THE UNIVERSITY OF UTAH
UTAH EDUCATION POLICY CENTER

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Advancing STEM Teaching And Learning In Utah

An Evaluation of the Impact of the Professional Learning Grant Program

PREPARED BY THE UTAH EDUCATION POLICY CENTER ON BEHALF OF THE UTAH STEM ACTION CENTER

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PART ONE:

INTRODUCTION

This section sets the context for the evaluation by reviewing literature on STEM professional learning in the United States. The review addresses topics including the quality of the United States' STEM K-12 teacher workforce; the state of STEM professional development and learning in the United States; STEM professional learning in high-performing nations in science and mathematics; the attributes of effective STEM professional learning; and the impact of effective STEM professional learning on teacher and student outcomes. In Part One, the report also provides an overview of the Professional Learning Grant Program, the evaluation's methods, and the report's organization.

Setting the Context

The Quality of the United States' STEM K-12 Teacher Workforce

The urgent need to address the declining performance and interest of U.S. K-12 students in science and mathematics has led to an increased focus on the quality of the nation's science, engineering, mathematics, and technology (STEM) teacher workforce (Chiyaka, Kibirige, Sithole, McCarthy, & Mupinga, 2017; Fulton & Britton, 2011; Rogers, Winship, & Sun, 2016). As researchers have unequivocally noted, most in-service STEM K-12 educators in the United States, whether in computer science, mathematics, or the life sciences, do not hold degrees in the very subject areas they teach (Hossain & Robinson, 2012; Leyzberg & Moretti, 2017; Swars, Smith, Smith, Carothers, & Myers, 2016). Resultantly, K-12 schools across the nation are having to grapple with the grave effects on student learning, proficiency, and interest in STEM brought on by systemic inadequacies in STEM teacher education and teachers who, by and large, lack the requisite knowledge of content and pedagogy needed to teach science and mathematics effectively (Berry III, Ellis, & Hughes, 2014; Jensen, Roberts-Hall, Magee, & Ginnivan, 2016a; Joshi & Jain, 2018; Onuma, 2017).

The State of STEM Professional Development and Learning in the United States

To rectify the ill-preparation of STEM K-12 teachers, as well as further the expertise and instructional practices of those who received adequate training in their subject areas, schools across the nation are increasingly relying on conventional interventions such as professional development and, in some cases, professional learning communities (Burrows, 2015; Chiyaka et al., 2017; Fulton & Britton, 2011; Hudley & Mallinson, 2017). While these supplementary training opportunities for STEM teachers have been ongoing in the United States for a decade or more, scholars have become more vocal about the deficiencies in the nation's approach to STEM professional development. In recent years, some scholars have described STEM professional development approaches in the United States as largely piece-meal in nature, fragmented, and ineffective (Hiebert & Stigler, 2017; Maltese, Lung, Potvin, & Hochbein, 2013; Onuma, 2017; Rogers et al., 2016). Additionally, national bodies such as the National Commission on Teaching and America's Future (NCTAF) have reported that "countries that persistently rank at the top of international measures of science and mathematics achievement do things [with regard to STEM professional development and learning] differently [than the United States]" (Fulton & Britton, 2011, p. 4).

STEM Professional Learning in High-Performing Nations in Science and Mathematics

In line with NCTAF's assertion, researchers have noted that a long-standing tradition of school systems that are high-performing in mathematics and science, such as those in mainland China, Hong Kong, and Taiwan, is to provide STEM teachers with discipline-specific, or subject-based, professional development (Onuma, 2017). This form of professional development involves collaborative learning with a group of teachers who provide instruction in the same subject area. And in mainland China, master teachers—who account for less than 0.5% of the nation's teachers, possess upwards of 10 years of teaching experience in the subject area, and have published widely on teaching and learning—oversee these subject-based professional learning communities (Jensen et al., 2016a; Onuma 2017; Jensen, Sonnemann,

Roberts-Hull, & Hunter, 2016b). Moreover, every new mathematics or science teacher in mainland China is provided a mentor who is not only an expert on the subject but is experienced in cultivating the expertise of new teachers (Jensen et al., 2016a; Onuma, 2017). In the United States, however, an antithetical system exists in which teachers neither receive adequate support from school leaders to seek out relevant professional development nor are provided with discipline-specific professional development in their schools (Chiyaka et al., 2017; Jensen et al., 2016a). The convention, rather, in the United States is to offer large-scale workshops or training sessions led by experts, with the expectation, whether implicit or made crystal clear, that teachers use the knowledge, if any, they acquire from these sessions to inform their practice (Jensen et al., 2016a; Maltese et al., 2013). Regrettably, research suggests that this form of professional development has provided little benefit, if any, to teaching quality in the United States (Hiebert & Stigler, 2017).

The Attributes of Effective STEM Professional Learning

In response to the shortfall of STEM professional development in the United States, researchers and national bodies alike have attempted to identify the qualities that make for effective professional development and learning. As Fulton and Britton (2011) posit, STEM learning communities are effective when they are undergirded by six principles which include *shared values and goals*, *leadership support*, *time (continuity)*, *use of student data and work*, *collective responsibility*, *good facilitation*, *trust*, and *focus on a single school subject*. Still, other researchers such as Rogers and colleagues (2016) have noted that STEM professional development is only effective in improving student learning outcomes and interest in as much as they facilitate teachers' ability to create "authentic" STEM learning experiences in their classrooms. To this end, Rogers and colleagues (2016) posit that effective STEM professional development is one that increases teachers' awareness of the various STEM careers available, provides them with opportunities to experience real-world STEM applications such as in STEM facilities, builds their STEM knowledge through intensive mentoring programs, and provides them with hands-on experiences in STEM teaching and learning.

The Impact of Effective STEM Professional Learning on Teacher and Student Outcomes

When professional development and learning takes on the aforementioned attributes posited by Fulton and Britton (2011) and Rogers and colleagues (2016), researchers tend to observe increased interest among teachers in teaching STEM or integrating STEM content in their lessons, increased use of inquiry-based and problem-solving approaches in STEM instruction, increased collaboration and shared learning among STEM teachers, increased content knowledge and pedagogical content knowledge in STEM subjects, increased self-efficacy and confidence among educators to teach STEM, and increased career satisfaction (Burrows, 2015; Chiyaka et al., 2017; Fulton & Britton, 2011; Nadelson et al., 2013; Nathan, Atwood, Prevost, Phelps, & Tan, 2011; Onuma, 2017; Webb, 2015). Moreover, teachers who participate in effective STEM professional learning communities have been found to be better able to improve and sustain the learning, achievement, and interest of their students in STEM subjects (Capraro et al., 2016; Estapa & Tank, 2017; Fulton & Britton, 2011; Jensen et al., 2016a).

Merits of the Current Evaluation

Despite the positive findings about the impact of effective professional development on teacher and student outcomes, scholars have noted the need for more research on "naturally occurring" STEM professional learning communities as most research studies (e.g., Baker & Galanti, 2017; Estapa & Tank, 2017; Nadelson et al., 2013; Nathan et al., 2011) have tended to examine quasi-experimental professional learning communities—that is, professional learning communities that were created as part of the research study.

The current report extends the existing bodies of knowledge on STEM professional development and learning in the United States in its evaluation of the *Professional Learning Grant Program* established in Utah to advance STEM teaching and learning. The next section of this introduction provides a broad overview of the program. More specifically, it discusses how the grant program was created and how it is supporting the formation of "naturally occurring" STEM professional learning communities in local education agencies in Utah.

Overview of the Professional Learning Grant Program

In 2014, House Bill 150 (H.B. 150)[1], passed in the Utah State Legislature, amended and enacted provisions related to the Science, Technology, Engineering, and Mathematics (STEM) Action Center. Among the bill's new provisions was a mandate that the STEM Action Center provide high quality STEM education professional learning to K-12 educators. Concerning the STEM education professional learning provision (also referred to as the *Professional Learning Grant Program*[2]), H.B. 150 proposed that the STEM Action Center either provides an online professional learning platform for teachers or creates a hybrid format that supports both online professional learning and face-to-face applied learning. The online application chosen for the professional learning, as the bill further elaborated, must undergo rigorous vetting and meet high-quality standards developed by the Utah State Board of Education. Additionally, it must 1) provide teachers with access to automatic tools, resources, and strategies, 2) allow teachers to work in online learning communities, 3) provide video examples of highly effective STEM education teaching, 4) permit additional STEM education video content to be uploaded, 5) track and report data on usage of the application's components, and 6) allow the Utah State Board of Education, school district, or school to track results of the professional learning.

Program Implementation

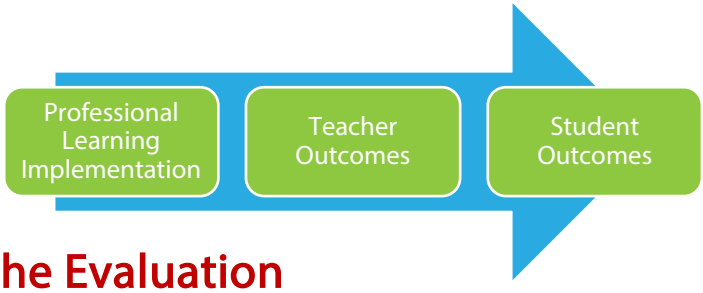
As the administrator of the Professional Learning Grant Program, the STEM Action Center selects the online application to be used in providing STEM education professional learning to teachers as well as the schools that participate in the grant program. Based on criteria specified in H.B. 150, the STEM Action Center selected Edivate, an online professional learning application provided by the School Improvement Network (SINET), for the Professional Learning Grant Program. Participating schools, according to the STEM Action Center, are selected on the basis of identified needs associated with STEM learning and are provided with

[1] https://le.utah.gov/~2014/bills/static/hb0150.html
[2] https://stem.utah.gov/grants/professional-learning-grant/

one-year or three-year grants to implement professional learning to address their needs. Additionally, as a requirement of participation, teachers involved in grant-funded professional learning activities must upload videos of themselves that will be used for self-reflection and also to receive feedback from peers.

The Professional Learning Grant Program is intended to impact three keys areas of STEM education as illustrated in Figure 1.

Figure 1. Expected Impact of the Professional Learning Grant Program



Purpose of the Evaluation

The current evaluation seeks to investigate the effectiveness of the Professional Learning Grant Program in meeting its stated objectives to impact professional learning implementation, teacher outcomes, and student outcomes.

Methods

Evaluation Questions

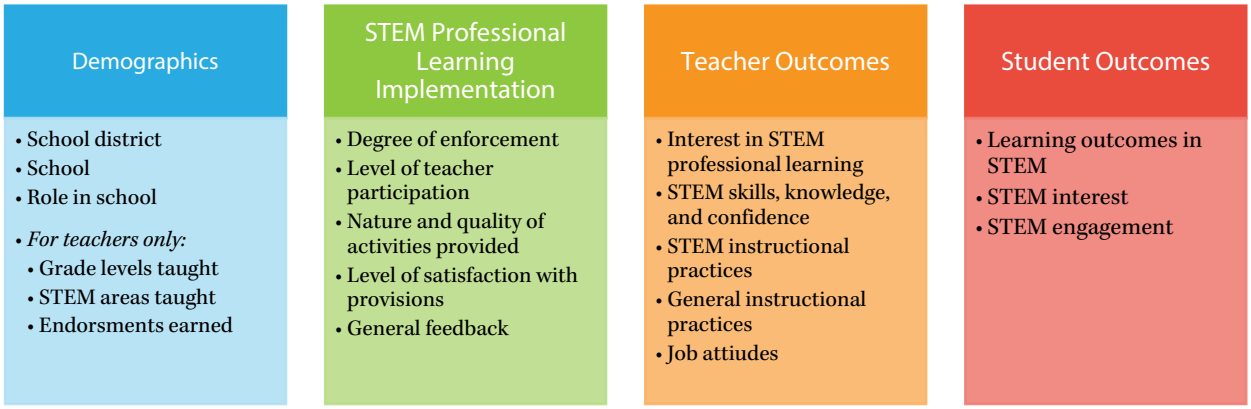
The purpose of the evaluation is addressed through the following questions:

1. What are the demographics of teachers and administrators in schools that receive grant funding?
2. How is professional learning implemented in schools that receive grant funding?
3. What impact does participating in professional learning have on teacher outcomes?
4. What impact does teacher participation in professional learning have on student outcomes?

Survey Design

To address the evaluation questions, a survey was designed for teachers and administrators in schools that received funding from the Professional Learning Grant Program. Teachers were asked to respond to questions about their demographics, how professional learning was implemented at their schools, their outcomes, and those of students. Administrators, similarly, were asked to report on their demographics, how professional learning was implemented at their schools, and teacher and student outcomes. Survey questions were intentionally developed to provide insight into the evaluation questions. As such, they can be grouped into four broad categories—demographics, professional learning implementation, teacher outcomes, and student outcomes. They can also be further organized into sub-categories, as illustrated in Figure 2. Both close-ended and open-ended question formats were included in the survey.

Figure 2. Survey Foci



Survey Administration

The survey was launched late-April 2020 and closed mid-June 2020. In advance of the survey launch, the Utah Education Policy Center (UEPC) shared the survey link with the STEM Action Center, who in turn, disseminated the link to teachers and administrators in schools that received grant funding. The survey garnered a total of 1,941 responses, including 1,861 from teachers and 80 from administrators.

Data Analysis

Close-ended responses were analyzed using descriptive statistics, such as frequencies and percentages and open-ended responses were analyzed using inductive coding, which is a process of aggregating responses using themes that emerge directly from the data (Merriam, 2009). In representing data from close-ended questions formatted as Likert scale items, bar graphs were utilized that organize data from positive to negative (e.g., strongly agree to strongly disagree). The inductive coding process for open-ended responses was undertaken by two researchers who each read the responses in their entirety and conferred with one another about the themes they gleaned from the data. This process of "investigator triangulation" was done to ensure the rigor and validity of the evaluation's qualitative analysis (Merriam, 2009, p. 216).

Where possible, findings covered in this report were compared to those discussed in the report from the previous year (2019). In the instances where comparisons were not made, the question was either not included in the 2019 survey or was altered from its original wording in a way that precludes comparison to prior data. To provide an example of a consequential change made to the wording of a survey question, the 2019 survey had asked administrators to specify the extent to which they agree or disagree that "my district strongly encouraged teachers to use *video-based* STEM professional learning." In the 2020 survey, the statement was modified to read as "my district strongly encouraged teachers to participate in STEM professional learning." In cases such as the example provided above, where the meaning of the question was effectively changed, a comparison between 2019 and 2020 findings was not provided.

Report Organization

This introduction constitutes the first of six sections of this report. The second section of the report, *Demographics,* provides demographic information on the teachers and administrators who participated in the survey. *Professional Learning Implementation,* the report's third section, explores the implementation of STEM professional learning in schools that participated in the grant program. The fourth section of the report, *Teacher Outcomes,* investigates the outcomes of teachers from participating in STEM professional learning. *Student Outcomes,* the fifth section of the report, address the effects of teacher participation in STEM professional learning on students. Finally, the sixth section of the report, *Conclusions and Considerations,* provides a summary of the report's findings as well as considerations for the Professional Learning Grant Program.

PART TWO:

DEMOGRAPHICS

A total of 1,941 teachers and administrators, from schools that received grant funding, participated in the survey that informed this report. Discussed in this section are key demographic information about these teachers and administrators.

Key Findings on Survey Participant Demographics

Teachers and Administrators Who Participated in the Survey Were Affiliated with A Variety of Local Education Agencies

Teachers and administrators who responded to the survey were asked to identify the local education agencies to which they belong. As Table 1 illustrates, most teachers and administrators (n = 1,773) were affiliated with public school districts, while a few others (n = 168) worked for charter schools. Of the local education agencies represented, Alpine District (n = 287), Davis District (n = 280), and Provo District (n = 276) accounted for the highest numbers of teacher and administrator respondents.

Table 1. Local Education Agencies and Number of Survey Respondents

LEA	Number of Survey Respondents
Alpine District	287
Box Elder District	3
Cache District	52
Davis District	280
Emery District	11
Granite District	124
Iron District	11
Jordan District	93
Juab District	4
Millard District	22
Morgan District	4
Murray District	24
Nebo District	43
Ogden City District	2
Park City District	1
Piute District	17
Provo District	276
Rich District	2
Salt Lake District	76
San Juan District	49
Sevier District	3
South Sanpete District	113
Tooele District	98
Wasatch District	9
Washington District	169
Charter or Other	168
Total	**1,941**

More Teachers Than Administrators Participated in the Survey

Survey respondents were asked to specify their roles within their schools by indicating whether they were teachers or administrators. As Figure 3 suggests, 96% of respondents identified themselves as teachers, and 4% indicated that they were administrators.

Figure 3. Teacher and Administrator Representation Among Survey Respondents

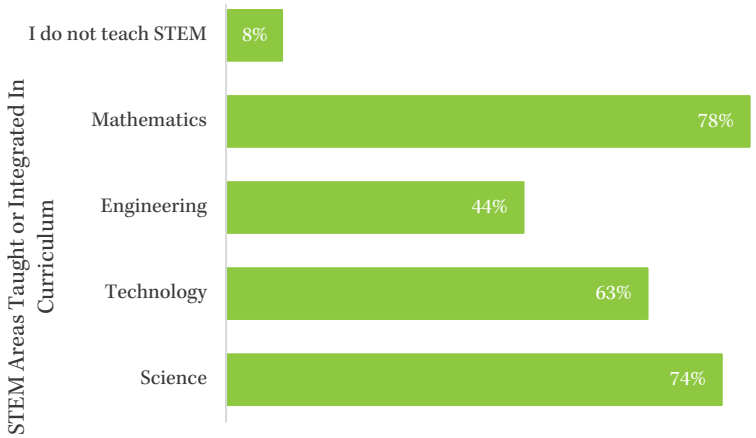
1861 Teachers (96%)
80 Administrators (4%)

Survey Respondents

Teachers Who Participated in STEM Professional Learning Teach or Integrate a Variety of STEM Areas in Their Curricula, Although Mathematics is The Most Popular STEM Area Taught or Integrated

Teachers who participated in STEM professional learning were asked to select the various STEM areas they teach or integrate into their curricula. As Figure 4 suggests, each STEM area (science, technology, engineering, and mathematics) was taught or integrated by some percent of teachers. However, mathematics (78%) was the most popular STEM area taught or integrated by teachers, followed closely by science (74%). These findings parallel those from the 2019 survey in which teachers most often indicated that they taught or integrated mathematics into their curricula (65%), followed by science (63%).

Figure 4. STEM Areas Taught by Teachers or Integrated into Curricula

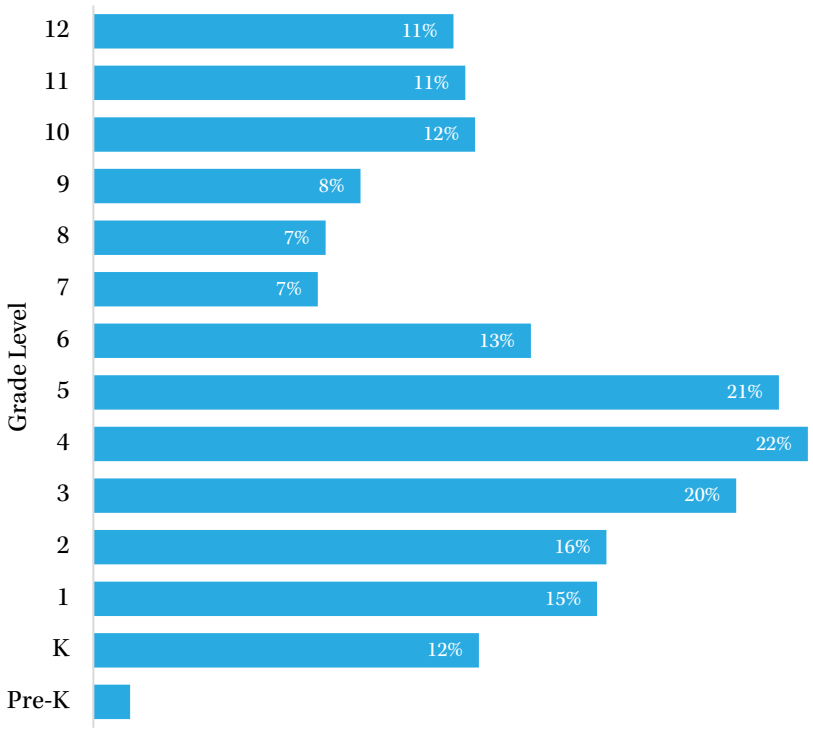


Note: Values do not sum to 100% because respondents could select more than one option. n=1839

Teachers Who Participated in STEM Professional Learning Teach Various Grade Levels, Although the 3rd, 4th, and 5th Grades Were the Most Frequently Reported Grade Levels Taught

Teachers who participated in STEM professional learning were asked to select all the grade levels they teach. As Figure 5 suggests, teachers who participated in STEM professional learning teach a variety of grade levels, spanning pre-kindergarten to grade 12, although they most often indicated teaching grades 3 (20%), 4 (22%), and 5 (21%).

Figure 5. Grade Levels Taught by Teachers

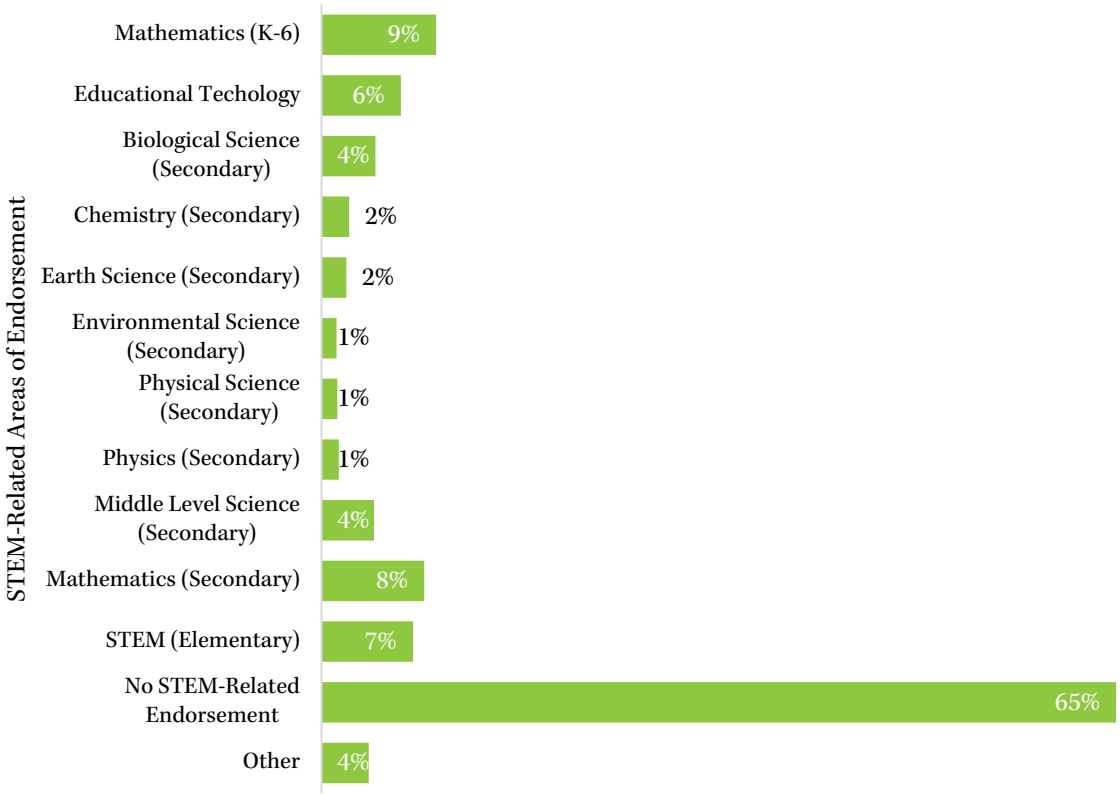


Note: Values do not sum to 100% because respondents could select more than one option. n=1680

Most Teachers Who Participated in STEM Professional Learning Do Not Have A STEM-Related Endorsement

Teachers were asked in the survey to identify the STEM-related endorsements they had earned. They were also permitted to indicate that they had either earned "other" endorsements or do not have a STEM-related endorsement. As Figure 6 illustrates, the majority of teachers (63%) indicated that they do not have a STEM-related endorsement.

Figure 6. STEM-Related Endorsements Possessed by Teachers

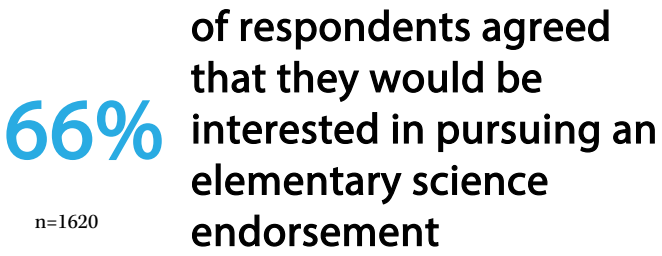


Note: Values do not sum to 100% because respondents could select more than one option. n=1680

Most Teachers Agree That They Would Be Interested in Pursuing an Elementary Science Endorsement If One Were Offered

When asked if they would be interested in pursuing an elementary science endorsement if one were offered, the majority of teachers (66%) strongly agreed or somewhat agreed that they would be interested (Figure 7). Thirty-four percent of teachers, however, somewhat disagreed or strongly disagreed that they would be interested.

Figure 7. Percent of Teachers Interested in Pursuing an Elementary Science Endorsement



PART THREE:

PROFESSIONAL LEARNING IMPLEMENTATION

This section explores the implementation of STEM professional learning in schools that participated in the grant program. More specifically, it reviews findings from the evaluation about the enforcement of STEM professional learning in participating schools, teacher participation and experiences with STEM professional learning, the nature and quality of STEM professional learning opportunities provided, teacher and administrator satisfaction with STEM professional learning, and feedback from administrators and teachers about the STEM professional learning opportunities provided and whether or not they would recommend participation to others.

Key Findings on STEM Professional Learning Enforcement

An Overwhelming Majority of Administrators and Teachers Strongly Agree or Somewhat Agree That STEM Professional Learning Was Enforced at their Schools and School Districts

Administrators were asked in the survey to specify the extent to which they agree that their school districts encouraged teachers to participate in professional learning. They were also asked to indicate the extent to which they agree that they personally encouraged teachers to participate in STEM professional learning and to video their teaching for use in peer or self-reflection. As Figure 8 suggests, between 96% to 98% of administrators, depending on the question, strongly agreed or somewhat agreed to the enforcement of STEM professional learning in their school districts and schools. Comparison of administrators' responses from the current survey and 2019 survey concerning the statement "I encouraged teachers to video themselves teaching and engage in peer or self-reflection" shows that the same percentage of administrators (96%) indicated that they somewhat agreed or strongly agreed.

Similar to administrators, teachers were asked to assess the enforcement of STEM professional learning at their schools. More specifically, they were asked to indicate the extent to which they agree that their "school or district encouraged teachers to participate in STEM professional learning" and their "school administrators supported my engagement with STEM professional learning." As Figure 9 illustrates, 96% and 97% of teachers respectively (up from 92% and 93% in 2019), strongly agreed or somewhat agreed that their "school or district encouraged participation in STEM professional learning" and that their "school administrators supported their engagement with STEM professional learning."

Figure 8. Administrator Reponses to Questions Regarding STEM Professional Learning Enforcement

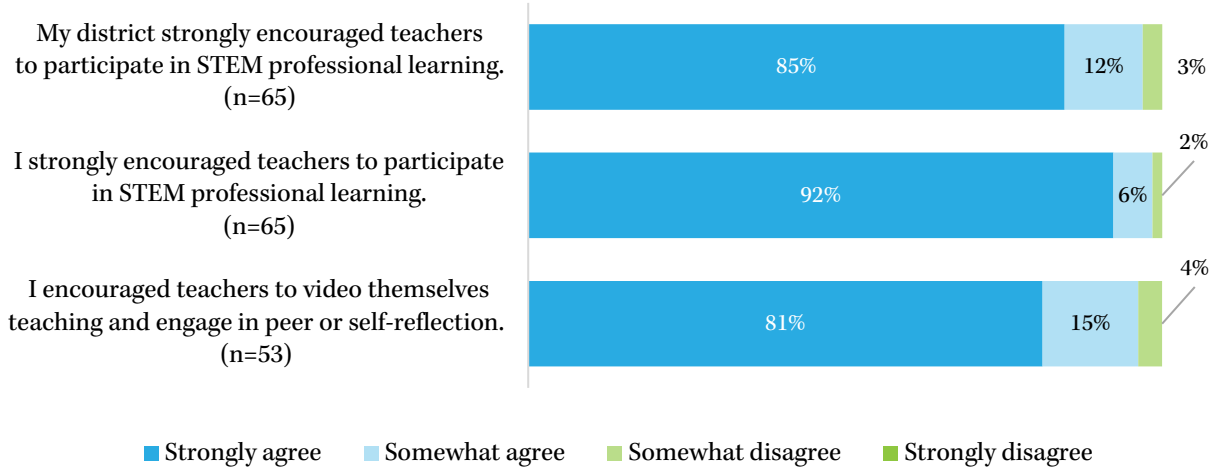
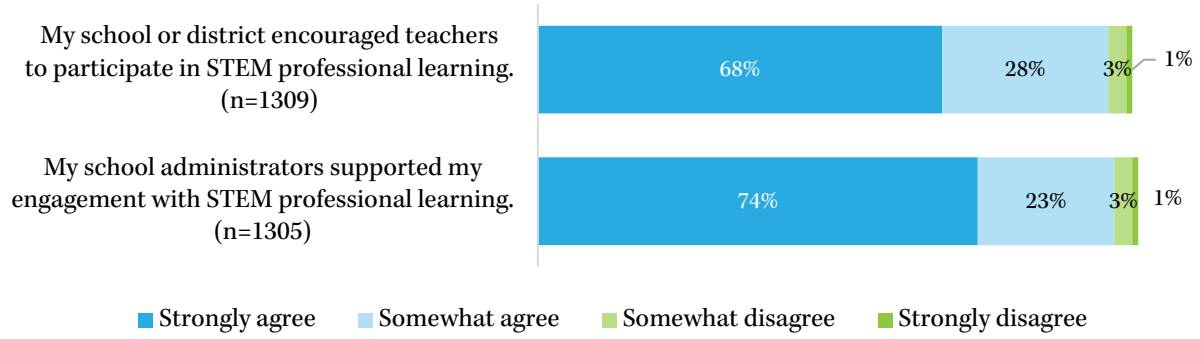


Figure 9. Teacher Reponses to Questions Regarding STEM Professional Learning Enforcement



Key Findings on Teacher Participation in STEM Professional Learning

Nearly All Administrators Indicated That Teachers in their Schools Participated in STEM Professional Learning During the School Year

When asked whether teachers at their schools participated in STEM professional learning during the school year, 95% of administrators responded affirmatively (by indicating "yes," Figure 10).

Figure 10. Percent of Administrators That Indicated "Yes" to Question Regarding Teachers' Participation in STEM Professional Learning

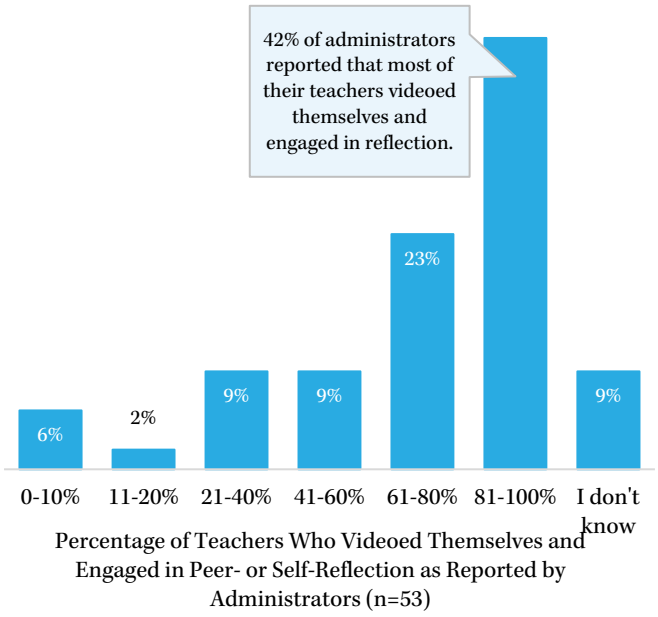
95% of administrators reported that their teachers participated in STEM-related professional learning during the current school year.

n=79

Administrators Were More Likely to Indicate That the Majority, If Not All, Of Their Teachers Engaged in Peer- or Self-Reflection

Administrators were asked in the survey to estimate the percentage of teachers at their school who recorded videos of themselves for use in peer- or- self-reflection. To answer this question, they were provided with the following options: "0-10%," "11-20%," "21-40%," "41-60%," "61-80%," "81-100%," and "I don't know." As Figure 11 illustrates, the highest percent of administrators (42%) indicated that 81% to 100% of teachers at their schools recorded videos of themselves for use in peer- or self-reflection.

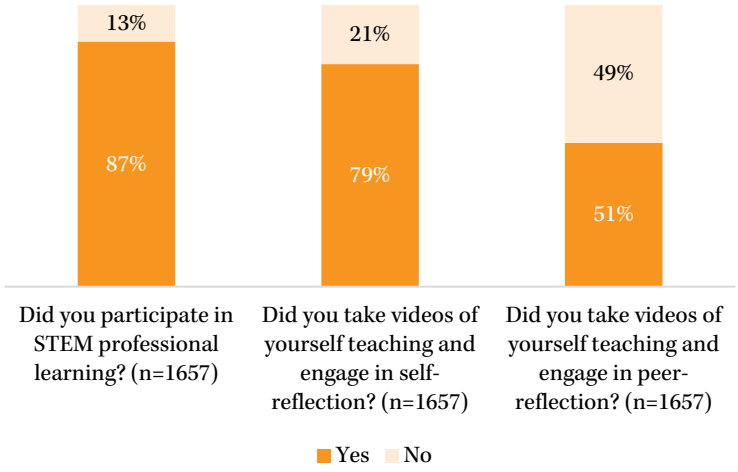
Figure 11. Administrators' Estimation of the Percent of Teachers Who Videoed Themselves and Engaged in Self- or Peer-Reflection



An Overwhelming Majority of Teachers Noted That They Participated in STEM Professional Learning. However, A Higher Majority of Them Used Videos of Their Teaching for Self- Than Peer-Reflection

Like administrators, teachers were asked a series of questions regarding their participation in STEM professional learning. More specifically, they were asked to respond with a "yes" or "no" about if they participated in STEM professional learning, if they recorded videos of themselves for use in self-reflection, and if they recorded videos of themselves for use in peer-reflection. As Figure 12 suggests, the vast majority of teachers (87%, down from 94% in 2019) who responded to the survey indicated that they participated in STEM professional learning. At the same time, however, teachers were more likely to affirm that they recorded videos of their teaching for self-reflection (79%) as compared to peer-reflection (51%).

Figure 12. Teachers' Responses to Questions About Their Participation in STEM Professional Learning



Key Findings About Teacher Experiences with STEM Professional Learning

Teachers were asked about why they do or do not intend to make videos of themselves for self- or peer-reflection. Table 2 suggests that teachers intend to continue making videos of themselves because it improves their instructional practices, promotes group learning among teachers, and encourages self-reflection. As Table 3 illustrates, teachers were unable, or do not intend, to make videos of themselves because of several issues including, but not limited to, the time-intensive nature of the practice, their discomfort with recording themselves, technological issues, and their perception that the practice is unbeneficial.

Table 2. Teachers' Reasons for Why They Intend to Continue Recording Videos of Themselves Teaching

Theme	Example Quotes
Improves Teachers' Instructional Practices	"To help myself become a better teacher." "The videos help me improve on my teaching." "Videos is one main tool I use for reflection and improvement of my teaching." "One of the best ways I have known what improvements/changes to make." "I felt like making SWIVEL videos of myself teaching was extremely beneficial. I intend to continue making them because it really helped me to see where I could improve." "The videos help me see what I need to improve when interacting with students." "It is an easy and powerful way to learn how to become a better teacher!" "I understand the value of using video to help improve my teaching."
Promotes Group Learning and Support Among Teachers	"It is a good way to focus on one area and share with my team mates." "I think it helps with self-reflection and team building." "I learn from watching myself and getting feedback from my peers." "I learn from watching myself and getting feedback from my peers." "It's a great way to see you style of teaching, and get feedback." "It helps us get ideas from one another."
Permits Self-Reflection and Improvement	"Every time I watch it back I notice something new." "I learn a lot when I make videos of myself or my peers." "I learned from watching myself and I want to improve." "I think that I learned lots from watching myself teach." "Self- or peer- reflection is an effective tool to bettering my own skills." "I do intend to make more videos because they are eye-opening and informative." "I think they really help and allow for self-reflection and peer advise." "It helps me reflect and make my teaching better." "I think this is a good way to analyze and self-reflect on teaching practices." "For self-reflection and improvement!"

Table 3. Teachers' Reasons for Why They Were Unable, or Do Not Intend, to Record Videos of Themselves Teaching

Theme	Example Quotes
Time Intensive	"It can be time consuming!" "I don't have time." "It takes a lot of time that I could spend instructing." "It is time consuming. I do not like to watch myself teach." "I am busy and don't feel I have time to video and get peer review." "I know I should, but it just takes more time and I hate watching myself." "I honestly don't have time to take and then reflect on videos."

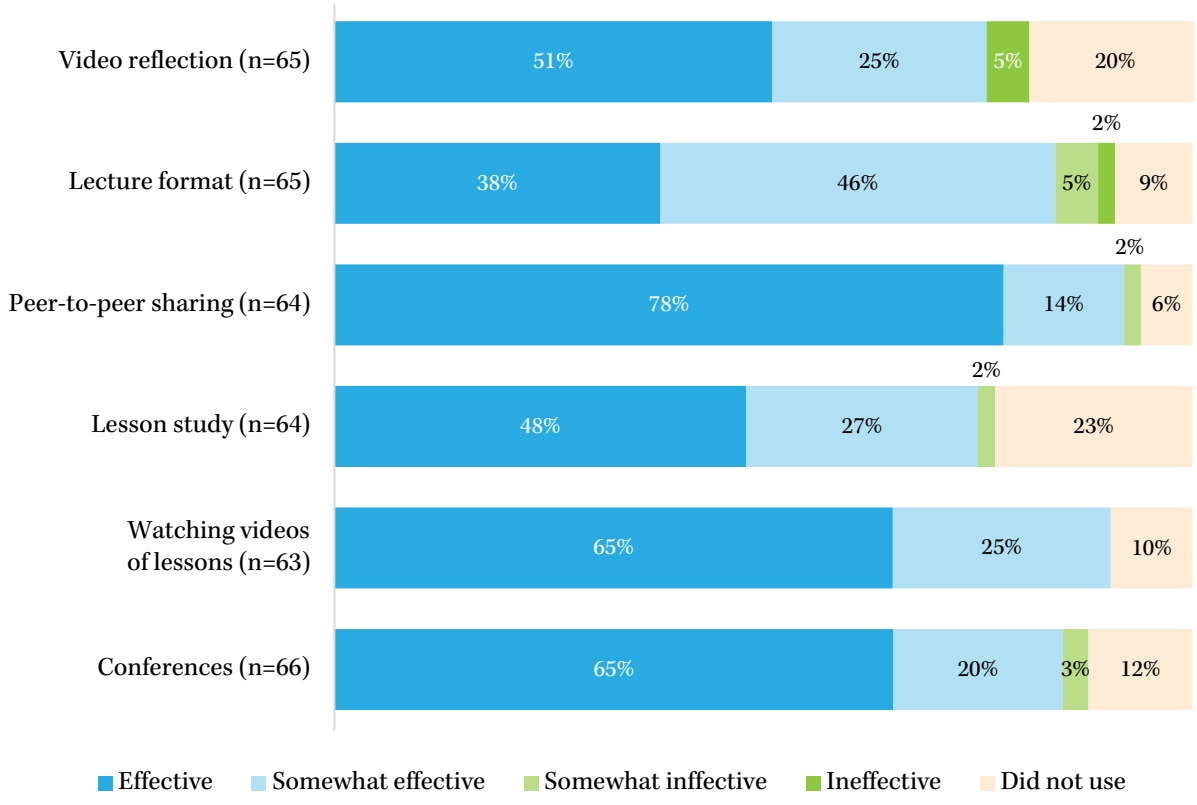
	"It is time consuming and I can see things in real time." "I feel it is a useful tool, however it takes time and preparation to do so." "I usually don't film myself because it takes time to set up."
Lack of Technology	"No technology available." "Lack of equipment to do so easily." "Not sure about equipment available." "School lacks the equipment to do so." "Not having access to recording devices." "Technology resources are unavailable to continue." "Honestly, sometimes it's hard to access the technology needed."
Unnecessary or Unbeneficial	"It was good to see what others see, but it does not change how I teach." "I can reflect on a lesson without needing to video tape myself." "I can reflect on a lesson without needing to video tape myself." "Because of the quarantine I wasn't able to." "I doubt the value of this experience." "I don't think it was helpful enough to justify the time." "I don't feel like it brought new insights into my teaching." "I really don't get much out of watching myself on video."
Competing Priorities	"There is already too much to do as a teacher." "It is one more thing to remember and do and I am too busy as it is." "Too many other things going on the classroom to take the time to do it." "It's on the to-do list, but hasn't hit the top of the priority list yet." "I need to - just trying to stay afloat of everything else I have to do."
Distracting For Students	"A little distracting to the class and I don't enjoy watching myself teach." "I think it is helpful but it is also very distracting." "It is currently not required and I do not want to disrupt my teaching." "Kids tend to act up when being videod." "It's VERY distracting to kinders." "Student distractions." "Kids act differently."
Discomfort with Practice	"I'm less at ease when a video is running." "I think it's a bit of a pain and embarrassing." "It's uncomfortable. But I see value in it, so I do it." "Videoing myself is intimidating and I don't like to do it." "I will make videos as needed. I am uncomfortable doing this." "It was too uncomfortable and I didn't really learn anything from it." "The videos can be helpful but uncomfortable for myself and others." "Videos make me look fatter than I am and I already have eating issues." "I will if it is a requirement but honestly I am not a fan of being videoed." "I don't like watching myself and don't want others videoing me either."
Overly Involved	"Too complicated." "Too much time/effort." "It is tedious." "A lot of fuss and bother."
Disrupted by School Closures Due to COVID-19	"I intended to and then COVID soft closure happened." "We are not currently teaching in our classrooms because of Covid-19." "I intended to this year, but COVID hindered me from having time to do it." "Learning methods changed with the online learning format due to the virus." "I am not working with students due to COVID-19." "Because of the quarantine I wasn't able to."

Key Findings About the Nature and Quality of STEM Professional Learning Opportunities Provided

Administrators Were More Likely to Rate Peer-to-Peer Sharing, Watching Videos of Lessons, and Conferences as "Effective" in Comparison to Other STEM Professional Learning Activities Offered

Administrators were asked to assess the effectiveness of the various STEM professional learning opportunities provided to teachers at their schools. They were also allowed to indicate that their schools "did not use" a particular professional learning format where applicable. As Figure 13 suggests, STEM professional learning activities rank in the following order based on the percent of administrators who indicated that they were "effective": peer-to-peer sharing (78%), watching videos of lessons (65%), conferences (65%), video reflection (51%), lesson study (48%), and lecture format (38%). Additionally, administrators were more likely to indicate that their schools "did not use" lesson study (23%) and video reflection (20%), in comparison to other STEM professional learning activities. Similar to the current survey's results, administrators in 2019 were most likely to rate peer-to-peer sharing (71%) and watching videos of lessons (48%) as effective. However, unlike this year's results, conferences (16%) and lesson study (16%) were the two primary formats that administrators indicated that they "did not to use" in 2019.

Figure 13. Administrators' Evaluation of the Nature and Quality of STEM Professional Learning Formats Provided

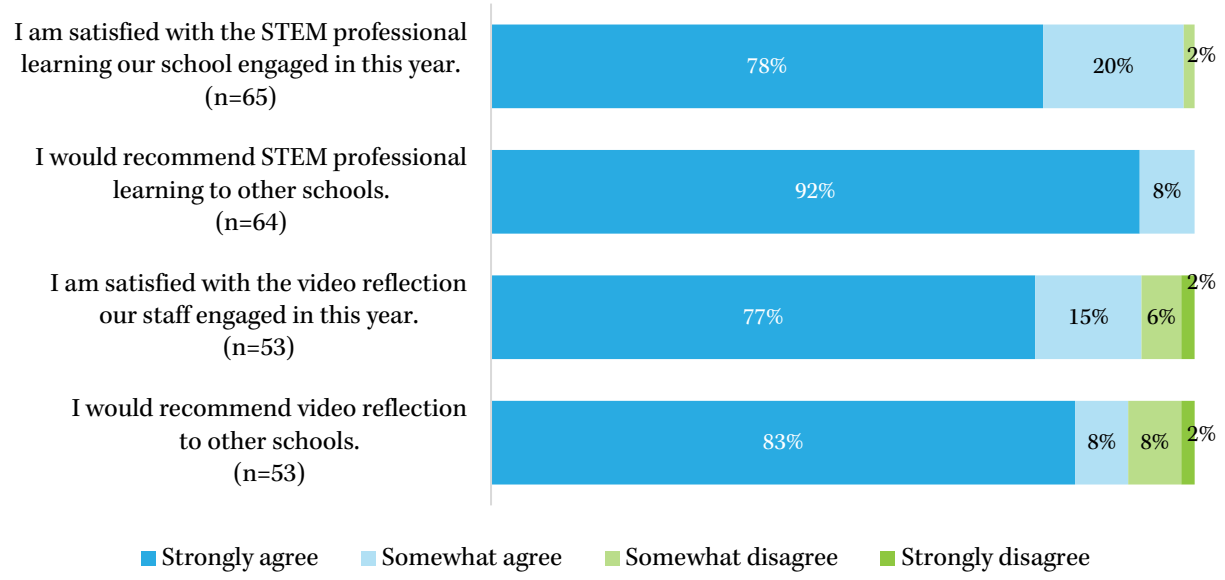


Keys Findings About Administrator and Teacher Satisfaction with STEM Professional Learning

The Vast Majority of Administrators Strongly Agree or Somewhat Agree with Indicators of Satisfaction with Professional Learning

Administrators were asked to evaluate their satisfaction with the STEM professional learning opportunities provided to teachers at their schools. To facilitate their assessment, they were asked to indicate the extent to which they agree with the following four statements: 1) "I am satisfied with the STEM professional learning our school engaged in this year;" 2) "I would recommend STEM professional learning to other schools;" 3) "I am satisfied with the video reflection our staff engaged in this year;" and 4) "I would recommend video reflection to other schools." As Figure 14 illustrates, the overwhelming majority of administrators expressed satisfaction with the STEM professional learning provided at their schools, with 98%, 100%, 92%, and 91% of administrators respectively (compared to 95%, 97%, 85%, and 96% in 2019), indicating that they "strongly agree" or "somewhat agree" to the four aforementioned statements.

Figure 14. Administrators' Responses to Questions About Their Satisfaction with STEM Professional Learning

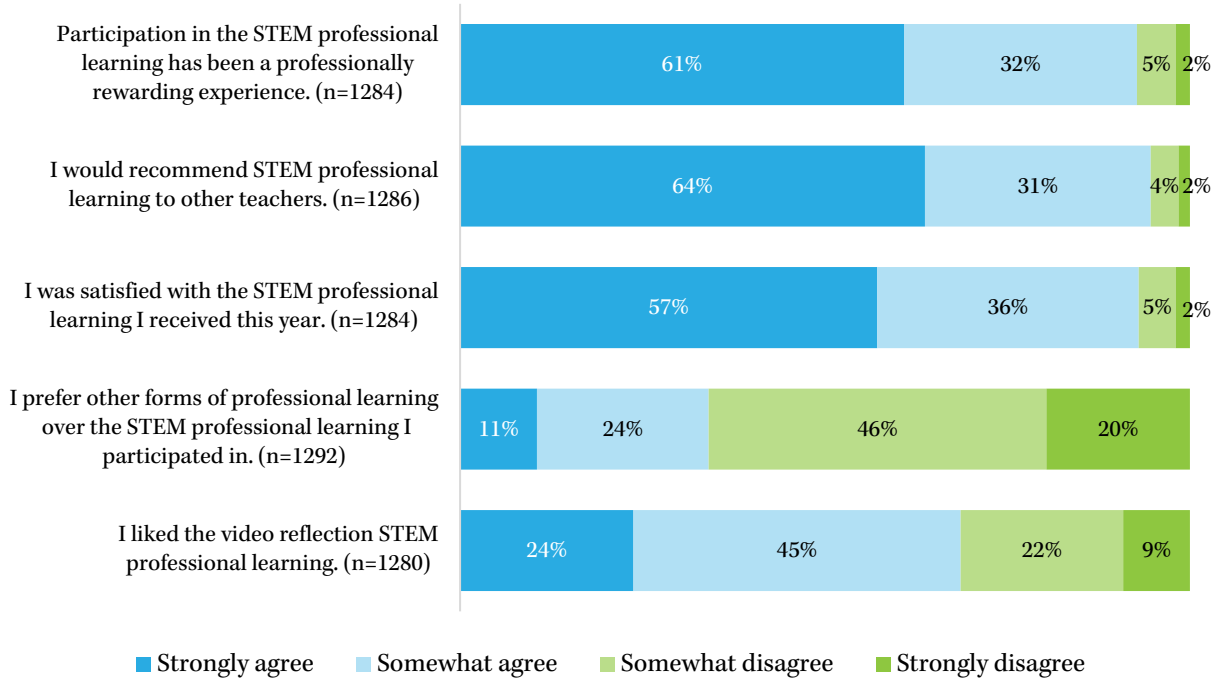


The Majority of Teachers Affirm Their Satisfaction with The STEM Professional Learning Provided at Their Schools

Teachers, like administrators, were queried about their satisfaction with the STEM professional learning provided at their schools. More specifically, they were asked to specify the extent to which they agree with the following statements: 1) "Participation in the STEM professional learning has been a professionally rewarding experience;" 2) "I would recommend STEM professional learning to other teachers;" 3) "I was satisfied with the STEM professional learning I received this year;" 4) "I prefer other forms of professional learning over the STEM professional learning I participated in; and 5) I liked the video reflection STEM professional

learning. As Figure 15 shows, the vast majority of teachers (93%, 95%, and 93% respectively, compared to 93%, 94% and 93% in 2019) strongly agreed or somewhat agreed to the first three indicators of satisfaction with STEM professional learning. Concerning the fourth statement, which was intentionally worded *negatively*, the majority of teachers (76%, up from 37% in 2019) strongly *disagreed* or somewhat *disagreed*; this response can be interpreted, positively, to mean that most teachers preferred the STEM professional learning they participated in over other forms of professional learning that could be provided. This finding provides additional evidence that teachers were mostly satisfied with their STEM professional learning experiences. Finally, with regard to the fifth indicator of satisfaction with STEM professional learning, the majority of teachers (69%, down from 71% in 2019) strongly agreed or somewhat agreed to liking "the video reflection format of STEM professional learning." It is important, however, to note that teachers who responded affirmatively concerning this indicator were much more likely to indicate that they "somewhat agree" as opposed to "strongly agree," which was unlike their responses to the other positively-worded indicators.

Figure 15. Teachers' Responses to Questions About Their Satisfaction with STEM Professional Learning



Administrator and Teacher Feedback About STEM Professional Learning and Whether or Not They Recommend It

Administrators and teachers were asked about whether or not they would recommend STEM professional learning to other schools. As Tables 4 and 5 illustrate, administrators and teachers held similar sentiments about why they would recommend STEM professional learning to other schools. More specifically, they discussed the benefit of STEM professional learning for increasing student knowledge and engagement, increasing teachers' content knowledge,

facilitating teachers' acquisition of new skills, and improving teachers' instructional practices to name a few. As Tables 6 and 7 suggest, some administrators and teachers would not recommend STEM professional learning to other schools because they perceived it as unbeneficial, time intensive or consuming, unorganized, providing insufficient coverage of grade-level specific topics, and providing insufficient examples of detailed lesson plans and videos.

Table 4. Administrators' Reasons for Why They Would Recommend STEM Professional Learning to Other Schools

Theme	Example Quotes
Increased Student Knowledge	"Expands teacher and student knowledge for better understanding in today's advancing technological world." "This process has helped my teachers engage their students more in learning activities that increase the students' ability to retain what they have learned." "Providing opportunities for students to create videos is very educational and they learn the material at a much greater depth when they have to produce a video on an explanation of a topic."
Increased Student Engagement & Interest	"Our students love their STEM explorations and other class or grade level STEM learning activities. They look forward to these activities and even the most difficult-to-engage students are generally fully immersed in STEM learning. Students cannot have these learning opportunities without teachers having the knowledge and skills to present them in the best way to students." "The STEM profession learning is essential as curricular content for 21st century skills and to cultivate students' engagement." "We have seen students' interest levels in STEM rise significantly." "It's a great tool for teachers to improve instruction and student engagement..."
Provided General Student Benefits	"The strategies learned through the professional development series impacted both teacher ability and student progress." "It is very helpful to engage with others and learn new skills. Students will benefit from the learning."
Increased Teacher Content Knowledge	"Having grade levels meet to collaborate on curriculum, engage in lesson studies, and use video reflection not only builds teachers' STEM knowledge and practices, but builds their understanding of what effective professional development should look like, in general." "Expands teacher and student knowledge for better understanding in today's advancing technological world." "I would definitely recommend the STEM professional learning & video reflection. The teachers were excited to learn & then use their new knowledge." "It has been fantastic PD and our teachers have learned a lot."
Increased Teacher Interest in STEM	"STEM professional learning really gave our faculty a boost. It re-energized them and helped them really jump in and love teaching STEM related topics. It provided a "can do" attitude for our faculty." "The teachers left every session energized and excited."
Improved Teachers' Instructional Practices	"The STEM professional learning has had outstanding results in our school and community as more and more teachers have included STEM practices in their teaching and been willing to take more risks with their own learning." "The hands on approach and intense training was undeniably an asset for our faculty…Teachers were willing to participate and engage in practicing lessons learned." "Teachers really changed their teaching practices after reviewing their teaching videos." "STEM professional learning and video reflection have provided teachers with multiple ways to present lessons and improve instructional practices. "

Promoted Group Learning and Support Among Teachers	"Yes, I would highly recommend the STEM professional learning and video reflection to other schools. The professional learning opportunities have been cutting edge and designed for teachers to engage and collaborate throughout." "It is very helpful to engage with others and learn new skills. Students will benefit from the learning." "This year's professional development was very useful. Teachers enjoyed working with their grade level teams to create something very authentic. They enjoyed sharing that with other grade levels of teachers and students. I feel that this was a wonderful addition to our schools professional development."
Provided Hands-On Training and Other Resources	'The hands on approach and intense training was undeniably an asset for our faculty." "We really appreciated the material and strategies that were presented in our professional development sessions and the opportunity to use the strategies we learned." "It is a great way to learn about yourself, get new ideas, learn from others, and learn how to improve." "It creates a venue that allows self-reflection and professional interaction and feedback receiving." "When video reflection is done in a team setting as we encourage with grade-level PLCs, our teams assist each other to start where they are, and then rise together as more effective professionals."

Table 5. Teachers' Reasons for Why They Would Recommend STEM Professional Learning to Other Schools

Theme	**Example Quotes**
Increased Student Engagement	"STEM has brought my class to a new level of engagement." "I have seen that STEM learning is highly engaging to the students." "Better understanding and more student engagement."
Increased Teacher Content Knowledge	"It helps me understand my content area better." "It really broke down the concepts and standards." "I learned a lot through the professional learning." "The videos are good at explaining technology to teachers." "I am new to science so I got a lot of good information to help me." "It makes teachers more knowledgeable about the subjects." "I have a greater understanding of STEM and how to implement it in my classroom."
Facilitated Teachers' Acquisition of New Skills	"I love how it develops problem solving skills." "I would recommend. It's always good to grow your skills." "I was able to learn new skills to help me become a better teacher." "I have new ideas to use in the classroom." "I love the ideas and strategies generated in the STEM professional learning."
Improved Teachers' Instructional Practices	"It has helped me improve my teaching skills for STEM." "There were a lot of simple practices to add to daily instruction." "I like getting ideas on how to improve my practice." "I learned a lot that I could directly integrate into my teaching." "It's a great refresher on best practices to use in the classroom." "The professional learning helps me be a better teacher." "Recording yourself can help improve your practice." "It will enhance lesson planning and experiences for the kids!" "It helped me create lessons that were fun and meaningful to me and my students."
Increased Teachers' Confidence	"It helped get me more confident in teaching science." "It really helped my confidence as a teacher in these areas!" "I feel more confident to teach the new standards." "I have more confidence in teaching the new SEED Science Standards." "I feel more confident in what I am doing so my job satisfaction increases."

	"It helped me become more confident in what I am supposed to be teaching."
Promoted Group Learning and Support Among Teachers	"It's always helpful to hear from other teachers." "It was great to get together with other teachers to learn." "It is awesome to collaborate with other teachers and get new ideas." "Great to meet and collaborate with other teachers." "Collaborating with other STEM teachers is inspiring and motivating."
Provided Needed Training and Other Resources	"It provided hands-on training and collaboration." "It gave me a lot of good ideas and resources." "Learned new tools to use and different ways to teach." "I like the resources that were presented." "More tools to utilize."
Effective Facilitators, Activities, and Presentations	"Excellent, knowledgeable instructors." "The presentations I saw were well thought out and interesting." "The content and professor was amazing." "I like the way Jaimie structured the class." "Kris Cunningham is an incredible mentor."
Increased Interest in Professional Development	"I just hope it continues to be available." "More please more time, more hands on etc." "Keep providing it in as many ways possible." "Keep this going for teachers in the same way." "MORE PLEASE!" "Let's do it more!"

Table 6. Administrators' Reasons for Why They Would Not Recommend STEM Professional Learning to Other Schools

Theme	**Example Quotes**
Ineffective for Improving Teaching Practice	"Teachers did not appreciate the filming component and we experienced little effectiveness from the filming sessions." "The video reflection was not as universally useful…Those 1 or 2 videos that some teachers made were useful, but did not create a great context for professional learning."
Need for More Detailed Lesson Plans and Videos	"I would have liked to see lesson plans with a very clear framework and to have videos of someone actually teaching the lessons."
Slow and Repetitive	"The only negative feedback was that it was slow moving at time and repeated itself during the sessions."
Ineffective Organization	"It is hard when everyone is at different levels of comfort of STEM. "
Time Intensive	"Video reflection works really well but it takes time to implement effectively."
Need for Additional Professional Development	"Need additional PD for teachers."

Table 7. Teachers' Reasons for Why They Would Not Recommend STEM Professional Learning to Other Schools

Theme	**Example Quotes**
Unbeneficial	"Waste of time. No benefit. Still confused." "It took time away from teaching to film myself and wasn't worth the stress." "Not all the sessions were useful."
Overwhelming	"It's a great deal of change. And there is always too much change at once."

	"It was overwhelming." "Fun and interesting ideas, but very overwhelming."
Time Consuming	"Sometimes I felt that they were too long to hold my attention." "It takes me out of my classroom too much." "The classes took too much time away from my classroom." "I felt a decrease in interest because the time commitment was overwhelming."
Unorganized Sessions	"The first session was a bit unorganized. " "Taught in a very confusing and incohesive way."
Insufficient Hands-On Professional Development	"Just hoping to be hands on next time." "More hands on lessons that we can take back." "More hands on manipulatives related to engineering."
Need for Grade-Level Specific Professional Development	"It does not target the curriculum in the grade I teach." "More 1/2 -day Kindergarten focus, please." "More organized by grades would be great."
Unhelpful Facilitators	"The trainers were not very helpful or interesting."

PART FOUR:

TEACHER OUTCOMES

This section explores teachers' outcomes from participating in STEM professional learning. More specifically, it addresses the impact of STEM professional learning on teachers' interest in professional learning, teachers' skills, knowledge, and confidence to teach STEM content, teachers' STEM instructional practices, teachers' general instructional practices, and teachers' job attitudes.

Key Findings on Teachers' Interest in Professional Learning

A Majority of Administrators and Teachers Agree That Participating in STEM Professional Increased Teachers' Interest in Professional Learning

Administrators were asked in the survey to specify the extent to which they agree or disagree that "teachers' interest in professional learning increased after STEM professional learning" (Figure 16). In turn, teachers were themselves asked to self-evaluate their interest in professional learning post-participation in STEM professional learning. More specifically, they were asked to indicate the extent to which their interest in professional increased or decreased following their participation in STEM professional learning (Figure 17). Additionally, they were asked to specify the extent to which they agree or disagree that they engage in, or intend to engage in, professional learning activities because of their participation in STEM professional learning (Figure 18). As Figure 16 illustrates, the vast majority of administrators (97%, down from 99% in 2019) "strongly agree" or "somewhat agree" that participating in STEM professional learning increased teachers' interest in professional learning. Teachers' views were a little less positive than those of administrators, with a lower majority of them (67%, down from 71% in 2019) indicating that participation in STEM professional learning "greatly increased" or "somewhat increased" their interest in professional learning (Figure 17). Finally, most teachers, as illustrated in Figure 18, "strongly agree" or "somewhat agree" that they engage in, or intend to engage in, professional learning because of their participation in STEM professional learning; concerning teachers' responses to this group of questions, however, the highest majority of teachers (93%, up from 57% in 2019) strongly agreed or somewhat agreed that they "intend to take videos of myself for peer-or self-reflection" and the lowest majority (56%), down from 92% in 2019) affirmed that they have "engaged in more self-reflection of my teaching."

Figure 16. Percent of Administrators Who Agreed That Teachers' Interest in Professional Learning Increased After Participation in STEM Professional Learning

97% of administrators agreed that their teachers' interest in professional learning increased after STEM professional learning.

Figure 17. Teachers' Assessment of their Interest in Professional Learning After Participating in STEM Professional Learning

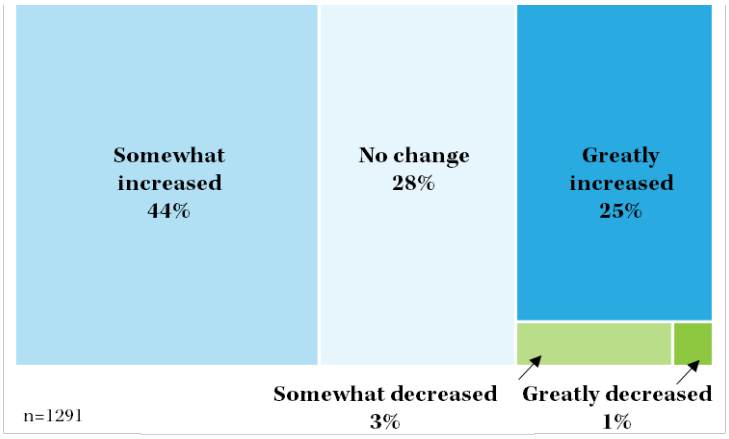
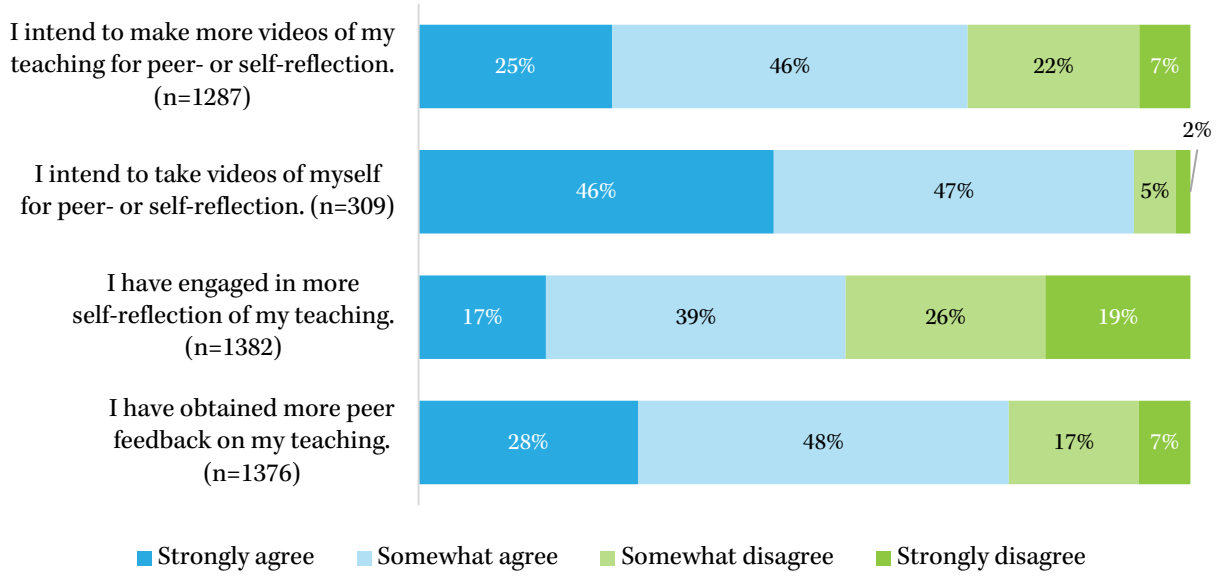


Figure 18. Teachers' Responses to Additional Questions About Their Interest in STEM Professional Learning



Key Findings on Teachers' STEM Skills, Knowledge, and Confidence

Most Administrators and Teachers Agree That Participating in STEM Professional Learning Increased Teachers Skills, Knowledge, and Confidence to Teach STEM Content

Administrators were asked in the survey to indicate the extent to which they agree or disagree that STEM professional learning was effective in "developing teachers' skills in STEM," "increasing teachers' STEM content knowledge," and "developing teachers' confidence to teach STEM content" (Figure 19). Teachers were also posed the very same set of questions as illustrated in Figure 20. Additionally, they were asked to evaluate how confident they were in teaching and creating STEM lessons before and after participating in STEM professional learning (Figure 21). As Figure 19 illustrates, 99%, 97%, and 100% of administrators respectively (compared to 100%, 92%, and 93% in 2019), "strongly agree" or "somewhat agree" that STEM professional learning was effective in develop teachers' skills in STEM, content knowledge, and confidence to teach STEM content. Teachers also expressed similarly positive sentiments with 95%, 92%, and 91% (up from 93%, 89%, and 90% in 2019) indicating that they "strongly agree" or "somewhat agree" that STEM professional learning was effective at increasing their skills in STEM, content knowledge, and confidence to teach STEM content (Figure 20). Concerning teachers' confidence to teach and create STEM lessons before and after participating in STEM professional learning, Figure 21 shows that teachers were much more likely to indicate that they were "strongly confident" or "somewhat confident" to "teach elementary math standards," "teach elementary science standards," "teach STEM lessons," and "create STEM lessons" *after* participating in STEM professional learning; this was also the case in 2019. It is important to

note, however, that teachers were least likely to indicate that they were confident with creating STEM lessons both before (51%) and after (88%) participating in STEM professional learning.

Figure 19. Administrators' Responses to Questions About the Impact of STEM Professional Learning on Teachers' STEM Skills, Content Knowledge, and Confidence

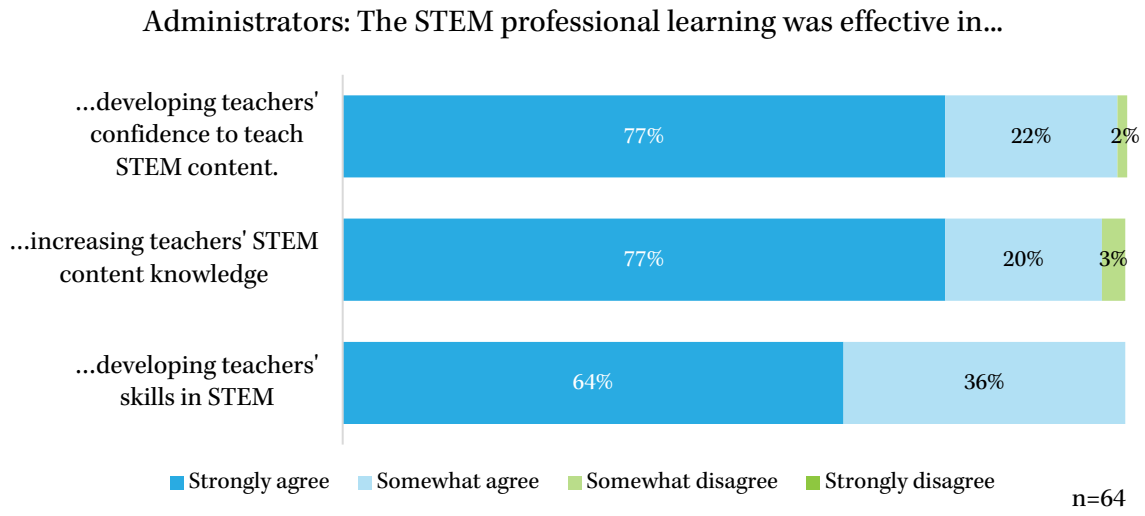


Figure 20. Teachers' Responses to Questions About the Impact of STEM Professional Learning on Their STEM Skills, Content Knowledge, and Confidence

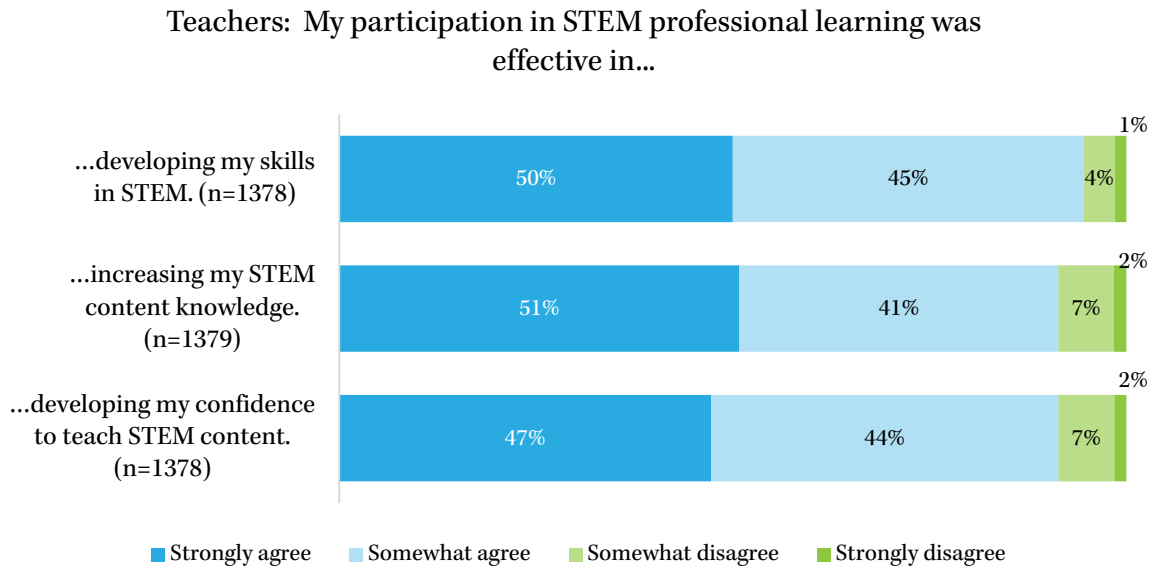
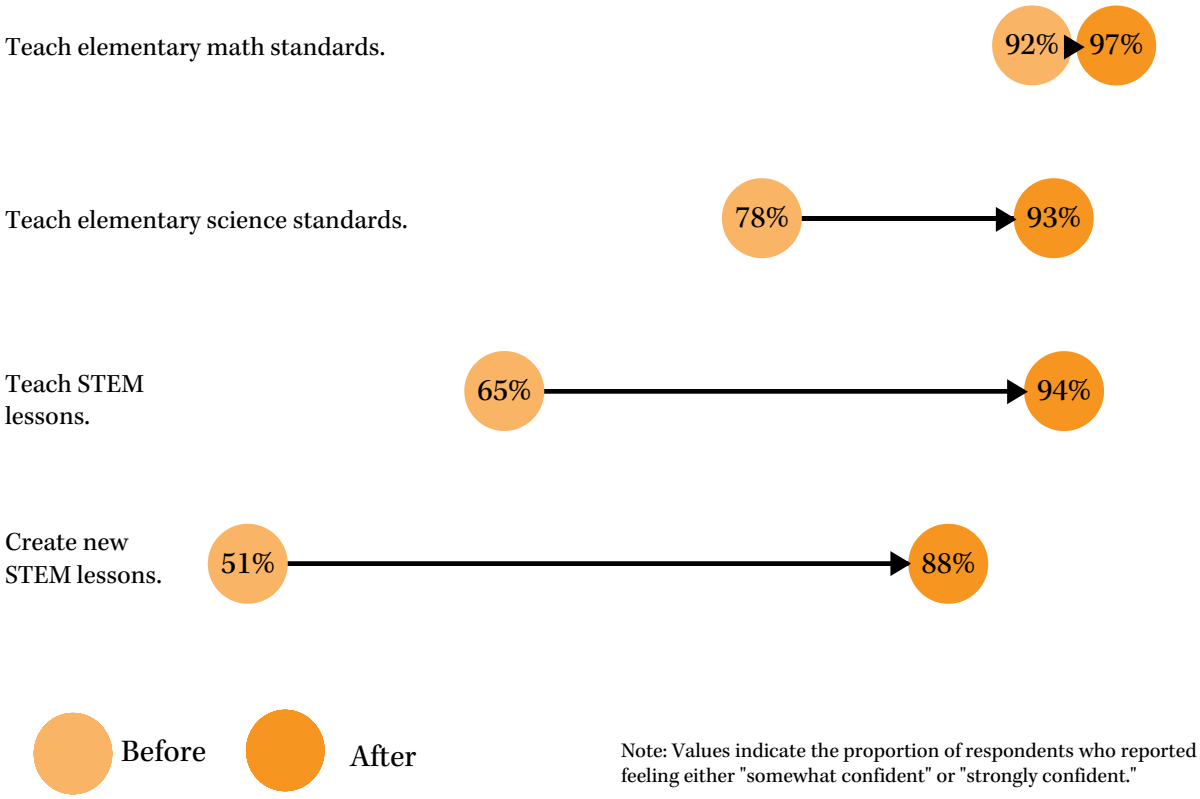


Figure 21. Teachers' Responses to Additional Questions About Their Skills Before and After Participating in STEM Professional Learning



Key Findings on Teachers' STEM Instructional Practices

A Vast Majority of Administrators and Teachers Agree That Participating in STEM Professional Learning Improved Teachers' STEM Instructional Practices

Questions were included in the survey to understand the impact of STEM professional learning on teachers' STEM instructional practices. The first of these questions, posed to administrators, sought to understand the extent to which they agree or disagree that STEM professional learning was effective at "advancing teachers' STEM instructional practice" (Figure 22). Teachers, in turn, were also asked to specify the extent to which they agree or disagree that STEM professional was effective at increasing their ability to integrate the different STEM areas (science, technology, engineering, and mathematics) in their instruction (Figure 23). Additionally, they were asked to indicate the extent to which they agree or disagree that they made important changes to their STEM curricula, lesson plans, and instructional practices following participation in STEM professional learning (Figure 24). As Figure 22 illustrates, 100% of administrators strongly agreed or somewhat agreed that STEM professional learning was effective at advancing teachers' STEM instructional practice. As shown in Figure 23, most teachers strongly agreed or somewhat agreed that STEM professional learning increased their ability to integrate different STEM areas in their instruction, although they held

the most positive sentiments concerning their ability to integrate technology in their instruction (86%, up from 85% in 2019), followed by mathematics (84%, up from 82% in 2019), science (83%, up from 75% in 2019), and lastly, engineering (74%, up from 60% in 2019). Finally, between 87% and 94% of teachers (compared to 87% to 93% in 2019), depending on the indicator, strongly agreed or somewhat agreed that they made important changes to their STEM curricula, lesson plans, and instructional practices following their participation in STEM professional learning (Figure 24).

Figure 22. Percent of Administrators That Agree That STEM Professional Learning Was Effective in Advancing Teachers' STEM Instructional Practice

100% **of administrators agreed that the STEM professional learning was effective in advancing teachers' STEM instructional practice.**

Figure 23. Teachers' Responses About the Impact of STEM Professional Learning on Their Ability to Integrate the Various STEM Areas in Their Instruction

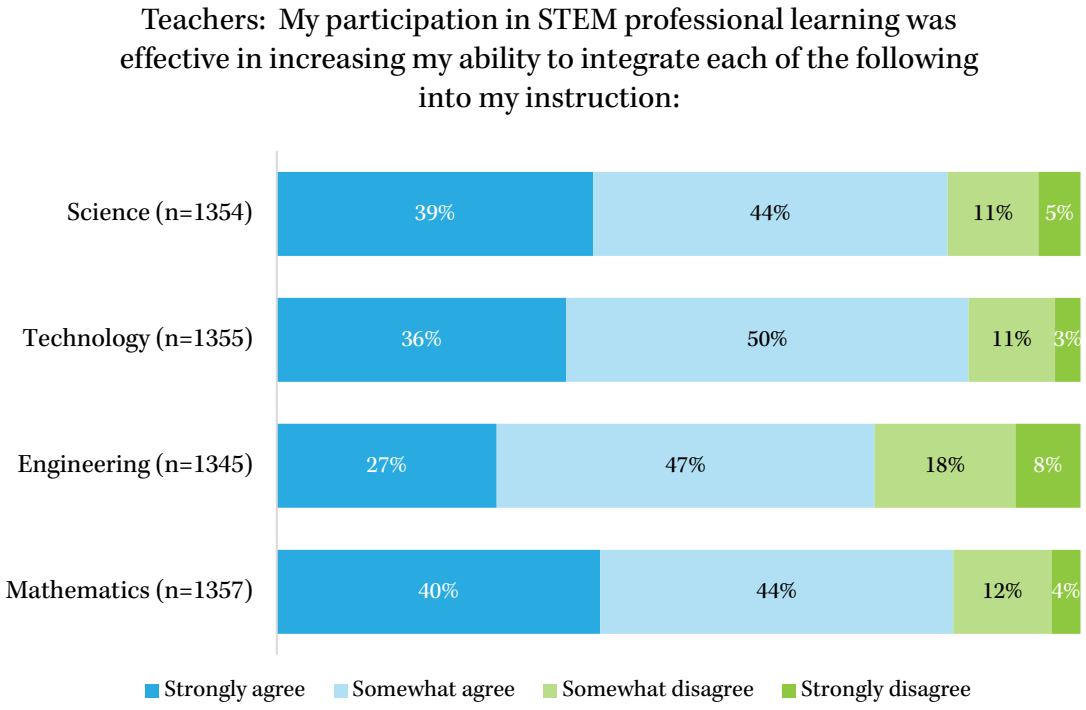
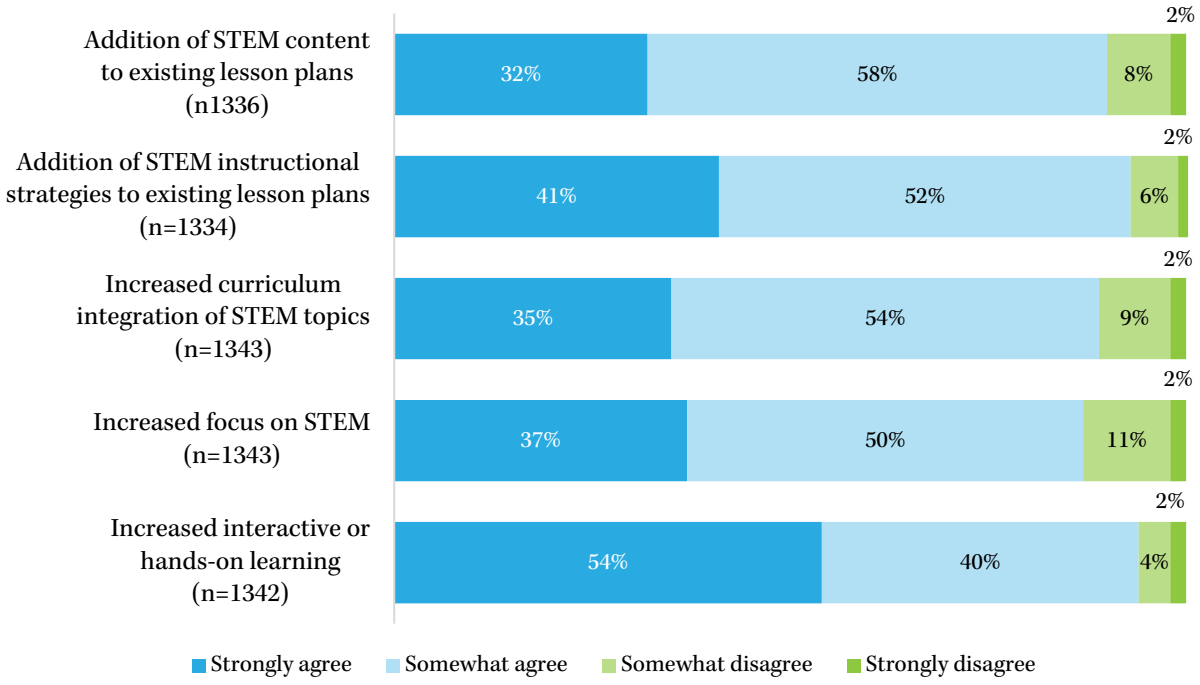


Figure 24. Teachers' Responses to Questions About the Impact of STEM Professional Learning on their STEM Instructional Practices



Key Findings on Teachers' General Instructional Practices

An Overwhelming Majority of Administrators and Teachers Agree That Participating in STEM Professional Learning Improved Teachers' General Instructional Practices

In addition to examining the impact of STEM professional learning on teachers' *STEM* instructional practices, the survey administered to administrators and teachers also sought to understand the impact of STEM professional learning on teachers' *general* instructional practices. For one, administrators were asked in the survey to indicate the extent to which they agree or disagree that they "observed a transfer of STEM professional learning to classroom practice" (Figure 25). Teachers, on the other hand, were asked to indicate the extent to which they agree or disagree that they made a variety of changes to teaching and learning in their classrooms following participation in STEM professional learning (Figure 26). Additionally, they were asked about the impact that STEM professional learning had on their ability to facilitate students' acquisition of important skills (Figure 27) and their ability to use effective and equitable pedagogical approaches in their instruction (Figure 28). As Figure 25 illustrates, 100% of administrators strongly agreed or somewhat agreed that they "observed a transfer of STEM professional learning to classroom practice." As shown in Figure 26, between 79% to 94% of teachers (compared to 81% to 94% in 2019), in response to the first six statements, strongly agreed or somewhat agreed that they made important changes to teaching and learning in their classrooms following participation in STEM professional learning. The seventh and last statement in Figure 26, "I've been too busy with professional learning to implement much in my classroom," was intentionally worded *negatively*; findings concerning this indicator can be interpreted to mean that most teachers (69%, down from 71% in 2019) have implemented new

practices in their classrooms since participating in STEM professional learning. Ninety-two percent, 95%, 94%, 94%, and 89% of teachers respectively (compared to 91%, 95%, 93%, 93%, and 87% in 2019) strongly agreed or somewhat agreed that STEM professional learning improved their ability to teach students to "communicate effectively," "think critically," "think creatively," "collaborate," and "be self-directed learners" (Figure 27). Finally, between 89% and 95% of teachers (compared to 90% to 95% in 2019), contingent on the indicator, strongly agreed or somewhat agreed that STEM professional learning improved their ability to utilize effective and equitable pedagogical practices in their instruction (Figure 28).

Figure 25. Percent of Administrators That Agree That STEM Professional Learning Influenced Teachers' Classroom Practice

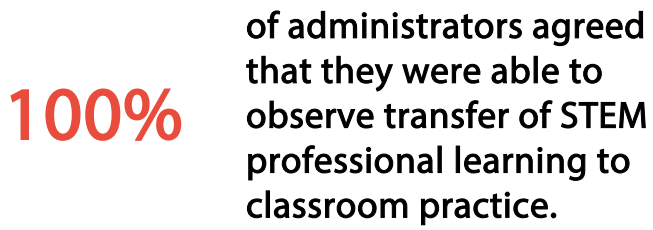


Figure 26. Teachers' Responses to Questions About the Impact of STEM Professional Learning on their General Instructional Practices

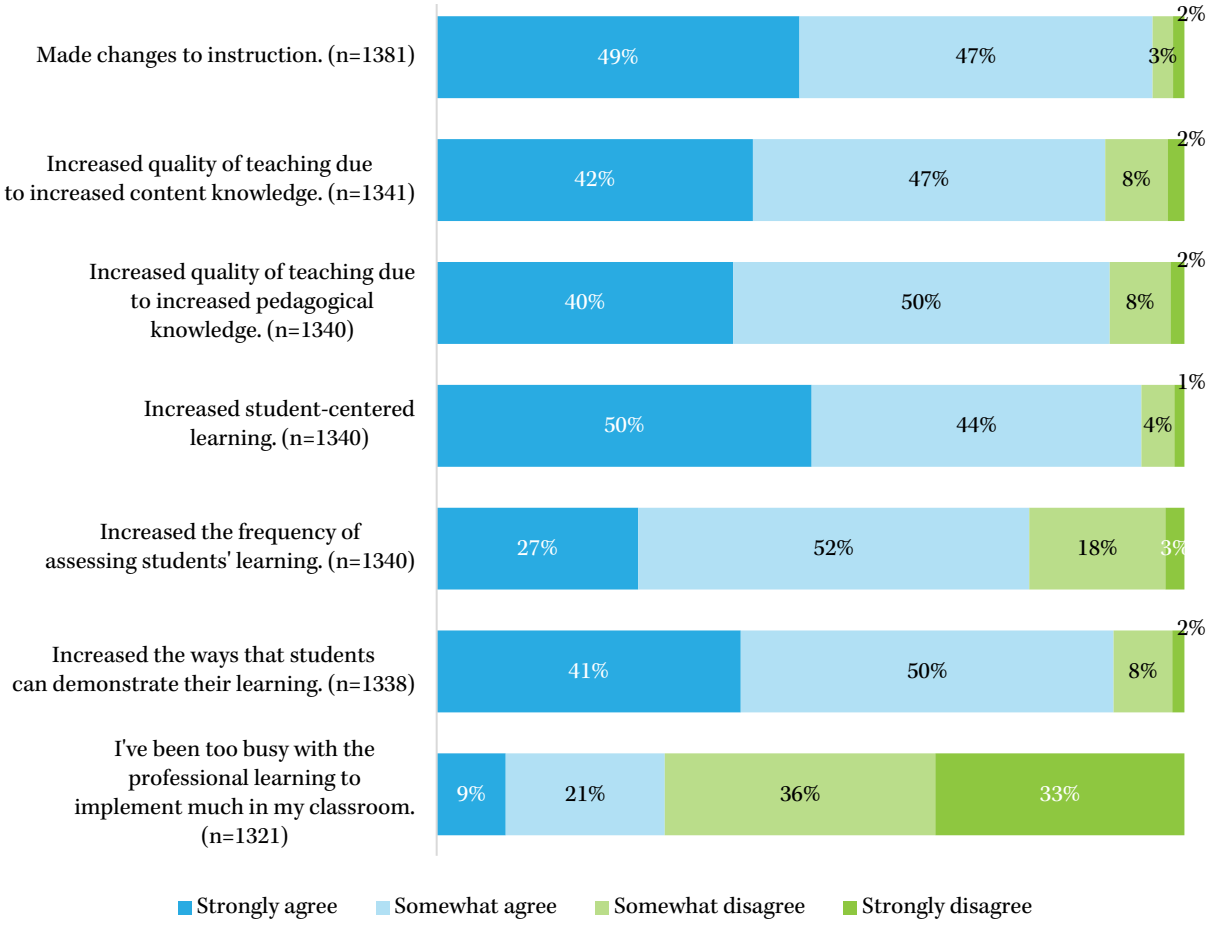


Figure 27. Teachers' Responses About the Impact of STEM Professional Learning on their Ability to Facilitate Students' Acquisition of Important Skills

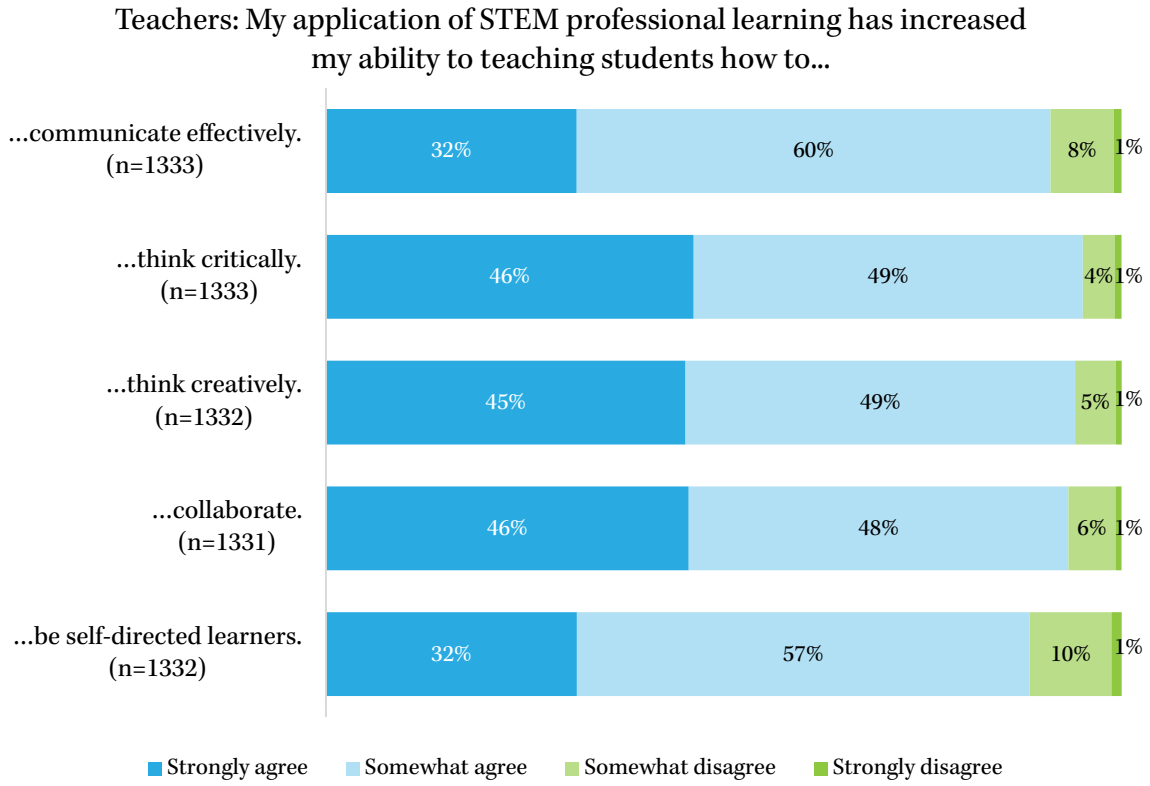
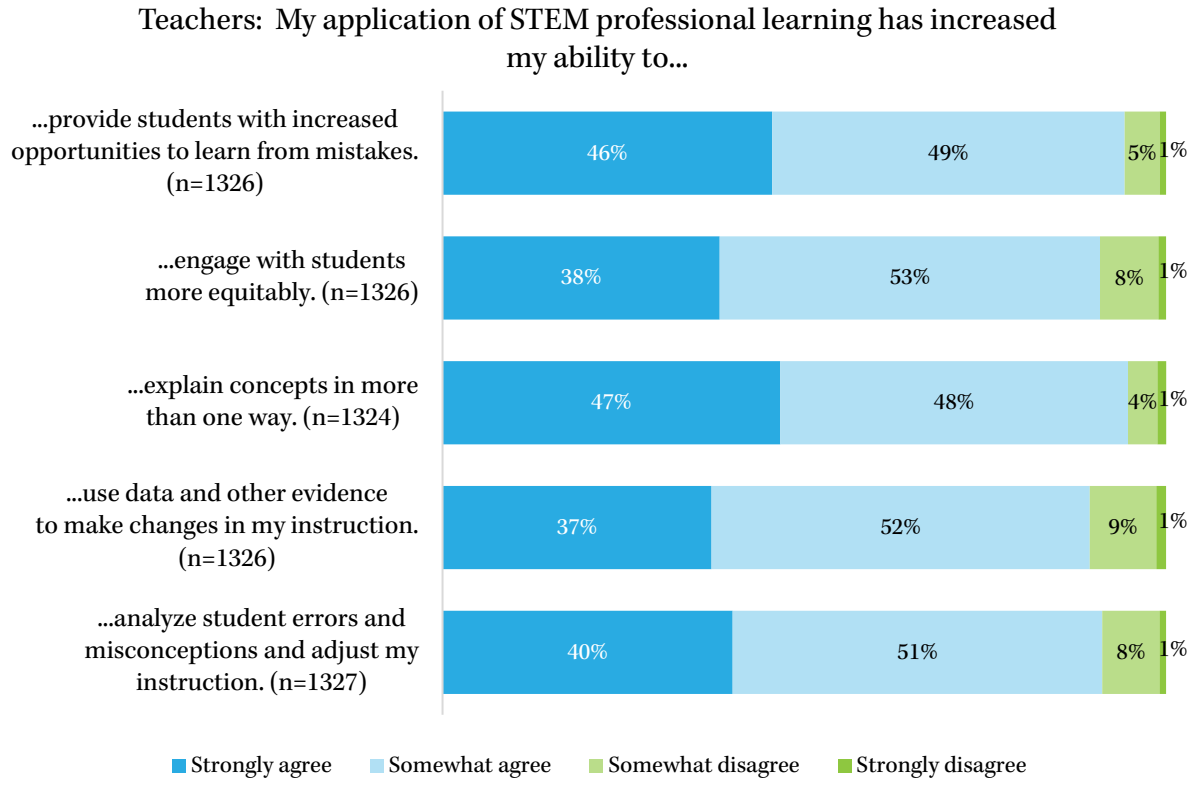


Figure 28. Teachers' Responses to Questions About the Impact of STEM Professional Learning on their Ability to Utilize Effective and Equitable Pedagogical Practices



Key Findings on Teachers' Job Attitudes

Most Administrators and Teachers Agree That Participating in STEM Professional Learning Improved Teachers' Job Attitudes

To gauge the impact of STEM professional learning on teachers' job attitudes, administrators were asked to indicate the extent to which they agree or disagree that STEM professional learning was effective at "increasing teacher job satisfaction" and "increasing teacher retention" (Figure 29). Relatedly, teachers were asked to specify the extent to which their "job satisfaction" and "commitment to teaching" increased or decreased following participation in STEM professional learning (Figure 30). As Figure 29 depicts, 87% and 90% of administrators, respectively, strongly agreed or somewhat agreed that STEM professional learning was effective at "increasing teacher job satisfaction" and "increasing teacher retention." As shown in Figure 30, 61% and 61% of teachers respectively (down from 62% and 63% in 2019), indicated that STEM professional learning "greatly increased" or "somewhat increased" their "job satisfaction" and "commitment to being a teacher."

Figure 29. Administrators' Responses to Questions About the Impact of STEM Professional Learning on Teachers' Job Attitudes

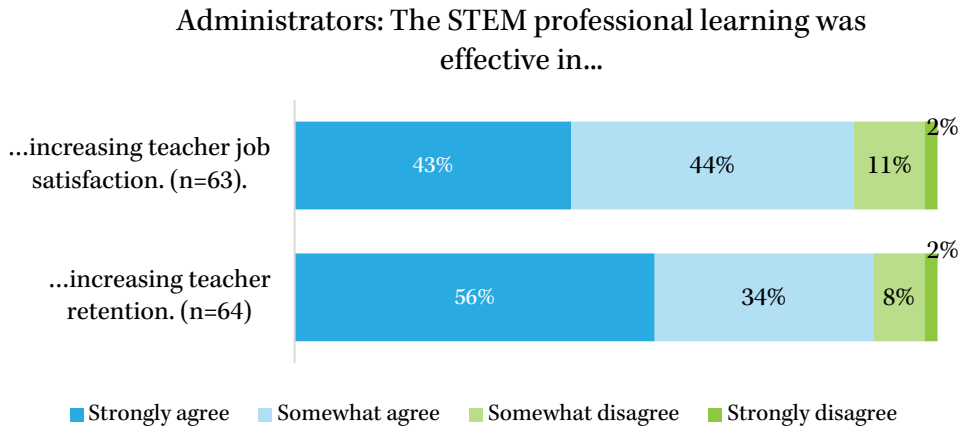


Figure 30. Teachers' Responses to Questions About the Impact of STEM Professional Learning on Their Job Attitudes

PART FIVE:

STUDENT OUTCOMES

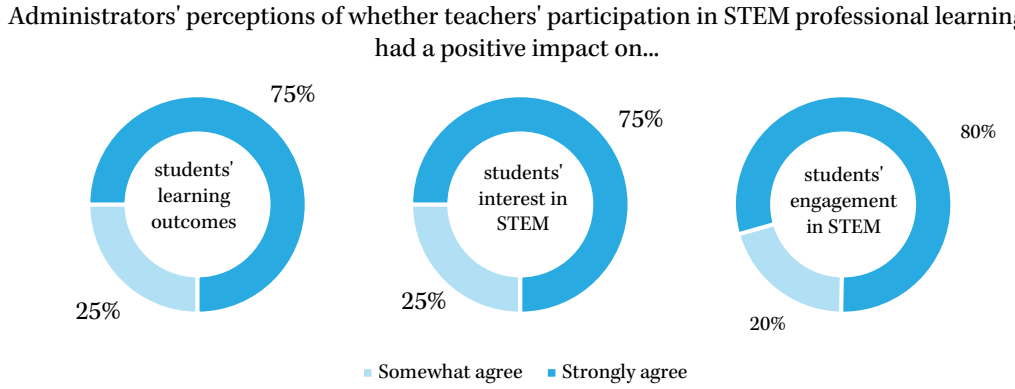
This section examines the impact that teachers' participation in STEM professional learning had on students' outcomes. The three student outcomes assessed include students' learning outcomes in STEM, interest in STEM, and engagement in STEM.

Key Findings on Student Outcomes

All Administrators Strongly Agreed or Somewhat Agreed That Teachers' Participation in STEM Professional Learning Positively Impacted Students' Outcomes

Administrators were asked to specify the extent to which they agree that teachers' participation in STEM professional learning had a positive impact on students' "learning outcomes in STEM," "interest in STEM," and "engagement in STEM." To provide their assessment, they were presented with a 4-item Likert scale that included the categories "strongly agree," "somewhat agree," "disagree," and "strongly disagree." As Figure 31 suggests, 100% of administrators strongly agreed or somewhat agreed that teachers' participation in STEM professional learning had a positive impact on the three aforementioned student outcomes. Equally importantly, Figure 31 also suggests that administrators' held very firm/conclusive stances, with the vast majority indicating that they "strongly agree" as opposed to "somewhat agree." In 2019, however, lower percents of administrators, 99%, 91% and 92% respectively, strongly or somewhat agreed that teachers' participation in STEM professional learning had a positive impact on students' "learning outcomes in STEM," "interest in STEM," and "engagement in STEM."

Figure 31. Administrators' Responses to Questions About the Impact of STEM Professional Learning on Student Outcomes in STEM

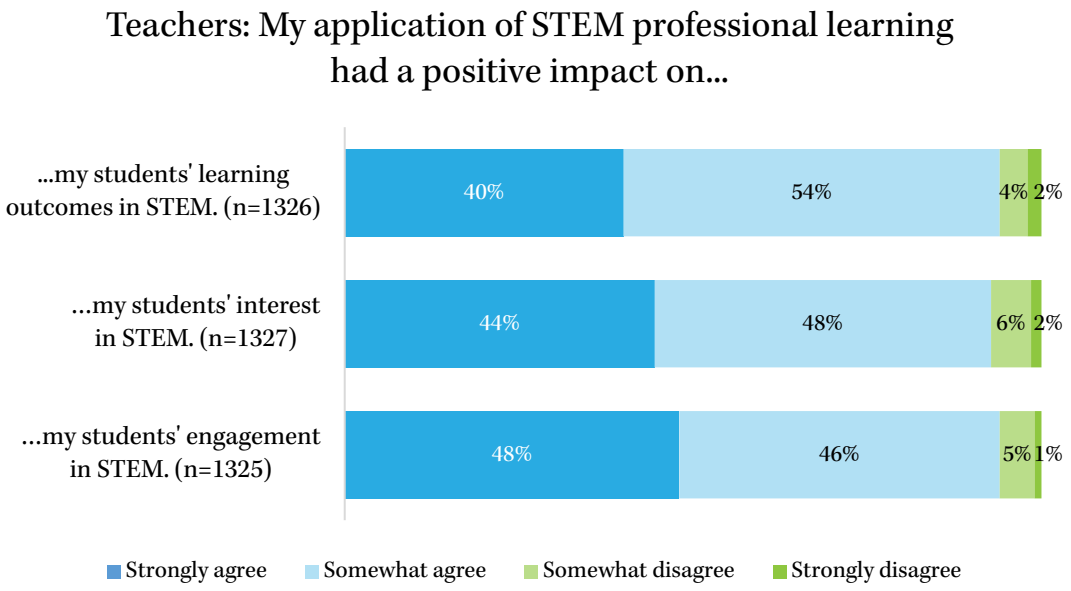


Most Teachers Affirmed That Their Participation in STEM Professional Learning Positively Impacted Students' Outcomes. However, Their Responses Were Less Conclusive Than Those of Administrators

Teachers were asked to self-evaluate the impact that their participation in STEM professional learning had on students' "learning outcomes in STEM," "interest in STEM," and "engagement in STEM." While the vast majority of teachers—94%, 92%, and 94% respectively—strongly agreed or somewhat agreed that their participation in STEM professional learning positively

impacted students' "learning outcomes in STEM," "interest in STEM," and "engagement in STEM" (Figure 32), their responses were less positive than those of administrators, 100% of whom agreed that teachers' participation in STEM professional learning positively impacted students' outcomes (Figure 31). Additionally, teachers' affirmative responses about the impact of STEM professional learning on students' outcomes were less firm/conclusive than those of administrators, with teachers being more likely than administrators to indicate that they "somewhat agree" than "strongly agree" (see Figures 31 and 32). In 2019, similar percents of teachers, 94%, 91% and 93% respectively, strongly or somewhat agreed that teachers' participation in STEM professional learning had a positive impact on students' "learning outcomes in STEM," "interest in STEM," and "engagement in STEM."

Figure 32. Teachers' Responses to Questions About the Impact of STEM Professional Learning on Student Outcomes in STEM



PART SIX:

CONCLUSION AND CONSIDERATIONS

This report evaluated the effectiveness of the Professional Learning Grant Program in meeting its stated objectives to impact STEM professional learning implementation as well as teacher and student outcomes in STEM. Drawing on survey data, the report addressed the demographics of teachers and administrators in schools that received funding from the grant program. Next, it examined a myriad of issues related to the implementation of STEM professional learning in participating schools, including the degree of enforcement of STEM professional learning, level of teacher participation, nature and quality of activities provided, level of administrator and teacher satisfaction with provisions, and actionable feedback for the grant program. Third, it explored the impact that participating in STEM professional learning had on teacher outcomes. Outcomes of concern for teachers included their interest in STEM professional learning, STEM skills, knowledge, and confidence, STEM instructional practices, general instructional practices, and job attitudes. Finally, the report examined the influence that teacher participation in STEM professional learning had on student outcomes in STEM. The student outcomes of interest included their learning outcomes, interest, and engagement in STEM. This section provides an overview of the report's main findings in relation to the aforementioned topics. It also provides considerations for the Professional Learning Grant Program that are informed by the evaluation's findings, relevant research, and program objectives.

Summary of Findings

Demographics

Findings reveal that a variety of local education agencies, including 25 public school districts, received funding from the grant program. As it concerns the demographics of survey respondents, the vast majority were teachers and a small percent were administrators. Teachers who participated in STEM professional learning primarily taught elementary grades, particularly grades 3, 4, and 5. Additionally, they tended to teach or integrate mathematics into their curricula more frequently than they did the other three STEM areas—science, technology, and engineering. With regards to their possession of STEM-related endorsements, a majority of teachers indicated that they did *not* have a STEM-related endorsement. However, most expressed interest in pursuing an elementary science endorsement if one were offered.

Professional Learning Implementation

The current evaluation also investigated the implementation of STEM professional learning in participating schools, particularly with respect to the degree to which it was enforced, the level of teacher participation, the nature and quality of activities provided, the experiences of teachers, and feedback from teachers and administrators about whether they would recommend participation to other schools. Findings from administrators and teachers suggest that STEM professional learning was highly enforced at participating schools and most teachers participated in STEM professional learning. Concerning the nature and quality of STEM professional learning activities provided, a variety of activities were provided, however, administrators rated peer-to-peer sharing as more effective than the others provided. Concerning teachers' experiences with recoding videos of themselves for self- or peer-reflection, teachers found the practice to be beneficial for improving their instructional practices, promoting group learning and support among teachers, and encouraging self-reflection and improvement. At the same time, an important number of teachers discussed negative experiences with the practice suggesting, for instance, that it was time-intensive, overly involved, discomforting, distracting to students, and unbeneficial for improving their teaching practice. With regard to whether or not teachers and administrators who recommend STEM professional learning to other schools, teachers and administrators tended to hold similar sentiments. Among teachers and administrators who would recommend STEM professional learning to other schools, they indicated that they would do so because of the benefit it provided for increasing student knowledge, increasing student engagement/interest in STEM, increasing teacher knowledge, improving teachers' instructional practice, providing hands-on training and other resources to teachers, and promoting group learning and support. However, others indicated that they would not recommend the practice because it was

unbeneficial/ineffective, overwhelming, time consuming, disorganized, and did not give adequate attention to particular grade levels.

Teacher Outcomes

Both administrators and teachers were asked to evaluate the impact that participating in STEM professional learning had on teachers' interest in STEM professional learning, teachers' STEM skills, knowledge, and confidence, teachers' STEM instructional practices, teachers' general instructional practices, and teachers' job attitudes. As findings reveal, an overwhelming majority of administrators and teachers agreed that participating in STEM professional learning improved teachers' outcomes in the aforementioned areas. Administrators, however, tended to hold slightly more positive sentiments than teachers.

Student Outcomes

In a similar vein to teacher outcomes, administrators and teachers were asked to assess the impact that teacher participation in STEM professional learning had on student outcomes, particularly their learning outcomes, interest, and engagement in STEM. *All* administrators agreed that teacher participation in STEM professional learning positively impacted students' learning outcomes, interest, and engagement in STEM. And while not all, the vast majority of teachers similarly affirmed that their participation in STEM professional learning positively impacted students' learning outcomes, interest, and engagement in STEM.

Considerations for the Professional Learning Grant Program

Encourage Participating Schools to Provide Teachers with Engineering-Specific Professional Learning Sessions

Findings from the current evaluation suggest that teachers who participated in STEM professional learning were least likely to integrate engineering in their teaching in comparison to the other STEM areas—science, technology, and mathematics. In line with the current evaluation, a number of research studies have also found that STEM teachers feel less competent and confident to teach science and mathematics concepts using engineering activities (Webb, 2015). As early introduction to engineering facilitates students' acquisition of 21st century skills such as the ability to analyze, evaluate, design, and create evidence-based solutions to problems, it may be useful to encourage the provision of engineering-specific professional learning sessions that provide teachers with hands-on participation in engineering research, information about various engineering-related careers available to students, and training with developing engineering-related lesson plans (Autenrieth, Lewis, & Butler-Purry, 2018; Estapa & Tank, 2017; Webb, 2015). When teachers participate in engineering-specific professional development, they often report an increase in their knowledge of engineering concepts and confidence to integrate engineering and inquiry-based activities in their lessons (Billiar et al., 2016; Holbert, Grable, Overbay, & Nzekwe, 2014; Nathan et al., 2011).

Provide Opportunities and Incentives for Teachers to Earn STEM-Related Endorsements

As research suggests, most STEM K-12 educators in the United States do not hold a degree in the subject areas they teach and for this reason, often lack the content knowledge and

pedagogical knowledge needed to teach STEM courses effectively and increase students' interest in STEM careers (Hossain & Robinson, 2012; Jensen et al., 2016a; Leyzberg & Moretti, 2017). Findings from this evaluation, in line with current research, shows that the majority of teachers who participated in STEM professional learning do not have a STEM-related endorsement. At the same time, most expressed interest in pursuing an elementary science endorsement if one were offered. It is useful, then, for the STEM Professional Learning Grant Program to provide opportunities and/or incentives for teachers to develop their knowledge and pedagogy in STEM though acquiring STEM-related endorsements.

Encourage Trust-Building in STEM Professional Learning Communities

As findings from the evaluation suggests, teachers who participated in STEM professional learning were less likely to use videos of their teaching for peer-reflection as compared to self-reflection. Additionally, in their responses to open-ended questions, teachers expressed discomfort with having other teachers watch videos of them teaching. Indeed, as research suggests, while STEM professional learning communities are important, they are mostly effective when anchored by particular principles, one of which is trust (Fulton & Britton, 2011). When professional learning communities place importance emphasis on cultivating trust among participants, teachers feel more empowered to learn collectively, to invite others to observe their teaching, and to receive feedback about areas for improvement (Roy & Hord, 2006; Thornton & Cherrington, 2014). In light of the aforementioned research findings, it is useful for the STEM Professional Learning Grant Program to encourage trust-building among teachers involved in STEM professional learning.

Provide Teachers with Access to the Technologies Necessary for Participation in STEM Professional Learning

Among the barriers teachers identified that precluded their participation in video-based STEM professional learning was access to technology. More specifically, teachers often expressed that the technology needed to participate in video-based professional learning were not available at their schools. To encourage or facilitate participation in video-based self- and peer-reflection activities, it may be useful for the grant program to either provide video equipment and related technologies to participating schools or encourage administrators at participating schools to acquire these technologies for their teachers.

Create and Make Available a Repository of STEM Lessons That Teachers Could Integrate in their Curricula

While the vast majority of teachers who participated in STEM professional learning noted that they feel confident with creating STEM lessons because of STEM professional learning, they felt least confident in their ability to perform this practice in comparison to other activities including teaching elementary science standards, teaching elementary math standards, and teaching STEM lessons. Given this finding, it may be useful for STEM professional learning communities to place greater emphasis on developing teachers' skills to create STEM lessons. Additionally, it may also be important for the STEM Professional Learning Grant Program to create and make available a repository of STEM lessons that teachers can utilize in their teaching.

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