of the grant was having "*instructors come in and we were able to receive instruction and then we were able to actually teach in our classroom, and we came together and discussed what worked, what didn't work, and then we'd try it again.*" While teachers had opportunities to practice what they learned, only 69% of survey respondents reported participating in professional learning lasting two or more consecutive days. The duration of professional learning sessions was not commonly discussed in focus groups, though some participants noted a "systematic" approach that seemed to involve professional learning sessions being shorter in duration but more frequent and consistent throughout the school year.

Figure 9. Educators' agreement that their professional learning experiences reflected appropriate consistency and duration



Theories of Action. This section of the survey asked educators about the extent to which their professional learning community activities reflected PL Grant Program theories of action. Overall, 77% of educators agreed that their professional learning community was implemented following theories of action. Item-level agreement ranged from 66% to 84% (see Figure 10). The highest percentage of teachers (84%) agreed that they analyzed student work to improve teaching and learning, and the lowest percentage of teachers (66%) agreed that they wrote assessments to match state learning standards.

Figure 10. Educators' agreement that their professional learning community followed theories of action ("In my STEM professional learning community, I…")



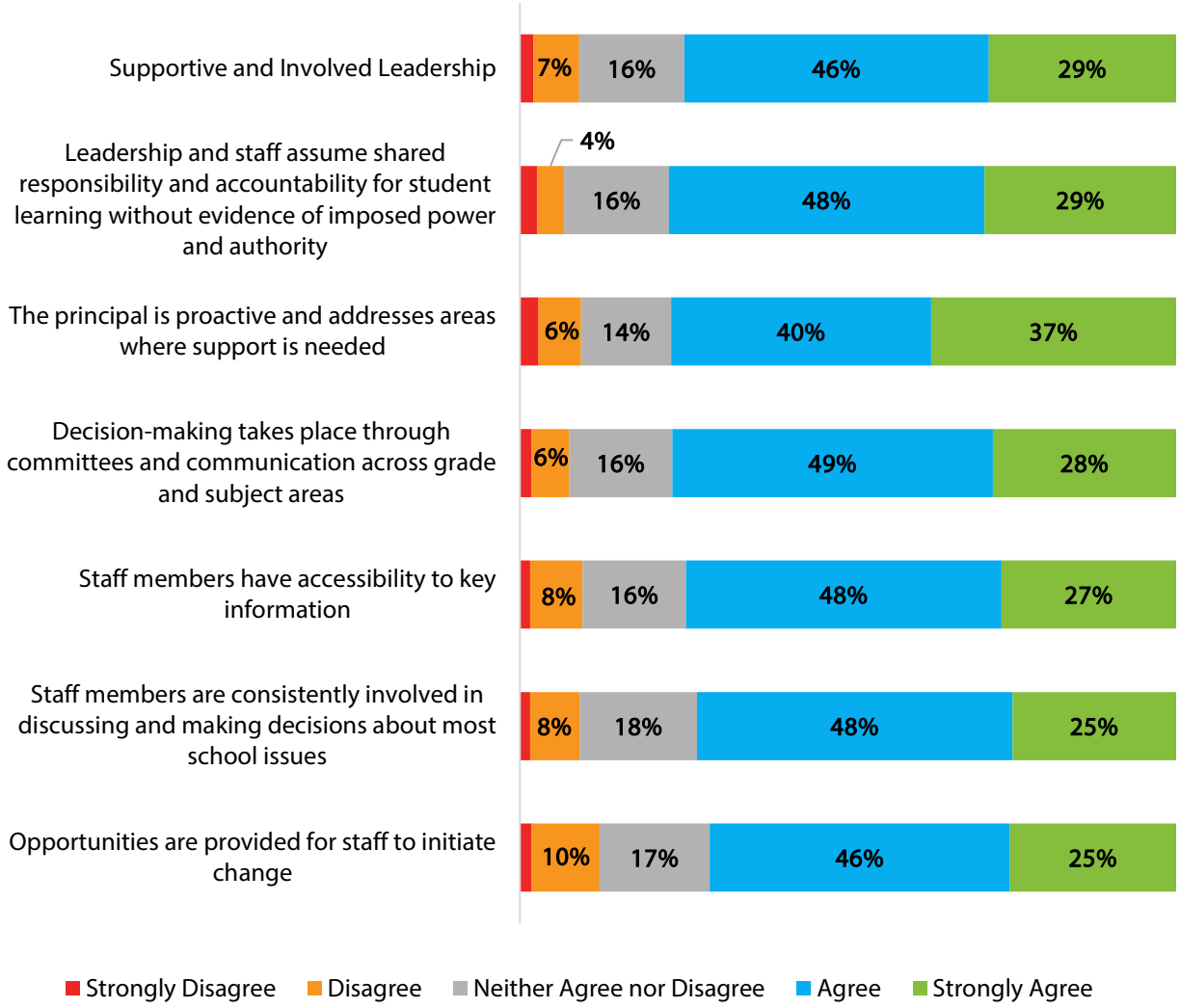
Supportive leadership—one of Utah's standards for effective professional learning—as well as coaching are areas of lower implementation of the PL Grant Program

As explained earlier in the report, the two core features of the Professional Learning Grant Program that had the lowest rates of educator agreement were supportive and involved leadership (75%) and coaching and shared practice (71%). These two areas of implementation had significantly lower levels of agreement when compared to the six other features outlined in the previous section ($F=20.4$, $p < .01$). This suggests that supportive leadership and coaching were not as present across educators' experiences in the program as the other features of the grant. In focus groups, teachers did not address the role or involvement of leadership, likely because district and school leaders were present in most of the groups. Focus group participants discussed some aspects of coaching and shared practices, such as opportunities for instructional coaching, though they did not mention other aspects, such as co-teaching. Overall, these two areas may be opportunities for more intentional, consistent, and widespread implementation across districts and schools receiving PL Grant funding.

Supportive and Involved Leadership. Supportive and involved leadership refers to school leaders providing access to information, sharing responsibility for student outcomes, and supporting school staff while also empowering them to make decisions and create change. Three-quarters of educators (75%) agreed that their school leadership was supportive and involved (75%). As shown in Figure 11, the item-level agreement for this implementation feature ranged from 71% to 77%. The highest percentage of educators (77%) agreed that leadership and staff share accountability for student learning. On the other hand, educators agreed least that staff have opportunities to initiate change (71%) and make decisions about school issues (73%). This is consistent with findings related to adult learning principles, discussed previously, which had the lowest rates of agreement for items about educator involvement in the design of professional learning. School leaders may have opportunities to better facilitate educator input and

advocate for their voice in decision-making. This area of growth is especially important given that supportive leadership reflects one of Utah's statewide PL standards[4]—namely that effective professional learning "requires skillful leaders who develop capacity, advocate, and create support systems for professional learning."

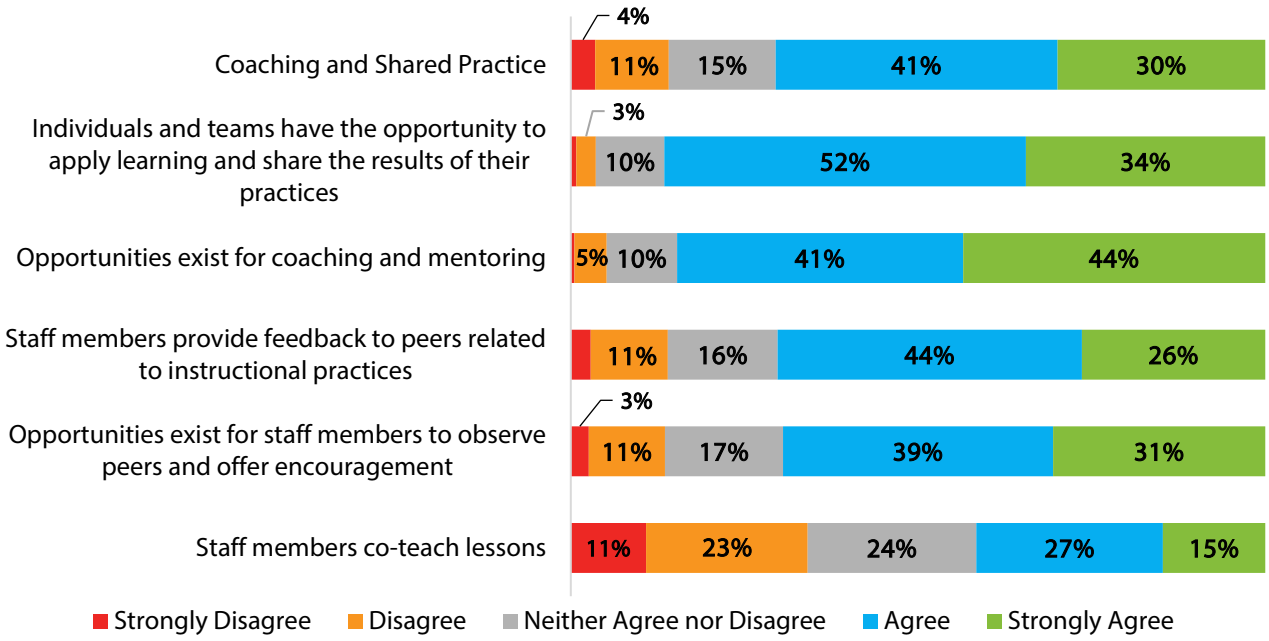
Figure 11. Educators' agreement that their professional learning experiences included supportive and involved leadership



Coaching and Shared Practice. Survey items related to coaching and shared practice address opportunities that participants have to engage in coaching/mentoring, co-teaching with other educators, and learning from peers in their professional learning experiences. Approximately 71% of educators agreed that their professional learning involved coaching and shared practice. Item-level agreement ranged from 41% to 86% (see Figure 12). The items with the highest agreement focused on opportunities to apply learning and share results (86%) and opportunities for coaching and mentoring (85%), and this finding was supported by focus groups discussions about applying STEM instructional practices and receiving feedback from peers and coaches. For example, one teacher explained her school's approach to instructional coaching:

- *To speak to your question about like, how do we implement this with instructional coaching – so, we have – we've been working with videoing each other and doing some reflection questions on our own practice by using various rubrics through Canvas to give each other feedback to help us reflect to ourselves. We do it once a quarter, and then, we have a peer that specifically reviews our video and gives us direct feedback with regards to maybe concerns that we've had or with regards to the rubric that has been set by the grant leader. And we occasionally have STEM Action Center lunches where we get together and we kind of discuss across campuses. Often, it's affiliated with a professional development day so, we have multiple locations together, not just in our own particular building, where we can be discussing some of those – our different practices and implementation with STEM... And then, we always have instructional coaches that we can counsel with in terms of specific concerns that we have as well.*

Figure 12. Educators' agreement that their professional learning community involved coaching and shared practice ("In my STEM professional learning community…")



The item related to coaching and shared practice that had the lowest percentage of agreement (41%) was "staff members co-teach lessons." In fact, this was the lowest-rated item across all implementation features, and it was 25 percentage points below the item with the second lowest agreement (61%, in theories of action). Co-teaching was only mentioned by one administrator across all 15 districts represented in focus groups. This may be due to teachers not being provided with opportunities to co-teach in their schools, or that co-teaching was not feasible this year due to staffing challenges.

Collaboration with peers was a key feature of educators' professional learning experiences, and effective collaboration increased overall from the fall to the spring

Collaboration was a key component of educators' experiences in the PL Grant Program, as evidenced by both survey and focus group data. To understand collaboration in professional learning communities across the PL Grant Program, educators completed the UEPC Collaboration Self-Assessment, which assessed the six domains of effective collaboration in the Fall of 2021 and again in the Spring of 2022. These six domains are: collective responsibility; inquiry-based; improvement-focused; intentionality;

empowerment; and capacity building. Respondents were asked to rate the extent to which collaboration in their STEM professional learning community reflected various items related to each domain. Table 3 outlines these domains with an example survey item and supporting quote from educator focus groups, which describes participants' experiences.

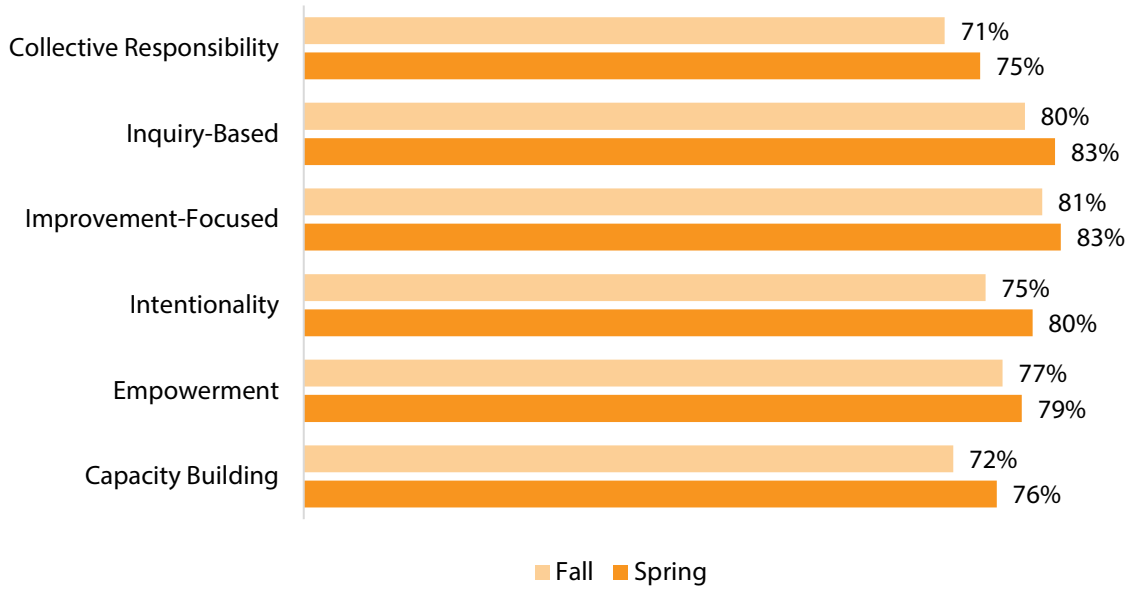
Table 3. The six domains of effective collaboration with example survey items and focus group quotes

Domains of Effective Collaboration	**Example Survey Item** ("Collaboration in our STEM professional learning community...")	**Example Focus Group Comment**
Collective responsibility	Provides structures for accountability	■ *But one thing that we added this year was a learning partner for every school for every teacher that's at their school. So there's more day-to-day accountability, and we've seen success in that area... [Administrator]*
Inquiry-based	Promotes routine feedback—seeking and receiving	■ *...That video club was way more bang for the buck because you don't have to do anything, just bring a video one time and give each other feedback, right? Like, 'It's no big deal. You just come and eat dinner with us and we have a great time.' ...And they always go home with a handful of ideas. [Administrator]*
Improvement-focused	Is data informed	■ *...In what you would call your STEM PLCs, we've held data meetings to go over our math data and try and support that implementation of number sense and number talks in our schools. [Administrator]*
Intentionality	Allocates time for collaboration	■ *...When we come together during those meetings each month, it's during that time that I would say we're very much engaged in learning... So it's that opportunity to collaborate when we're together and think deeply about our practice, and how we can adjust and improve it so that our students will benefit from that. [Educator]*
Empowerment	Encourages and celebrates risk-taking	■ *...A direct quote from several of our participants in those trainings was 'I've left this training energized and ready to try new things.' And I thought, 'That's what we're looking for," because to integrate STEM that's what it takes; you have to take some risks and changing your practices from what you've always done to something new is a challenge, especially in the current context... [Administrator]*

Capacity building	Is flexible in structure and allows for spontaneous collaborations	■ *...A lot of our stuff tends to be just like, hey, we met up in the teacher's lounge and I'm giving this subject right now, can you do something with that in your math class? Or like...I teach biology and chemistry and so I was teaching error bars on graphs for the science section and I talked to the math teacher and was like, 'So did they learn standard deviation? Is that something you can add in in the next couple of weeks?' And he's like, 'Yeah, sure, not a problem,' right, and so and I feel like our school – because we're just we're small enough that we can really – we all know or at least have an idea of what's going on in the other classes and they're pretty helpful for just like informal collaboration... [Educator]*

Educators rated each collaboration item on a five-point scale: not at all, slightly, somewhat, moderately, or extremely. Figure 13 shows the average percentage of educators who reported moderate or extreme collaboration across the items in each domain of effective collaboration. Overall, teachers and administrators reported an increase in collaboration from fall to spring of the 2021-2022 school year. This is a marked improvement from last year's results, which showed a decrease in collaboration from the fall to the spring. The decrease was attributed to challenges stemming from the COVID-19 pandemic, and this year's results suggest that pandemic-related challenges were no longer hindering collaboration in professional learning communities.

Figure 13. Educator reports of moderate or extreme collaboration, by area, in their professional learning communities in Fall 2021 and Spring 2022



However, changes in collaboration varied by district, and collaboration decreased in some districts from the fall to the spring

While collaboration in professional learning communities improved from the fall to the spring across districts, there was substantial variation by district in rates of collaboration (moderate or extreme). Table 4 shows the range of district-level collaboration ratings for each of the six domains of effective collaboration. District-level ratings represent the average proportion of teachers in a given district who reported moderate or extreme collaboration for the items in each domain. For all six domains, the minimum district rating in the spring was lower than the minimum rating in the fall, suggesting that collaboration in some districts decreased from the fall to the spring.

Table 4. Range of district-level ratings of moderate or extreme collaboration for the six domains of effective collaboration

	Fall		Spring	
Collaboration Domain	**Min**	**Max**	**Min**	**Max**
Empowerment	29.6%	93.8%	5.6%	100.0%
Capacity Building	20.0%	92.1%	11.1%	88.6%
Collective Responsibility	31.3%	89.5%	18.8%	91.7%
Inquiry-Based	35.7%	97.7%	26.2%	100.0%
Improvement-Focused	18.8%	98.7%	16.7%	100.0%
Intentionality	40.0%	98.9%	0%	97.5%

STEM Educator and Student Outcomes

To evaluate the extent to which the STEM Action Center's Professional Learning Grant Program was associated with positive educator and student outcomes, we analyzed data from the UEPC Educator STEM Professional Learning Survey, the UEPC Student STEM Survey, and focus group data. We explored educator outcomes in the following STEM areas: identity; instructional skills; teaching self-efficacy and confidence; knowledge; and planning and integration of STEM content. Student outcomes that will be discussed, both specific to STEM and more broadly, include student achievement, interest, confidence, engagement, understanding/knowledge, and identity development. We also considered how participation in the Professional Learning Grant Program was associated with changes in instructional time devoted to STEM.

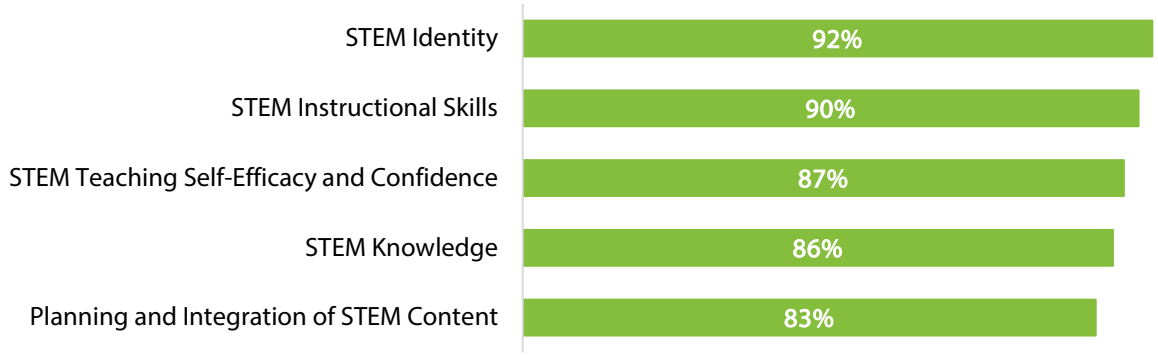
EQ2: What are the outcomes of teachers who participate in STEM Professional Learning?

The STEM PL Grant Program aims to support effective professional learning for educators across school levels and districts. As mentioned above, in the Educator Survey, five specific outcomes of participation were assessed for educators: STEM identity; STEM instructional skills; STEM teaching self-efficacy and confidence; STEM knowledge; and planning and integration of STEM content. Each outcome was measured through multiple (between 6 and 9) survey items. For each item, respondents were presented with a five-point scale (ranging from strongly disagree to strongly agree) and asked whether they agreed that their participation in STEM PL led them to implement specific practices related to each outcome. Teachers and administrators also discussed these outcomes during focus groups when asked about their experiences in the PL Grant Program. Focus group quotes are integrated throughout this section to provide examples of each outcome in the words of educators, and to add nuance to the survey findings.

Educators indicated that they improved in a variety of STEM outcomes as a result of participating in the PL Grant Program, especially developing stronger STEM identity

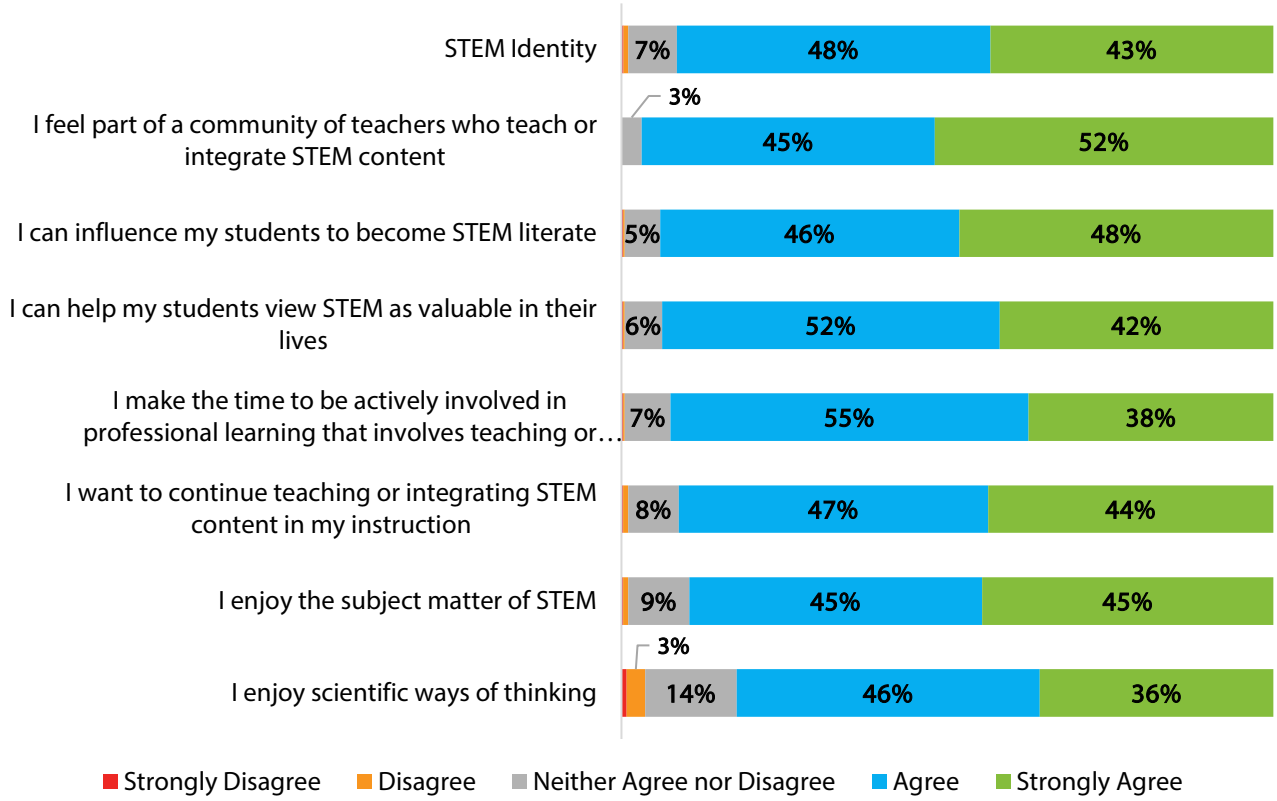
Educators' overall STEM outcome constructs were calculated by averaging percent agreement (agree or strongly agree) for all items within each construct. Overall, the highest rate of agreement for teachers (92%) was related to growth in STEM identity as a result of the PL Grant Program (see Figure 14). The lowest rate of agreement (83%) was in planning and integration of STEM content, though this was a key theme in educator focus group discussions. Overall, teacher outcomes were positive (above 80%) for those taking part in the PL Grant Program.

Figure 14. Educators' agreement that their participation in STEM PL led to growth in five key outcome areas



Educator STEM Identity As illustrated in Figure 15, almost all teachers (91%) reported an increase in STEM identity while taking part in the PL Grant Program. Notably, teacher reports of STEM identity were significantly higher than reports of other STEM outcomes ($F = 12.11$, $p < .05$), suggesting that identity development was the most prominent impact of the program on participating teachers. The item-level agreement in the STEM identity construct ranged from 82% to 97%. Teachers agreed most that they felt part of a community of teachers (97%), and 43% of teachers strongly agreed with that statement. However, they agreed least (82%) with the statement that they enjoy the scientific way of thinking.

Figure 15. Educators' agreement that their participation in STEM PL impacted their STEM identity



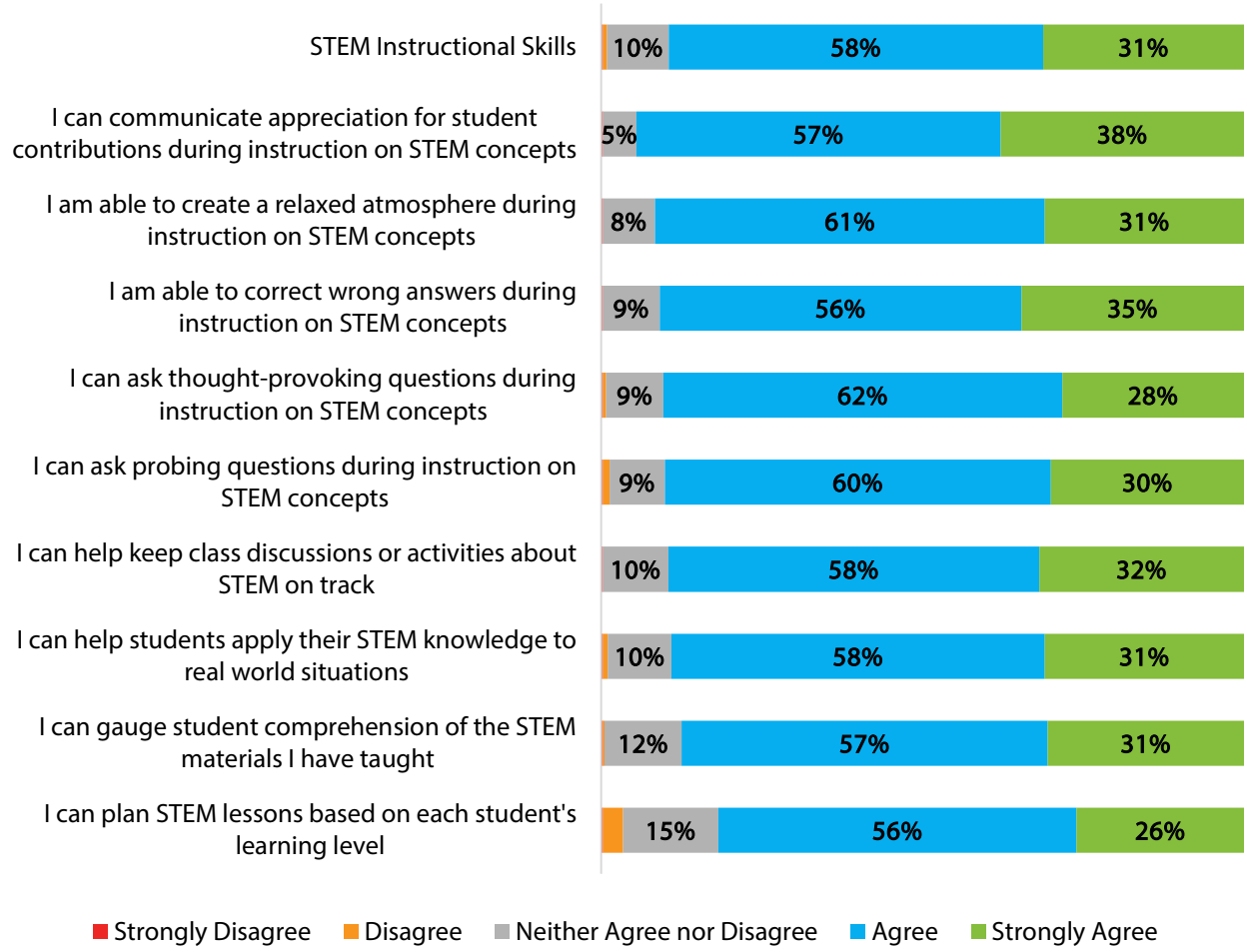
Although STEM identity was the area with the highest rate of agreement on the Educator Survey, it is interesting to note that identity development was rarely mentioned by teachers and administrators in focus group discussions. In fact, across the 15 districts represented in focus groups, there were only two comments about teachers' STEM identity development as a result of participation in the PL Grant Program (see below).

- *I would also say a greater STEM identity [has been a benefit of the professional learning for teachers]. Though, you know, we're not just – we're talking about this through a math lens and a science lens, I think because of the SEEd [Science and Engineering Education] standards, it's so focused on some of those science and engineering practices that teachers do walk away saying, "Hey, I'm not just a science teacher or a math teacher, but I'm teaching STEM as well." [Administrator]*

- *Students just are believing that they are good at math, and that they can do it. And then I think our elementary teachers a lot of times are pretty terrified of math, and they are feeling stronger math identities themselves. [Administrator]*

Educator STEM Instructional Skills. Overall, 90% of teachers self-reported that their STEM instructional skills increased as a result of participating in the PL Grant Program (see Figure 16). The item-level agreement ranged from 82% to 95%. Teachers agreed most that they can communicate appreciation for student contributions to STEM concepts during instruction (95%). Teachers agreed least that they can plan lessons tailored to each student's learning level (82%), with one-quarter (26%) of teachers strongly agreeing with that statement. These results demonstrate improvement from last year, when only 18% of teachers strongly agreed that they can plan STEM lessons for different learning levels.

Figure 16. Educators' agreement that their participation in STEM PL impacted their STEM instructional skills



Some teachers and administrators discussed improved instructional skills during focus groups, most commonly related to questioning, as reflected in the two Educator Survey items about asking thought-provoking and probing questions during STEM instruction. For example, one administrator described how she observed a math teacher use questions to guide student understanding:

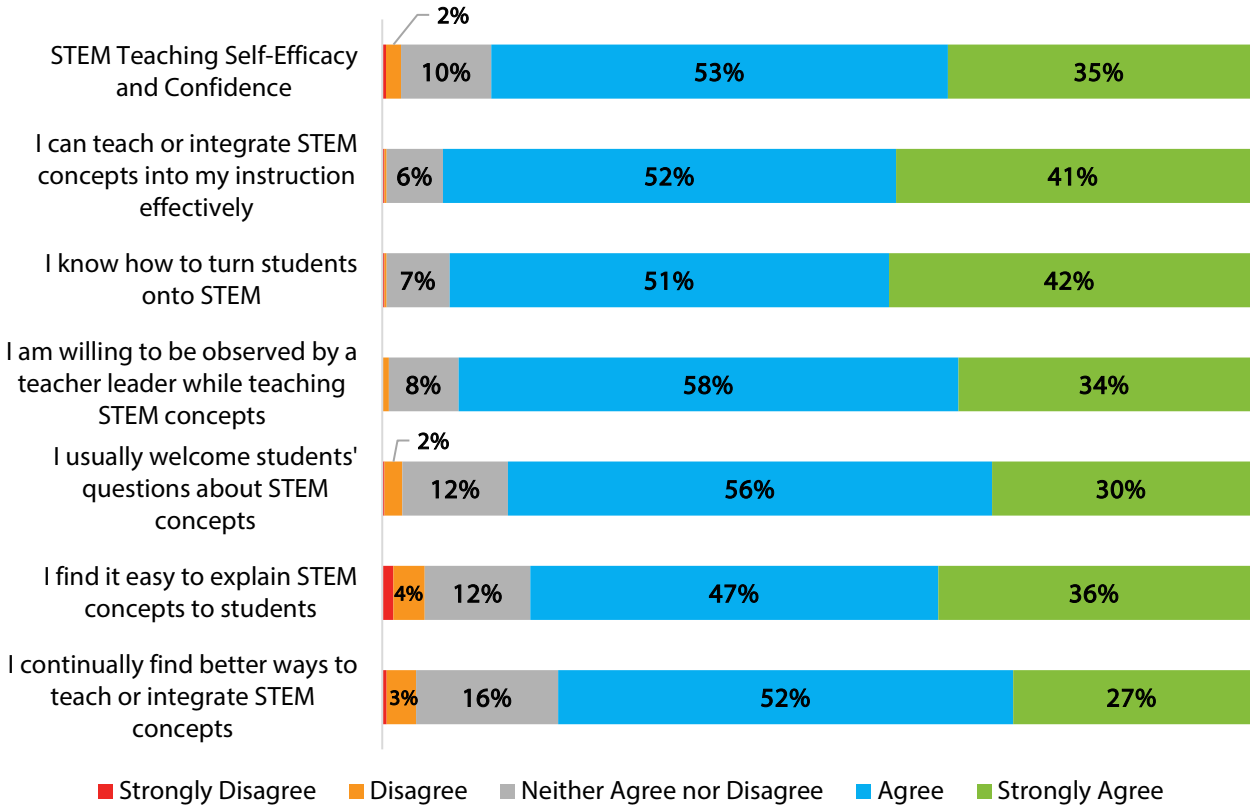
- *I was able to observe a math lesson, and [the teacher] masterfully followed what would be called a solidified lesson. So where the kids have been introduced to a concept and should already kind of surface some of their learning about it, and then through a series – a string of related questions she rather – it was just a worksheet, but [the teacher] turned an ordinary worksheet into almost a sieve that the kids went through, where they're wide open at the top and there's lots of things going on, and then as she got further and further down the kids just knew it. They just knew exactly where it was supposed to go. And by doing that she captured all of those little stragglers at the top of where maybe they were thinking a little off, but by the time they got to the end, just because of the way she orchestrat'd the lesson and the discussion she had with the kids and the way she posited what they were learning, it was just beautiful...*

Interestingly, one administrator suggested that educators may not associate these new instructional skills with STEM education in particular, but as broader improvements in their role as teachers.

- *I think that [teachers] would say that it's really helped with their knowledge of curriculum, but it's also really helped bolster their pedagogical awareness as well. So, many of them are – we're trying to teach good pedagogy as we're implementing so, three-dimensional science practices – what that looks like, how to make the shift from a lecture-based classroom to an inquiry-based classroom... So, I think that that's what they would say. I don't know if they would use the word "I'm a better STEM educator" but I think they would use the word, "I'm a better educator."*

Educator STEM Teaching Self-Efficacy and Confidence. 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 17). The item-level agreement for this construct ranged from 79% to 93%. Teachers' agreement was highest with regard to their ability to teach and integrate STEM concepts in their instruction (93%), and agreement was lowest with the statement that they continually find better ways to teach STEM concepts.

Figure 17. Educators' agreement that their participation in STEM PL impacted their self-efficacy and confidence



Confidence was also discussed by teachers and administrators during focus group discussion. Educators explained that attending training sessions/workshops and improving their instructional skills often led to increased confidence.

- *It has improved my instructional skills. So, I can teach 3D [three-dimensional]. The planning and the integration, so we can integrate this new chemistry core. It has definitely given me confidence as I go into teach. [Teacher]*

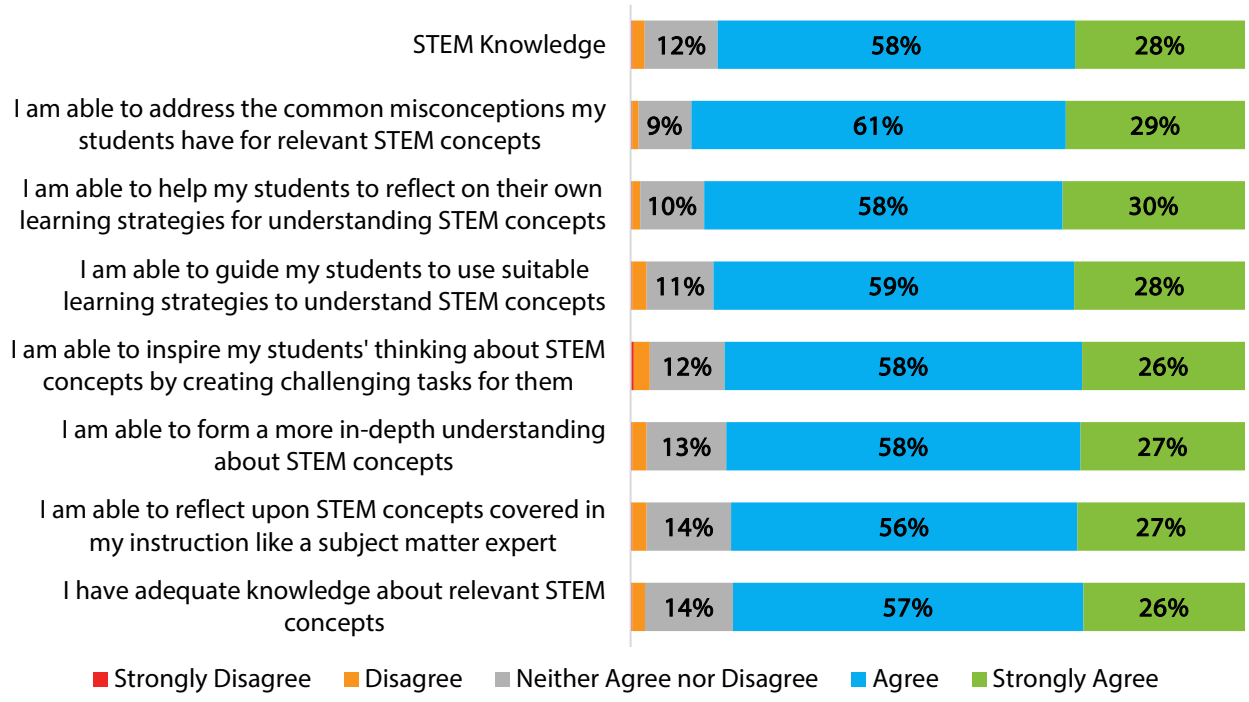
- *I feel like for sure the confidence part [stands out for me as an impact of the grant]. Like I think I've done this a couple of times, now, like the actual like CMI [Comprehensive Mathematics Instruction] training as well as all the collaboration pieces of it, obviously, which is like a daily thing. But that has like definitely increased my confidence. And then also I feel like satisfaction, because I feel like that – like with that confidence comes the satisfaction of I feel good about what I'm doing, I feel confident about what I'm doing and I'm able to instill that in my kids and in my team. [Teacher]*

- *I really think that our instructional skills, fine-tuning the tier one instruction using those types of STEM strategies provides confidence for our teachers. [Administrator]*

- *I would just say that participating in those workshops that were provided has improved – or like my confidence in teaching science has improved a lot. And it also gave me I guess different instructional skills that I can use to, like [name] was saying, with the sense making. Because then I just…like with every science lesson that I have I just pattern it after the sense making things that I've learned through the workshops. [Teacher]*

Educator STEM Knowledge. Overall, 86% of teachers agreed or strongly agreed that their STEM knowledge increased as a result of the PL Grant Program (see Figure 18). The range of agreement for items related to STEM knowledge was 83% to 90%. Nine out of 10 teachers agreed that they can address students' misconceptions about STEM concepts, which is important because it lays the groundwork for future STEM learning. However, teachers agreed least that they have adequate knowledge about relevant STEM concepts (83%), and only one-quarter of teachers (26%) strongly agreed with that statement.

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

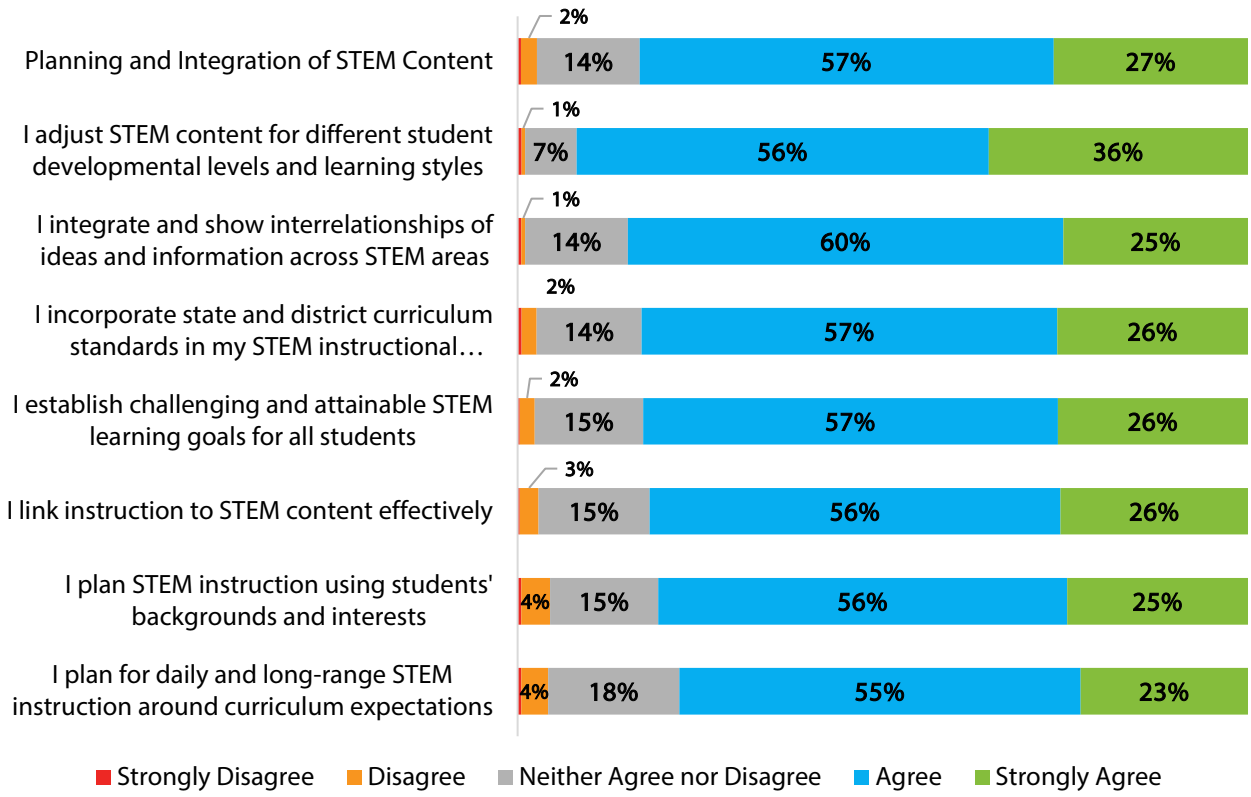


Helping teachers develop and enhance their own STEM knowledge may be an opportunity for additional focus and support from STEM AC, particularly because teachers' STEM knowledge is related to students' learning potential. During a focus group discussion, one administrator shared an example highlighting the importance of teachers having content knowledge to be able to maximize students' STEM learning:

- *…To add on that with the content that CMI [Comprehensive Mathematics Instruction] that we talk about is, it's fun to hear teachers say, "Oh after last session I was having this conversation in my class and this kid said blah, blah, blah," something content-wise that is pretty profound about the, something about the fractions or something, so pretty profound mathematical idea that the kids have on their own that the teacher probably historically has heard that, but not picked up on it… And so now having the deeper content knowledge themselves they hear these mathematical ideas that students are having and are able to bring them to light for other kids and expand on them and connect them.*

Educator Planning and Integration of STEM Content. As illustrated in Figure 19, 83% of teachers reported an increase in planning and integration of STEM content due to their participation in the PL Grant Program. This was the lowest-rated educator outcome overall. Item-level agreement related to STEM planning and integration ranged from 78% to 92%. Teachers agreed most (92%) that they could adjust STEM content for students' developmental levels and learning styles. Interestingly, as discussed above, only 82% of teachers agreed with a similar item related to STEM instructional skills that asked whether they could plan STEM lessons based on each student's learning level. The lowest level of agreement in STEM planning and integration was related to teachers' planning for daily and long-range STEM instruction (78%), with only 23% of teachers strongly agreeing with this item. This indicates that teachers might need more time for STEM instructional planning, which could be addressed by school administrators but is likely outside of STEM AC's control.

Figure 19. Educators' agreement that their participation in STEM PL impacted their planning and integration of STEM content



Importantly, although STEM planning and integration was the outcome with the lowest overall agreement in the Educator Survey, it was one of the main themes of focus group discussions. When talking about the PL Grant Program, one administrator noted, "*I think it's really created opportunities for the planning and integration of more [STEM] content. It's made teachers a little more…just intentional in looking for ways to do that.*" Teachers described how their professional learning experiences helped them understand "*how STEM can be embedded instead of an extra*," and that STEM concepts can be integrated into all subject areas, not just math and science:

- *So, I think that talking to some of the other teachers at my campus, they're like, "Oh, we have to teach a STEM concept" and I think they don't realize that STEM concepts are broad and so, they don't realize how many things do fit into those little pigeon holes and how much they can really – you know, even just talking about it so that our students know what we're doing and where we're going and using technology in new ways and having our students kind of experiment with technology and teaching them how to do those different things. And so, I think that it has, for a lot of us, opened our eyes to how we can incorporate those, because it's not just for the math teacher and the science teacher; it's for everyone. And I think that that's been probably the most beneficial thing for who I have interacted with – the other English teacher, the health teacher, the art teacher. [Teacher]*

As reported by survey respondents, more than 4 out of 5 teachers (85%) agreed that they were able to "integrate and show interrelationships of ideas and information across STEM areas." In some cases, teachers did this within their own classrooms or subject areas:

- *We're currently just pushing out actual STEM integration into their content, so 3-D design, robotics, coding into the elementary with what they teach right in their classroom. [Administrator]*

- *…It's interesting because I've been able to take what we've learned better to apply it to other things we were talking about. The telegraph, when we talked about how it's a closed circuit just like we did with our batteries and wires, and that when it closes, it makes the sound. And so being able to have them hands-on-experience how switches and things work, help apply it to other areas of things I've taught as well. So I've been able to tie more things in. [Teacher]*

At other times, the focus on STEM integration encouraged interdisciplinary thinking, connections across classrooms and subject areas, and collaboration among teachers. In a few schools, students engaged in projects that intentionally included components in each of their classes and facilitated involvement by teachers from multiple subject areas.

- *So, this has allowed us to work within a traditional schedule and traditional subject, but to also move toward that idea of thinking about a question or a subject from those different disciplinary points of view. What does a poet bring to our understanding of the water cycle? How does a poet see and understand, and then express that different from maybe the way a scientist might do it, or a historian, right? In history, looking at a problem like that through the eyes of history teaches about it. Teachers themselves, based on whatever their own particular background is, can do that to some degree within their own class. But we just wanted to find some ways to incentivize the teachers to collaborate a little bit more across those disciplinary areas. [Administrator]*

- *As a science teacher myself, there are some times where I feel like I'm cheating a little bit, just because like, it literally is – my subject is science. But one thing that I've been working on with the*

grant this year is to work more closely with math and English in terms of how can I bring their content into my content, as well as like, the four Cs of like, the STEM program and like, how can I make sure that they're collaborating and thinking critically more frequently, and then, communicating what they've learned and so on. And that has improved my practice as well and has really helped. Recently, we were talking about layers of the Earth, and it hit right at a good time when they were talking about proportions and scale in math. And so, I got to teach a math lesson for my lesson, essentially, as we were talking about the layers of the Earth in a scale model of the layers of the Earth. [Teacher]

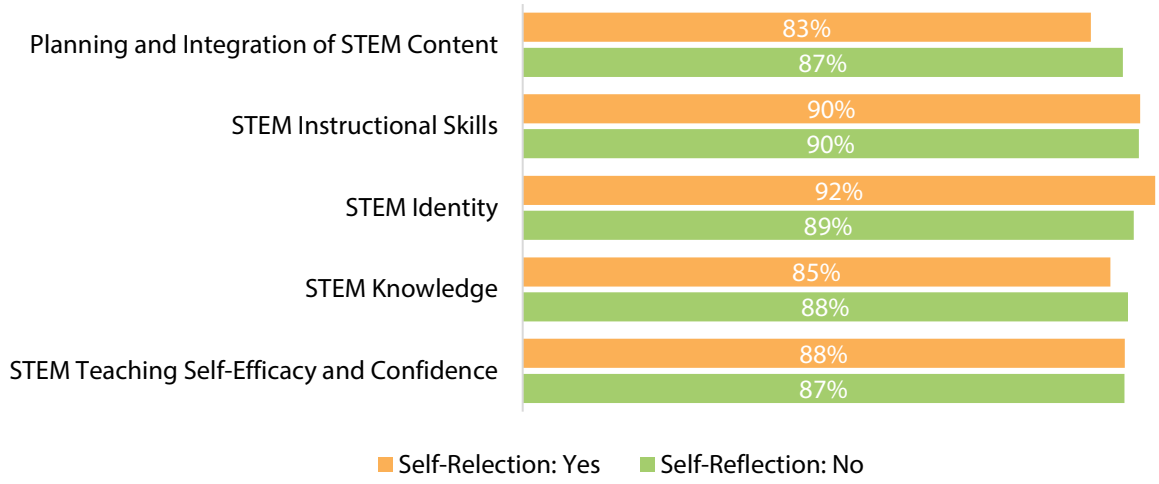
- *…Our school has the STEM expo which is kind of unique for our school. And while the science teachers are kind of the leaders for that particular thing, all of the teachers are supporting us and we, the students use – so they pick a project at the beginning of the year that they're going to demo at the expo, which is – [at the end of the year]. And so they work on it all year in science class. But they also write a script with their English class and they – some of the projects are math-based so they might ask the math teachers or the computer science teachers or even some of them are art-based… Each student has that project and they kind of – we try to have – make that kind of a collaborative where they're talking about it in all of their classes. [Teacher]*

Teachers who engaged in peer reflection reported higher STEM outcomes than teachers who participated in self-reflection

Over the course of the Professional Learning Grant Program, educators were encouraged to take part in video-based self-reflection or peer reflection. As described during focus group discussions, video-based reflection involved teachers recording themselves (or each other) as they taught a lesson. After the lesson, teachers who participated in self-reflection watched their own video recording and reflected individually, while teachers who participated in peer reflection showed their video recording to other teachers and solicited feedback. Reflections were conducted in writing and/or conversationally (for self-reflection, in one-on-one conversations with instructional coaches, and for peer reflection, in group discussions). In some cases, focus group participants mentioned using a written or oral protocol for reflection. This section explores the impact of self-reflection compared to peer reflection on teachers' STEM outcomes.

Self-Reflection. Teachers who engaged in video-based self-reflection had mixed outcomes compared to teachers who did not, as shown in Figure 20. Teachers who did not engage in self-reflection has slightly higher agreement than those teachers who did in the areas of STEM planning and integration (4 percentage points) and STEM knowledge (3 percentage points). Conversely, teachers who did engage in self-reflection had higher agreement in the area of STEM identity (3 percentage points) than those that did not. Engagement in self-reflection, or lack thereof, did not affect teachers' agreement in the areas of STEM instructional skills and teaching self-efficacy/confidence. Overall, these differences based on participation in self-reflection are small.

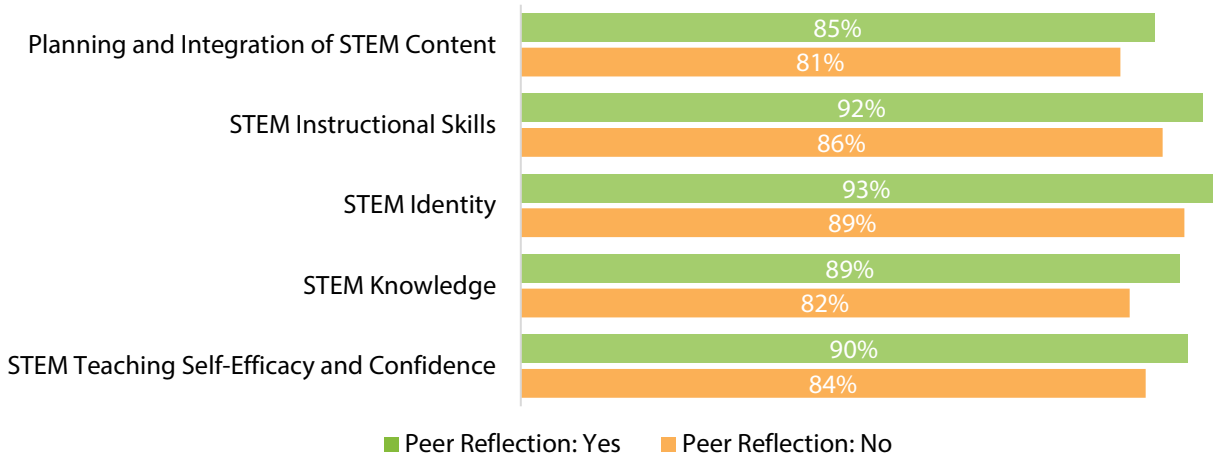
Figure 20. Comparison of educator outcomes by engagement in video-based self-reflection



Peer Reflection. While there were mixed outcomes when comparing teachers based on engagement in self-reflection, teachers who participated in video-based peer reflection reported higher levels of agreement in all STEM outcomes (Figure. 21) than those who did not. The largest percentage point difference between teachers who did and did not engage in peer reflection was in the area of STEM knowledge (7 percentage points), and the smallest difference was in STEM identity (4 percentage points). While this was not discussed widely across focus groups, one kindergarten teacher provided insight into the unique benefits of video-based peer reflection:

- *To me, the most beneficial thing has been videotaping myself, because I – not only for the STEM aspect and being like, "Oh, I could have done that better, or I could have done this better," but because we're having a peer review it and we're talking about things. And I don't know about your campuses, but we asked to be with someone that is close to our grade level and I'm working with someone and we have gotten so many ideas from each other just by watching each other. Like, I love watching other teachers teach because I think you learn so much from them. And so, just by watching each other, she's like, "Oh, I didn't even think about doing it that way." And we're doing the same STEM activity. We planned it the same 'cause we're both kindergarten, and yet, we both present the same activity very differently. And she liked certain aspects of what I did, and I liked certain aspects of what she did so, it's stuff like that where you plan together and then, you don't execute it the same way. And because we are videotaping each other – or because we both are videotaping, watching each other's – we're like, "Oh. We're learning so much more than we would learn by just planning together." 'Cause we'll talk about it. "I didn't even think about doing it that way," or, "You did this and that was really cool. You added this onto it." And that was something we hadn't discussed in our planning because it was just something natural that came to us during teaching.*

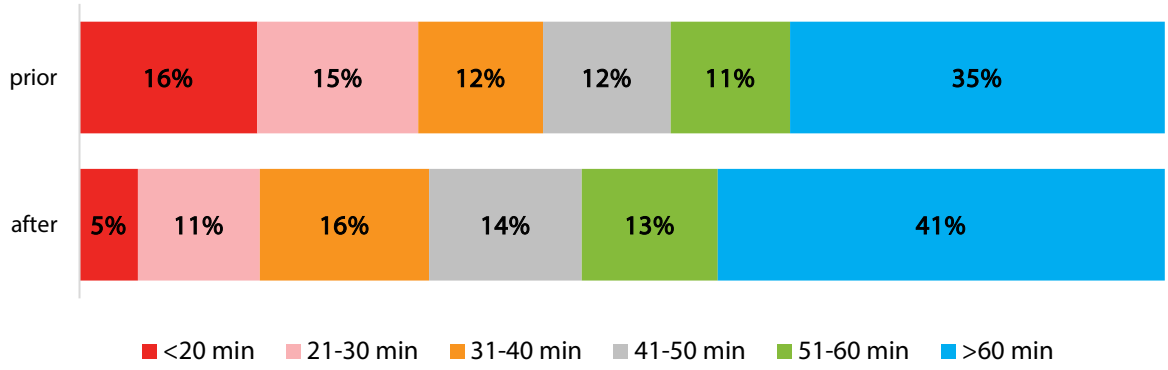
Figure 21. Comparison of educator outcomes by engagement in video-based peer-reflection



One-third of teachers reported increasing the proportion of time each day spent on STEM instruction after participation in the Professional Learning Grant Program

The Spring 2022 Educator Survey asked teachers how long they spent on STEM instruction each day both prior to (retrospectively) and after having participated in the Professional Learning Grant Program (see Figure 22). Before participating in the program, 16% of teachers said their daily STEM instruction comprised less than 20 minutes of their instructional time. After the program, only 5% of teachers reported spending less than 20 minutes on STEM instruction. Furthermore, the percentage of teachers who said they spent more than 60 minutes on STEM instruction each day increased from before to after participating in PL Grant Program activities (35% to 41%).

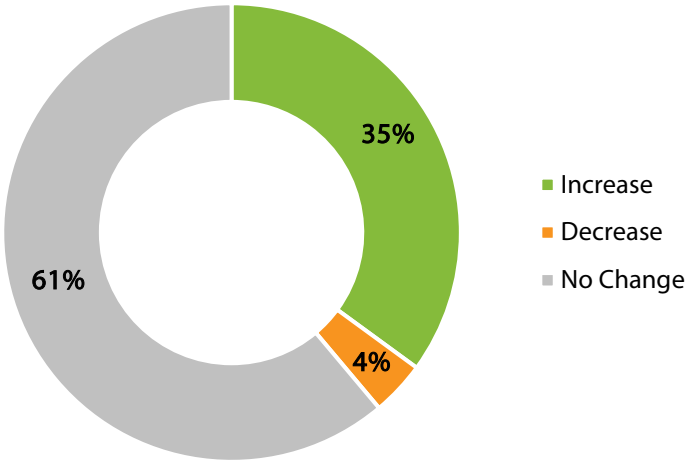
Figure 22. Time spent on daily STEM instruction by teachers prior to and after having participated in the PL Grant Program



To better understand changes in teachers' individual instructional practices that were attributed to the PL Grant Program, the Educator Survey also included a more direct question about changes in STEM instructional time. Teachers were asked whether the proportion of time they spent on daily STEM instruction increased, decreased, or did not change as a result of their participation in the PL Grant Program. As shown in Figure 23, 35% of teachers reported increasing their STEM instruction, while 61% reported no change. A very small amount (4%) reduced the amount of time spent on daily STEM activities. Though some teachers seemed to add dedicated time for STEM topics into their instruction,

those who focused more on integrating STEM content and skills into existing lessons/plans may not have thought about that as increasing STEM instructional time but more as shifting their instructional approach and utilizing their time differently.

Figure 23. Reported changes in teachers' daily STEM instructional time as a result of their participation in the PL Grant Program



EQ3: What are the outcomes of students whose teachers participate in STEM professional learning?

While the Professional Learning Grant Program focused on professional learning for teachers, the long-term goal of the professional learning program is to improve STEM outcomes for students.[5] In the Student Survey, along with district focus groups, student outcomes were explored and described in various ways from a range of perspectives, including district and school administrators, teachers, and students themselves. The outcomes discussed in this section, both specific to STEM and more broadly, include student achievement, interest, confidence, engagement, understanding/knowledge, and identity development.

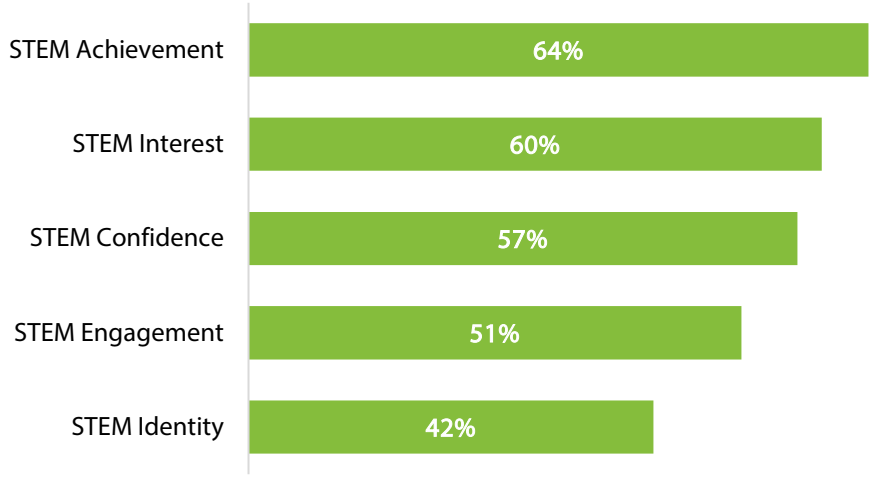
More than half of students agreed with survey items reflecting STEM achievement, interest, confidence, and engagement

In the 2021-2022 school year, all students whose teachers participated in the PL Grant Program were asked to participate in the Student Survey. This was the first time that the survey was distributed widely, as it was piloted to only a select number of students in the 2020-2021 school year. Students were asked to self-report their agreement of individual survey items related to STEM achievement, interest, confidence, engagement, and identity. The overall results for these STEM constructs, shown in Figure 24, were calculated by averaging percent agreement (agree or strongly agree) for all items within each construct. Overall, student agreement was moderate, with STEM achievement being the highest (64% agreement) followed closely by STEM interest (60% agreement). The lowest student agreement was STEM identity,

[5] In Utah state law H.B. 320 (2014), Section 53A-3-701 states that effective "professional learning is a comprehensive, sustained, and evidence-based approach to improving teachers' and principals' effectiveness in raising student achievement."

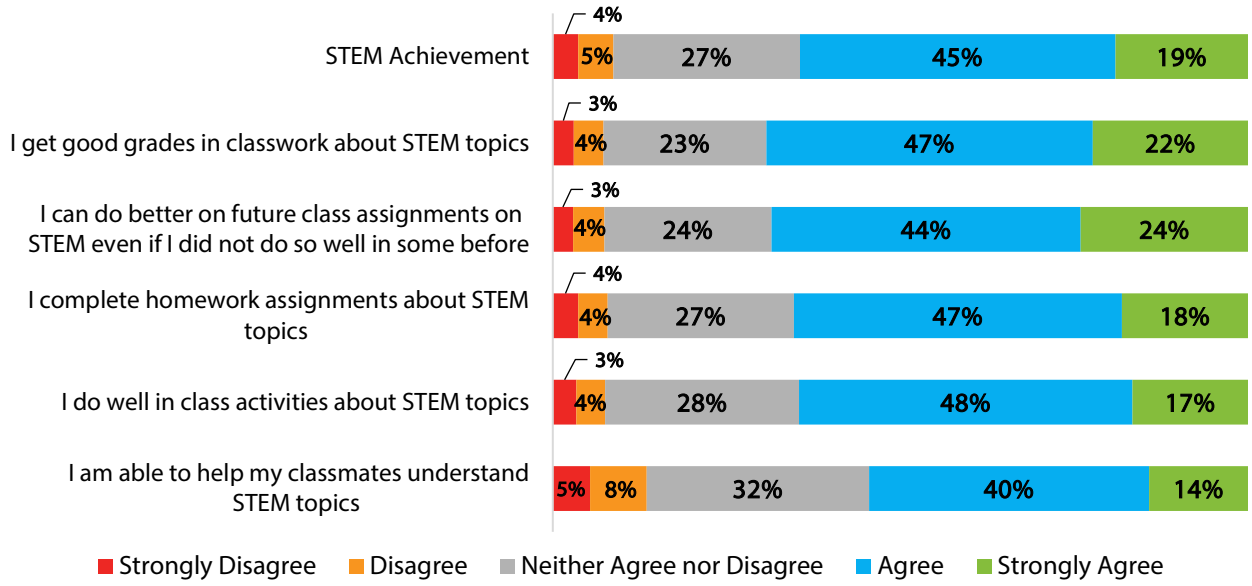
with only 42% agreement, which will be discussed further later in this report. The sections that follow present the results for the individual survey items associated with each student outcome.

Figure 24. Students' agreement with key STEM outcomes



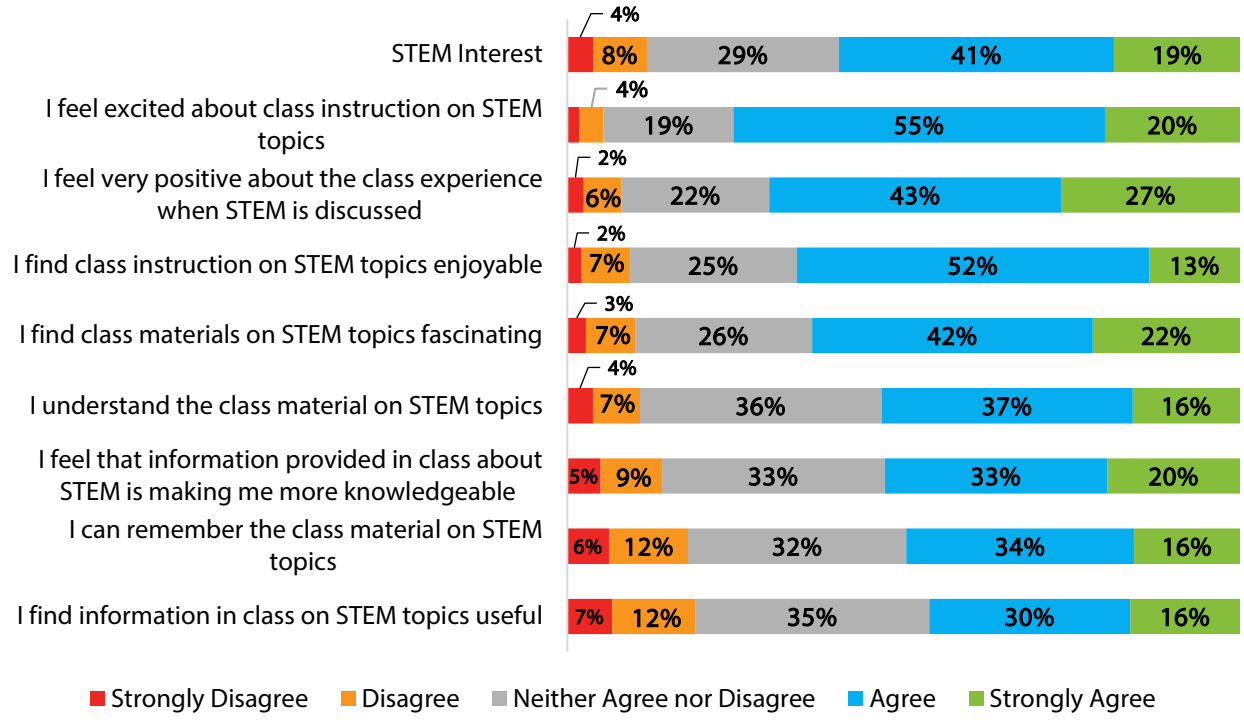
Student STEM Achievement. Students' self-reported perceptions of STEM achievement were highest (64%) out of all student outcomes assessed. Agreement with achievement items ranged from 54% to 69% (see Figure 25). For example, over two-thirds of students agreed that they get good grades on STEM classwork (69%) and that they can do better on future STEM assignments even if they did not do well before (68%). While students are comfortable with their own STEM abilities, only 54% of students agreed that they can help classmates understand STEM topics.

Figure 25. Students' self-reported perceptions of STEM achievement, overall and by item



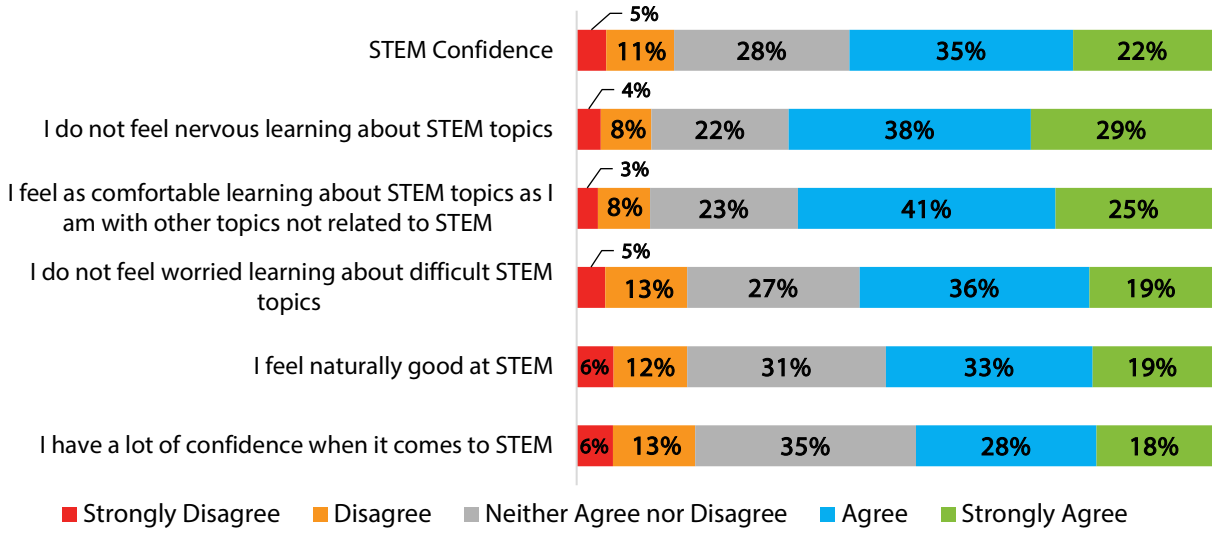
Student STEM Interest. Overall, student agreement across items related to STEM interest was 60%, with an average of 29% neither agreeing nor disagreeing. As shown in Figure 26, the range of item-level agreement was 46% to 75%. Students agreed most that they feel excited about class instruction on STEM topics (75%), though only 20% strongly agreed with that item. Less than half (46%) of students agreed that the information they learn in class was useful to them. This suggests that STEM topics are of interest to students, but the real-world application and utility of STEM material may be lacking.

Figure 26. Students' self-reported perceptions of STEM interest, overall and by item



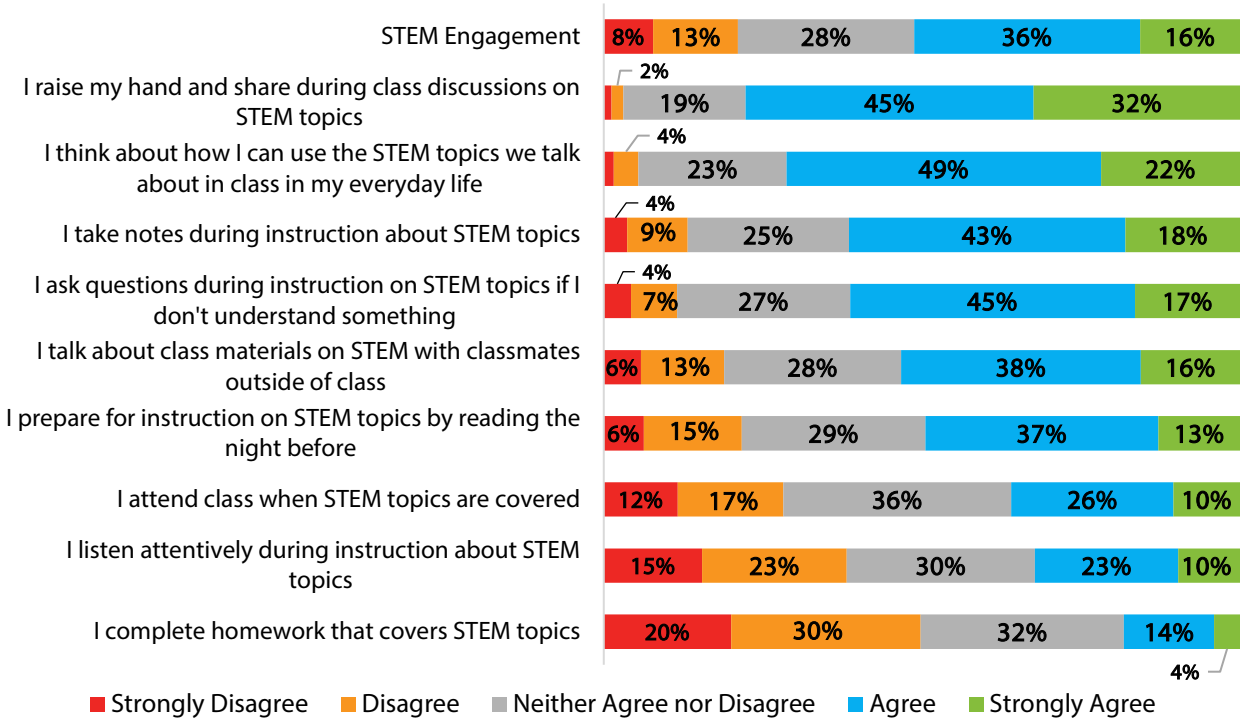
Student STEM Confidence. Overall, 57% of students agreed (35%) or strongly agreed (22%) with items related to STEM confidence (see Figure 27). Item-level agreement for STEM confidence ranged from 46% to 67%. Students reported the highest levels of agreement that they do not feel nervous about learning STEM topics (67%), and that they are as comfortable learning about STEM topics as they are with other non-STEM topics (66%). However, only 46% of students agreed that they have a lot of confidence with STEM, with only 18% strongly agreeing.

Figure 27. Students' self-reported perceptions of STEM confidence, overall and by item



Student STEM Engagement. As shown in Figure 28, slightly more than half of students agreed (36%) or strongly agreed (16%) with items related to STEM engagement. Item-level agreement ranged from just 18% to 77%, which is the largest variation in all measured student outcomes. While three-quarters (77%) of students reported being engaged with classroom discussions of STEM topics, homework completion related to STEM was lacking (18%). Half of students disagreed or strongly disagreed with the statement, "I complete homework that covers STEM topics." It is worth noting the possibility that students selected "disagree" or "strongly disagree" to indicate that their teachers did not assign homework that covered STEM topics, rather than being assigned STEM homework and not completing it.

Figure 28. Students' self-reported perceptions of STEM engagement, overall and by item



Teachers and administrators described a broad increase in student engagement, extending beyond STEM topics to general classroom engagement

While students' survey responses to items related to engagement were varied, focus group discussions suggested that student engagement was a key outcome for students whose teachers participated in STEM professional learning. However, different from students, teachers and administrators described engagement in a broader sense, not only focused on STEM topics but occurring across content areas due to changes in classroom experiences. Specifically, student engagement was expanded via two primary pathways based on shifts in educators' instructional practices. First, students were engaged because their classroom experiences involved more independent thinking and problem-solving. For example, as a participating teacher explained:

- *More students are talking, and collaborating, and communicating, and thinking critically. The lessons are focused on what students bring with them. The students have an opportunity to*

contribute regularly and get feedback from each other and from me. So the nature of what's happening during class is way more engaging.

In one district, two teachers suggested that students' development of thinking and problem-solving skills was associated with opportunities for them to try new things and participate in hands-on learning:

- *...I agree that we have all the supplies for the hands-on activities and that the kids get really engaged and they try to figure out things by themselves. [Teacher]*

- *I also really liked the batteries with the wires. So it was so amazing to have all of the materials and the kids, okay, and I just gave it to them, figure it out, make the light bulb light up. And to see them try to figure things out and try different things and they're like, it works. Hey, why did it work, I don't know. And they couldn't make it work again, but to see them thinking through things and be able to actually have the hands-on ability to do that with the supplies, so much better than how I tried to teach it last year. [Teacher]*

Administrators corroborated the importance of thinking and problem-solving in facilitating student engagement. A math specialist described results from their district's teacher survey: *"Our surveys indicated that teachers felt like there was a significant increase in engagement with students, particularly in their willingness to take risks and give things a try and start to try to problem solve..."* Another district representative noted when observing classrooms that *"every student – and I really mean every student, is engaged in thinking, and that's like our number one goal, is to get them to think."*

Secondly, interviewees across districts shared that student engagement stemmed from enhanced discourse, communication, and interaction occurring between teachers and students, and between students and their peers. Several teachers connected student communication to critical thinking, noting that students learned to share ideas, explain their thinking, and synthesize information when participating in lessons led by teachers involved in the PL grant.

- *The communication that I have with the kids using keywords, just their ability to have a conversation with me about what's going in increased because of this. That just actively being part of it, the activities that we did really, really increased their understanding, their ability to talk about it, their keywords that they use. I mean it really was great. [Teacher]*

- *I'd have to say on the engagement the students--they're interacting with each other better. They're willing to take a student's suggestions on how to change their problem, because what they've got in front of them they may disagree with, so they're learning how to say, "Well, this is what I've got. Why don't you try this?" They're learning to communicate in a positive way, where their ideas stimulate ideas in the other students. They look at a lot of students, each others' work and they see a progression in the work, they think, "Well, I can connect right here" and another student will say, "Well, I'm connecting here" and each progression moves them forward in the step that you want them to get to. [Teacher]*

- *...And then we work with teachers to improve their instructional model in a way that they are able to get kids engaged in those three things in a collaborative environment where student discourse is high and communication is high and where students have to pull multiple sources of information to think critically about a concept. [Administrator]*

Student engagement led to increased understanding and knowledge of concepts being taught across subject areas

Teachers, as well as administrators who observed teachers' classrooms, suggested in their responses that student engagement was associated with increased understanding and knowledge. This finding supports Student Survey data, in which STEM achievement had the highest level of student agreement (64%) among the outcomes that were assessed. However, similar to their descriptions of student engagement, focus group participants discussed a broad increase in student understanding and knowledge across subject areas, including but not limited to STEM concepts. Their comments revealed that as students think critically and communicate, they independently make connections and develop skills that help them achieve a deeper level of understanding of concepts. For example, a kindergarten teacher described how specific instructional practices that she implements facilitate student engagement through enhanced discourse in her classroom, leading to greater understanding of literacy concepts:

- *…Even in my literacy lessons…'cause I teach kindergarten – instead of being like, "This is the letter A. Here's some things that start with A", having them come up with the things that start with A, having them peer and share, and having more of a conversation instead of just me teaching, because it's made my classroom more interactive, and they pay attention more, and they remember it more when they were the ones that came up with what stood for that letter. It just hits home more for them when they're more involved with it.*

In one district, two teachers discussed how classroom activities promoted through the PL grant successfully engaged students who typically have difficulty understanding concepts in the classroom. Both educators specifically mentioned that their students were able to explain and have conversations that represented their understanding of the concepts.

- *And some of my kids that are the lowest in reading and that struggle in a lot of other areas did amazing with the experiments and could explain to me this is what happened and this is how it works. Which it was funny because my kids who usually know everything and are on top of it, my lower kids were explaining it faster than they could understand it. So just that ability to show in different ways and try them in different things and it was so good for them. [Teacher]*

- *I have two classes and one of them is very, very, very low. And these activities where reading or doing other things, they wouldn't get it. But because of the way that…they are set out to engage kids and make them think about things, the lower kids got it. Like we – those kids had conversations, so it really was great with differentiation. [Teacher]*

Teachers and administrators also noted the importance of applied, "real-world" experiences in solidifying students' understanding and knowledge, particularly through classroom activities that engaged students in simulation and data analysis.

- *…I love teaching the wave [lesson]…you can see the buckets in my background. We have the buckets and we put the water in it and we – it simulated these waves. And it did not take much for these kids to understand what waves, crests, troughs are, all the stuff. It was so great, it was so easy. And they had a blast with it. [Teacher]*

- *I definitely see better engagement. Because the kids…they're not in the habit of doing data analysis. This [computer program] helps them do the data analysis. Because it's as easy as clicking a button instead of like, "Oh my gosh, I have to open up Excel. And I have to do a graph." You know what I mean? It helps them make those connections easier, because it's there at their*

fingertips instead of old school thing... And therefore, because it helps them make the analysis and helps them connect those dots, it's helping with their student achievement. Because they're making those connections better than being hamstrung like, "I don't understand what this point of the procedure is asking me to do" or..."Oh the data is kind of wonky, like I don't really see a pattern in the data." ...So it's helping with the connections, its helping with the theory to connect to practicality. So after lab, I can then take a practical real-world situation and ask them about it. Because they've been able to make those connections, we can have a really good solid discussion about that, and why something would work and why another thing will not work. [Teacher]

- *I'll use a fifth-grade class as an example. I visited this class…they were doing a unit on weather and precipitation patterns… [The teacher] found some very cool websites, a NASA website – actual sites that the meteorological survey scientists use to measure precip[itation] around the plant, and wind patterns, and things like that. He had these websites up and the class, they were analyzing the data from these actual websites… They were studying--they were looking at patterns and then trying to interpret those patterns, based on the data that actual meteorologists use to make their interpretations… Some of it was real-time data. They were watching, they were picking plots on the globe and zooming in on real time, and seeing what the wind speeds were, wind temperatures in those spots. Then, looking at temperatures in the ocean and trying to connect the relationship between those wind and wind speeds and temperatures, and what was happening in the ocean… For those kids, they were having a real-life experience. Not everything we do in school has to be real life, but I think making those connections to how these things we're learning, how communication, how civility, how understanding history, how understanding how weather works connect... And they loved it. The kids…they were very excited about it. They were super engaged. [Administrator]*

Some teachers and administrators reported increased student interest and confidence in STEM

With increased student engagement and, as a result, increased understanding, some teachers and administrators reported that students developed greater STEM interest and confidence. For example, one teacher explained that the PL grant has allowed her to practice implementing more engaging activities in the classroom that have led to greater interest in math:

- *...Sometimes you have students who say they don't like math. And I find that when we approach math in this way and the attitude from me is that I love math and it's interesting and the ideas they have are interesting. And they know on our daily schedule when math comes and I don't have students that are going, "Aaagh, I don't want to do math." Now...they might not want to get on the computer and do the Freckle thing, but the activities that we're doing in class that we've been practicing with CMI [Comprehensive Mathematics Instruction] are much more engaging for them and interesting to them. I feel like they have a better taste in their mouth for math.*

Similarly, teachers and administrators reported increased student confidence in STEM subject areas, such as math, and STEM skills, such as reporting and making inferences using data.

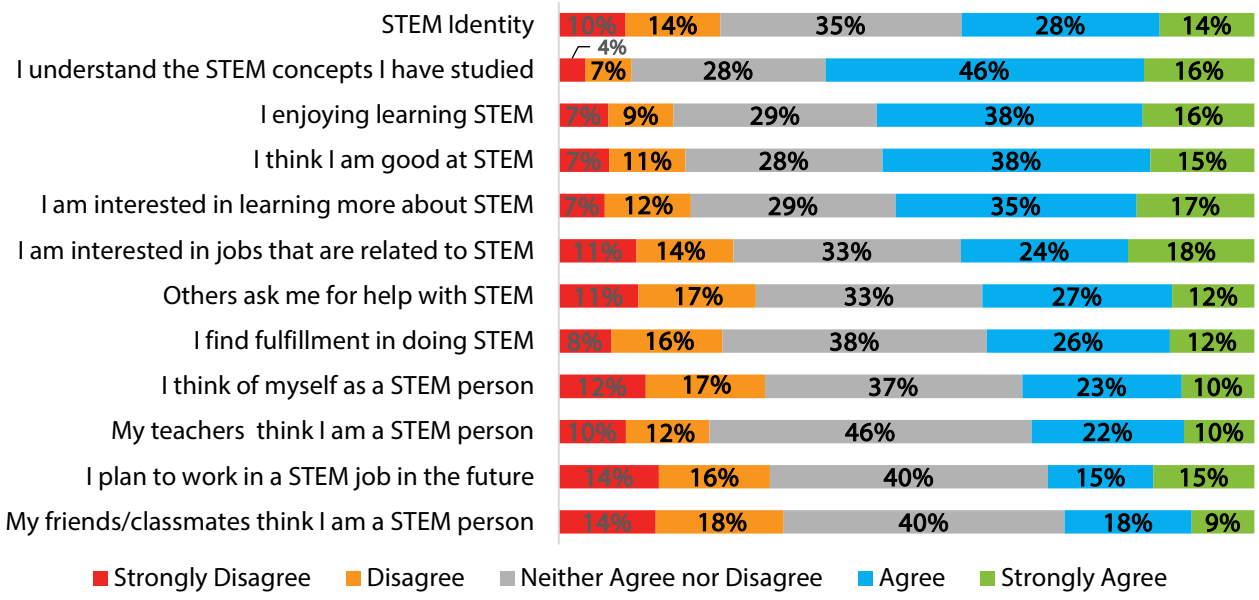
- *Well I'm hearing a lot about kids feeling more confident, even so in our surveys at the end of our sessions, or just listening to teachers talk to me, but a lot about after doing the number talks routine, or some of the other things that they are learning about their kids are a lot more confident, even outside the routine, just in mathematics... And there that students just are believing that they are good at math, and that they can do it. [Administrator]*

- *So we found a very valuable resource that we're hoping to be able to keep on using, because it's actually much in some ways, it's more valuable to the students, some of the labs that don't work super well. Now we found them way better. Actually, been able to get the kids to have more confidence in reporting data, making inferences on the data. [Teacher]*

Students' STEM identity development is an area for increased attention

Student Survey results showed a statistically significant difference between the five student STEM outcomes ($F = 48.8$, $p < .05$), and further analysis revealed that STEM identity was significantly lower in student agreement compared to achievement, interest, confidence, and engagement. On average, approximately 4 out of 10 students (41%) agreed with survey items related to STEM identity, with item-level agreement ranging from 27% to 62%, as shown in Figure 29. Students most highly agreed that they understand the STEM concepts they have studied (62%) but had low perceptions that their friends would consider them a "STEM person" (27%) and that they would work in a STEM job in the future (30%). Notably, the items with the lowest agreement are specific to students' perceptions of themselves in STEM and/or how others (i.e., teachers, classmates) perceive them in STEM.

Figure 29. Students' self-reported perceptions of STEM identity, overall and by item



Similar to the Student Survey results, in focus group discussions with teachers and administrators, the relationship between Professional Learning Grant activities and the development of students' STEM identity was not as explicit as discussions of other student outcomes. In a few districts, however, STEM identity was mentioned, specifically as a result of deeper thinking and engagement that was observed among students. For example, one district staff member described how teachers have noticed this in their science classes:

- *...Teachers are shocked how deep the students will go, and what background knowledge they're coming, how they're starting to reason... And they are finding that tweaking their lessons so that they have a phenomenon first allows students to really start making sense of and start looking at the world in a genuinely different way in a way of that wondering and sense making. So kind of just like what everyone else has said, it just is driving that deeper thinking and then students I think are genuinely, I mean we've seen...students engaging in a lot of our extracurricular tasks having more of that identity with science.*

In another district, a teacher mentioned the connection between engagement, math identity, and students thinking about pursuing post-secondary opportunities in math:

- *And I do see kids are more interested in math, so I know that that number eight is increased STEM interest, but if one of our outcomes is we want kids to maybe pursue STEM-related careers we are dispelling the idea that math is only for math brains. And so by getting them engaged and having those learning opportunities they're seeing themselves, they're developing that math identity as "I'm good at this and I can pursue math as an option.*

It is interesting to note that one teacher expressed a lack of clarity about what it means to have a "STEM identity" and what student characteristics might be associated with that:

- *As far as STEM identity, I don't know because, like I said, I've only been here a year and a half, but I don't know if our district has articulated what that can look like, and what that means for someone in a southern Utah county to do. I think we have some more work to do in that area, but I think the work starts with our directors and our principals.*

Overall, based on survey and focus group findings, there may be an opportunity for STEM AC to facilitate a shared definition and understanding of student STEM identity at the state, district, and school levels.

STEM Action Center as an Intermediary

To evaluate the role of the STEM Action Center as an intermediary in supporting the Professional Learning Grant Program and educators, we examined survey data from 18 grant administrators, as well as focus group data from teachers and administrators. Overall, we found that the STEM Action Center provided essential funding to support educators, particularly through compensation for teachers' time in professional learning activities that otherwise would not have been possible. In addition, STEM AC staff were viewed as responsive, flexible, and supportive in districts scaling up their professional learning.

EQ 4: What is the role of the STEM Action Center as an intermediary in facilitating and/or supporting STEM Professional Learning?

STEM AC provided essential funding to support educators and was responsive and flexible given the unique implementation context of each school/district

In their survey, grant administrators were asked about the extent to which they felt STEM AC built the capacity and practice of participating educators. Overall, 78% of administrators reported that STEM AC made it possible to a large or very large extent to earmark funds for capacity building and to provide professional learning opportunities and resources (see Figure 30). Administrators who participated in focus groups corroborated and expanded on this, emphasizing that the opportunities that came from Professional Learning Grant Program funding would not have been possible for their schools/districts without STEM AC's support:

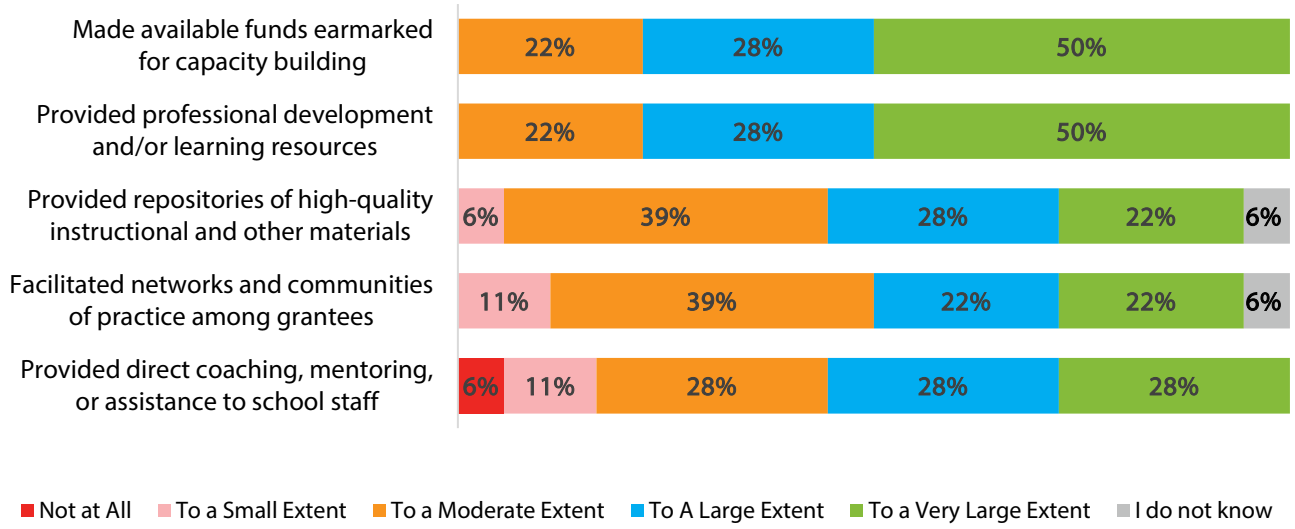
- *I would just say that we're just really grateful and we appreciate everything the STEM Action Center does for us. It makes a big difference. If we – there has been a lot of change and a lot of growth, and we have seen significant movement in our district around STEM centered learning and wonder sensemaking and problem solving... And if we tried to do that with our district level funding, but we would never have been able to make these kinds of gains. So we have made gains and the majority of our money came from STEM Action Center, so thank you.*

- *I would like to share gratitude. Our district does not have any money set aside for STEM or science training. We actually don't even have the money set aside for math training. This is the only way our teachers get training. Now, last year they didn't have any money set aside for science materials or curriculum, and we did get a supplemental curriculum for them. I begged and pleaded, and then they did set aside just a little bit in the budget, like $1.50 a student to provide some materials in addition to the other things that we're providing along the way. But, the only way we get the PD right now is through you guys. Incredibly grateful for that opportunity, and to be able to continue to use it with our teachers and have the flexibility to meet them where they are, are both really important.*

- *I would definitely say that the funding that the STEM Action Center provides allows us to provide professional learning opportunities that we would not be able to offer.*

- *I think one thing that I want to put on record for sure is we would not be able to do what we have been doing in our district without the grant. It helps us pay for people to facilitate those conversations; it pays for the training to come. We would not have any option to do this work without it.*

Figure 30. Grant administrators' perceptions of STEM AC's efforts to build capacity and practice of educators



Teachers and administrators also explained that the funds earmarked for capacity building were often used to provide stipends for participating teachers. These stipends compensated them for the time they spent engaging in a range of professional learning activities, such as attending workshops, completing video reflections and coaching cycles, and developing new lessons. Table 5 includes specific quotes from focus group participants related to offering educator stipends for different activities.

Table 5. Teacher and administrator comments about stipends provided to teachers to compensate them for time spent engaging in different professional learning activities

Professional Learning Activity	Related Quotes
General	■ *And so you know, like it a lot of it this time around has been to teacher stipends for participating, I think, you know, a longstanding tradition is that teachers do a lot of unpaid work. And so I think they're very appreciative that we can offer a stipend to participate in this extra learning. And I'm sure many of them would participate maybe without the stipend. But they've expressed gratitude time-after-time for that they're just being treated as professionals, you know, just being paid at a reasonable rate to continue to improve their practice and enhance their day-to-day preparation for their students. [Administrator]* ■ *And being able to pay teachers is huge. Like, that is the biggest thing of all is being able to pay teachers for their time. [Administrator]*

Attending training workshops/ sessions	■ *We're primarily using the grant to fund district led workshops and stipends for teachers that attend those workshops. [Administrator]* ■ *...We offered small chunks of time sessions over a period of time, so hour and a half sessions every other week for up to seven sessions in the series... So then we paid a stipend, because we knew that these folks had a lot on their plates, and so them spending time outside of their contract learning to improve their practice we felt like they should be compensated for that. And it ended up being really great, because then it was spread out over time, and they had the expectation of implementation, and then constant support as they did implement. [Administrator]*
Completing video reflections and coaching cycles	■ *...We set aside just a small stipend, $50.00, for any teachers that would be willing to do the video, do a coaching cycle, which they have the option to do anytime anyway with our new instructional coaches… We have enough money in the plan for, I think, 50 teachers to do it, and I think we have 27 that are currently completing– It's just like a little piece, and it may not be completely STEM-y, but we're using technology that we're not really comfortable with, and trying, and it gives our coaches a chance to talk to them and get feedback, or maybe even do another coaching cycle. [Administrator]* ■ *Another thing we did, we offered the USBE content courses, so the disciplinary content. There were two credit courses. If you would do that on your own time, plus do two video reflections and talk to your coach, you could get a stipend. [Administrator]*
Developing lessons/units	■ *And then we will have a formal lesson study that we do in March where teachers now take what they've learned through the professional learning and then they write a lesson, teach the lesson, debrief the lesson, and really just kind of do a real deep dive on their pedagogy in terms of teaching mathematics. And the grant itself is paying for the stipend for lesson study... I think the grant has also got us a swivel camera so they can record their lessons. But for the most part, it's-- every penny is going to just reimbursing staff for their time. [Administrator]* ■ *By having the STEM Action Center help pay our salaries, my little team was able to create lessons for my district. We actually are contacted from everybody across the United States that is using our lessons… So, not only are we helping Utah, but we're also helping other states, too, as they implement the MGSS standards. [Teacher]* ■ *I think what it does, it creates an incentive and a reason to do it. I guess if you looked at it on the spectrum, you could say on one end, on the low end, you would just say to your teachers, hey, we encourage you to try to collaborate with each other when you can find a moment... Just do it. It's as if we were just sitting around with big gaps of time that needed to be filled. So, this didn't create any more time for us, but it did create, we can give our teachers $1,000.00 to create, produce an interdisciplinary unit over the course of a year. Then, record it, share it with their colleagues, talk about it. It's actually, we've seen the teachers do that. Again, for some teachers, it's not so much that $1,000.00 makes the difference for them. But it's a little bit of a nudge and acknowledges the time commitment that it takes to*

	produce new and interesting – this isn't just jumping on the Internet and doing a one-day activity. This takes some time and planning. [Administrator]
Other	■ *I can tell you with in the chemistry department, what we use what we have used it for, especially this year, has been to help finance a lot of the time they were put again outside of contracted hours. Not so much for grading, but for all the lab prep, for figuring out what do we need to get now, for mixing the chemicals for the clean-up, for taking care of this, that, and the other. And looking at student data. [Teacher]*

Furthermore, school and district administrators who worked with STEM AC felt that STEM AC staff were supportive, available, and responsive when they had questions or concerns. They noted that STEM AC staff understood the unique complexities of implementing grant activities in different districts and helped them troubleshoot and make changes as necessary, which was important for the success of the grant program's implementation.

- *The STEM Action Center has gotten better and better at the supports with the grant, so I just want to call that out, that it's been very helpful to have [STEM AC personnel]. You know, you know you're going to have a time with her. You're going to talk to her about the grant and the purposes, so I just wanted to put this out there.*

- *I think that one of the huge things that the STEM Action Center does, and I want to specifically call out [STEM AC personnel], so this is on record and document, that [STEM AC personnel] is amazing. And she is so responsive and so flexible in terms of knowing that we are running these massive programs across 90 school buildings with all sorts of different things going on... And that there has to be some change and adaptation in that we have to kind of be flexible and move around. And so she holds the line, but she definitely is available to talk and is very responsive, and we're like hey, we got to change lanes here real quick. Can we do that? This is what we'll do... And I've worked with a lot of grants...but they are, I would say that out of anybody I've worked with they're probably the most responsive.*

- *It has also been helpful when we needed to tweak this grant a little bit to include more coaching cycles, [STEM AC personnel] was like, "Do it. Make the change that you need." That was helpful, too, because then we could pivot towards, "We thought our teachers were here, but they're really here," and they gave us the flexibility to do that. I can't tell you how important that is. It's wonderful to be able to be flexible…*

- *I feel like we are well supported by the STEM Action Center. I feel like that's been a good group to work with over the years. I've been down there a few times. I just feel like they're a pretty responsive group. I like our relationship with them.*

A few focus group participants mentioned that STEM AC staff facilitated connections between grant administrators from different districts. This was consistent with survey data showing that less than half of grant administrators (44%) felt that STEM AC facilitated networks and communities of practice to a large or very large extent (see Figure 30 above). When they did occur, these connections were reported to be helpful as the participating districts were all working toward similar goals and could share questions and ideas with each other.

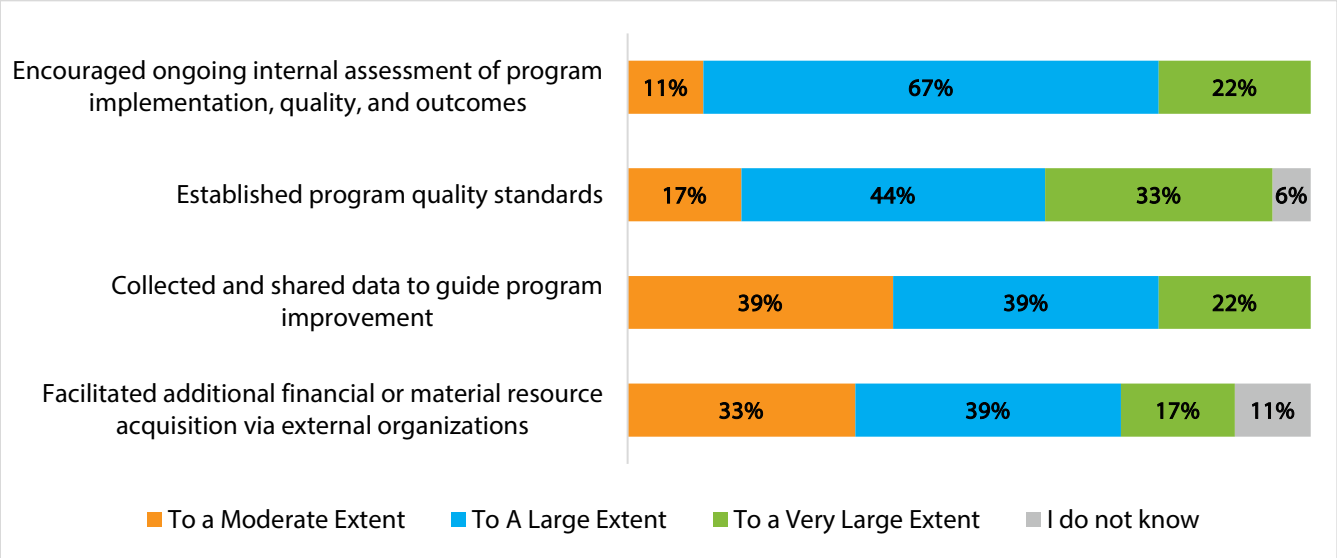
- *Well, [STEM AC personnel] has offered those Zoom conferences where we chat with each other and find out what we're doing, how to implement, how to get more people involved, how to share out messaging. That has all been really helpful.*

- *At a district level though too, it's been kind of nice to have lots of districts working around this Professional Learning Grant and the new SEEd [Science and Engineering Education] standards so that you could hear like as I collaborate with other science specialists, or if I just ask them questions like what are you guys doing for this? ...And we're able to kind of collaborate since we all have a similar goal of providing professional learning around the SEEd [Science and Engineering Education] standards, and everyone is working on that. So that's, I think those connections through the STEM Action Center have also been helpful.*

STEM AC supported the scaling up of professional learning and connected some districts with external resources

Grant administrators were also asked in their survey about the extent to which they felt STEM AC supported the scaling up of professional learning. As shown in Figure 31, 89% of administrators self-reported that to a large or very large extent, STEM AC encouraged the ongoing internal assessment of program implementation, quality, and outcomes. Only 61% of administrators indicated that STEM AC collected and shared data to guide improvement to a large or very large extent, and this was not discussed by administrators in focus groups.

Figure 31. Grant administrators' perceptions of STEM AC's efforts to support the scaling up of professional learning



Furthermore, 56% of survey respondents reported that STEM AC facilitated additional resource acquisition via external organizations, to a large or very large extent (see Figure 31). However, in focus group discussions, several administrators and one teacher discussed "*bringing in*" external individuals, organizations, and resources. In some cases, it was clear that STEM AC facilitated these connections, while in other cases it was not clear whether they were facilitated by STEM AC or pursued by the district/school directly.

- *From my standpoint if we needed something I would call [STEM AC personnel] in a heartbeat. I feel like I have a relationship with [STEM AC personnel] just as the grant-writer and then the building principal where if I needed something she's so connected throughout the state that she could definitely get us hooked up. We were already pretty connected with resources…so we didn't really need much more from the STEM Action Center, but if we needed it I feel pretty confident that she would get it for us. [Administrator]*

- *...[STEM AC staff] do provide some good supports as far as some curriculum. They help us get attached to people who can provide us with some other resources. [Administrator]*

- *We're bringing in [content area specialist] this summer to work with our third to fifth grade teachers to really model that science teaching and allow them to work together and to do some of that planning. [Administrator]*

- *...I've also been able to bring in some groups from outside the math education collaborative and math perspectives in to present and to help us to put together professional learning that we'll use for years to come. [Administrator]*

- *What my district did is we ended up hiring [an educator from Vermont. We flew her in a few times. Then, once Zoom got going, then we Zoom called with her. But she modeled how to teach the NGSS [Next Generation Science Standards] way. Then, she helped us develop units around the Utah Chemistry Core. I actually participated in that, writing the units for our district... But she basically held our hand the whole way. When they first enacted the Utah Core, I realized was a big leap it was from what it was before to what it is now. I went to our district science person with concerns. It took her a few months to realize what a big project this was. But then, she just went in and got some special help for us through this educator from Vermont. She just really helped us... [Teacher]*

Discussion

The evaluation of STEM AC's Professional Learning Grant Program addressed both program impact and implementation through educator focus groups, educator surveys, and student surveys. Key findings are summarized below, synthesizing the high-level results of the 2021-2022 evaluation. This section is followed by considerations for program improvement going into the 2022-2023 school year. These considerations, informed directly by the evaluation findings, identify specific action items for STEM AC to improve certain aspects of the PL Grant program, promote quality implementation, and maximize impact.

Summary of Key Findings

Key Finding #1: Program implementation primarily involved teacher training and professional learning communities that were aligned with adult learning principles and several of Utah's professional learning standards, and reflected both increases and decreases in district-level collaboration throughout the year.

The funds provided by STEM AC to Professional Learning grantees were used by schools and districts to hold training sessions and workshops for teachers and to support their involvement in professional learning communities. These activities aligned with three of Utah's standards for effective professional learning (H.B. 320, 2014) related to coordinating resources for educator learning, establishing learning communities, and using data to inform PL planning and evaluation. In last year's evaluation, 75% of Educator Survey respondents reported using multiple sources of data as part of their professional learning, and expanding data use was a consideration suggested to STEM AC. This year, 80% of survey respondents agreed with this item, and the use of data was discussed in several focus groups, indicating improvement in this area. Furthermore, both teachers and administrators offered a number of examples of educator training at the school and district levels. While funds were generally described as being used for their intended purpose and in line with several standards for effective PL, some teachers lacked clarity on how funds were allocated and used within their districts. This made it difficult, at times, for participating teachers to differentiate between activities and initiatives supported by the STEM AC PL Grant Program and other grants or funding sources, such as district funds or supplemental grants.

Secondly, most educators felt that PL Grant Program activities addressed adult learning principles, taking into consideration teachers' unique learning styles, needs, and previous knowledge. Teachers and administrators noted this in focus group discussions as well as the Educator Survey, where 84% of respondents agreed or strongly agreed that their professional learning experiences adhered to adult learning principles. More than three-quarters of educators also felt that implementation of the PL Grant Program reflected shared values and vision (85%), collective learning (85%), positive relational conditions (81%), appropriate consistency and duration (81%), and theories of action (76%).

Lastly, educators overall reported increased collaboration in their professional learning communities as a result of the PL program from Fall 2021 to Spring 2022. This was a marked improvement from the previous school year, when collaboration decreased over the same time period. The greatest increase this year was seen in the intentionality of collaboration in professional learning communities. While the average level of collaboration across districts increased from the fall to the spring, there were some individual districts that demonstrated a decrease in collaboration, indicating differential effects of the PL Grant Program across districts.

Key Finding #2: Over 80% of educators who participated in STEM Professional Learning reported increases in STEM identity, instructional skills, confidence, knowledge, and content integration, and these outcomes were stronger for teachers who engaged in video-based peer reflection as part of their grant activities.

Educators felt that they improved on a number of STEM outcomes as a result of participating in the PL Grant Program. In fact, at least 83% of educators agreed or strongly agreed that their STEM identity, STEM instructional skills, STEM teaching self-efficacy/confidence, STEM knowledge, and planning/integration of STEM content improved as a result of their participation in the program. STEM identity was the outcome with the highest level of agreement (92%), and planning and integration of STEM content had the lowest agreement (83%).

The 2020-2021 evaluation noted that participating teachers may benefit from additional emphasis on the importance of differentiating STEM content to meet all students' learning needs, and this year's evaluation showed improvement in this area. For example, in the 2020-2021 school year, only 18% of teachers strongly agreed that they could adjust STEM content for different student developmental levels and learning styles. This year, twice as many teachers (36%) strongly agreed with that item. Similarly, in the 2020-2021 school year, 18% of teachers strongly agreed that they can plan STEM lessons based on each student's learning level, and 26% of teachers strongly agreed with that item this year.

Over the course of the PL Grant Program, teachers were given the opportunity to engage in peer and/or self-reflection practices. Teachers who engaged in peer reflection showed higher rates of agreement in the areas of STEM identity, instructional skills, teaching confidence/self-efficacy, knowledge, and planning/integration of STEM content, as compared to those who did not take part in peer reflection. In contrast, teachers who took part in self-reflection did not have consistently higher outcomes compared to those who did not. Overall, the results were mixed and inconclusive as to the impact of self-reflection on teachers' STEM outcomes.

Lastly, some teachers reported spending more time on STEM instruction as a result of their participation in the PL Grant Program. For instance, before the program, 16% of teachers said their daily STEM instruction comprised less than 20 minutes of their instructional time before the program, and this was reported by only 5% of teachers after the program. About one-third (35%) of teachers reported that they increased the proportion of instructional time spent on STEM as a result of their participation in the program, and only 4% reported a decrease in STEM instructional time. However, last school year, 40% of responding teachers said they increased their STEM instruction, meaning that the 2021-2022 school year saw a five-percentage-point decline.

Key Finding #3: More than half of students whose teachers participated in STEM Professional Learning reported increased achievement, interest, confidence, and engagement in STEM, and educators noticed improvement more broadly in students' classroom engagement and understanding.

Students were asked to self-report their level of agreement with survey items reflecting various STEM outcomes: achievement, interest, confidence, engagement, and identity. STEM achievement showed the highest agreement among students, with 64% of students agreeing or strongly agreeing. STEM identity was the outcome with the lowest percentage of students who agreed or strongly agreed (42%). Within the domain of STEM identity, items related to students' perceptions of themselves as a "STEM person," and how others (i.e., teachers, classmates) perceive them in STEM, had the lowest rates of agreement.

Students' overall engagement in the classroom increased over the course of the school year, and those improvements were not just related to STEM topics. Teachers and administrators suggested that this

heightened level of engagement was a result of providing students more opportunities for independent problem solving as well as enhanced discourse, communication, and interaction between teachers and students. Engagement, in turn, led to students gaining knowledge and understanding across subject areas and, for some students, increased interest and confidence in STEM.

Key Finding #4: The STEM Action Center provided essential funding, offered responsive and flexible support, facilitated efforts to scale up professional learning, and connected some LEAs with external resources.

Of the PL Grant Program administrators who completed the Educator Survey, more than 78% agreed that STEM AC earmarks funds for both capacity building and professional learning to a large or very large extent. Educators also noted that the funding provided by STEM AC made it possible for them to engage in professional learning. Without this funding, most districts would not have had the resources to offer professional learning opportunities to the same extent. In many cases, funds were used to provide teachers with stipends, which adequately compensated them for their time and expertise. Given the unique context of each school and participating district, STEM AC's flexibility in how funds were used was essential to successful program implementation.

Aside from providing flexible funding, educators found that STEM AC provided support to scale up professional learning, and connected some districts with external resources. For example, 78% of grant administrators agreed that to a large or very large extent, STEM AC provided professional learning development and key resources needed. Educators felt that STEM AC staff were supportive, responsive, and available to answer questions throughout the school year.

Considerations for Program Improvement

Consideration #1: Encourage school and district leaders to support and advocate for educators by soliciting their input in the design, content, and continuous improvement of professional learning experiences.

Across the key features of the PL Grant Program, supportive and involved leadership was one of the two lowest areas of implementation in educators' professional learning experiences. However, school and district leaders play a critical role in professional learning, as Utah H.B. 320 (2014) states that effective implementation "requires skillful leaders who develop capacity, advocate, and create support systems for professional learning." To better support and advocate for their staff, it will be important for school leaders to have a heightened focus on collecting and considering input from teachers and other staff members. Less than three-quarters of educators reported that there are opportunities for staff to initiate change or be involved in school decisions, and the adult learning principles with the lowest agreement involved various ways that educators could have participated in the design and evaluation of professional learning. However, focus group discussions suggested that some leaders have ideas and experiences related to promoting educator voice—for example, using surveys to ask about teachers' needs or providing them with "menus" of choices for professional learning activities. STEM AC should consider creating a community of practice (see Consideration #4) for school leaders to share and brainstorm about how to effectively solicit and integrate educator input in the design, content, and continuous improvement of STEM professional learning. Ultimately, this would enhance alignment of the PL Grant Program's implementation with professional learning standards as well as adult learning principles.

Consideration #2: Leverage grant administrators as ambassadors of the PL Grant Program among teachers to expand STEM AC's presence as a program leader and enhance use of evaluation data for site-level PL program improvement.

In some districts, teachers were unclear about how PL Grant Program funds were allocated, which activities or resources they supported, and how they differed from other grants awarded by STEM AC or other entities. As a result, the role of STEM AC as a program leader and intermediary organization was not consistently clear, and data collected from certain districts as part of this evaluation may have been affected by the lack of clarity. To address this, STEM AC should consider leveraging grant administrators as ambassadors who are responsible for sharing with teachers in more detail about the use and allocation of PL Grant Program funds, and reporting to STEM AC about other grants that will be implemented simultaneously in their schools or districts. Administrators could also facilitate teachers' understanding of the PL grant by sharing data about the program and engaging them in discussions about continuous improvement, as noted in Consideration #1. STEM AC should consider providing administrators with data about the program in formats that are concise and user-friendly to share with teachers (e.g., evaluation vignettes), and ensuring that findings are distributed to all participants, as only 61% of administrators reported knowing that STEM AC collects and shares data. Leveraging grant administrators as ambassadors of the PL Grant Program for the teachers in their schools and districts would not only expand STEM AC's presence as a program leader in the state, but also increase the utilization of the evaluation findings to inform local PL practice and improvement.

Consideration #3: Promote STEM identity as a goal of the PL Grant Program, for both teachers and students, by creating a shared understanding of STEM identity and providing support for administrators and teachers to facilitate identity development through grant activities.

For teachers who participated in the PL Grant Program, as well as their students, STEM identity development was an inconsistent outcome. While teachers' STEM identity was the area with the highest rate of agreement among survey respondents, it was rarely discussed by teachers and administrators in focus groups. Similarly, when asked about student outcomes, most teachers did not mention STEM identity, and it was rated significantly lower than other outcomes by students themselves. STEM identity development is particularly important for students as a gateway to post-secondary pursuits in STEM. It would be beneficial for STEM AC to provide additional communication and support around STEM identity as a program goal, and to help LEAs promote identity development for both teachers and students through grant requirements or targeted professional learning. Focus group data suggested that school staff do not have a clear understanding of STEM identity. Thus, there is an opportunity for STEM AC to facilitate the creation of a shared definition of teacher and student STEM identity at the state, district, and school levels, along with shared goals and strategies for increasing STEM identity. This could be done through a community of practice led by STEM AC focused on STEM identity (see Consideration #4). Ultimately, increasing teacher STEM identity may increase other outcomes of interest (e.g., instructional practices such as STEM integration) and expand the use of best practices to support students' STEM identity development.

Consideration #4: Establish and lead communities of practice for grant administrators and participating educators to increase consistency and connections across districts, and to strengthen program implementation, outcomes, and sustainability.

Less than half of PL Grant Program administrators reported that STEM AC facilitated networks and communities of practice to a large or very large extent. Given STEM AC's role as a program leader and intermediary organization, this highlights an opportunity to more intentionally facilitate networks of participating administrators and educators from different districts. The few focus group participants who discussed being connected with grantees from other districts by STEM AC felt that the relationships and

collaborations were valuable. STEM AC could establish communities of practice for a range of purposes. For example, STEM AC could facilitate a community of practice to discuss general successes and challenges related to program implementation; to generate ideas about how to meet specific program goals, like soliciting educator input (see Consideration #1) or expanding co-teaching practices; to disseminate data and evidence-based practices related to the program (see Consideration #2), like data showing the benefits of peer reflection over self-reflection; or to expand collective definitions of program goals and outcomes, like STEM identity development (see Consideration #3). Creating cross-district networks could provide STEM AC with a platform for increasing the consistency and quality of program implementation across districts. Furthermore, the relationships and collaborations that begin in these communities would likely extend outside of and beyond the PL Grant funding period, naturally supporting the scaling up and sustainability of the grant's activities and intended outcomes.

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